



Standard Specification for Indicators, Sight, Liquid Level, Direct and Indirect Reading, Tubular Glass/Plastic¹

This standard is issued under the fixed designation F2045; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers the requirements for direct and indirect reading sight liquid level indicators for general applications. General applications for indirect reading sight glasses are water and fuel service at working pressures 2.07 MPa (300 lb/in.²) and below, temperatures of 149°C (300°F) and below. General applications for direct reading sight glasses are applications in which the temperature does not exceed 66°C (150°F).

1.2 Direct reading sight glass indicators may consist of glass or plastic tubes with fittings including shutoff valves. Glass tubes may be used for low shock direct reading sight glass indicators in which the fluid is not compatible with plastic.

1.3 Indirect reading indicators may consist of a sealed chamber with a magnetic float or flag indicator.

1.4 Special requirements for naval shipboard applications are included in the supplement to this standard.

1.5 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards*:²

D3951 Practice for Commercial Packaging

2.2 *ANSI Standards*:

B16.5 Pipe Flanges and Flanged Fittings (DoD adopted)³

3. Terminology

3.1 *Definitions*:

¹ This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.10 on Electrical.

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² 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.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

3.1.1 *SI (Le Systeme International d'Unites) Units*—units of measurement recognized by the CIPM (Comite' International des Poids et Mesures).

4. Design Classification

4.1 *Types*—Indicator designs are classified as either direct reading or indirect reading. Both types are depicted in Fig. 1, complete with dimensions that facilitate ordering.

4.2 *Special Considerations*—Special considerations that may affect selection and installation are listed below. This is not to be construed as a complete listing.

(1) Type of indicator,

(2) Manual or automatic shutoff valves,

(3) Indication length of liquid level range,

(4) Method of connection,

(5) Location of indicator relative to vibrating equipment,

(6) Protection of the instrumentation,

(7) Application of each indicator,

(8) Cleaning procedure or reference to the cleaning procedure being used, and

(9) Selection of indicator for compatibility with materials, temperature, pressure, ambient environment, and with the parameter being measured.

5. Ordering Information

5.1 The buyer shall provide the manufacturer with all of the pertinent application data outlined in the acquisition requirements.

5.2 *Acquisition Requirements*—Acquisition documents shall specify the following:

(1) Title, number, and date of this specification;

(2) Type and quantity of indicators required;

(3) Manufacturer's part number;

(4) When qualification testing is required;

(5) Final disposition of qualification test samples;

(6) Environmental requirements;

(7) Operating media;

(8) Viscosity and specific gravity of fluid for indirect indicators;

(9) Materials;

(10) Indication length;

