



# Standard Specification for Filters Used in Air or Nitrogen Systems<sup>1</sup>

This standard is issued under the fixed designation F1791; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers the design, construction, test, and performance requirements for air or nitrogen system filters, referred to hereinafter as filters. These filters are intended to be installed in-line to protect equipment from particular contamination.

1.2 The values stated in this specification in inch-pounds units are to be regarded as the standard. The SI equivalent shown in parentheses are provided for information only.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

F992 Specification for Valve Label Plates

### 2.2 American Society of Mechanical Engineers (ASME):

B1.1 United Screw Threads (UN and UNR Thread Form)<sup>3</sup>

B1.20.1 Pipe Threads, General Purpose (Inch)<sup>3</sup>

B16.11 Forged Steel Fittings, Socket-Welding and Threaded<sup>3</sup>

B16.25 Buttwelding Ends<sup>3</sup>

B16.34 Flanged, Threaded, and Welded End<sup>3</sup>

### 2.3 Society of Automotive Engineers (SAE):

ARP 901 Aerospace Recommended Practice—Bubble-Point Test Method<sup>4</sup>

### 2.4 Military Standards and Specifications:

MIL-STD-167-1 Mechanical Vibrations of Shipboard Equipment (Type I—Environmental and Type II—Internally Excited)<sup>5</sup>

MIL-STD-740-1 Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment<sup>5</sup>

MS16142 Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for<sup>5</sup>

MIL-S-901 Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for<sup>5</sup>

MIL-F-1183 Fittings, Pipe, Cast Bronze, Silver-Brazing, General Specifications for<sup>5</sup>

### 2.5 Naval SEA Systems Command (NAVSEA): Government Drawings:

NAVSEA 803-1385884 Unions, Fittings and Adapters Butt and Socket Welding 6000 PSI, WOG, NPS<sup>5</sup>

NAVSEA 803-1385943 Unions, Silver Brazing 3000 PSI, WOG, NPS, for UT Inspection<sup>5</sup>

NAVSEA 803-1385946 Unions, Bronze Silver Brazing, WOG for UT Inspection<sup>5</sup>

## 3. Terminology

### 3.1 Definitions:

3.1.1 *absolute contaminant removal rating*—the smallest size of contaminant as defined in ARP 901 that the filter will retain with 100 % efficiency by weight.

3.1.2 *bubble point*—the pressure differential across a submerged filter element required to produce a visible and steady stream of air bubbles. Correlation between bubble point and contaminant removal capability provides an economical means to test for contaminant removal capability on a production basis. The bubble point indicates the maximum pore size of the filter media under static conditions.

3.1.3 *bubble-tight*—no visible leakage over a 3-min period using either water submersion or the application of bubble fluid for detection.

3.1.4 *clean filter element pressure drop*—the pressure drop across the filter element when it is new or uncontaminated.

3.1.5 *cleanable filter element*—a filter element that, after being contaminated to its dirt-holding capacity (contaminated filter element pressure drop), can be restored by cleaning to operational condition and with a pressure drop not exceeding the required clean filter element pressure drop.

3.1.6 *contaminant removal rating*—this is a measure of the size of contaminants that the filter can remove from the flow stream.

3.1.7 *contaminated filter element pressure drop*—the pressure drop across the filter element when it is contaminated to the point where cleaning or replacement is required.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

Current edition approved May 1, 2006. Published May 2006. Originally approved in 1997. Last previous edition approved in 2000 as F1791 – 00. DOI: 10.1520/F1791-00R06.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990.

<sup>4</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

<sup>5</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3.1.8 *differential pressure indicator actuation pressure*—the pressure drop across the filter element at which the differential pressure indicator actuates.

3.1.9 *disposable filter element*—a filter element that, after being contaminated to its dirt-holding capacity (contaminated filter element pressure drop), cannot be restored to operational conditions and thereafter should be replaced.

3.1.10 *external leakage*—leakage that escapes to atmosphere.

3.1.11 *filter element bypass full-flow differential pressure*—the pressure drop across the filter element at which the filter bypass is passing the full-flow rating of the filter.

