

INCH-POUND
MIL-G-18997E(SH)
18 November 1991
SUPERSEDING
MIL-I-18997D
8 October 1987
(See 6.9)

MILITARY SPECIFICATION

GAUGE, PRESSURE, DIAL INDICATING

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers environmentally hardened pressure gauges that utilize a mechanical elastic element to sense the pressure to provide an analog indication of the pressure on a circular dial or vertical scale, Helical Edgeview Mechanical Pressure Indicator (HEMPI). Depending on case size and design, the pressure gauge may either be stem or flush/surface mounted.

1.2 Classification. Pressure gauges are classified according to the following variables (see 6.2):

- (a) Design (see 1.2.1).
- (b) Type of pressure (see 1.2.2).
- (c) Dial size, case design (see 1.2.3).
- (d) Elastic element material and style (see 1.2.4).
- (e) Dial range and color (see 1.2.5).
- (f) Pressure connection and connection location (see 1.2.6).
- (g) Liquid fill case fluid and vibration category (see 1.2.7).
- (h) Cleanliness (see 1.2.8).

1.2.1 Design. Pressure gauge design is designated by one of the following symbols:

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 5523, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A

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<u>Pressure gauge design</u>	<u>Symbol</u>
Simplex	S
Simplex - special applications	
Caisson	K
Cruising range	C
Oxygen	X
Refrigerant	R
Duplex	D

1.2.2 Type of pressure. Type of pressure that the pressure gauge shall indicate is designated by one of the following symbols:

<u>Type of pressure</u>	<u>Symbol</u>
Gauge pressure	G
Vacuum	V
Compound	C
Suppressed, gauge pressure	S
Retarded, gauge pressure	R
Retarded, compound pressure	T

1.2.3 Dial size and case design. The dial size and case design is designated by one of the following symbols:

<u>Dial size</u>	<u>Case design</u>	<u>Symbol</u>
2	Stem mounted	1
2-1/2	Stem mounted	2
3-1/2	Flush/surface mounted	3
4-1/2	Flush/surface mounted	4
8-1/2	Flush/surface mounted	8
1-1/4 (vertical scale)	Flush	H

1.2.4 Elastic element. The elastic element is designated by two symbols as provided below. The first symbol designates the elastic element material. The second symbol designates the elastic element style.

<u>Elastic element material</u>	<u>Symbol</u>
K-monel	M
Inconel	I
K-monel or Inconel (manufacturer option)	N

<u>Elastic element style</u>	<u>Symbol</u>
C-type bourdon tube (gear drive)	C
Helical (also helical-spiral) bourdon tube (gear drive)	H
Helical (also helical-spiral) bourdon tube (direct drive)	D
C-type, helical (gear drive), or helical (direct drive)-manufacturer option	N

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1.2.5 Dial range and color. The range and color of the pressure gauge dial is designated by a sequence of symbols for the range followed by a single symbol for the color of the dial. The sequence of symbols for the range should be selected from the appropriate table in 3.3.10.4. Each HEMPI shall be furnished with two dials; one with white background and black markings (installed) and one with black background and white markings. The single symbol for the color of the dial is designated by one of the following symbols:

<u>Dial color</u>	<u>Symbol</u>
Black background dial with white graduations and markings	B
White background dial with black graduations and markings	W
Special (see 6.2)	S
Vertical dials (HEMPI only)-white background with black markings and black background with white markings	G

1.2.6 Pressure connection and connection location. The type of pressure connection and its location for connection is designated by two symbols as provided below. The first symbol designates the type of connection fitting. The second symbol designates the location of the pressure connection.

<u>Pressure connection</u>	<u>Symbol</u>
O-ring union	R
1/4 NPT (male)	P
Welded nipple	W
Threaded vent (caisson only)	K
Flareless (bite type) 7/16-20 UNF-2A	C
7/16-20 UNF-28 (HEMPI only)	H

<u>Connection location</u>	<u>Symbol</u>
Back	A
Bottom	O
5 o'clock	C

1.2.7 Liquid fill case fluid and vibration category. The option for the pressure gauge case containing a liquid fill and the vibration category is designated by the two symbols as provided below. The first symbol designates whether a fill fluid is required (see 3.3.8). The second symbol designates the vibration category (see 4.4.9.1).

<u>Liquid fill</u>	<u>Symbol</u>
None	N
Silicone	S

<u>Vibration category</u>	<u>Symbol</u>
Category A	A
Category B	B
Category C	C

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1.2.8 Cleanliness. The cleanliness is designated by the symbols as specified below. The symbol designates the method of cleaning the pressure element assembly (see 3.3.4).