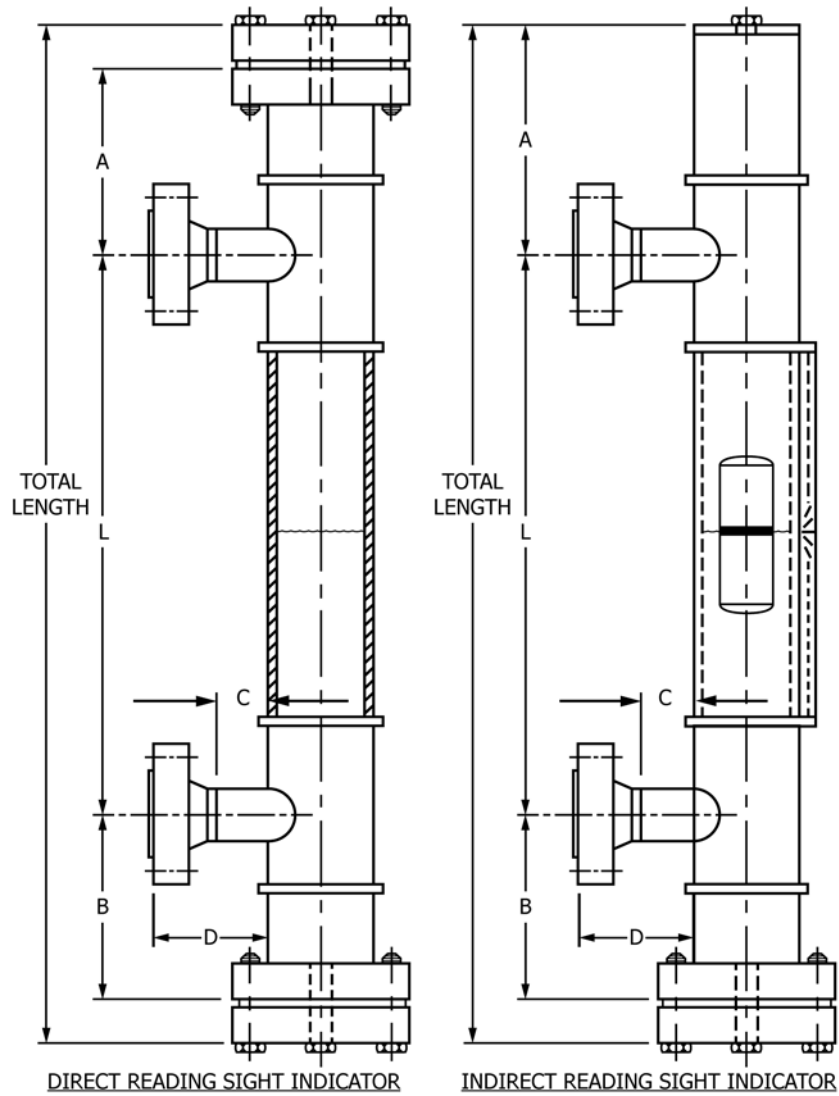


FIG. 1 Indicator Design Types

- (11) Size and type of connections;
- (12) Shutoff valve requirements;
- (13) Cleaning requirements;
- (14) When certification is required;
- (15) Marking requirements;
- (16) Unique packaging requirements; and
- (17) Unique preservation requirements.

6. Materials and Manufacture

6.1 *Materials*—The materials for all wetted parts shall be selected for long-term compatibility with the process medium and ambient conditions.

6.2 *Material Inspection*—The manufacturer shall be responsible for ensuring that materials used are manufactured, examined, and tested in accordance with the specifications and standards as applicable.

6.3 *Gaskets and O-Rings*—Gaskets and O-rings shall be fabricated of materials suitable to the operating pressure, temperature, and process medium for each application.

7. Physical Properties

7.1 *Connections*—Sight indicators are usually installed using standard pipe fittings or flanges. Pipe fittings and material should match that of the existing pipe for each installation. Type and size of fittings shall be specified in the acquisition requirements. Welding or brazing shall be performed in accordance with industry standards.

7.2 *Flanged Connections*—Where sight indicators are installed using flanges, flanges shall be in accordance with ANSI B16.5. Standard flange sizes include 1.27 cm (½ in.), 1.9 cm (¾ in.), 2.54 cm (1 in.), 3.8 cm (1-½ in.), and 5.08 cm (2 in.). Standard flange pressure ratings include 1.034 MPa (150 psi), 2.07 MPa (300 psi), and 4.14 MPa (600 psi). Other flange requirements shall be specified in the acquisition requirements.

7.3 *Vent and Drain Connections*—Where required, vent and drain connections are usually plugged, ½- or ¾-in. NPT or with NPT valves. Other vent and drain connections shall be specified in the acquisition requirements.

8. Performance Requirements

8.1 *Performance Considerations*—In many applications, certain performance characteristics are deemed critical to the intended or desired function of a sight liquid level indicator. The following are prime examples:

- (1) Accuracy,
- (2) Shock and vibration classifications, and
- (3) Operating pressure and temperature ranges.

9. Workmanship, Finish, and Appearance

9.1 *Finish and Appearance*—Any special surface finish and appearance requirements shall be specified in the acquisition requirements.

9.2 *Sight Glass Cleaning*—Any special cleaning requirements shall be specified in the acquisition requirements.

