SECTION 23 40 00 - CONTAINMENT FILTER HOUSING ASSEMBLIES

Author’s Note: This document contains notes to the specification writer that will not print. These notes offer additional information to help you select certain paragraphs to include in your final document. These notes are easily distinguished by font type, color and have a dotted line below the text. Although these notes will not print, ***you should delete these notes after you have customized this specification***.

Note: Typically, containment filter housings are located in Division 23 (Heating, Ventilation and Air Conditioning) for specifications following the MasterFormat® format published by the Construction Specifications Institute (CSI). CSI further sub-divides Division 23 to sub-division 23 40 00 - HVAC Air Cleaning Devices.

**PART 1 - GENERAL**

* 1. RELATED DOCUMENTS
     1. Drawings and general provisions of the contract, including General and Supplementary Conditions, Section 23 05 00 and other Division I Specification Sections, apply to this Section.
  2. WORK INCLUDED
     1. Containment filter housing assemblies
     2. Prefilters
     3. High Efficiency Particulate Air (HEPA) filters
     4. High Efficiency Gas Adsorbers (HEGA)
     5. Housing accessories (e.g. differential pressure gages)
  3. RELATED SECTIONS
     1. Examine all drawings and criteria sheets and all other Sections of the Specifications for requirements, which affect work under this Section whether or not such work is specifically mentioned in this Section.
     2. Refer to Section 23 41 00 for HEPA filters to be furnished by the containment manufacturer.
  4. REFERENCES
     1. Applicable provisions of the following Codes and Trade Standard Publications shall apply to the work under this Section whether or not such work is specifically mentioned in this section.
        1. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers
           1. ASHRAE 52.2: Method of Testing Air-Cleaning Devices in General Ventilation for Removal Efficiency by Particulate Size (Minimum Efficiency Reporting Value)
        2. ASME – American Society of Mechanical Engineers
           1. AG-1-2012: Code on Nuclear Air and Gas Treatment
           2. NQA-1-2008: Quality Assurance Requirements for Nuclear Facility Applications (QA)
           3. N509-2002: Nuclear Power Plant Air Cleaning Units and Components
           4. N509-1989 (1995 Reaffirmed): Nuclear Power Plant Air Cleaning Units and Components
           5. N510-2007: Testing of Nuclear Air Cleaning Systems
           6. N510-1989 (1995 Reaffirmed): Testing of Nuclear Air Cleaning Systems
           7. N511-2007: In-Service Testing of Nuclear Air Treatment, Heating, Ventilating, and Air-Conditioning Systems
           8. BPVC-IX-2007: Welding and Brazing Qualifications
        3. ASNT – American Society of Nondestructive Testing
           1. SNT-TC-1A (2006): Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing
        4. AWS – American Welding Society
           1. D9.1M/D9.1:2006: Sheet Metal Welding Code
        5. DOE – US Department of Energy
           1. HDBK-1169-2003: Nuclear Air Cleaning Handbook
        6. IEST – Institute of Environmental Sciences and Technologies
           1. IEST-RP-CC001.5: HEPA and ULPA Filters
           2. IEST-RP-CC002.3: Unidirectional Flow Clean-Air Devices
           3. IEST-RP-CC008.2: Gas-Phase Adsorber Cells
           4. IEST-RP-CC034.3: HEPA And ULPA Filter Leak Tests
        7. UL – Underwriter’s Laboratory
           1. UL 900: Air Filter Units
  5. QUALITY ASSURANCE
     1. A written quality assurance program must be established for all components of the containment filtration system and the manufacturer shall meet and conform to ISO-9001 and all the Basic Requirements of ASME NQA-1 quality assurance program.  
        Note: It is recommended the housing manufacturer submit a current ISO-9001 certificate for the factory producing equipment specified under this Section.
     2. Assemble filters and housing components to form a containment filtration system from a single manufacturer (except vended components such as differential pressure gages and valves).
  6. SUBMITTALS
     1. See Section 23 0500 and General Conditions for additional requirements.
     2. Submit product data:
        1. Bid Documents: In order to validate that the Filter Housing Offer meets the drawings and specification, the Housing Manufacturer shall furnish the following qualifying documentation with their Bid.
           1. Statement of complete scope of supply.
           2. Statement that clearly indicates how the scope of supply meets the specification.
           3. A listing of all non-compliant features.
           4. Supporting documentation to demonstrate specification compliance.
           5. Submit appropriate catalog cut sheets related to the bid offer.
           6. Submit validation reports for the following (if applicable):

Validation report proving the offered test section injection/sample manifolds operate within the specified parameters

Validation report proving the automated function of the filter scan section operates within the specified parameters.

* + - 1. Engineering Submittal Documents: The selected Offeror shall furnish the following documentation for Engineer Approval and Fabrication Release.
         1. Submit a copy of the project specification stating line by line compliance.
         2. Submit General Arrangement drawings for each Filter Housing size and configuration. As a minimum, the following shall be included.

Overall dimensions

Interface locations and sizes

Mounting base anchor bolt plan

Service clearance dimensions

Filter and differential pressure gage requirements for each housing tag number

System performance data at design flow (pressure drop, etc.) with manifold test sections in operating position.

* + - * 1. Submit an uncontrolled copy of the manufacturer’s Quality Assurance manual
      1. Delivery Documentation: The filter housing manufacturer shall furnish the following documentation in conjunction with their equipment delivery.
         1. Submit Housing Leak test reports
         2. Submit Seal Surface Leak test reports
         3. Submit final As-Built drawings
         4. Submit three (3) copies of Operations and Maintenance manuals
  1. EXTRA STOCK
     1. Provide one extra set of all required Prefilters and HEPA filters,
     2. Provide two extra sets of all required PVC change-out Bags and Straps.
  2. DELIVERY, STORAGE, and HANDLING
     1. Housings shall be shipped to the jobsite on factory fabricated protective skids or containers (if size allows). Items shall be blocked, anchored, braced and/or cushioned as deemed necessary to prevent physical damage. All openings shall be covered. The housings and filters shall be stored in a clean dry place and protected from weather and construction traffic. Housings shall be handled carefully to avoid contact with carbon steel and damage to accessory components, enclosures and finish.