<u>Cleanliness</u>	<u>Symbol</u>
General applications	G
Oxygen applications	X

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- QQ-A-250 - Aluminum and Aluminum Alloy Plate and Sheet: General Specification For.
- QQ-A-250/6 - Aluminum Alloy 5083, Plate and Sheet.
- QQ-N-281 - Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
- QQ-N-286 - Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500).
- QQ-S-763 - Steel Bars, Wire, Shapes, and Forgings, Corrosion Resisting.
- QQ-S-766 - Steel, Stainless and Heat Resisting, Alloys, Plate, Sheet, and Strip.
- UU-P-268 - Paper, Kraft, Wrapping.
- PPP-B-566 - Boxes, Folding, Paperboard.
- PPP-B-636 - Boxes, Shipping, Fiberboard.
- PPP-B-640 - Boxes, Fiberboard, Corrugated, Triple-Wall.
- PPP-B-665 - Boxes: Paperboard, Metal Edged and Components.
- PPP-B-676 - Boxes, Setup.
- PPP-C-850 - Cushioning Material, Polystyrene, Expanded, Resilient (For Packaging Uses).
- PPP-C-1120 - Cushioning Material, Uncompressed Bound Fiber For Packaging.

MILITARY

- MIL-B-117 - Bags, Sleeves and Tubing.
- MIL-S-901 - Shock Tests, H.I. (High-Impact) Shipboard Machinery, Equipment, and Systems, Requirements for.
- MIL-T-1368 - Tube and Pipe, Nickel-Copper Alloy, Seamless and Welded.
- MIL-P-5425 - Plastic Sheet, Acrylic, Heat Resistant.
- MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.

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- MIL-R-6130 - Rubber, Cellular, Chemically Blown.
- MIL-R-6855 - Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes, General Specification for.
- MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
- MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 111).
- MIL-C-15726 - Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod and Wire.
- MS16142 - Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for.
- MIL-T-16420 - Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706).
- MIL-F-18866 - Fitting, Hydraulic Tube, Flared, 37 Degree and Flareless, Steel.
- MIL-R-20092 - Rubber or Plastic Sheets and Assembled and Molded Shapes, Synthetic, Foam or Sponge, Open Cell.
- MIL-S-22473 - Sealing, Locking, and Retaining Compounds: (Single-Component).
- MIL-P-25732 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Limited Service at 275°F (135°C).
- MIL-P-26514 - Polyurethane Foam, Rigid or Flexible, for Packaging.
- MIL-T-28800 - Test Equipment for Use with Electrical and Electronic Equipment, General Specification for.
- MIL-R-83248 - Rubber, Fluorocarbon Elastomer, High Temperature, Fluid, and Compression Set Resistant.
- MIL-P-83310 - Plastic Sheet, Polycarbonate, Transparent.
- MIL-P-83461 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F (135°C).

STANDARDS

FEDERAL

- FED-STD-H28 - Screw-Thread Standards for Federal Services.
- FED-STD-595 - Colors Used in Government Procurement.

MILITARY

- MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-130 - Identification Marking of U.S. Military Property.
- MIL-STD-278 - Welding and Casting Standard.
- MIL-STD-777 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships.
- MIL-STD-1330 - Cleaning and Testing of Shipboard Oxygen, Nitrogen and Hydrogen Gas Piping Systems.
- MIL-STD-1622 - Cleaning of Shipboard Compressed Air Systems.
- MIL-STD-45662 - Calibration Systems Requirements.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

803-841569 - Ring, Steel, for Flush Mounted Plastic Case, Gauges and Thermometers.

803-1385799 - Cases, Plastic for Pressure Gauges and Thermometers.

803-1385850 - Piping, Instrument, Pressure, for all Services.

(Application for copies should be addressed to: Commander, Portsmouth Naval Shipyard, Code 202.2, Portsmouth, NH 03801.)

PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSHIPS 0900-001-7000 - Fabrication and Inspection of Brazed Piping Systems.

(Application for copies should be addressed to the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
(DoD adopted)

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
(DoD adopted)

A 276 - Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes.