10. Inspection

10.1 *Classification of Inspections*—The inspection requirements specified herein are classified as follows:

- (1) Qualification testing and
- (2) Quality conformance testing.

10.2 *Qualification Testing*—Qualification test requirements shall be specified where applicable. Qualification test methods should be identified for each design and performance characteristic specified. Test report documentation requirements should also be specified.

10.3 *Quality Conformance Testing*—Quality conformance testing is accomplished when qualification testing was satisfied by a previous acquisition or product has demonstrated reliability in similar applications. Quality conformance testing is usually less intensive than qualification, often verifying that samples of a production lot meet a few critical performance requirements.

11. Number of Tests and Retests

11.1 *Test Specimen*—The number of test specimens to be subjected to qualification testing shall depend on the design. If each range is covered by a separate and distinct design, a test specimen for each range will require testing. In instances in which a singular design series may cover multiple ranges and types, only three test specimens need be tested provided the

physical similarities are approved by the buyer. In no case, however, shall less than three units, one unit each representing low, medium, and high ranges, be tested, regardless of design similarity.

12. Test Methods

12.1 *Tests*—All tests shall be performed in accordance with ASTM, ASME, or industry standards as specified.

12.2 *Test Data*—All test data shall remain on file at the manufacturer's facility for review by the buyer upon request. It is recommended that test data be retained in the manufacturer's files for at least three years or a period of time acceptable to the buyer and manufacturer.

13. Quality Assurance Provisions

13.1 *Warranty*—Unless otherwise specified, the manufacturer is responsible for the following:

- (1) All materials used to produce a unit and
- (2) Manufacturer will warrant his product to be free from defect of workmanship to produce the unit.

14. Certification

14.1 When specified in the purchase order or contract, the buyer shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

15. Product Marking

15.1 User-specified product marking shall be listed in the acquisition requirements.

16. Packaging and Package Marking

16.1 *Packaging of Product for Delivery*—Product shall be packaged for shipment in accordance with Practice **D3951**.

16.2 Any special preservation, packaging, or package marking requirements for shipment or storage shall be identified in the acquisition requirements.

17. Keywords

17.1 direct level indicator; indirect level indicator; liquid level indicator; sight glass

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements established for U.S. Naval shipboard application shall apply when specified in the contract or purchase order. When there is conflict between the standard (Specification F2045) and this supplement, the requirements of this supplement shall take precedence for equipment acquired by this supplement. This document supersedes MIL-I-20037, Indicators, Sight, Liquid Level, Direct/Indirect Reading, Tubular Glass/Plastic, for new ship construction.

INDICATORS, SIGHT, LIQUID LEVEL, DIRECT AND INDIRECT READING, TUBULAR GLASS/PLASTIC (NAVAL SHIPBOARD USE)

S1. Scope

S1.1 This supplement covers sight liquid level indicators of the direct and indirect reading type having tubular glass, clear polycarbonate, or rigid polyvinyl chloride (PVC).

S1.2 Direct reading sight glass indicators may consist of glass or plastic tubes with fittings including shutoff valves. Indirect reading indicators may consist of a sealed chamber with a magnetic float or flag indicator.

S1.3 Indirect indicators are intended for use in water and fuel service at working pressures of 2.07 MPa (300 lb/in.²) and below, temperatures of 149°C (300°F) and below, and for hi-shock applications. Direct indicators are intended for use in hi-shock applications and shall use plastic sight tubes where the fluid is compatible and temperatures do not exceed 66°C (150°F). Glass tubes shall only be used for low shock applications and where the fluid is not compatible with plastic tubes.

S1.4 Only direct-type indicators with glass tube material less than 92 cm (36 in.) in length or indirect type indicators shall be used for hydrocarbons and flammable fluid applications.