**PART 2 - PRODUCTS**

* 1. ACCEPTABLE MANUFACTURERS CONTINGENT OF COMPLIANCE WITH SPECIFICATONS
     1. Camfil (Basis of Design)
     2. Substitutions  
        Note: A lot of effort goes into specifying the correct equipment for a specific application. To prevent a last minute substitution of substandard products, include the “substitutions” clause. It does not prevent other manufactures from furnishing a competitive bid. This clause gives the Engineer and the Owner an opportunity to review a substituted product for compliance to the written specification.
        1. Due to life safety concerns, this specification section describes highly specialized equipment and components known to be included in the basis of design. Equipment and component substitutions may not be made at the time of bid. However, a full evaluation package shall be submitted to the Engineer at least two weeks prior to the bid date. A letter of acceptance from the Engineer shall be submitted with the alternate manufacture’s proposal. The offeror shall clearly state the proposed manufacturer’s offers of all equipment and components specified under this section. The offeror shall provide a complete and detailed response to each paragraph of the contract specification. The offeror shall clearly note after each specification paragraph one of the following responses: 1. comply, 2. deviate, or 3. exception. For deviation or exception responses, the offeror shall fully explain the deviation or exception. Detailed equipment drawings shall be furnished to demonstrate full compliance with the dimensional requirements shown on the contract drawings. Any deviation shall be clearly shown on the drawings of the proposed equipment. Any alternative bids not including the above required information will be rejected. The Contractor shall bear the responsibility to furnish equipment in complete compliance with this specification. The owner or its representative reserves the right to reject any deviation or exception if it does not meet the intent or the requirements of this project.
        2. Note: The requirement that the housing and filter shall be manufactured by the same company removes potential issues that may arise during start up and commissioning.  
           All acceptable manufacturers shall be the producer of all products specified in this Section. Vended products shall be limited to raw sheet metal materials, fasteners, gages, damper operators, valves and specialized items. The specified filters shall be considered a vended product and shall be produced by the same company that produces the filter housings. The offeror shall clearly identify all purchased components, weldments and assemblies from outside sources. Failure to comply shall result in the rejection of the offered product.
  2. CONTAINMENT FILTER HOUSINGS
     1. General
        1. The Containment Filter Housing Assemblies shall be Camfil CamContain series housing units that have been fabricated, assembled and pressure decay tested in the same factory. Each system may consist of a combination of the following housing sections and components assembled into a complete containment system:
           1. Inlet isolation damper
           2. Inlet transition
           3. Prefilter section
           4. In-place test injection section
           5. HEPA filter section
           6. Combination injection and sampling test section
           7. Second HEPA section or HEGA filter section
           8. In-place test sampling section
           9. Postfilter Section
           10. Outlet transition
           11. Outlet isolation damper
           12. Assembly welded onto a mounting structure
        2. The system shall be designed for the scheduled CFM as indicated on the contract documents at 15 inches water gage and the maximum design temperature shall be 130°F. The furnished system shall be sized not to exceed the scheduled “clean” pressure drop across the containment system from inlet flange to outlet flange, including the inlet and outlet bubble-tight dampers. The scheduled “dirty” pressure drop assumes the “clean” HEPA filter initial pressure drop times two plus a maximum final prefilter pressure drop of 1.0” w.g.
        3. Sealing Mechanism  
           Note: There are two styles of sealing mechanisms; gasket seal and gel seal. Select one of the two mechanism styles.
           1. GB style Gasket Filter Seal (Choose this or Gel seal and delete other version. Gasket seal filters are typically used in the Nuclear and Healthcare industries and feature neoprene gaskets which are compressed by the mechanism on the sealing side of the filter)

All high efficiency filters and adsorbers shall be mechanically sealed by means of a compressible gasket fixed to the filtering device.

The filter sealing mechanism shall be replaceable.

The filter clamping mechanism shall be operated from outside of the housing by means of a standard wrench.

The filter clamping mechanism shall be designed with mechanical stops. When the mechanism has reached the mechanical stop, it shall be fully engaged and the clamping shall be exerted solely by means of its pressure compensating springs. The clamping mechanism shall include two pressure channel assemblies with eight (8) springs per filter for full-width filters (nominal 24” wide x 24” high) and shall exert a minimum filter sealing force of 1,400 pounds (20 psi of gasket surface) for full high, full wide filters. The force shall be applied as an even, uniform load along at least 80 percent of the top and bottom of each filter outer frame. The clamping assembly shall penetrate through the housing wall and shall be leak tight.

* + - * 1. FB style Gel Filter Seal (Choose this or Gasket seal and delete other version. Gel seal is typical on Pharmaceutical and Bio-safety applications where gaskets may stick or deteriorate due to the usage of decontamination and cleaning agents. Filters require extraction clips to be removed from the housing)

All high efficiency filters and adsorbers shall be mechanically sealed by means of a gel seal design, which incorporates a knife-edge that mates into the gel filled perimeter channel on the face of the filtering device.

The filter sealing mechanisms shall be replaceable and shall be operated through the change-out bag by a locking handle.

Prior to leaving the factory, each knife-edge shall be checked with an alignment gage to insure proper alignment with the filter.

The mechanism shall exert equal force at the top and bottom edge of the filter when engaging or disengaging the filter at the knife-edge.

* + - 1. Bagging Ring  
         Note: Containment housings may include a feature to replace spent filters through a PVC bag without breaking the containment barrier. The model number for a bag-in / bag-out housing is xB.

Each filter housing section shall have a bagging ring around each access port. The bagging rings shall have two (2) continuous ribs to secure the PVC filter change-out and scan bags. The outer edge of the ring shall be hemmed to prevent the PVC bag from tearing.

* + - 1. Access Doors
         1. The filter access port shall be covered with an access door. Each access port and bagging ring shall be covered by an access door having an extruded silicone gasket that is replaceable (if damaged) after the door has been removed. When closed, the door shall not press against the bag-out port and PVC bag, thus eliminating the possibility of potential leak paths or the bag being cut by pressure from the door to the bag-in bag-out port.
         2. (Improved Professional Series Option; choose or delete) The filter access door shall have a view port that allows the visual indication of the installation of the change-out bag. (Optional)
         3. (Standard Option Choose one and delete other “c”)Fixed Latches - There shall be four (4) tie down latches per access door. Each latch assembly shall comprise of a 300-series threaded stud and an aluminum star knob. The access door shall provide a means to fit over the threaded stud array and shall be sealed against the filter housing front by tightening the star knobs.
         4. (Standard Option Choose one and delete other “c”)Swivel Latches - There shall be four (4) tie down latches per access door. Each latch assembly shall comprise of a 300-series threaded stud and an aluminum star knob. The access door shall provide a means to fit over the threaded stud array and shall be sealed against the filter housing front by tightening the star knobs.
         5. (Improved Professional Series Alternate choose one and delete other “c”)Quick Clamp Latches - The filter access doors shall be fastened to the housing using quick connect fasteners and all fasteners shall be an integral part of the door. No loose components shall be used to fasten the door. There shall be four (4) quick clamp draw latches per access door and they shall be manufactured in such a manner that they pivot away from the bag-out port after they are released, therefore, the latches do not impede the filter change-out process. The latch shall be designed to provide proper sealing between the access door and the containment barrier as well as incorporate the capability of being locked. The draw latches shall be manufactured from 300 series stainless steel. The use of protruding studs is prohibited to eliminate the hazard of sharp protruding objects.
         6. (Pro Series Hinged door option)Hinged Door - The filter access door shall be hinged such that it allows the access door to remain connected to the housing during filter change-out. The access doors shall be hinged on the containment housing in such a manner as to prevent inference with the door and the bagging ring during opening and closing of the access door
      2. Orientation and Handedness