3.1.12 *filter element bypass reseal differential pressure*—the pressure drop across the filter element at which the filter bypass reseats after passing the full-flow rating of the filter.

3.1.13 *filter element bypass set differential pressure*—the pressure drop across the filter element at which the filter bypass opens.

3.1.14 *filter element collapse strength*—the maximum pressure drop or differential across the filter element that the element must withstand without collapse, damage, or impairment of performance capabilities.

3.1.15 *filter element contaminant-holding capacity*—also commonly termed “dirt capacity.” The amount of a contaminant, expressed in weight, that the element can hold when its resistance to flow causes a pressure drop equal to the contaminated filter element pressure drop.

3.1.16 *filter element pressure drop*—the pressure drop across the filter element.

3.1.17 *filter housing pressure drop*—the pressure drop accounted for by the filter housing.

3.1.18 *filter pressure drop*—the pressure drop across the entire filter (element and housing) at any given flow rate of the service fluid (air or nitrogen).

3.1.19 *flow capacity*—the maximum flow rate that the filter is required to pass.

3.1.20 *hydrostatic shell test pressure*—the hydrostatic test pressure that the filter is required to withstand without damage. The filter must be capable of meeting all performance requirements after the shell test pressure has been removed.

3.1.21 *media migration*—any material released into the flow stream by the filter media and its materials of construction. This term refers to the tendency of the filter media or “built-in” contamination, such as, welding scale, metal particles, or air-borne dust combined with the media during its manufacture, to leave the filter and shed or migrate into the flow stream.

3.1.22 *nominal contaminant removal rating*—the smallest size of contaminant as defined in ARP 901 that the filter will retain with 98 % efficiency by weight.

3.1.23 *operating pressure*—the pressure within the filter during service.

3.1.24 *pressure ratings*—the pressure rating of the filter shall be defined in the documents listed in **Table 1**. The

**TABLE 1 Filter Inlet and Outlet End Connections**

Type of End Connection	Pressure Rating	Applicable Documents for Dimensional Details of End Connections
Butt-welded	ASME B16.34 Class 150, 300, 400, 600, 900, 1500, 2500, or 4500	ASME B16.25
Socket-welded	ASME B16.34 Class 150, 300, 400, 600, 900, 1500, 2500, or 4500	ASME B16.11
Threaded (tapered pipe thread)	ASME B16.34 Class 150, 300, 400, 600, 900, 1500, or 2500	ASME B1.20.1 and ASME B16.11
Union-end, <sup>A</sup> silver-brazed	MIL-F-1183 (O-ring type) 400 lb/in. <sup>2</sup> (2.758 MPa)	MIL-F-1183 (O-ring type) 400 lb/in. <sup>2</sup> (2.758 MPa)
Union-end, <sup>A</sup> silver-brazed	803-1385946 1500 lb/in. <sup>2</sup> (10.342 MPa)	803-1385946 1500 lb/in. <sup>2</sup> (10.342 MPa)
Union-end, <sup>A</sup> silver-brazed	803-1385943 3000 lb/in. <sup>2</sup> (20.684 MPa)	803-1385943 3000 lb/in. <sup>2</sup> (20.684 MPa)
Union-end, <sup>A</sup> butt/socket weld	803-1385884 6000 lb/in. <sup>2</sup> (41.369 MPa)	803-1385884 6000 lb/in. <sup>2</sup> (41.369 MPa)
Other, as specified	as specified	as specified

<sup>A</sup> For union inlet and outlet connections, only the pertinent dimensions listed in the applicable documents (military specification or NAVESA requirements) shall apply. The filter shall be supplied with the thread pieces only, without the tail pieces and union nuts.

pressure rating for a filter is the maximum allowable working (service) pressure at 100°F (38°C).

#### 4. Classification

4.1 Filters shall be of the following types, compositions, styles, pressure ratings, sizes, end connections, and contamination removal ratings, as specified in Section 5.

##### 4.1.1 Filter Element Type:

- 4.1.1.1 Type 1—Disposable.
- 4.1.1.2 Type 2—Cleanable.

##### 4.1.2 Filter Element Bypass Composition:

- 4.1.2.1 Composition A: with bypass.
- 4.1.2.2 Composition B: without bypass.