S2. Referenced Documents

S2.1 *Commercial Documents:*

ANSI B16.5 Pipe Flanges and Flanged Fittings (DoD adopted)³

ANSI/ASQC Q9001-1994 Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, Inspection, Testing and Servicing³

ASTM A312/A312M Specification for Seamless and Welded Austenitic Stainless Steel Pipes (DoD adopted)²

ASTM B61 Specification for Steam or Valve Bronze Castings (DoD adopted)²

ASTM B62 Specification for Composition Bronze or Ounce Metal Castings (DoD adopted)²

ASTM B117 Practice for Operating Salt Spray (Fog) Apparatus²

ASTM B283 Specification for Copper and Copper-Alloy Die Forging Hot-Pressed²

ASTM D1784 Specification for Rigid Poly Vinyl Chloride PVC Compounds and Chlorinated Poly Vinyl Chloride CPVC Compounds (DoD adopted)²

ASTM D3935 Specification for Polycarbonate (PC) Unfilled and Reinforced Material²

ASTM D3951 Practice for Commercial Packaging²
MSS-SP-72 Ball Valves with Flanged or Butt-Welding Ends for General Service⁴

MSS-SP-110 Ball Valves, Threaded Socket-Welding, Solder Joint, Grooved and Flared Ends⁴

S2.2 *Government Documents:*

S2.2.1 *Military Standards:*

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

S2.2.2 *Military Specifications:*

MIL-S-901 Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for⁵

S2.2.3 *Other Government Documents:* Drawings and publications, Naval Sea Systems Command (NAVSEA)

803-5184222 Gage Glass Ball Valve⁵

S8700-1385802 Level Indicator Shield⁵

S9074-AR-GIB-010/278 Requirements for Fabrication Welding and Inspection and Casting Inspection and Repair for Machinery, Piping and Pressure Vessels⁵

S3. Terminology

S3.1 *Definitions:*

S3.1.1 *direct indication*—the tank fluid level is visible in the glass or tube.

S3.1.2 *indirect indication*—the tank fluid level is contained in a sealed chamber and indicated by some other means such as a float or flag actuated by a magnet contained in a float in the fluid chamber.

S4. Design Classification

S4.1 *Designation*—Sight glass indicator designation shall consist of a series of designations which shall be assigned and listed in the format below:

⁴ Available from Manufacturers Standardization Society of the Valve and Fittings Industry (MSS), 127 Park St., NE, Vienna, VA 22180-4602, <http://www.mss-hq.com>.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

Example: F 2045-SGI-D-A-PLY-PA

F2045	SGI	D	A	PLY	PA
Specification	Equipment designator (see S4.2)	Indication (see S4.3)	Shutoff valve (see S4.4)	Slight glass material (see S4.5)	Application (see S4.6)

S4.2 Equipment Designator—The level indicator shall be designated as SGI—Sight Glass Indicator.

S4.3 Indication—The type of indication desired shall be specified as follows:

- D—Direct indication
- I—Indirect indication

S4.4 Shutoff Valves—The sight glass indicators shall be equipped with a manual or automatic shutoff valve of the ball-check type depending on the type of indication specified. Valve type shall be designated as:

- A—Automatic for direct indication
- M—Manual for indirect indication

S4.5 Sight Glass Material—The tube material of direct reading sight glass indicators shall be designated as follows:

- GWT—Glass with teflon heat shrink tube
- PLY—Polycarbonate
- PVC—Rigid polyvinyl chloride

S4.6 Application—The sight glass indicators may be used, but are not limited to, the following applications:

- LA—Lubricating oil and air interface
- PA—Potable water and air interface
- DA—Diesel oil and air interface
- JA—JP fuel and air interface
- FT—Deaerating feed tanks
- FA—Feed water and air interface
- AG—Aviation gasoline
- 3F—Aqueous film-forming fluid

S5. Ordering Information

S5.1 The buyer shall provide the manufacturer with all of the pertinent application data shown in accordance with S5.2. If special application operating conditions exist that are not shown in the acquisition requirements, they shall also be described.

