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USACE / NAVFAC / AFCEA / NASA UFGS-23 41 13.00 40 (July 2007)  
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Preparing Activity: NASA Superseding  
UFGS-23 41 13.00 40 (April 2007)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated March 2008

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PANEL FILTERS

07/07

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### SECTION 23 41 13.00 40

#### PANEL FILTERS 07/07

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NOTE: This specification covers the requirements for This section covers basic types of filters for use with air handling equipment.

Specify any required extra media, filters, and adhesive.

Drawings shall indicate overall physical features, dimensions, ratings, service requirements, and equipment weights.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

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## PART 1 GENERAL

### 1.1 REFERENCES

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

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

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

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

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

ASHRAE 52.1 (1992) Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

ASME INTERNATIONAL (ASME)

ASME AG 1 (2003; Errata 2004; Addenda 2005) Code on Nuclear Air and Gas Treatment

ASTM INTERNATIONAL (ASTM)

ASTM A 526/A 526M (1990) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality

ASTM A 653/A 653M (2007) Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM D 92 (2005a) Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester

ASTM E 84 (2007b) Standard Test Method for Surface Burning Characteristics of Building Materials

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST PS 1 (2007) Construction and Industrial Plywood

U.S. DEPARTMENT OF DEFENSE (DOD)

MIL-F-29177 (Rev A; CANC Notice 1) Filter, Air-Extended Area, Initial Installation

MIL-STD-282 (Basic, Notice 4) Filter Units, Protective

Clothing, Gas-Mask Components and Related  
Products: Performance-Test Methods

U.S. GENERAL SERVICES ADMINISTRATION (GSA)

FED-STD-209

(Rev C) Clean Room and Work Station  
Requirements, Controlled Environment

UNDERWRITERS LABORATORIES (UL)

UL 586

(1996; Rev thru Aug 2004) Standard for  
High-Efficiency Particulate, Air Filter  
Units

UL 723

(2003; Rev thru May 2005) Standard for  
Test for Surface Burning Characteristics  
of Building Materials

UL 900

(2004; Rev thru Nov 2007) Standard for Air  
Filter Units

## 1.2 SUBMITTALS

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NOTE: Review Submittal Description (SD) definitions  
in Section 01 33 00 SUBMITTAL PROCEDURES and edit  
the following list to reflect only the submittals  
required for the project. Submittals should be kept  
to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the  
submittal requires Government approval. Some  
submittals are already marked with a "G". Only  
delete an existing "G" if the submittal item is not  
complex and can be reviewed through the Contractor's  
Quality Control system. Only add a "G" if the  
submittal is sufficiently important or complex in  
context of the project.

For submittals requiring Government approval on Army  
projects, a code of up to three characters within  
the submittal tags may be used following the "G"  
designation to indicate the approving authority.  
Codes for Army projects using the Resident  
Management System (RMS) are: "AE" for  
Architect-Engineer; "DO" for District Office  
(Engineering Division or other organization in the  
District Office); "AO" for Area Office; "RO" for  
Resident Office; and "PO" for Project Office. Codes  
following the "G" typically are not used for Navy,  
Air Force, and NASA projects.

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

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Government approval is required for submittals with a "G" designation;  
submittals not having a "G" designation are [for Contractor Quality Control

approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-02 Shop Drawings

Installation Drawings shall be submitted in accordance with the paragraph entitled, "Holding Frame Installation," of this section.

#### SD-03 Product Data

Equipment and Performance Data shall be submitted for air filters in accordance with paragraph entitled, "General Requirements," of this section.

Manufacturer's catalog data shall be submitted for the following items:

Air Filters  
Filter Gages  
Manometers

#### SD-06 Test Reports

Test Reports shall be submitted for air filters in accordance with paragraph entitled, "Tests," of this section.

#### SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the reference standards contained in this section.

Air Filters  
Filter Gages  
Manometers

### 1.3 GENERAL REQUIREMENTS

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NOTE: If Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.  
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Section 23 00 00.00 40 HEATING, VENTILATING, AND AIR-CONDITIONING applies to work specified in this section.

Equipment and Performance Data shall be submitted for air filters consisting of use life, system functional flows, safety features, and mechanical automated details. Curves indicating tested and certified equipment responses and performance characteristics shall also be submitted.

## PART 2 PRODUCTS

### 2.1 FILTERS

Air filters shall have a net effective filtering area and a face area to provide the required airflow at the indicated initial pressure-drop.

Filter assembly shall be suitable for space provided with sufficient clearance for maintenance and operation.