A 473 - Standard Specification for Stainless and Heat-Resisting Steel Forgings. (DoD adopted)

A 480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip. (DoD adopted)

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ASTM (Continued)

- A 581 - Standard Specification for Free-Machining Stainless and Heat-Resisting Steel Wire and Wire Rod. (DoD adopted)
- A 582 - Standard Specification for Free-Machining Stainless and Heat-Resisting Steel Bars, Hot-Rolled or Cold-Finished. (DoD adopted)
- B 26 - Standard Specification for Aluminum-Alloy Sand Castings. (DoD adopted)
- B 36 - Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar. (DoD adopted).
- B 85 - Standard Specification for Aluminum-Alloy Die Castings. (DoD adopted)
- B 117 - Standard Test Method of Salt Spray (Fog) Testing. (DoD adopted)
- B 124 - Standard Specification for Copper and Copper-Alloy Forging Rod, Bar, and Shapes. (DoD adopted)
- B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate. (DoD adopted)
- B 443 - Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625) Plate, Sheet, and Strip.
- B 637 - Standard Specification for Precipitation-Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High-Temperature Service.
- D 788 - Standard Specification for Methacrylate, Molded and Extruded Compounds.
- D 3951 - Standard Practice for Commercial Packaging. (DoD adopted)

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

UNDERWRITERS LABORATORIES INC. (UL)

404 - Gauges, Indication Pressure for Compressed Gas Service.

(Application for copies should be addressed to the Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), samples shall be subjected to first article inspection (see 6.4) in accordance with 4.2.1.

3.2 Materials. Materials of component parts of the pressure gauges shall be as specified in table I. Cast iron or glass shall not be used.

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TABLE I. Indicating assembly materials.

Part	Material	Material specification	Remarks
Case	Aluminum 1/	ASTM B 26 ASTM B 85	2/ 5/ 8/
		ASTM B 209 (alloy 5083)	2/ 6/
	Corrosion-resisting steel 1/	ASTM A 167 (300 series)	2/ 6/
	Corrosion-resisting steel 1/	ASTM A 473 (300 series)	2/ 5/
	Brass 1/	ASTM B 36 ASTM B 124	6/
Dial	Aluminum 1	ASTM B 209	See 1.2.3, 1.2.5
	Corrosion-resisting steel 1/	ASTM A 167	
	Plastic	MIL-P-83310	HEMPI only
Window	Plastic	ASTM D 788 MIL-P-5425 MIL-P-83310	Grade 8 11/
Movement	Corrosion-resisting steel	ASTM A 276 (300 or 400 series)	Bearings may be of special material as approved
Pointer	Aluminum	ASTM B 209	3/
	Corrosion-resisting steel 1/	ASTM A 167	
	Inconel	ASTM B 637	Inconel X750
Threaded fasteners	Corrosion-resisting steel	ASTM A 276 ASTM A 581 ASTM A 582 (300 or 400 series)	7/
Washers	Corrosion-resisting steel	ASTM A 276 ASTM A 480	
Gaskets	Neoprene	MIL-R-6130 MIL-R-6855	Type II, grade A Class 4, type A

See footnotes at end of table.

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TABLE I. Indicating assembly materials - Continued.

Part	Material	Material specification 9/	Remarks
O-rings	Fluorocarbon rubber	MIL-R-83248	O-rings, type 1
	Nitrile rubber (Buna N) (180°F max)	MIL-P-25732 MIL-P-83461	
Elastic element 10/	K-monel UNS-NO5500 11/	QQ-N-286	
	Inconel UNS-NO7750	ASTM B 637	Inconel X750
	Inconel UNS-NO6625	ASTM B 443	Inconel 625
Pressure element assembly 4/	Monel	QQ-N-281 MIL-T-1368	
	Copper-nickel	MIL-T-16420 MIL-C-15726	Cu-Ni 70-30 Cu-Ni 90-10
	Nickel-copper	MIL-T-1368	

- 1/ Aluminum shall be prepared for protection against corrosion by chromate conversion coatings in accordance with MIL-C-5541, or by anodizing in accordance with type I or II of MIL-A-8625. Corrosion-resisting steel and brass shall be prepared by providing a 0.001 to 0.002 inch surface profile.
- 2/ Case finish shall include a flash air-dry primer and a gray enamel finish coat. The finish coat shall be in accordance with type II of MIL-E-15090.
- 3/ Indicating pointers shall be dull black color with white background dials and white color when dials have black backgrounds. Red index (see 6.7) shall be painted red and adjustable to any pressure on the scale. Duplex indicator pointers shall be orange and green. Pointer tip shall be in accordance with ANSI B40.1. The HEMPI pointer shall be florescent orange in accordance with FED-STD-595, color number 38903.
- 4/ Pressure element assembly shall include elastic element, pressure connection, stem, tip, capillary, joints, and other components which are exposed to the process fluid. These components shall be in accordance with ANSI B40.1. Note: The elastic element material is specified separately.
- 5/ Flush/surface mounted pressure gauge case material shall be aluminum or corrosion-resisting steel.
- 6/ Stem mounted pressure gauge case material shall be aluminum, corrosion-resisting steel or brass. Brass shall only be used for ranges 0/100 pounds per square inch (lb/in²) and below.
- 7/ Unless otherwise specified herein, retaining compound in accordance with grade C of MIL-S-22473 shall be used.
- 8/ Aluminum alloy shall be selected to meet shock test requirements (see 3.4.10).
- 9/ The following Federal specifications are compatible with and can be used in lieu of the ASTM specification listed:

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<u>Federal</u>	<u>ASTM</u>	<u>Remarks</u>
QQ-A-250 and QQ-A-250/6	ASTM B 209	alloy 5083
QQ-S-763	ASTM A 276	300 or 400 series
QQ-S-766	ASTM A 167	300 series

10/ The elastic element material for oxygen service shall be K-monel.

11/ Material specification is for material composition only.

3.2.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which 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 otherwise specifically specified.

3.2.2 Restricted materials. The pressure gauge shall not contain restricted material as defined in MIL-T-28800.

3.2.3 Liquid fill pressure gauge gaskets and O-rings. Gaskets and O-rings used in liquid filled pressure gauges as case seals shall show no discoloration of the liquid fill case fluid (see 4.6).

3.3 Construction. Gauges shall be constructed as specified in 3.3.1 through 3.3.12 (see 6.3 and appendix). Pressure gauges shall mount as specified in 1.2.3. The gauges shall not be damaged or affected by applying vacuum pressure or overpressure (see 4.4.4). "Zero" adjustment shall be made to the pressure gauges from the front of the gauge.

3.3.1 Parts interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance, and strength.

3.3.2 Oxygen service. Oxygen pressure gauges shall be simplex for indicating gauge pressure. The gauge shall be cleaned as specified herein (see 3.3.4) without disassembly (except removal of the backplate). Only pressure gauges utilizing a C-type bourdon tube as the elastic element shall be used for oxygen service. Minimum bore diameter throughout the pressure element assembly shall be not less than 0.025 inch.

3.3.3 Non-oxygen service. Minimum bore diameter throughout the pressure element assembly shall be not less than 0.030 inch when the elastic element is a C-type bourdon tube.

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3.3.4 Cleaning. Pressure element assembly and associated parts in contact with the service fluid shall be free of loose scale, rust, grit, filings, mercury, calibration liquids, oil, grease, solvents, or other organic materials.

3.3.5 Welding and brazing. Internal pressure containing parts shall be joined by welding or brazing. Welding shall be in accordance with MIL-STD-278 and brazing in accordance with NAVSHIPS 0900-001-7000 .

3.3.5.1 General applications. Joints shall be either welded or microbrazed. Depending on the pressure range, MIL-STD-278, class P-1 or P-2 shall apply for welding. Class P-3 shall apply for microbrazing.

3.3.5.2 Oxygen applications. Joints shall be welded for all ranges, MIL-STD-278, class P-1 shall apply.

3.3.6 Threads. Threads shall be in accordance with FED-STD-H28. Tapered threads shall not be used except on 2- and 2-1/2 inch dial sizes for ranges 0/100 lb/in² and below.

3.3.7 Case. Pressure gauge cases shall be safety solid front as defined in ANSI B40.1. Nonsolid front is permitted for gauges with elastic element styles H and D (see 1.2.4). Nonsolid front gauges shall be constructed so that no parts of the gauge shall be propelled or thrown from the assembly due to an application of excessive pressure (see 4.4.13). Pressure shall be relieved out the back or side of the case should slow leakage or rupture of the pressure element assembly occur.

3.3.7.1 Circular scale gauges.

3.3.7.1.1 Flush/surface mounted case. Cases with the flush or surface mounted configuration shall be interchangeable for mounting purposes with the cases shown in Drawing 803-1385799. Case mounting dimensions shall be as specified in table II. Dimensions A, A1, A8, A10, A15, A17 and A29 shall be critical dimensions of the case and shall be in strict accordance with Drawing 803-1385799. Dimension A30 may be greater than indicated in Drawing 803-1385799 but shall not exceed 4 inches. Flush mounting rings for pressure gauge cases shall be similar to and interchangeable with those shown in Drawing 803-841569. Dimensions A2, A3, A4, A5, C12, H1 and H2 shall be critical dimensions of the flush mounting ring and shall be in strict accordance with Drawing 803-841569. Unless otherwise specified (see 6.2), flush or surface mounted gauges shall be provided with this flush mounting ring and the associated mounting hardware.

TABLE II. Mounting dimensions.