S5.2 Acquisition Requirements—Acquisition documents shall specify the following:

- (1) Title, number, and date of this specification;
- (2) Quantity and designation of indicator;
- (3) Size of connection if specified;
- (4) Handwheel with chain when required;
- (5) Dimensions, as applicable (see Fig. 1);
- (6) Operating temperature, minimum and maximum;
- (7) Operating pressure, normal and maximum;
- (8) Operating media;
- (9) Viscosity and specific gravity of fluid for indirect indicators only;
- (10) When qualification testing is required;
- (11) Final disposition of qualification test samples;
- (12) National Stock Number (NSN) if available;
- (13) Unique product marking requirements; and
- (14) Unique packaging requirements.

S6. Materials and Manufacture

Piping material used in the construction of sight glass indicators shall be compatible with the intended service piping and media. Material for indirect indicators using a magnetic operating principle shall be corrosion-resistant steel in accordance with Type 304 of Specification A312. Only direct-type indicators with glass tube material less than 91.44 cm (36 in.) in length or indirect-type indicators shall be used for hydrocarbon and flammable fluid applications.

S6.1 Castings—The composition of castings shall be in accordance with Specifications B61 or B62.

S6.2 Forgings—The composition of forgings shall be in accordance with Alloy 632M of Specification B283.

S6.3 Welding—Welding and nondestructive testing shall be in accordance with NAVSEA Publication S9074-AR-GIB-010/278. In no case shall such processes as peening or plugging be used on castings or forgings for reclaiming any parts.

S6.4 Glass—Glass tubing shall be of annealed borosilicate transparent glass with a 1.59-cm (5/8-in.) outside diameter (o.d.) and a minimum wall thickness of 0.24 cm (3/32 in.) with a transparent fluorinated ethylene propylene plastic insulating sleeving heat shrunk over the glass tube. Glass tubes shall be used for temperatures above 66°C (150°F) but not to exceed 132°C (270°F) or where the fluid is not compatible with polycarbonate or rigid PVC. Maximum length of glass tubes shall be as specified in Drawing 803-5184222.

S6.5 Plastics—Plastics used in the sight glass indicator shall be polycarbonate in accordance with Specification D3935 or rigid PVC in accordance with Specification D1784.

S6.6 Recovered Materials—Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing intended use. The term “recovered materials” means materials that have been collected or recovered from solid waste and reprocessed to become a source of raw materials as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless specified.

S7. Physical Properties

S7.1 Design and Construction—The indicators shall be constructed so as to allow replacement of the glass tube or indicating element and also allow cleaning from either end without loosening any packing or sealing material while the pressure vessel is under pressure.

S7.1.1 Sizes—Unless otherwise specified in the acquisition requirements, the connections of direct indicators shall be of the size specified for the diameter of the tube in accordance with Table S7.1.

Connection Sizes	
Tube Diameter	Connection Size (Flanged)
1.59 cm (5/8-in. o.d.)	1.91 cm (3/4 in.)
1.91 cm (3/4-in. o.d.)	1.91 cm (3/4 in.)

S7.1.2 Valves:

S7.1.2.1 *Nonautomatic Shutoff*—The nonautomatic shutoff valve shall be in accordance with MSS SP-72 or MSS SP-110.

S7.1.2.2 *Automatic Shutoff*—Direct indicators shall have an automatic shutoff valve of the solid ball-check type in accordance with Drawing 803-5184222. The check valve shall be constructed so as to allow leakage of 5 to 25 cm³ per minute at 345 kPa (50 lb/in.²) when the check valve is in the closed position.

S7.1.2.3 *Handwheel*—When required for remote operation, the shutoff valves shall be furnished with a handwheel having an o.d. not less than 8.89 cm (3½ in.) and with holes drilled in the rim located for adapting to chain operation. When specified in the acquisition requirements, chain shall be provided.

S7.1.2.4 *Glands*—Glands for direct reading gage glasses shall be designed to minimize torsional stress on the glass when the gland is tightened.