Filter-holding frames shall be constructed of [extruded aluminum] [type 300 corrosion-resistant steel] [corrosion-resistant coated 1.6 millimeter 16-gage (minimum) steel] [not less than 1.6 millimeter 16-gage galvanized carbon steel conforming to ASTM A 653/A 653M with not less than 0.38 kilogram of zinc per square meter 1.25 ounces of zinc per square foot of two-sided surface] [wood-pulp products]. All frame assemblies and fasteners shall be corrosion-resistant metal or carbon steel with a corrosion-resistant finish to preclude surface degradation.

[Viscous-impingement framed panel filter gaskets shall be made from a material inert to filter impregnants. Minimum thickness after compression shall be 3 millimeter 1/8 inch.]

[Dry filter gaskets shall be closed-cell foamed neoprene or urethane elastomer of sufficient hardness to compress to not more than 40 percent of original thickness when filter is in position.]

#### 2.1.1 Filters, Disposable Type

Minimum acceptable performance for the air filter shall be as listed below:

<u>DIMENSIONS</u> <u>(MILLIMETER)</u>	<u>INITIAL</u> <u>RESISTANCE</u> <u>(pascal)</u>	<u>ARRESTANCE</u> <u>(PERCENT)</u>	<u>DUST-HOLDING</u> <u>CAPACITY</u> <u>(GRAM/SQ FT)</u>
350 by 500 by 25	10	65	1560
400 by 500 by 25	10	65	1560
400 by 650 by 25	10	65	1560
500 by 500 by 25	10	65	1560
500 by 650 by 25	10	65	1560
400 by 500 by 25	20	75	2050
400 by 650 by 50	20	75	2050
500 by 500 by 50	20	75	2050

<u>DIMENSIONS</u> <u>(MILLIMETER)</u>	<u>INITIAL</u> <u>RESISTANCE</u> <u>(pascal)</u>	<u>ARRESTANCE</u> <u>(PERCENT)</u>	<u>DUST-HOLDING</u> <u>CAPACITY</u> <u>(GRAM/SQ FT)</u>
500 by 650 by 50	20	75	2050

<u>DIMENSIONS</u> <u>(INCHES)</u>	<u>INITIAL</u> <u>RESISTANCE</u> <u>(INCH WG)</u>	<u>ARRESTANCE</u> <u>(PERCENT)</u>	<u>DUST-HOLDING</u> <u>CAPACITY</u> <u>(GM/SQ FT)</u>
14 by 20 by 1	0.04	65	145
16 by 20 by 1	0.04	65	145
16 by 25 by 1	0.04	65	145
20 by 20 by 1	0.04	65	145
20 by 25 by 1	0.04	65	145
16 by 20 by 2	0.08	75	190
16 by 25 by 2	0.08	75	190
20 by 20 by 2	0.08	75	190
20 by 25 by 2	0.08	75	190

For all sizes of filters, final resistance value shall be 125 pascal 0.50 inch, air volume shall be 0.6 cubic meter per second 1,200 cubic feet per minute, and airflow velocity shall be 1.5 meter per second 300 feet per minute.

#### 2.1.1.2 Filters, Cleanable Type

Filtering element shall be nonwoven synthetic-fabric-type, supported on rigid pleats of suitable grid material. Filter element shall be sealed into an enclosing frame of rigid chipboard, providing a unit that will not rack. Overall depth shall be nominally [50 millimeter] [100 millimeter] [2 inches] [4 inches]. Initial pressure drop at a face velocity of 2.5 meter per second 500 fpm shall be [62] [55] pascal [0.25] [0.22] inch wg. Average dust-spot efficiency shall be [10 percent] [18 percent] and arrestance shall be [85 percent] [87 percent] when filter is operated to a final pressure drop of 250 pascal 1 inch wg. Under these circumstances, dust-holding capacity shall be [485] [750] grams per square meter [45] [70] grams per square foot of face area.

Test method shall be in accordance with ASHRAE 52.1.

### 2.1.1.3 Filters, Replaceable Type

Filters shall conform to MIL-F-29177, Type I or Type II. Filter efficiency shall be based on ASHRAE 52.1. Efficiency, by definition, is dust-spot efficiency using atmospheric dust. Arrestance is weight efficiency using test dust. Type III filter arrestance efficiencies shall be in accordance with MIL-STD-282 DOP test.

Each air filter shall consist of a permanent corrosion-resistant holding frame and a replaceable factory-assembled filter element. Permanent holding frame shall be supplied with suitable gaskets and shall be designed to maintain a positive pressure seal between the frame and the filter element(s).