Size (inches)	Panel hole diameters (inches)	Bolt circle (inches)	Bolt hole diameter (inch)	Bolt size and threads
3-1/2	4-15/32	4-1/4	7/32	10-24
4-1/2	5-19/32	5-3/8	7/32	10-24
8-1/2	9-29/32	9-5/8	9/32	1/4-20

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3.3.7.1.2 Stem mounted case. Cases with the stem mounted configuration shall be only used with 2- and 2-1/2 inch dial sizes. The 2- and 2-1/2 inch dial size pressure gauges shall have a maximum case diameter of 2-1/4 and 2-3/4 inches respectively. The pressure gauge case shall prevent pressure buildup within the case as specified in 3.4.12. The case shall be fitted with a window of not less than 1/16-inch thickness which is free from blemishes and scratches. The window may be secured to the case with a threaded ring. Pressure gauge materials shall be as specified in table I. This pressure gauge case configuration shall be for non-oxygen service. For ranges of 0/150 lb/in² and above, the case shall be of a solid front configuration except for types H and D (see 1.2.4).

3.3.7.2 Vertical scale gauges. HEMPI mounting configuration shall be as specified on figure 1. HEMPIs shall be flush mounted in a panel opening either individually or in groups not to exceed ten indicators. Panel opening dimensions shall be as specified in table III.

TABLE III. Vertical scale mounting dimensions, inches.

Number of indicators	Rectangular panel opening	
	Horizontal	Vertical
One	1-3/16	4-3/8
Two	2-3/8	4-3/8
Three	3-9/16	4-3/8
Four	4-3/4	4-3/8
Five	5-15/16	4-3/8
Six	7-1/8	4-3/8
Seven	8-5/16	4-3/8
Eight	9-1/2	4-3/8
Nine	10-11/16	4-3/8
Ten	11-7/8	4-3/8

3.3.8 Liquid fill case fluid. When liquid filled cases are required, the fill fluid shall be Dow Corning DC-200, or equal. The case shall be filled to a minimum of 75 percent of the case volume. Liquid filled gauges shall not be used on oxygen systems, and shall have a warning label on the rear of the case which states:

"WARNING
DO NOT USE ON OXYGEN SYSTEMS.
CONTAINS SILICONE LIQUID FILL."

3.3.9 Connections. Connections shall be as specified in 3.3.9.1 through 3.3.9.4.2.

3.3.9.1 Non-oxygen service. Unless otherwise specified (see 6.2), the pressure connection shall be in accordance with Drawing 803-1385850 for the figures showing "connectors for gauges with male straight thread O-ring

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connections". A complete assembly, including the threaded end, the union nut, the tail piece and the O-ring shall be provided with each gauge. The threaded end shall be integral with the gauge. Alternative pressure connection shall be selected from the pressure connections specified in table IV. The pressure connection specified shall be configured to permit wrench tightening.

TABLE IV. Pressure connection requirements and applications.

Pressure connection	Threads	Documents	Intended use
O-ring union	9/16-18UNF-3A	Drawing 803-1385850	For new construction, retrofit, and replace- ment.
Taper pipe thread	1/4-18NPT-2A	FED-STD-H28	For use in stem mounted pressure gauges with ranges 0/100 lb/in ² or below (see MIL-STD-777).
1/4-inch nps, nickel-copper pipe nipple, 6 inches long	Welded (see MIL-STD-278)	MIL-T-1368, schedule 80	For oxygen systems for welding the pressure connection to adjacent piping.
Flareless (bite type)	7/16-20 UNF-2A	MIL-F-18866- Male 7/16-20 thread, 6000 psi for 1/4- inch od tubing	For use in existing submarine service appli- cations where conversion to an O-ring union con- nection is not appropriate
O-ring union (HEMPI)	7/16-20 UNF-2B	MS16142	For HEMPI applications only

3.3.9.1.1 Caisson gauge vent configuration. Caisson gauge case shall be open to the ambient pressure through a vent in the bottom of the case. The vent shall be threaded to accept a 1/4-inch NPT male fitting.

3.3.9.1.2 Stem mounted case. The pressure connection shall be threaded with 1/4-inch NPT male threads as specified in table IV for ranges 0/100 lb/in² and below.

3.3.9.1.3 HEMPI case. The pressure connection shall be in accordance with MS16142. In addition, an adapter shall be provided. The adapter shall consist of a fitting (7/16-20 UNF-2A to 9/16-18 UNF-3A), nut, O-ring, and tailpiece in accordance with Drawing 803-1385850 except that the tailpiece shall be configured for 1/8-inch tubing.