##### 4.1.3 Filter Element Differential Indicator Style:

- 4.1.3.1 Style I: with differential pressure indicator.
- 4.1.3.2 Style II: without differential pressure indicator.

4.2 *Pressure Ratings*—Filters shall have pressure ratings selected from those listed in **Table 1** and specified in Section 5. The pressure rating selected shall be the same for both the filter inlet and outlet.

4.3 *Size*—Filter sizes shall be ¼ NPS (13.5 mm), ½ NPS (21.3 mm), ¾ NPS (26.9 mm), 1 NPS (33.7 mm), 1 ¼ NPS (42.4 mm), 1 ½ NPS (48.3 mm), and 2 NPS (60.3 mm) or as specified in Section 5 (see **Table 2**).

4.4 *End Connections*—Filters shall have inlet and outlet end connections selected from those listed in **Table 1** and specified in Section 5. Inlet and outlet connections shall be identical.

4.5 *Contamination Removal Ratings*—Filters shall have contamination removal ratings selected from the following three categories: 20 µm nominal/50 µm absolute, 5 µm nominal/18 µm absolute, and 0.4 µm nominal/5 µm absolute. The contamination rating selected shall be specified in Section 5.

**TABLE 2 Filter Performance Characteristics**

Filter Size, NPS	Minimum Dirt-Holding Capacity Grams AC Coarse
¼ (13.5 mm)	6.0
½ (21.3 mm)	6.0
¾ (26.9)	10.0
1 (33.7 mm)	12.0
1¼ (42.4 mm)	12.0
1½ (48.3 mm)	14.0
2 (60.3 mm)	16.0
As specified	as specified

**TABLE 3 Filter Pressure Drop Requirements**

NOTE 1—Percentages shown above shall read as percent of the operating pressure of the filter (see 3.1.23 and 5.1.10).

Maximum Allowable Clean Element (see 7.1.5)	$\Delta P$ Indicator Actuation (see 7.1.5)	Maximum Allowable Contaminated Element (see 7.1.5)	Filter Pressure Drop		
			Filter Element Bypass (see S1.0)		
			Set	Full Flow	Reseat
2.5 %	4.75 to 5.25 %	6.25 %	7.25 to 8 %	8.25 to 9.25 %	6.25 to 7 %

Example:

Operating pressure: 1000 psi (6895 kPa)

Maximum allowable clean element pressure drop: 25 psi (172 kPa)

$\Delta P$  indicator actuation: 47.5 to 52.5 psi (327 to 346 kPa)

Maximum allowable contaminated element pressure drop: 62.5 psi (431 kPa)

Filter element bypass set pressure drop: 72.5 to 80 psi (500 to 552 kPa)

Filter element bypass full-flow pressure drop: 82.5 to 92.5 psi (569 to 638 kPa)

Filter element bypass reseat pressure drop: 62.5 to 70 psi (431 to 483 kPa)

## 5. Ordering Information

5.1 Ordering documentation for filters under the specification shall include the following information, as required, to describe the equipment adequately.

- 5.1.1 ASTM designation and year of issue,
- 5.1.2 Title, number, and date of this specification,
- 5.1.3 Filter element type (see 4.1.1),
- 5.1.4 Filter element bypass composition (see 4.1.2),
- 5.1.5 Filter element differential pressure indicator style (see 4.1.3),
- 5.1.6 Filter pressure rating (see 4.2),
- 5.1.7 Size (see 4.3),
- 5.1.8 End connections (see 4.4),
- 5.1.9 Contaminant removal rating, absolute/nominal (see 4.5),
- 5.1.10 Maximum filter operating pressure,
- 5.1.11 Flow capacity required (see 7.1, S1.3),
- 5.1.12 Supplementary requirements, if any (S1.0 through S4.0), and
- 5.1.13 Maximum vibration frequency and amplitude, if other than specified (see S1.8).