S7.2 Protection:

S7.2.1 *Class A*—The glass tube of direct indicators shall be protected from damage by not less than four solid rods of corrosion-resistant material a minimum of 0.64 cm (¼ in.) in diameter of sufficient length to allow for a maximum 91.44-cm (36-in.) tube length. A shield shall be provided in accordance with Drawing S8700-1385802 for combustible fluids.

S7.2.2 *Class B*—Where all plastic sight tubes are used, protective rods or shields are not required. Protective rods or shields shall not be required for indirect indicators.

S7.3 *Connections*—Sight glass indicators shall have flat-face ranged connections. Flanges shall be 1.91 cm (¾ in.) in accordance with the dimensions of ANSI B16.5 classes. The flange rating shall be compatible with the maximum pressure and temperature conditions expected in the intended application and shall be based upon the ratio of the allowable stress at temperature of the material used to that for the material specified in ANSI B16.5.

S7.3.1 *Drain Connections*—The indicators shall have a drain connection to which a drain line may be connected. For pressures below 345 kPa (50 lb/in.²), the drain line connection shall be ⅜-in. NPT or larger. For pressures of 345 kPa (50 lb/in.²) or above, the drain line connection shall be a welded socket pipe nipple, ½-in. NPS or larger.

S7.4 *Temperature*—Direct reading indicators using plastic tubes shall not be used in applications above 66°C (150°F). Glass tubes shall be used for temperatures above 66°C (150°F) but not to exceed 132°C (270°F). Indirect reading indicators using flags in the indicator may be used up to 149°C (300°F) with plastic flags and 232° (450°F) with aluminum flags.

S7.5 Working Pressure:

S7.5.1 *Direct Indicators*—Maximum working pressure for direct indicators shall be as specified on Drawing 803-5184222.

S7.5.2 *Indirect Indicators*—Maximum working pressure for indirect indicators shall be 2.07 MPa (300 lb/in.²) at 149°C (300°F).

S7.6 *Interchangeability*—Parts, components, and attachments shall be interchangeable with parts and components of the same types and classes produced by the same contractor.

S8. Performance

S8.1 Accuracy:

S8.1.1 *Direct Indicator Accuracy*—Accuracy of direct indicator shall be within ±1.27 cm (½ in.).

S8.1.2 *Indirect Indicator Accuracy*—Accuracy of the indirect indicator shall be within ±2.54 cm (1 in.). In addition, when indirect indicators are capable of providing a remote indication, the remote indication shall be accurate to within ±3 % of full scale.

S8.2 *Hydrostatic Effects*—Each indirect sight glass indicator shall be capable of withstanding a hydrostatic pressure of 3.1 MPa (450 lb/in.²) when tested in accordance with S12.2.2.1. Each direct sight glass indicator shall be capable of withstanding a hydrostatic pressure of 3.1 MPa (450 lb/in.²) when tested in accordance with S12.2.2.3.

S8.3 *Inclination*—The indirect sight glass indicator shall provide accurate operation when inclined up to a 45° in any direction and tested as specified in S12.2.3.

S8.4 *Salt Spray*—The sight glass indicator shall provide accurate operation in a salt spray marine environment when tested as specified in S12.2.4.

S8.5 *Reliability*—The sight glass indicator shall operate reliably in a naval shipboard environment for a service life of at least 40 000 h. The sight glass indicator shall be mechanically reliable for operating at least 2000-h mean time between failures at a 90 % confidence level. A failure is any malfunction that requires unscheduled corrective maintenance of more than 1 h or which requires replacement of the equipment. The reliability of the sight glass indicator shall be demonstrated in accordance with S12.2.5.

S8.6 *Shock*—The indicator shall show no signs of damage when exposed to Grade A, Class I shock for indirect indicators and Grade B for direct indicators in accordance with MIL-S-901 as specified in S12.2.6.

S8.7 *Vibration*—The indicator shall show no signs of damage when exposed to Type I vibration in accordance with MIL-STD-167-1 as specified in S12.2.7.