Air filters shall be designed and constructed to facilitate field maintenance. Adjustments and replaceable accessories shall be readily accessible. Conditions which may be hazardous to personnel or deleterious to equipment shall not be permitted.

Filter element shall be nonallergenic and nontoxic, with no detectable odor. Filter element shall have no adverse effect on the health of personnel handling or served by the filter element.

Adhesive coatings used on filters shall have a flashpoint of not less than 163 degrees C 325 degrees F and shall conform to ASTM D 92.

[Filters shall be Type 1, Grade A, 30 percent commercially rated efficiency, and shall conform to UL 900, Class 2, and requirements specified herein. Filters, when operated at rated capacity of [ ] cubic meter per second cfm, shall have an initial pressure drop of not more than [ ] pascal [ ] inch wg, and final pressure drop shall not exceed [ ] pascal [ ] inch wg. Filter initial efficiency shall be not less than 20 percent, and the average efficiency shall be not less than 25 percent. Dust-holding capacity (grams per square meter foot), at a rated air flow (cubic meter per second feet per minute) shall be not less than [ ] at [ ] [6460 at 0.7] [10800 at 0.9] [1.2]] [600 at 1,500] [1,000 at 2,000] [1,000 at 2,500], respectively.]

[Filter shall be Type I, Grade B, 40 percent commercially rated efficiency, and shall conform to UL 900, Class 2, and requirements specified herein. Filters, when operated at rated capacity of [ ] cubic meter per second cfm, shall have an initial pressure drop of not more than [ ] pascal [ ] inch wg and final pressure drop shall not exceed [ ] inch wg pascal. Filter initial efficiency shall be not less than 20 percent, and the average efficiency shall be not less than 35 percent. Dust-holding capacity (grams per square meter foot), at a rated air flow (cubic meter per second feet per minute) shall be not less than [ ] at [ ] [5380 at 0.7] [6460 at 0.9] [7535 at 1.2] [500 at 1,500] [600 at 2,000] [700 at 2,500], respectively.]

[Filter shall be Type II, Grade C, 85 percent commercially rated efficiency [minimum of 58 percent per ASHRAE 52.1 using atmospheric dust], and shall conform to UL 900, [Class 2] [Class 1] and requirements specified herein. Filters, when operated at rated capacity of [ ] cubic meter per second [ ] cfm, shall have an initial pressure drop of not more than [ ] pascal [ ] inch wg, and final pressure drop shall not exceed [ ] pascal [ ] inch wg. Filter initial efficiency shall be not less than 58 percent, and the average efficiency shall be not less than 76 percent. Dust-holding capacity (grams per square meter foot), at a rated air flow



(cubic meter per second feet per minute) shall be not less than [\_\_\_\_\_] at [\_\_\_\_\_] [3230 at 0.7] [4300 at 0.9] [5060 at 1.2], [300 at 1,500] [400 at 2,000] [470 at 2,500], respectively.]

[Filter shall be Type II, Grade D, 95 percent commercially rated efficiency [minimum of 78 percent per ASHRAE 52.1 using atmospheric dust], and shall conform to UL 900, [Class 2] [Class 1] and requirements specified herein. Filters, when operated at rated capacity of [\_\_\_\_\_] cubic meter per second cfm, shall have an initial pressure drop of not more than [\_\_\_\_\_] pascal [\_\_\_\_\_] inch wg, and final pressure drop shall not exceed [\_\_\_\_\_] pascal [\_\_\_\_\_] inch wg. Filter initial efficiency shall be not less than 80 percent, and the average efficiency shall be not less than 90 percent. Dust-holding capacity (grams per square meter foot), at a rated air flow (cubic meter per second feet per minute) shall be not less than [\_\_\_\_\_] at [\_\_\_\_\_] [2370 at 0.7] [3230 at 0.9] [4090 at 1.2] [220 at 1,500] [300 at 2,000] [380 at 2,500], respectively.]