The contract drawings shall determine the filter access side of each housing. The handedness of a housing shall be designated as right hand or left hand. When looking in the direction of airflow (as if standing inside of the housing with the air flow hitting the person’s back) of the HEPA filter, if access is required on the right side, then the housing shall be determined to be right hand access. If access is required on the left side from the above stated vantage, then the housing shall be determined to be left hand access.

* + - 1. Filter Removal Rods

Multi-wide filter housing sections shall be equipped with a filter removal rod to draw the filters to the change-out position. The removal rod shall be operated from inside the change-out bag and shall remove the filter by pulling against the bottom of the filter frame. There shall not be any penetrations through the pressure boundary of the housing for operation of the removal rod. All change-out operations shall be within the bag so there is always a barrier between the worker and filter.

* + - 1. Hardware

All hardware on the filter housing such as the filter clamping mechanism components, door handles, door studs, and labels, shall be 300 series stainless steel. The threaded pivot blocks in the gasket filter clamping mechanisms shall be brass. The standard filter access door knobs are cast aluminum (to prevent galling of threads).

* + - 1. Flanges

The upstream and downstream flanges shall have a 1 ½ inch minimum flange width. Flanges shall be turned to the outside of the airstream to prevent contamination build-up and allow the customer to connect mating ductwork from outside of the housing. Bolt hole spacing is in accordance with the recommendation in DOE-HDBK-1169-2003, Nuclear Air Cleaning Handbook (4” inches or less on centers).

* + - 1. Welding
         1. All "pressure retaining" weld joints and seams shall be continuously welded. Joints and seams on items such as reinforcement members, shall be intermittently welded. Housing will be free of all burrs, and sharp edges. All weld joints and seams that are a portion of any gasket sealing surface, (duct connection flanges and filter sealing surfaces), shall be ground smooth and flush with adjacent base metals.
         2. All welding procedures, welders, and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All welded joints and seams shall be wire brushed to remove heat discoloration. The nondestructive test personal shall be qualified to the requirements of ANST-SNT-TC-1A. All production welds shall be visually inspected by qualified personnel, in accordance with section 5 and 6 of AWS D9.1, "Specification for Welding of Sheet Metal."
      2. Quality Assurance
         1. Note: Containment housings are a premium grade product. To prevent sub-standard product submission, it is important to require a prospective manufacturers to furnish proof of a quality program.  
            The filter housing shall be manufactured under a quality assurance program that has been assessed and independently certified to meet the requirements of ISO 9001:2008 for design, manufacture and distribution of containment and HVAC air filtration products. Additionally, filter housing shall be manufactured under a quality assurance program that meets all of the basic requirements of ASME NQA-1, “Quality Assurance Program Requirements for Nuclear Facilities”. The manufacturer shall submit documented evidence they have been independently audited and successfully passed at least three (3) audits within the last five (5) years to ASME NQA-1 requirements. The final containment filtration system shall be completely fabricated, assembled, tested and cleaned at the manufacturer’s facility. Sub-assemblies from outside sources will not be acceptable. The Offeror shall certify their compliance with this paragraph.
         2. The filter housing shall be factory tested for filter fit, operation of filter clamping mechanism, and flatness of gasket filter seal surface. Both the filter sealing surface and the complete assembly pressure boundary shall be leak tested by the "pressure decay method" in accordance with N510-1989 (1995 reaffirmed), "Testing of Nuclear Air Cleaning Systems", paragraphs 6 and 7. The filter sealing surface shall be tested at +10" water gage 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 +15" water gage and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume.
      3. Service Clearance

A minimum of four (4) feet clearance in front of each access door on the HEPA containment filter assembly shall be reserved for filter replacement and in-place testing.

(Containment housings are designed to form filter assemblies with basic components. The following paragraph sections define those basic components. Include those components as required for your specific application.)

* + 1. Housing System Components
       1. Inlet Isolation Damper (Choose ONE of the three types)
          1. Round Blade-style (This is most commonly used option and is most economical using a single round damper for sealing)

Damper shall be Camfil CamContain Bubble-Tight Flat Blade Isolation Damper. The damper shall be manufactured from 7 gauge and 11 gauge type 304/304L stainless steel. The damper shall have (2) 7 gauge 304/304L stainless steel blades with a silicone gasket between them to seal against the inside wall of the damper. The damper shall have a 1-½” wide 7 gauge flange on the inlet and outlet with pre-drilled 7/16” mounting holes and ¼” silicone gasket. Bolt hole spacing is in accordance with the recommendation in DOE-HDBK-1169-2003, Nuclear Air Cleaning Handbook (4” inches or less on centers). The damper shall be adequately reinforced to withstand a negative or positive pressure of 15” water gage.

All ‘pressure retaining’ weld joints and seams shall be continuously welded with no porosities allowed. Joints and seams requiring only intermittent welds, such as reinforcement members, shall be intermittently welded. Damper shall be free of all burrs, and sharp edges. All weld joints and seams that are a portion of any gasket sealing surface (duct connection flanges), shall be ground smooth and flush with adjacent base metals. All welding procedures, welders and welder operators shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX. All welded joints and seams shall be wire brushed to remove heat discoloration.

The complete pressure boundary of the damper housing shall be leak tested at 15” w.g. per the “Pressure Decay Method” in accor­dance with ASME N510-1995 Reaffirmed, Testing of Nuclear Air Cleaning Systems. The housing shall not exceed a leak rate of 0.0005 cfm per cubic foot of housing volume. The damper blade shall be tested in the closed position at +10” w.g. and shall be bubble tight when tested in accordance with ASME N509-1995 Reaffirmed, paragraph 5.9.7.3.

The isolation damper design shall be manufactured in accordance with ASME NQA-1 and ISO9001:2008 and qualified by cycle testing the assembly a minimum of 20,000 cycles. A qualified design shall pass the above specified leak test requirements without any adjustments to the assembly (including the gasket) throughout the cycle testing. Evidence of a successfully qualified design shall be furnished prior to bidding.