## 6. Filter Design and Construction

6.1 Filters shall incorporate the design features specified in 6.1.1-6.1.6.

6.1.1 *Materials of Construction*—Materials shall be 300 series corrosion-resistant steel (SS304, 304L, 316, or 316L), or other materials selected to provide compatibility with the line medium, weldability, and corrosion resistance without requiring painting, coating, or plating. The filter body and the filter bowl shall be weld repairable. Materials for contacting parts shall be selected to minimize electrolytic corrosion and galling.

6.1.2 *Design Construction Requirements* :

6.1.2.1 *General Construction*—The filter shall have a bolted flanged body and filter bowl to expedite removal of the filter element for cleaning or replacement.

6.1.2.2 *Collapse Strength*—The filter element shall be capable of withstanding a differential pressure equal to the maximum inlet pressure rating without structural degradation.

6.1.2.3 *Automatic Bypass*— When specified (see 5.1.4), the filter assembly shall incorporate an automatic bypass feature to bypass system fluid automatically around the filter element in the event of excessive flow restriction through the filter element. The automatic bypass shall be set in accordance with Table 3 and shall have a capacity equal to or greater than that of a clean filter assembly.

6.1.2.4 *Filter Element Installation* —Positive means shall prevent any play or looseness of the filter element in service and prevent cocking or misalignment during installation.

6.1.2.5 *Filter Element Flow Direction* —The filter element flow direction shall be from the outside to the inside surface of the element.

6.1.2.6 *Cleanability*— Cleanable filter elements shall be cleanable and reusable by means of scrubbing and washing the outside surface with detergent and tap water and blowing through with compressed air not exceeding 30-psig (207-kPa gage pressure). Once cleaned, the element shall be capable of meeting the requirements for a new element. Cleanable filter elements shall not be adversely affected by immersion in water and shall be capable of meeting the above criteria for not less than five cleaning and reuse cycles.

6.1.2.7 *Differential Pressure Indicator* —When specified (see 5.1.5), the filter body shall incorporate a nonelectrical, “pop up” differential pressure indicator which senses the pressure drop across the element and actuates in accordance with Table 3. Once actuated, a red indicator button shall remain up until manually reset.

6.1.2.8 *O-Ring Locations*— O-rings in face-seal applications shall have the grooves located in the lower members to simplify assembly.

6.1.2.9 *Pressure Envelope*—The hydrostatic shell test pressures shall be 1.5 times the filter rated pressure at 100°F (38°C).

6.1.2.10 *Connections*— The inlet and outlet end connections of the filter shall be as specified in Table 1. Any exposed threads shall be protected by plastic caps for shipping.

6.1.2.11 *Port Configuration*—The filter body shall have in-line inlet and outlet end connections for installation into the piping system.

6.1.2.12 *Pressure Lines*— All pressure lines in the filter shall be internally ported.

6.1.2.13 *Accessibility*— The filter shall be fully and easily accessible for cleaning or repair without removal of the filter body from the line.

6.1.2.14 *Threads*—Threads shall be as specified in ASME B1.1. Where necessary, provisions shall be incorporated to

prevent the accidental loosening of threaded parts. The design shall be such that standard wrenches can be used on all external bolting. Lock-wire shall not be used.

6.1.2.15 *Interchangeability*—The entire filter, including all associated piece parts, shall have part number identity and shall be replaceable from stock or the manufacturer on a nonselective and random basis. Parts having the same manufacturer's part number shall be directly interchangeable with each other with respect to installation (physical) and performance (function). Physically interchangeable assemblies, components, and parts are those that are capable of being readily installed, removed, or replaced without alteration, misalignment, or damage to parts being installed or adjoining parts. Fabrication operations such as cutting, filing, drilling, reaming, hammering, bending, prying, or forcing shall not be required.

6.1.2.16 *Nonmetallic Element Interchangeability*—Nonmetallic elements, including but not limited to, cushions and O-rings, shall be treated as separately identified and readily replaceable parts.

6.1.2.17 *Pressure Gage Ports*—The filter shall be provided with threaded gage connection ports to permit attachment of pressure gages for sensing the inlet and outlet pressures. The gage connections shall be located to measure the pressure differential across the filter element accurately.