[Filters shall be Type III, Grade E, 95 percent rated efficiency [DOP test using 0.2-micrometer particles], and shall conform to UL 900, [Class 2] [Class 1] and requirements specified herein. Filter initial pressure drop shall not exceed [250 pascal with face velocity of 1.7 meter per second on 150 millimeter deep filter] [250 pascal with face velocity of 2.5 meter per second on 300 millimeter deep filter] [[\_\_\_\_\_] pascal with face velocity of [\_\_\_\_\_] on [\_\_\_\_\_] millimeter deep filter] [1.0 inch wg with face velocity of 325 fpm on 6 inch deep filter] [1.0 inch wg with face velocity of 500 fpm on 12 inch-deep filter] [[\_\_\_\_\_] inch wg with face velocity of [\_\_\_\_\_] fpm on [\_\_\_\_\_] inch-deep filter], and final pressure drop shall not exceed [500 pascal with face velocity of 1.7 meter per second on 150 millimeter deep filter] [500 pascal with face velocity of 2.5 meter per second on 300 millimeter deep filter] [[\_\_\_\_\_] pascal with face velocity of [\_\_\_\_\_] on [\_\_\_\_\_] millimeter deep filter] [2.0 inches wg with face velocity of 325 fpm on 6 inch-deep filter] [2.0 inches wg with face velocity of 500 fpm on 12 inch-deep filter] [[\_\_\_\_\_] inches wg with face velocity of [\_\_\_\_\_] fpm on [\_\_\_\_\_] inch deep filter]. Filter efficiency shall be not less than 95 percent and shall be determined in accordance with MIL-STD-282, using 0.3-micrometer particle of thermally generated DOP smoke.]

#### 2.1.4 Filters, Automatic Type

Filters shall be of the automatic renewable filtering element type in which a roll of the element is unwound across the airstream by a mechanism regulated by a timer or a differential-pressure control, or a combination of both.

Unit shall be suitable for 120-volt, single-phase, 60-hertz power.

Filter performance data shall be manufacturer-established in accordance with ASHRAE 52.1 dynamic loading test procedures. Initial resistance shall not exceed 5 pascal 0.20 inch wg at an airstream velocity of 2.5 meter per second 500 fpm. Each filter, when operating at its specified rate of airflow, shall have a dust-holding capacity of 700 grams per square meter 65 grams per square foot when the resistance to airflow is maintained between 112 and 137 pascal 0.45 and 0.55 inch wg. Filtering element shall have an average dust-spot efficiency of not less than 20 percent and an arrestance of 85 percent.

Filtering element shall be the viscous-impingement progressively graded density UL, Class 2, fibrous-glass type. Element shall be continuous material with a normal depth of 50 millimeter 2 inches when clean and shall

not compress more than 6 millimeter 1/4 inch when subject to air velocity of 2.5 meter per second 500 fpm. Element shall be reinforced in both length and width and supported so that there will be no leakage of unfiltered air. Dirty element shall be wound with the dirty surface inward and shall be rerolled automatically under tension. Each spool of filtering element shall be provided with guide keys to ensure correct installation. Element shall have a compressibility that will allow 20 meter 65 feet to be wound to a maximum of 400 millimeter 16 inches in diameter on the used roll. Each roll of filtering element shall be not less than 20 meter 65 feet long.

Clean and dirty filtering element shall be wound and fed so that no blowoff of collected dirt can occur. Otherwise, clean and dirty elements shall be contained in steel enclosures in reverse-flow units and in horizontal units where the element is wound outside of airstream.

Filter widths provided shall be of uniform size for all project air-handling units.

Timer shall be the electrically driven type, readily adjustable in the field without special tools. Timer shall be electrically interlocked with the fan motor to start and stop the filter element advancing mechanism, as required, when the fan is operating. Initial adjustment of the timer shall be such that the pressure-drop through the filter element will be maintained at approximately 112 pascal 0.45 inch wg. If used, the differential-pressure control shall be adjustable to any cut-in and cutout with a differential of from 12 to 25 pascal 0.05 to 0.10 inch wg. Initial adjustments shall be 137 pascal 0.55 inch cut-in to 112 pascal 0.45 inch wg cutout. Controls shall be out of the airstream.

Master section shall be equipped with a runout switch to stop the feed movement and operate a signal light when the element from one of the sections runs out. A manual feed-advance switch shall be furnished with each drive unit to advance the element to the end of the roll as required. Signal light shall be located on the air-handling unit temperature-control panel.

Filter-supporting structural members shall be fabricated of not less than 2 millimeter 14-gage mill-galvanized carbon steel for the base and side panels and 1.6 millimeter 16-gage mill-galvanized carbon steel for the top panel. Galvanized steel sheet shall be in accordance with ASTM A 526/A 526M.

#### 2.1.5 Filters, High-Efficiency Particulate Air (HEPA)

HEPA filters shall be fire-resistant type and shall be capable of withstanding a minimum of 90-percent relative humidity determined dynamically at temperatures between 21 and 38 degrees C 70 and 100 degrees F.