Damper shall be factory equipped with a manual actuator. Actuator shall be equipped with a hand wheel. Actuator shall be a quarter-turn manual worm geared operator. Actuator housings and covers shall be cast iron, worm gears shall be heat-treated carbon steel, hand wheels shall be cast ductile iron, input shafts shall be carbon steel, shaft and shaft seals shall be BUNA-N rubber, housing to cover seals shall be impregnated cellulose fiber, bushings shall be oil impregnated copper nickel steel alloy. The actuator shall be of sufficient capacity to operate the damper under all conditions, and to guarantee tightness of the damper against all system pressures encountered.

* + - * 1. Square Dish-style (This style is not commonly used and is limited to two filter wide applications. Multiple dampers can be attached horizontally to one shaft and actuator)

The damper shall be Camfil CamContain Bubble Tight Dish damper, model CF-BTD series. Damper shall be adequately reinforced to withstand a negative or positive pressure of 15" water gage. Damper shall be manufactured from 14 ga. and 11 ga. 304/304L stainless steel sheet metal. The damper shall have a 20" (nominal) 304/304L stainless steel dish shaped disc with a knife-edge that seats against an 11 ga. 304/304L stainless steel frame with a solid membrane silicone gasket. This creates a gasket-to-knife edge seal. Damper shall have a 1-1/2" wide flange on the inlet and outlet.

Damper shall be factory equipped with a manual actuator. Actuator shall be equipped with a hand wheel. Actuator shall be a quarter-turn manual worm geared operator. Actuator housings and covers shall be cast iron, worm gears shall be heat-treated carbon steel, hand wheels shall be cast ductile iron, input shafts shall be carbon steel, shaft and shaft seals shall be BUNA-N rubber, housing to cover seals shall be impregnated cellulose fiber, bushings shall be oil impregnated copper nickel steel alloy. The actuator shall be of sufficient capacity to operate the damper under all conditions, and to guarantee tightness of the damper against all system pressures encountered.

* + - * 1. Square Linear-style (This is a more advanced version of the square damper style that eliminates the need for an upstream transition and test section but is limited to having one damper ahead of each filter. Multiple dampers can be connected to a single section but no more than two on one actuator are recommended)

Damper shall be Camfil CamContain Linear Bubble Tight Dish damper, model CF-LBTD series. The damper shall be manufactured from 7 gauge, 14 gauge and 16 gauge type 304/304L stainless steel. The damper shall have a spun stainless steel dish with a receptacle that contains a closed cell silicone sponge gasket. A mating knife-edge shall be installed on the damper so that when the damper is actuated, the knife-edge will seal against the gasket.

Damper shall be high-cycle, low torque linear type design. The damper mechanism shall operate linearly, without rotation or pivoting of the damper dish. The required input torque to operate and adequately seal the damper shall not exceed 25 pound-feet per damper width.

The linear damper design shall be manufactured in accordance with ASME NQA-1 and ISO9001:2008 and qualified by cycle testing the assembly a minimum of 15,000 cycles. A qualified design shall pass the above specified leak test requirements without any adjustments to the assembly, including the gasket, throughout the cycle testing. Evidence of a successfully qualified design shall be furnished prior to bidding.

* + - 1. TSU: Upstream Aerosol Mixing Section  
         (The TSU is used to inject challenge aerosols and thoroughly mix them with the airstream in a very short distance. Also known as an INJECTION section. This section is typically located upstream of the HEPA filter bank to be tested. It is designed to inject the test aerosol, mix the aerosol and take a reference sample of the air/aerosol mixture.)

The upstream test section shall be Camfil CamContain model TSU. The upstream test section shall be designed to perform aerosol testing on HEPA filters, and halide gas testing on carbon adsorbers. Test section shall have an injection manifold for injection of aerosol or halide gas, and a sample manifold to obtain representative sample upstream concentrations, when testing filters and/or adsorbers. The test section shall be able to perform the applicable acceptance or surveillance test as required per ASME AG-1.

Maximum pressure drop through the test section with baffles engaged shall be 0.05 inches of water gage at 250 fpm.

Rotating or swing-away baffle plates and diffusers do not adequately represent actual operating conditions. As such, these devices are not acceptable and shall not be offered. The manufacturer shall provide detailed validation reports demonstrating compliance with ASME AG-1 for air/aerosol uniformity.

* + - 1. PB / PN: Prefilter Section  
         (Prefilters are generally used to extend the life of the HEPA filter. This housing section should be located upstream of the first HEPA filter section. The prefilter housing does not have a clamping mechanism. Prefilters are typically only required if there is not HEPA level supply filtration to the served areas or if significant particles are generated within the containment space)

The prefilter housing shall be side access Camfil CamContain model PB for a bag-in / bag-out style housing. The housing shall be side servicing for filter installation and change-out. Housing design and filter arrangement shall allow air to enter and exit the 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. Housing shall accommodate a 2”, 4” or 6” nominal depth prefilter. Filters shall be industry standard half (12” by 24”) or full (24” by 24”) size. The upstream and downstream ductwork connections shall have 1 ½” flanges. Sizes shall be noted on enclosed drawings or other supporting materials.

* + - 1. FB / GB : HEPA Filter Section  
         (There are four (4) housing styles for a HEPA filter housing. FB and GB designate gel seal and gasket seal clamping mechanisms, xB designates bag-in / bag-out.)

The HEPA filter housing shall be side access Camfil CamContain model FB or GB for a bag-in / bag-out style. The housing shall be side servicing for filter installation and change-out. Housing design and filter arrangement shall allow air to enter and exit the 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. Filters shall be industry standard half (12” by 24”) or (24” by 12”) or full (24” by 24”) size. The upstream and downstream ductwork connections shall have 1 ½” flanges. Sizes shall be noted on enclosed drawings or other supporting materials.

* + - 1. FB / GB: HEGA Adsorber Section  
         (Housings for High Efficiency Gas Adsorbers (or HEGA) function the same as those used for HEPA filters. There are four (4) housing styles for a HEGA filter housing. FB and GB designate gel seal and gasket seal clamping mechanisms, respectively. xB designates bag-in / bag-out style. There are four (4) adsorber cell depth dimensions: 11 ½”, 16”, 18” and 19”.)

The HEGA housing shall be side access Camfil CamContain model FB or GB for a bag-in / bag-out style. The housing shall be side servicing for filter installation and change-out. Housing design and filter arrangement shall allow air to enter and exit housings 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 upstream and downstream ductwork connections shall have 1 ½” outward-turned flanges. Sizes shall be noted on enclosed drawings or other supporting materials.