S9. Workmanship, Finish, and Appearance

S9.1 *Cleaning and Surface Finishes*—Surfaces of castings, forgings, molded parts, stampings, and machined and welded parts shall be free of defects such as cracks, porosity, undercuts, voids, and gaps as well as sand, dirt, fins, sharp edges, scale, flux, and other harmful or extraneous materials. External surfaces shall be smooth and edges shall be either rounded or beveled. There shall be no burn-through. There shall be no warpage or dimensional change as a result of heat from welding operation. There shall be no damage to adjacent parts resulting from welding.

S10. Inspection

S10.1 *Inspection System*—The testing set forth in this specification shall become a part of the manufacturer's overall inspection system or quality program. The manufacturer's quality system shall comply with the requirements of ANSI/ASQC 9001-1994, Quality Systems—Model for Quality Assurance in Design, Development, Production, Installation, and Servicing. Certification and registration is highly desired but not required.

S10.2 *Classification of Inspections*—The inspection requirements specified herein are classified as follows:

- (1) Qualification testing and
- (2) Quality conformance testing.

S10.3 *Qualification Testing*—Qualification testing shall consist of two samples of each type indicator subjected to the examinations and tests in accordance with Table S10.1 in the order shown. Failure of any sight glass indicator to meet the requirements of this specification shall be cause for rejection.

Qualification and Quality Conformance Testing

Examination or Test	Requirement	Qualification Test Method	Quality Conformance Test Method
General examination		S12.1	S12.1
Accuracy	S8.1	S12.2.1	
Hydrostatic test	S8.2	S12.2.2	S12.2.2
Inclination	S8.3	S12.2.3	
Salt spray	S8.4	S12.2.4	
Reliability	S8.5	S12.2.5	
Shock	S8.6	S12.2.6	
Vibration	S8.7	S12.2.7	

S10.4 *Quality Conformance Testing*—Sight glass indicators that are produced on the same facilities, using identical materials, manufacturing, and assembly procedures shall be subjected to the quality conformance tests specified in Table S10.1. Sight glass indicators of the same type, class, and size offered for delivery at one time shall be considered a lot for purposes of inspections and tests.

S11. Number of Tests and Retests

S11.1 The number of tests and retests, if any, shall be specified in the acquisition requirements.

S12. Test Methods

S12.1 *General Examination*—Sight glass indicators shall be given a thorough examination to determine that it conforms to this specification and the approved drawings with respect to material, finish, construction, assembly, dimensions, workmanship, marking, identification, and information plates.

S12.2 Test Methods:

S12.2.1 *Accuracy*—Indicator accuracy shall be determined by mounting the indicator assembly to a test tank with a capacity at least 10 % greater than the total indication at the indicator. The tank shall be filled to the zero point of the indicator and in 10 % increments until the maximum level of the indicator is reached. Measurements of the actual fluid level of the tank shall be compared to level shown on the indicator. Indicator accuracy shall be in accordance with S8.1.

S12.2.2 *Hydrostatic Tests*—Sight glass indicators shall be tested at ambient conditions as a complete assembly for strength and porosity. With the shutoff valves in the open position, a pressure of 3.1 MPa (450 lb/in.²) shall be applied for 20 min. Any weeping, porosity, or deformation shall be cause for rejection. Indicators having plastic sight tubes shall have no permanent deformation of the tube upon release of the test pressure. Upon completion of the test, the pressure shall be reduced to 2.07 MPa (300 lb/in.²) and the valve shall be checked for closing readily against the maximum working pressure of the indicator. The valve shall operate with a maximum force of 13.6 kg (30 lbs).

S12.2.2.1 *Nonautomatic Shutoff Valve*—After operating the valve for ten cycles (open-close), conduct a hydrostatic test for seat tightness. With the valve in the closed position, apply 2.07 MPa (300 lb/in.²) to the inlet. Pressure shall be maintained for 15 min. No leakage shall be allowed.

S12.2.2.2 *Automatic Shutoff Valves*—Direct reading sight glass indicator shutoff valves shall be tested in accordance with Drawing 803-5184222.