Filtering element shall conform to ASME AG 1. Filter shall be individually certified to have an efficiency of not less than 99.97 percent. However, the certification shall not be earned by the DOP test specified in FED-STD-209. An acceptable method for certification is to remove a filter from a production run prior to testing, then test the five filters before and after the removed filter in accordance with the DOP test (99.97 percent). Successful passing of the test by the five filters before and five filters after the untested filter shall be the acceptance criteria for the untested filter. Clean filter static pressure drop shall not exceed 250 pascal 1.0 inch wg when the filter is tested at rated capacity.

Filtering element shall contain no holes, cracks, slits, or other visual

imperfections. Every splice required in the assembly of a filter pack shall be joined with not less than 40 millimeter 1-1/2 inches of fire-retardant adhesive for a continuous coating along the entire width of the element. Filter element shall be glass paper with a minimum tensile strength of 525 newton per meter 3 pounds per inch of width and shall retain 50 percent of its tensile strength when folded flat upon itself. Elongation before rupture shall be a minimum of 1 percent. Element shall be water-proofed and shall retain 50 percent of its original tensile strength after being immersed in water.

Results of test penetration, test resistance, test flow rate, together with direction of test airflow, manufacturer's name, model number, and serial number of the filter unit, shall be registered legibly and indelibly on the frame of the filter unit.

Frames shall be 19 millimeter 3/4 inch plywood, Grade A-B EXT-DFPA or better, conforming to NIST PS 1. Plywood shall be treated to exhibit a flame-spread of not more than 30 when tested according to UL 723 or ASTM E 84. Flathead wood screws shall be countersunk after drilling lead holes. Corner joints shall have positive seal by coating adjoining surfaces with a suitable adhesive having the characteristics specified below. Particle board conforming to the flame-spread requirements specified for plywood may be used in lieu of plywood.

Inside face of frame members of materials shall be coated entirely with an adhesive before assembly with filter pack. Following assembly, a continuous bead of the same adhesive shall be formed to seal between cut edges of filter pack and edges of abutting frame member on both faces of the filter unit. Filter unit shall be square to a diagonal tolerance of 3 millimeter 1/8 inch.

Adhesive, when cured, shall be resilient and water-resistant and shall withstand a temperature of 121 degrees C 250 degrees F for 8 hours. If capable of ignition, the adhesive shall be self-extinguishing and shall meet general operating conditions without change in physical properties and without loss of seal. Cured adhesive shall contain no cracks, checks, alligating, or separation.

HEPA filters shall be in accordance with UL 586.

[Frames shall be 2.0 millimeter 14-gage [aluminum sheet] [zinc] [aluminum] [cadmium-coated 1.6 millimeter 16-gage steel sheet]. Corner joints shall be given a positive seal by coating adjoining surfaces with a suitable adhesive having the characteristics indicated.]

Separators shall be constructed of [aluminum] [\_\_\_\_\_] that will not contribute to fire, will remain structurally intact under fire exposure, and will not be damaged by exposure to the humidity and temperature.

Gasket shall be 6 millimeter 1/4 inch thick closed cellular construction neoprene or approved elastomer of 20 to 40 Shore A durometer hardness. Gasketing shall be attached firmly and continuously to the frame with rubber-based adhesive.

Filter unit shall be assembled to provide uniformity of materials and construction, surface smoothness and finish, cleanliness, and freedom from protrusions and obvious flaws.

## 2.2 FILTER GAGES AND MANOMETERS

Air-filter gages or manometers shall be provided for each type filter assembly.

Gages shall be the dial-indicator type, graduated to read 0 to 500 pascal 0 to 2 inches wg, except that gages for HEPA filters shall read 0 to 750 pascal 0 to 3 inches wg. Manometers shall measure from minus 125 to 750 pascal 0.5 to 3 inches wg and be equipped with a built-in indicator bubble. Gage or manometer shall be connected to static-pressure ports of approved design and located so that resistance to airflow will be correctly indicated.

## PART 3 EXECUTION

### 3.1 FILTER INSTALLATION

Filter supports and retention elements shall be coordinated to provide a substantial, structurally sound, leakproof installation.

### 3.2 HOLDING FRAME INSTALLATION

Installation drawings shall be in accordance with referenced standards in this section.

Holding frames shall be gasketed on perimeter, or calked to each other, to supplementary steel, or to closures with elastomeric compounds recommended by the filter manufacturer. Substrate shall be prepared in accordance with the elastomer manufacturer's instructions, including the priming of surfaces in areas where the elastomer is not confined.

### 3.3 TESTS

Test reports shall be submitted for air filters in accordance with ASHRAE 52.1.

-- End of Section --