* + - 1. TSC: Combination Test/Aerosol Mixing Section  
         (The TSC is used to inject challenge aerosols and thoroughly mix them with the airstream in a very short distance as well as test an upstream filter element. Also known as an COMBINATION section. This section is typically located between two HEPA filter banks to be tested. It is designed to inject the test aerosol, mix the aerosol and take a reference sample of the air/aerosol mixture.)
         1. The combination test section shall be Camfil CamContain model TSC. The combination test section shall be designed to perform aerosol testing on HEPA filters, and halide testing on carbon adsorbers. The test section shall have an injection manifold for injection of aerosol or halide gas, and a sample manifold to obtain a representative upstream concentration sample and downstream concentration sample, when testing filters and/or adsorbers. The test section shall be able to perform the applicable acceptance or surveillance test as required per the intent of ASME AG-1.
         2. Maximum pressure drop through the test section with baffles engaged shall be 0.25" water gage at 250 fpm.
         3. Rotating or swing-away baffle plates and diffusers do not adequately represent actual operating conditions. As such, these devices are not acceptable and shall not be offered. The manufacturer shall provide detailed validation reports demonstrating compliance with ASME AG-1 for air/aerosol uniformity.
      2. Downstream Test Section  
         (There are two downstream testing options: 1. overall efficiency testing (TSD), and filter scanning. As for scanning, there are also two options; 1. Non-intrusive manual scanning (SafeScan-M), and 2. Non-intrusive automated scanning (SafeScan-A)). Camfil publishes a selection guide (Camfil Technical Bulletin: CamContain™ Test Sections: A Selection Guide) to assist with selection of the correct downstream test section. )
      3. TSD: Downstream Aerosol Mixing Section (Choose ONE of the three types)

(The TSD is used to thoroughly mix the downstream effluent from an upstream filter element in a very short distance. Also known as a SAMPLE section. This section is typically located downstream of the HEPA filter bank. Its purpose is to sample the downstream penetration of the test aerosol.)

* + - * 1. The downstream test section shall be Camfil CamContain model TSD. The downstream test section shall be designed to perform aerosol testing on HEPA filters, and halide gas testing on carbon adsorbers. Test section shall have an injection manifold for injection of aerosol or halide gas, and a sample manifold to obtain representative downstream concentration sample, when testing filters and/or adsorbers. The test section shall be able to perform the applicable acceptance or surveillance test as required per the intent of ASME AG-1.
        2. Maximum pressure drop through the test section with baffles engaged shall be 0.25" water gage at 250 fpm.
        3. Rotating or swing-away baffle plates and diffusers do not adequately represent actual operating conditions. As such, these devices are not acceptable and shall not be offered. The manufacturer shall provide detailed validation reports demonstrating compliance with ASME AG-1 for air/aerosol uniformity.
      1. SafeScan-A: Downstream Non-Intrusive Scanning Section (Choose ONE of the three types)
         1. The Camfil CamContain SafeScan-A section shall be non-intrusive and shall not require the external pressure boundary of the housing to be breached in order to conduct a scan test of the filter element. The SafeScan test housing shall be designed to perform in-place scan testing of HEPA filter(s) by traversing the scan probes across the full face of the filter and the perimeter filter-to-housing seal surfaces. The scanning process shall be accomplished by mechanically positioning probes from the exterior of the containment system without removing an access door or access cover or otherwise breaching the exterior pressure boundary of the housing. The probe assembly and scan testing process shall be designed and validated to meet the intent of IEST-RP-CC001.4 for scan testing Type C HEPA filters.
         2. All ports for the scan testing process shall be 300 series stainless steel and identified with 300 series stainless steel labels attached to the housing. All probe assembly and mechanical scan test components of the in-situ scanning section shall be manufactured from Teflon coated aluminum, 300 series stainless steel, polycarbonate, polyurethane, ABS or other materials that are chemically compatible with vaporous hydrogen peroxide, chlorine dioxide or paraformaldehyde decontamination agents.
         3. The drive assembly shall be self-lubricating and not require oiling or greasing of mechanical components in order to maintain operability over the service life of the equipment. The drive assembly shall include non-contact end-of-traverse detection of the probe assembly and provide feedback to the exterior of the housing to indicate end-of-traverse. The drive assembly and associated components shall be manufactured from T-304L stainless steel, Teflon coated aluminum, polycarbonate, polyurethane, ABS, Teflon or other materials that are chemically compatible with vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination agents.
         4. The scan probe assembly shall meet the intent of IEST-RP-CC-034.3 regarding “overlapping” strokes when scan testing. This requirement ensures that the entire face area of the media is scanned. The probe assembly shall be designed, installed, and operated such that the entire face area of the filter media as well as the filter-to-housing seal is scanned in order to ensure that there is no bypass leakage around the filter element. The scan probe assembly shall consist of a minimum of two (2) individual scan probes for a half high size filter system and four (4) individual scan probes for a full size high filter system. The aperture or opening of a scan probe shall be designed such that the sample velocity into the probe is 225 fpm ±10%. Each scan probe shall be connected to a quick-release fitting installed on the front of the housing using flexible tubing and stainless steel hardware. The scan probe assembly shall be manufactured from chemical resistant, static dissipative polycarbonate and the flexible tubing shall be manufactured from flexible tubing. Both shall be chemically compatible with vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination agents.
         5. The quick-release fittings installed on the exterior of the housing shall be connected to the scan probes via the flexible tubing and shall be manufactured from 300 series stainless steel and feature an integral bubble-tight check valve with VITON seals. The fitting design shall be such that accidental or inadvertent operation of the check valve is not possible without the use of tools, appliances, or other hardware. Each fitting shall be uniquely color-coded and mechanically keyed so that only one (1) mating fitting will fit each of the quick-release fittings. This ensures that the sample lines from the control system are connected to the proper quick-release fittings, which is critical in order to ensure accuracy of the scan test results. Penetrations through the pressure boundary of the housing that may be required for the drive assembly, scan assembly and associated hardware shall be sealed such that they meet the pressure decay requirements.
         6. Maximum pressure drop through the test section with baffles engaged shall be 0.01" water gage at 250 fpm.
      2. SafeScan-M: Downstream Non-intrusive Scanning Section (Choose ONE of the three types)
         1. The Camfil CamContain SafeScan-M section shall be non-intrusive and shall not require the external pressure boundary of the housing to be breached in order to conduct a scan test of the filter element. The non-intrusive scan system shall be designed to perform in-place scan testing of HEPA filter(s) by traversing the scan probes across the full face of the filter and the perimeter filter-to-housing seal surfaces. The scanning process shall be accomplished by mechanically positioning the probes from the exterior of the containment system without removing an access door or access cover or otherwise breaching the exterior pressure boundary of the housing. The probe assembly and scan testing process shall be designed and validated to meet the intent of IEST-RP-CC001.4 for scan testing type C HEPA filters. All probe assembly, sample ports and mechanical scan test components of the safe scan retrofit system shall be manufactured 304/304L stainless steel, polycarbonate, polyurethane, ABS or other materials that are chemically compatible with vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination agents.
         2. The drive assembly shall be self-lubricating and not require oiling or greasing of mechanical components in order to maintain operability over the service life of the equipment. The drive assembly and associated components shall be manufactured from 304/304L stainless steel, polycarbonate, polyurethane, ABS, Teflon or other materials that are chemically compatible with vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination agents. Penetrations through the pressure boundary of the housing that may be required for the drive assembly, the scan assembly and associated hardware shall be sealed such that they meet the pressure decay requirements.
         3. The scan probe assembly shall consist of a drive assembly and a probe assembly coupled to the drive assembly. The drive assembly shall be designed and installed such that it will be operated from outside of the housing, causing the probe assembly to move linearly such that the probe transverses the entire face of the filter element which is being scanned. The opening of the probe assembly where the sample is taken shall be parallel to the face of the seal surface of the housing within 5 degrees. The opening of the probe assembly shall also be maintained at a maximum distance of 1” from the plane of the filter/housing seal surface and shall maintain a uniform distance as the probe traverses across the housing with maximum variation in distance from the plane of the filter/housing seal surface of ±0.125”.
         4. The scan probe assembly shall meet the intent of IEST-RP-CC-034.3 regarding “overlapping” strokes when scan testing. This requirement ensures that the entire face area of the media is scanned. The probe assembly shall be designed, installed, and operate such that the entire face area of the filter media as well as the filter-to-housing seal is scanned in order to ensure that there is no bypass leakage around the filter element. The scan probe assembly shall consist of a minimum of two (2) individual scan probes for a half high size filter system and four (4) individual scan probes for a full size high filter system. The aperture or opening of a scan probe shall be designed such that the sample velocity into the probe is 225 fpm ±10%. Each scan probe shall be connected to a quick release fitting installed on the front of the housing using flexible tubing and stainless steel hardware. The scan probe assembly shall be manufactured from chemical resistant, static dissipative polycarbonate and the flexible tubing shall be manufactured from static dissipative polyurethane. Both shall be chemically compatible with vaporous hydrogen peroxide, paraformaldehyde and chlorine dioxide decontamination agents.
         5. The quick-release fittings installed on the exterior of the door connected to the scan probes via the flexible tubing shall be manufactured from polypropylene or materials that are chemically compatible with vaporous hydrogen peroxide, paraformaldehyde and chlorine dioxide decontamination agents. The quick-release fittings shall feature an integral bubble-tight check valve with EPDM seals. The fitting design shall be such that accidental or inadvertent operation of the check valve is not possible without the use of tools, appliances, or other hardware.
    1. COMMON HOUSING ACCESSORIES
       1. Transitions  
          (Transitions are typically required to make the connection of the housing to the ducting. Factory fabricated and welded housings are tested to the same requirements as the containment housing and are subject to the same overall pressure decay leak testing.)
          1. Each containment system shall be fitted with reducing transitions.
          2. Transitions shall be constructed of 304/304L stainless steel and designed with reinforcement to withstand a negative or positive working pressure of 15” water gauge. The minimum acceptable sheet metal thickness shall be 16-gauge. They shall be attached to the filter system by continuous seal welding. Integrated duct connection flanges on the transition shall be a 1-½” inch wide 7-gauge plate flange. The flange on the transitions shall have pre-drilled 7/16” mounting holes and bolt hole spacing in accordance with the recommendation in DOE-HDBK-1169-2003, Nuclear Air Cleaning Handbook (4” inches or less on centers).
       2. Decontamination Port Assembly  
          (A decontamination port assembly is used to allow the safe injection of a decontamination (or decon) solution into the housing. The decon solution is meant to decontaminate or kill biological spores with in the housing and on any filter element. The designer should verify what solution is intended to be used by the owner and that their equipment will properly interface with the port assembly.)