S12.2.3 *Inclination Test*—Indirect indicators shall be tested inclined at 45° forward, backward, left, and right. The fluid level shall be varied between 20 to 80 % indication to verify satisfactory operation.

S12.2.4 *Salt Spray*—The complete indicator assembly and shutoff valves shall be subjected to a salt spray in accordance with Test Method B117. No appreciable corrosion or other damage shall be evident after exposure to the salt spray.

S12.2.5 *Reliability*—Reliability of the assembled indicator shall be demonstrated by the following tests:

S12.2.5.1 *Cycling*—The assembled indicator and shutoff valves shall be cycled at a minimum of 25 000 cycles at the rate of 3 to 6 cycles per minute. The fluid level shall be varied between 20 to 80 % of the total indication level. Test temperature and pressure shall be in accordance with Drawing 803-5184222, Notes 17B, C, and D. During the cycling period, the following tests shall be conducted:

(1a) After every 1000 cycles, the indicator shall be blown down by shutting the lower indicator shutoff valve and rapidly opening the indicator drain valve. Shut the drain valve and reopen the indicator lower shutoff valve.

(2) Thermal Shock. After every 3000 cycles, the indicator shall be allowed to cool to ambient temperature $24 \pm 1^\circ\text{C}$ ($75 \pm 2^\circ\text{F}$) and drained. The indicator shall be rapidly filled with hot water, 93 to 100°C (200 to 212°F) for glass tubes, 66°C (150°F) for rigid PVC tubes, to the maximum indication level. After 2 min, the indicator shall be drained and rapidly refilled with cold water, 10°C (50°F). Any evidence or spalling, cracking, breaking of the sight glass, or any abnormal wear or material deformation (during or at the end of the tests) shall constitute a failure.

S12.2.5.2 *Hydrostatic*—Upon completion of the 25 000 cycles, the indicator and valves shall be subjected to the hydrostatic test as specified in S8.2.

S12.2.6 *Shock*—Indicators shall be subjected to shock in accordance with MIL-S-901, Class I, Grade A for indirect indicators and Grade B for direct indicators. The indicators shall be tested as a complete assembly mounted on a Type 4-A mounting fixture. The shock test shall be performed in the following sequence:

(1) Valves open, indicator at 50 % fluid level and pressurized to normal working pressure. A total of nine blows shall be applied, three blows shall be applied parallel to each of the three principal axes.

(2) Valves shut, normal working pressure applied to valve inlet. Indicator dry and drain plug removed. A total of nine blows shall be applied, three blows shall be applied parallel to each of the three principal axes.

After exposure to shock, the indicator shall be refilled and the fluid level varied between 20 to 80 % to ensure satisfactory operation. The shutoff valves shall be hydrostatically tested to 3.1 MPa (450 lb/in.²) in the open position to check for body and valve stem leakage and the closed position to check for seat leakage. The indicators and valves shall be disassembled and visually examined for any damage.

S12.2.7 *Vibration*—The complete indicator assembly shall be subjected to vibration in accordance with MIL-STD-167-1, Type I. The indicator shall be filled to the 50 % indication level and pressurized to normal working pressure during exposure to vibration. After exposure to vibration, the operation of the indicator shall be accurate when the fluid level is varied between 20 to 80 % of the indicator range.

S13. Quality Assurance Provisions

S13.1 *Warranty*—Special warranty requirements shall be specified in the acquisition requirements. Otherwise, the standard commercial warranty applies.

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S14. Certification

S14.1 When specified in the purchase order or contract, the buyer shall be furnished certification that samples representing each lot have been either tested or inspected as directed in this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test result shall be furnished. It is recommended that all test data remain on file for three years at the manufacturer's facility for review by buyer upon request.

S15. Product Marking

S15.1 Unique product marking or identification plate requirements shall be specified in the acquisition requirements.

S16. Packaging and Package Marking

S16.1 Packaging shall be in accordance with the requirements of Practice **D3951**. Unique preservation, packaging, or package marking requirements shall be specified in the acquisition requirements.