6.1.2.18 *Springs*—Any spring incorporated in the filter shall not be compressed solid during operation. Spring ends shall be squared and ground. Engagement or disengagement of parts against spring compression shall not be required.

6.1.3 *Maintainability*—The filter shall permit direct access for disassembly, repair, and reassembly of the filter element and all internal working parts and subassemblies when mounted for operation in the system. Maintenance shall require standard tools to the maximum extent possible. Any special tools required for maintenance shall be identified and shall be supplied as part of the filter.

6.1.4 *Reversibility*—The filter element, and all other parts in the filter, shall not be physically reversible unless they are also functionally reversible to preclude incorrect assembly.

6.1.5 *Adjustments*—There shall be no adjustments required in the filter during or after assembly other than the set points of a differential pressure indicator or an automatic bypass valve or both, where applicable.

6.1.6 *Reliability*—Except for cleaning or replacement of the filter element, periodic maintenance of the filter or any of its components shall not be required. There shall be no postassembly lubrication required.

## 7. Performance

7.1 Filters shall meet the performance requirements of 7.1.1-7.1.8.

7.1.1 *Contaminant Removal Rating*—The filter shall be capable of the levels of contaminant removal specified in the ordering information (see 4.5 and Section 5).

7.1.2 *Flow Capacity*—The flow capacity of the filter shall be as specified in 5.1.11 in standard cubic feet per minute (cubic metre per second) [at 60°F (16°C) and 14.7 psia (101 kPa absolute)]. The filter shall meet the specified maximum flow capacity, or any intermediate capacity, and shall operate

while providing the specified filter contaminant removal rating. If an automatic bypass is specified (see 5.1.4), it shall also meet the flow capacity requirements of the filter.

7.1.3 *External Leakage*—Filter external leakage shall be bubble-tight at operating pressure conditions over a 3-min period.

7.1.4 *Filter Element Contaminant-Holding Capacity*—Solid particulate contaminant (dirt) holding capacity shall be as specified in Table 2.

7.1.5 *Pressure Drop*—The maximum allowable filter element clean and contaminated pressure drops shall be as specified in Table 3.

7.1.6 *Differential Pressure ( $\Delta P$ ) Indicator Actuation Pressure*—The pressure drop across the filter element at which the differential pressure indicator, where applicable, actuates shall be as specified in Table 3.

7.1.7 *Filter Element Bypass Set, Full-Flow, and Reseat Differential Pressures*—The set, full-flow, and reseal differential pressures of an automatic filter element bypass, where applicable, shall be as specified in Table 3.

7.1.8 *Media Migration*—There shall be no media migration.

## 8. Tests Required

8.1 Each filter shall pass the tests outlined in 8.1.1-8.1.4.

8.1.1 *Visual Examination*—The filter shall be examined visually to determine conformance with the ordering data and workmanship without disassembly.

8.1.2 *Hydrostatic Shell Test*—The filter shall be hydrostatically tested by applying pressure equal to 1.5 times the 100°F (38°C) rated pressure to the inlet and outlet ports, respectively, to check the structural integrity of the filter. The filter element may be removed for this test. Pressure shall be applied for a minimum of 3 min. Air or nitrogen gas may be used in lieu of water providing appropriate safety precautions are taken to minimize the risk associated with the use of a compressible gas. There shall be no external leakage, permanent distortion, or structural failure.

8.1.3 *External Leakage Test*—Air shall be applied at rated pressure to the filter. External leakage shall be checked using bubble fluid or by submerging the filter in water. There shall be no visible external leakage over a 3-min period.

8.1.4 *Bubble Point Test*—The filter element shall be tested to determine the initial bubble point. The bubble point test shall be performed in accordance with the procedure specified in ARP 901. To ensure the correct nominal contaminant removal rating and absolute contaminant removal rating, acceptance criterion shall have been previously established for the particular filter design being tested by an empirical correlation of the results of bubble point testing with actual particle retention testing as outlined in ARP 901.

## 9. Marking

9.1 *Identification Plate*—An identification plate of corrosion-resistant metal in accordance with Specification F992; Types I, II, III, or IV shall be permanently attached to the filter and shall include the following information (some or all information may instead be stamped or etched directly on the filter body):