These ports shall be installed on each filter train as shown on the drawings and shall be compatible with the User’s decontamination equipment. Unless otherwise specified, each port shall consist of a reinforcement plate welded to the housing side wall, 3 inch IPS Schedule 40, stainless steel pipe, 3 inch IPS stainless steel pipe flange, 3 inch IPS butterfly valve and 3 inch female IPS aluminum hose connection with dust plug. The butterfly valve shall be wafer style, lever operated, and shall be bubble-tight at 150 psi. It shall have a cast iron body, stainless steel disc, stainless steel stem and EPDM seat.

* + - 1. Weather Cover  
         (A weather cover will prevent the collection of debris and standing water on the top of a housing when exposed to the weather)
         1. Filtration systems located in unsheltered areas shall be protected by use of an integral weather cover. The weather cover shall be fabricated from the same material as the filter housing and intermittently welded to the filter housing.
         2. If differential pressure gages are included on the filter housing assembly, they shall be covered with the same material as the filter housing. A means to access the gages shall be provided.
      2. Change-out Bags  
         (Change-out bags are used to exchange filters without breaking the containment barrier. A first set of bags should be included with the housing. Replacements bags should be ordered with replacement filters.)
         1. One (1) PVC change-out bag shall be furnished for each access port. Each bag shall have its stock number rolled in the hem. The PVC bag material shall be 8 mil thick, yellow in color, with a translucent, taffeta textured finish and shall not stick together.
         2. For visibility during filter change-out, this bag shall include approximately 16 inches of clear PVC at the mouth. Three (3) glove sleeves shall be built into the bag to facilitate handling during the filter during change-out.
         3. All PVC bags of this design shall be produced by filter housing manufacturer and shall have been tested by an independent laboratory to prove the bag's operability at extreme temperature ranges of 0°F - 130°F (a test report verifying this test shall be furnished upon request). An elastic shock cord shall be hemmed into the mouth of the bag so that it fits securely when stretched around the bagging ring. To prevent the bag from sliding off the bagging ring during the change-out operation, one (1) nylon security strap shall be provided with each filter access port. Additionally, one (1) nylon cinching strap shall be provided with each access port to tie off the slack in the PVC bag while the ventilation system is operating.
      3. Banding Kit  
         (A bagging kit will improve the change-out process by furnishing the proper tools for the job.)
         1. One complete banding kit shall be provided with the filtration unit(s) equipped with a bag-in/bag-out assembly. The banding kit shall provide secure clamping of the bag between the housing and the spent filtration element. Each kit shall contain the following items:

heavy duty tie-banding tool

bag cutting tool

¼ inch socket ratchet w/ 3 inch long extension

5/16 inch hex socket

13 inch cinching strap with buckle fastener

set of ten (10) 100 pound tensile strength 14 inch long plastic ties

set of twenty (20) stainless steel bands

plastic case/apron

* + - * 1. The banding kit and the change-out bags shall be manufactured by the same manufacturer as the housing. Additional tools required to complete the bag-in/bag-out procedure shall also be provided.
      1. Differential Pressure Gages  
         (Differential pressure gages measure the pressure differential across filter banks.)
         1. Differential pressure gages shall be Dwyer Series 2000 Magnehelic pressure gage or equal. Unless otherwise indicated select gage scale ranges to read at 75 percent full range (rounded up) at the expected dirty filter pressure drop. Typical ranges follow:

Filters with 25 to 30% efficiency 0 - 1.0 inches water column  
based on atmospheric dust spot  
test

Filters with 31 to 99% efficiency 0 - 3.0 inches water column  
based on atmospheric dust spot

HEPA filters 0 - 3.0 inches water column

HEGAs 0 - 3.0 inches water column

Overall \*specified based on total dirty system pressure drop

* + - * 1. Gages shall be furnished for each filter bank, including gages across each individual filter bank in built-up rack assemblies, suitable for flush mounting in a panel. All sensing tubing shall be ¼ inch O.D. copper tubing or stainless steel tubing.
        2. Differential Pressure Gage Ports

Static pressure ports shall be located on the filtration unit upstream and downstream of each prefilter, HEPA filter, HEGA and Overall System banks. The port connections shall be 1/4 inch 300 series stainless steel pipe half-couplings with brass plugs.

* + - * 1. In-Line Gage HEPA Filters  
           (In-line gage HEPA filters protect differential pressures from contamination. It makes it possible to change gages without decontaminating the sensing lines.)

In-line gage HEPA filter shall be Camfil Gage Guardian air filter, designed to protect diaphragm pressure indicating instrumentation (i.e. Magnehelic Gages, Photohelic Gages, etc.) from particulate contaminants.

Due to life safety concerns, and considering that the integrity of the pressure boundary of these filters is as critical as that of the containment housing, each filter shall be factory tested to assure it is leak free and bubble-tight at a pressure of +20” w.g. by submerging the entire filter assembly in water, pressurizing the assembly to +20” w.g. and visually inspecting for leaks. The presence of a single bubble generated by this method constitutes a leak. Each filter shall have a label indicating that it was leak tested. The filter media shall be hydrophobic with a minimum efficiency of 99.9995%. The filter body shall be manufactured from 304/304L stainless steel with silicone gaskets or O-rings to ensure long service life. All wetted surfaces of the filter shall be chemically compatible with vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination agents.

* + - * 1. Gage Decontamination Ports   
           (Gage decontamination ports are used to introduce deco solution to the gage sensing lines.)

These ports shall be installed in the gage lines between the containment housing and gage(s) as shown on the drawings and shall be compatible with commercially available vaporous hydrogen peroxide, chlorine dioxide and paraformaldehyde decontamination systems. Each port shall consist of a stainless steel ball valve with a 3/8” female NPT connection allowing for connection to commercially available paraformaldehyde or vaporous hydrogen peroxide decontamination system to enable decontamination of the gage lines and in-line HEPA filter.

* + - * 1. Gage Calibration Line  
           (A gage calibration line allows the owner to zero-out a differential pressure without taking the filtration system out of service.)

As shown on the drawings, stainless steel shutoff valves shall be provided to isolate each gage from the process stream. A stainless steel equalization valve shall be installed between the high and low pressure sides of each gage in such a manner that when the shutoff valves are closed, and the equalization valve is open, the pressure across the gage equalizes for calibration purposes without the possibility of venting to the ambient space. Shutoff and equalization valves shall be 300 series stainless steel.

* + - 1. Lifting Lugs  
         (Lifting lugs are used to facilitate safe system rigging.)
         1. Lifting lugs shall be provided on the housing as required. Lifting lugs shall be fabricated from ¼ inch plate of the same material as the housing. Lifting lugs shall have a minimum of 1 ½ inch diameter eyeholes and be located on the top and side of the housing. Lifting lugs shall be capable of supporting the housing (less adsorbers and filters) without causing housing deflection during transport and installation.
         2. All portions shall be free of sharp edges and burrs. Six (6) lifting lugs are required on each double HEPA assembly, and four (4) on each single HEPA assembly.
      2. Filter Change-out Tray  
         Note: A change-out tray is a service platform to facilitate a filter change-out.

Camfil shall provide a filter change-out tray to aide in filter installation and removal or in the Bag-in/Bag-out procedure. All the components of the change-out tray shall be manufactured from 300 series stainless steel. The tray assembly shall be securely fastened to the housing. The tray shall be designed to withstand the load of (1) filter and shall be installed over the top two door studs and use the existing hardware. One (1) tray per filter size shall be furnished.

* + 1. FILTERS
       1. Prefilters
          1. General

Filter shall be Camfil model 30/30 or equal.

Air filters shall be medium efficiency ASHRAE pleated panels consisting of cotton and synthetic media, welded wire media support grid, and beverage board enclosing frame.

Sizes shall be noted on drawings or other supporting materials.

* + - * 1. Construction

Filter media shall be a cotton and synthetic blend, lofted to a uniform depth of 0.15”, and formed into a uniform radial pleat.

A welded wire grid, spot-welded on one-inch centers and treated for corrosion resistance 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.

* + - * 1. Performance

The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2-2007. It shall also have a MERV-A of 8 when tested per Appendix J of the same standard. The media shall maintain or increase in efficiency over the life of the filter.

Initial resistance to airflow shall not exceed 0.31” w.g. at an airflow of 500 fpm on 2” deep models respectively.

The filter shall be classified by Underwriters Laboratories as UL 900.

Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

Manufacturer shall guarantee the integrity of the filter pack to 2.0” w.g.

* + - * 1. Supporting Data

Provide product test report including all details as prescribed in ASHRAE Standards 52.2, including Appendix J.

* + - 1. HEPA Filter (Very High Capacity) – Absolute V
         1. General

Air filters shall be Camfil model Filtra 2000 or engineer-approved equal. 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 sealing gasket.

Sizes shall be as noted on drawings or other supporting materials.

* + - * 1. Construction

Filter media shall be micro fiber glass formed into minipleat 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.