3.3.9.2 Oxygen service. Pressure connection shall be a monel pipe nipple, 1/4-inch nominal pipe size (nps) with 0.109-inch minimum wall thickness, 6 inches long, welded to the socket in accordance with MIL-STD-278. Connection location shall be at the lower back or bottom of the case.

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3.3.9.3 Connection location. Connection location shall be in accordance with 3.3.9.3.1 through 3.3.9.3.3.

3.3.9.3.1 Flush/surface mounted case. The pressure connection for flush/surface mounted cases shall be located at the lower back or bottom of the case or at the 5 o'clock position (except for caisson gauges). The 5 o'clock position shall only be used for non-oxygen applications.

3.3.9.3.2 Stem mounted case. The pressure connection for stem mounted cases shall be located at the bottom or center back of the case.

3.3.9.3.3 HEMPI case. The pressure connection for the HEMPI case shall be located at the lower back of the case as shown on figure 1.

3.3.9.4 Connection length. The connection length requirements shall only pertain to flush/surface mounted pressure gauges.

3.3.9.4.1 Back connection location. The protrusion length of the pressure connection from the back of circular scale cases shall be 1.2 ± 0.3 inches. The HEMPI case pressure connection (without adapter fitting shall protrude 0.75 ± 0.3 inches from the back of the case.

3.3.9.4.2 Bottom connection location (also 5 o'clock position). The interchangeability length is the distance from the horizontal center line of the pressure gauge dial to the free end of the pressure connection (not including the union nut and tailpiece for the O-ring union type). The interchangeability length shall be 3.2 ± 0.3 inches for the 3-1/2 inch dial size, 3.8 ± 0.3 inches for the 4-1/2 inch dial size, and 5.8 ± 0.3 inches for the 8-1/2 inch dial size.

3.3.10 Dial.

3.3.10.1 Circular scale gauges. Dial configuration, style, pointer rotation and pointer interface shall be in accordance with ANSI B40.1.

3.3.10.1.1 Dimensions. Dial numerals and scale dimensions shall be as specified in table V.

TABLE V. Dial dimensions.

Size (inches)	Numeral height (min) (inch)	Diameter scale base line (min) (inches)	Dial blank diameter (min) (inches)
2	1/8	1-13/16	2
2-1/2	5/32	2-5/16	2-9/16
3-1/2	7/32	3	3-5/16
4-1/2	9/32	4-1/8	4-5/16
8-1/2	1/2	7-3/4	8-1/4

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3.3.10.1.2 Markings. Dial markings shall include:

- (a) Manufacturer's name or trademark.
- (b) Military Specification classification (see 1.2).
- (c) National stock number.
- (d) Manufacturer's cage number.
- (e) Scale graduations, numerals and units of graduations.
- (f) The words "OXYGEN SERVICE" in red printing, for gauges intended for oxygen service applications.
- (g) Pressure gauges with scales calibrated in lb/in² gauge shall be marked "PSIG".
- (h) Markings for submarine seawater service shall be single scale. Depth gauges shall be graduated in feet of seawater; other submarine sea water gauges shall be graduated in lb/in².
- (i) Cruising range gauges shall contain the words "cruising turbine exhaust pressure".
- (j) Unless otherwise specified (see 6.2), dial color markings shall be white background with black graduations and markings.
- (k) Caisson gauges shall be dual scale with the inner scale graduated in feet of seawater and the outer scale in lb/in².

3.3.10.2 HEMPIs. Dial configuration, style, pointer rotation, and pointer interface shall be as specified on figure 1.

3.3.10.2.1 Dimensions. The dial numerals shall be 1/8 inch (minimum) in height. The scale shall be 3/4 inch (maximum) in width. At least 1/8 inch of the dial blank, measured from the left hand edge, shall remain blank along it's entire length.

3.3.10.2.2 Dial markings. Dial markings shall include:

- (a) HEMPIs with scales calibrated in lb/in² gauge shall be marked "PSIG".
- (b) HEMPIs with compound scales shall have "PSIG" marked in the positive portion of the scale and "in HG" marked in the negative portion of the scale.

3.3.10.2.3 Case markings. Case markings shall be on the top surface of the HEMPI gauge (see figure 1). Case markings shall include:

- (a) Manufacturer's name or trademark.
- (b) Manufacturer's cage number.
- (c) Military specification classification (see 1.2).
- (d) National stock number.

3.3.10.3 Scale. Scales for circular dials shall cover an arc of not less than 270 degrees central angle. Scales for circular dial gauges with pressure ranges below 0/60 lb/in² shall cover an arc of not less than 135 degrees central angle. HEMPI dials shall cover an arc of not less than 45 degrees central angle. Graduations shall consist of minor, intermediate and numbered graduations.