The filter shall be a gasket seal type with a poured-in-place seamless sealing gasket included on the downstream side of the enclosing frame to form a positive seal between the filter and the filter housing.

* + - * 1. Performance

Filter efficiency shall be 99.99% when evaluated according to the IEST Recommended Practice. Each filter shall be labeled as to tested performance.

Initial resistance shall be 1.0” w.g. target at rated airflow.

Filter shall be qualified as UL 586 and UL 900 per Underwriters Laboratories.

Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

* + - * 1. Supporting Documentation

The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification.

* + - 1. HEPA Filter (Very High Capacity) – Absolute XH
         1. General

Air filters shall be HEPA grade high-capacity air filters with waterproof micro glass fiber media, tapered corrugated aluminum separators, urethane sealant, 16-gauge steel enclosing frame, and (neoprene sealing gasket or seamless gasket)

Sizes shall be as noted on drawings or other supporting materials.

* + - * 1. Construction

Filter media shall be one continues pleating of micro glass fiber media.

Pleats shall be uniformly separated by tapered corrugated aluminum separators incorporating a hemmed edge to prevent damage to the media.

The media pack shall be potted into the enclosing frame through the use of a urethane sealant.

The enclosing frame of the 16-gauge steel with a zinc aluminum alloy finish, 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 assure no frame penetrations. Overall dimensional tolerances shall be correct within -1/8”, +0” and square within 1/8”.

A poured in place seamless gasket shall be included on the downstream side of the enclosing frame to form a positive seal upon installation.

* + - * 1. Performance

Filter efficiency shall be (99.97%, 99.99%, 99.999%) when evaluated according to the IEST Recommended Practice. Each filter shall be labeled as to tested performance.

Initial resistance shall be 1.35” w.g. target at rated airflow.

Filter shall be qualified as UL 900 per Underwriters Laboratories.

The filter shall be capable of withstanding 10” w.g. differential without failure to the media pack.

Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

* + - * 1. Supporting Documentation

The filter shall be labeled as to tested efficiency, rated/tested cfm, pressure drop and shall be serialized for identification.

* + - 1. High Capacity Gas Adsorber (HEGA)
         1. General

Carbon adsorber shall be Camfil High Efficiency Gas Adsorber (HEGA) and shall contain 1" deep beds, arranged in a V-bank configuration.

* + - * 1. Construction

Adsorber shall be constructed of combustible high impact polystyrene for disposal by incineration. The adsorber screens shall be perforated and supported by external spacers to prevent distortion during filling with adsorbant media.

Adsorbent bed depth shall be 1”.

* + - * 1. Performance

Each adsorber shall have a maximum operating temperature of 120°F.

Each adsorber is tested and packaged in accordance with IEST-RP-CC-008.2, to assure a minimum mechanical efficiency of 99.9%.

Toxic gas life testing is not required for this media.

Manufacturer shall provide evidence of facility certification to ISO 9001:2008.

**PART 3 - EXECUTION**

* 1. INSTALLATION
     1. Install containment air filtration system in accordance with manufacturer’s instructions and applicable sections of ASME N-509, and in accordance with the manufacturer's diagrams and recommendations.
     2. Clean all dirt, dust and debris that may be in the containment system or attached ductwork during construction and installation.
     3. The HEPA filters and adsorbers shall be shipped separately and must be handled carefully to prevent damage and stored in a safe, dry space until ready for installation. The filter train shall be installed, cleaned and operated for a minimum of one hour prior to any filter installation. The filters must be handled carefully during storage and installation.
     4. Refer to details on the drawings for different configuration requirements.
  2. WELDING
     1. Welding procedures, welders, and welding operators shall be qualified in accordance with ASME BPVC SEC IX. 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.
  3. FACTORY QUALITY ASSURANCE PROGRAM
     1. The filter housing shall be manufactured under a quality assurance program that has been assessed and independently certified to meet the requirements of ISO 9001:2008 for design, manufacture and distribution of containment and HVAC air filtration products.
     2. Additionally, the transitions and/or plenums, housings, test sections and mounting components shall be manufactured and inspected under a Quality Assurance Program that meets all of the basic requirements of ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities". The manufacturer shall submit documented evidence they have been audited by customers at least three (3) times to these requirements and successfully passed all three (3) audits within the past five (5) years.
     3. All production welds shall be visually inspected to assure that they meet the workmanship acceptance criteria described in Sections 5 and 6 of AWS D9.1M/D9.1:2006, Specification for Welding of Sheet Metal or ASME Boiler and Pressure Vessel Code Section IX.
  4. FACTORY ACCEPTANCE TESTS
     1. All acceptance tests shall be in accordance with the procedures in ASME N510-1989 (1995 reaffirmed). Proposed test schedules for adjusting and balancing, housing leak and pressure, air-aerosol mixing uniformity, damper operation and leakage, system bypass, and performance tests of systems, shall be provided at least 2 weeks prior to the start of related testing.
     2. Visual Inspection
        1. Visual inspection shall be performed in accordance with ASME N510-1989 (1995 reaffirmed)
        2. Housing Leak and Pressure Test
           1. The filtration system housing shall be factory leak tested in accordance with ASME N510-1989 (1995 reaffirmed), Section 6, using the pressure decay method. The housing shall be tested positively to the design pressure of 15 inches water gauge and have a maximum leak rate of 0.0005 cfm per cubic foot of housing volume.
        3. Damper Operation and Leakage Test
           1. The damper shall be tested to verify that it operates as specified. The air leakage rate through loose isolation dampers shall be measured and recorded. The damper shall be functionally tested as required in ASME N510-1989 (1995 reaffirmed).
        4. System Bypass Test
           1. The filtration element housing and housing seal shall be tested in accordance with ASME N510-1989 (1995 reaffirmed). The maximum housing leakage rate acceptance criteria shall be 0.0005 cfm per cubic foot of housing volume at 10 inches of water gauge pressure differential.
  5. PREPARATION FOR SHIPPING
     1. The filtration system shall be mounted with protective shipping skids, crated or covered, blocked, braced, and cushioned as necessary to prevent physical damage during shipping.
  6. FIELD ACCEPTANCE TEST
     1. 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 the housing. Testing shall occur after installation and shall be performed by a testing agency in accordance with ASME N510-1989 (1995 reaffirmed). The test agency shall be qualified in accordance with ASME NQA-1.
  7. FIELD TRAINING
     1. The Contractor shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. The manufacturer shall determine the appropriate length of the training course. The field instruction shall cover all of the items contained in the approved Operating and Maintenance Instructions.

END OF SECTION 23 4145