3.3.10.3.1 Cruising range gauge. Scales for the cruising range gauge shall contain the information shown on figure 2 and shall appear on the dial in the form of arcs in the format as shown on figure 2.

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3.3.10.4 Ranges and minor graduations. Ranges and minor graduations shall be in accordance with tables VI through XIV, as specified (see 6.2). Ranges shall apply only to the case sizes specified.

TABLE VI. Gauge pressure ranges and minor graduations.

Gauge pressure ranges $\frac{3}{}$ (lb/in ²)	Minor graduations						Range designator (see 1.2.5)
	2-inch size	2-1/2 inch size	3-1/2 inch size	4-1/2 inch size	8-1/2 inch size	HEMPI	
1/ 0/15	1/2	1/2	1/2	1/4	1/4	--	15P
1/ 0/30	1	1/2	1/2	1/2	1/4	1/2	30P
1/ 0/60	2	1	1	1	1/2	1	60P
1/ 0/100	2	2	2	1	1	2	1hP
1/ 0/200	-	5	5	2	1	5	2hP
1/ 0/300	-	5	5	5	2	5	3hP
1/ 0/400	-	10	10	5	2	10	4hP
1/ 0/600	-	10	10	10	5	10	6hP
1/ 0/800	-	10	20	10	5	20	8hP
1/ 0/1000	-	20	20	10	5	20	1kP
2/ 0/1500	-	20	20	20	10	25	15hP
2/ 0/2000	-	20	20	20	10	50	2kP
2/ 0/3000	-	50	50	50	20	50	3kP
2/ 0/5000	-	-	100	50	25	100	5kP
2/ 0/8000	-	-	100	100	50	200	8kP
2/ 0/10000	-	-	200	100	50	200	10kP

1/ Applicable to simplex and duplex indicators.

2/ Applicable to simplex only.

3/ If the minor graduation is not provided, that particular range is not covered by this specification.

TABLE VII. Vacuum pressure ranges and minor graduations.

Range (inches of mercury (Hg))	Minor graduations					Range designator (see 1.2.5)
	2-inch size	2-1/2 inch size	3-1/2 inch size	4-1/2 inch size	8-1/2 inch size	
0/30	1	1/2	1/2	1/2	1/4	V

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TABLE VIII. Compound pressure ranges and minor graduations.

Ranges		Minor graduations						Range designator <u>1/ 2/</u> (see 1.2.5)
		3-1/2 inch and 4-1/2 inch		8-1/2 inch		HEMPI		
Vacuum scale (inches Hg)	Gauge pressure scale (lb/in ²)	Vacuum	lb/in ²	Vacuum	lb/in ²	Vacuum	lb/in ²	
30	0/15	1	1/2	1/2	1/4	2	1	15C
30	0/30	1	1/2	1/2	1/4	5	2	30C
30	0/60	2	1	1	1/2	5	2	60C
30	0/100	2	1	1	1	5	2	1hC
30	0/150	5	2	2	1	5	2	150C
30	0/200	5	2	2	2	10	5	2hC
30	0/300	10	5	5	2	10	5	3hC
30	0/400	10	5	5	2	15	10	4hC
30	0/600	10	10	10	5	15	20	6hC
30	0/800	10	10	10	5	--	--	8hC
30	0/1000	30	10	15	10	--	--	1kC

- 1/ Refrigerant identification symbol and a separate temperature degrees Fahrenheit (°F) equivalent scale in red printing in addition to the pressure scale in lb/in², when applicable.
- 2/ When applicable, the type of refrigerant used with the pressure gauge shall be designated by the appropriate numeral following the letter "C":

Refrigerant Numeral

R11	1
R12	2
R22	3
R114	4

TABLE IX. Suppressed pressure ranges and minor graduations,
8-1/2 inch size.

Pressure range lb/in ²	Minor graduation	Range designator (see 1.2.5)
1000/1500	5	S

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TABLE X. Retarded pressure ranges and minor graduations, 4-1/2 inch size.

Ranges		Minor graduation				Range designator (see 1.2.5)
Vacuum scale (inches Hg)	Gauge pressure scale (lb/in ²)	Expanded portion of scale		Retarded portion of scale		
		Range	Graduation	Range (lb/in ²)	Graduation (lb/in ²)	
---	0/30	0/10 lb/in ²	1/4 lb/in ²	10/30	5	R1
30	0/30	30 inches	1 inch	5/30	5	R2
30	0/150	0/5 lb/in ²	1/4 lb/in ²			
		30 inches	1 inch	75/150	5	R3
		0/75 lb/in ²	1 lb/in ²			

TABLE XI. Caisson pressure ranges and minor graduations.

Ranges 1/, 2/	Minor graduations						Range designator (see 1.2.5)
	3-1/2 inch		4-1/2 inch		8-1/2 inch		
	lb/in ²	ft.dp.	lb/in ²	ft.dp.	lb/in ²	ft.dp.	
0/100 lb/in ² -0/230 ft.dp.	1	2	1	2	1	2	1hK
0/200 lb/in ² -0/450 ft.dp.	1	2	1	2	1	2	2hK
0/300 lb/in ² -0/675 ft.dp.	2	5	2	5	2	5	3hK
0/380 lb/in ² -0/850 ft.dp.	2	10	2	10	2	10	380K
0/400 lb/in ² -0/900 ft.dp.	2	10	2	10	2	10	4hK

- 1/ Select range that is 50 percent greater than normal operating pressure (depth).
 2/ Feet shall indicate feet (depth) of seawater. One foot of seawater shall equal 0.4453 psi.

TABLE XII. Receiver pressure ranges and minor graduations. 1/

Ranges		Minor graduations (percent)			Range designator (see 1.2.5)
Percent scales (percent)	Pressure ranges (lb/in ²)	2-1/2 inch	3-1/2 inch		
0/100	3/15	1	1	15N	
0/100	3/27	1	1	27N	
0/100	0/60	1	1	60N	

- 1/ Receiver gauges shall include five equally spaced referenced pressure graduations in lb/in² on the graduated scale in addition to the scale graduations and markings in units for the range of the primary sensing transmitter, when applicable.

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TABLE XIII. Oxygen service ranges and minor graduations.

Ranges lb/in ²	Minor graduations		Range designator (see 1.2.5)
	3-1/2 inch size	4-1/2 inch size	
0/100	2	1	1hX
0/3000	50	50	3kX
0/5000	100	50	5kX

TABLE XIV. Cruising range pressure and minor graduations,
8-1/2 inch size.

Ranges		Minor graduations		Range designator (see 1.2.5)
Vacuum scale (inches Hg)	Gauge pressure scale (lb/in ²)	Vacuum	lb/in ²	
30	0/200	1	none	T

3.3.10.4.1 Submarine depth gauges. If submarine sea water system pressure gauges which require "feet" (depth) of seawater equivalent scales are required, test depth shall be specified and the contract classified accordingly. The range designator for depth gauges shall be the letter "D".

3.3.10.5 Units of graduation. Units of graduation shall be those specified in tables VI through XIV for ranges and minor graduations.

3.3.11 Overrange stops. Overrange stops for circular scale gauges shall be in accordance with 3.3.11.1 and 3.3.11.2.

3.3.11.1 Direct drive gauges. An elastic element overrange stop shall be installed in each pressure gauge. The pointer stop shall prevent the pointer from completing a full rotation. The pointer stop should be located at a position where the pointer can be stopped without the accuracy exceeding its limits and without a permanent deformation in the bourdon tube (this being verified by the pressure integrity test of 4.4.4).

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3.3.11.2 Gear drive gauges. An elastic element overrange stop shall be installed in each pressure gauge. The overrange stop shall be adjustable and shall be set for 105 percent of the full scale pressure.

3.3.12 Red index. When specified (see 6.2), a red index (see 6.7) shall be provided.

3.4 Performance. Performance shall be as specified in 3.4.1 through 3.4.12.

3.4.1 Accuracy. Accuracy shall be in accordance with 3.4.1.1 through 3.4.1.3

3.4.1.1 Pressure gauge. The accuracy of the pressure gauges shall be within plus or minus the percent of span listed below.

3.4.1.1.1 Dial size - 2-inch. The accuracy of 2-inch dials shall be within plus or minus 3 percent of span.

3.4.1.1.2 Dial sizes - 2-1/2 inch. The accuracy of 2-1/2 inch dials shall be within plus or minus 2 percent of span.

3.4.1.1.3 Dial sizes - 3-1/2, 4-1/2 and 8-1/2 inch. The accuracy of 3-1/2, 4-1/2 and 8-1/2 inch dials shall be within plus or minus 1 percent of span.

3.4.1.1.4 Cruising range gauge. The accuracy of cruising range gauges shall be within plus or minus 1 percent of span in the vacuum portion of the range. The pressure portion of the cruising range gauge shall be set at three points (0, 100, and 200 lb/in²) and provide a rough indication of gauge pressure (plus or minus 10 percent of span) at the three points.

3.4.1.1.5 Retarded gauges. The accuracy of retarded gauges in the expanded portion of the span shall be plus or minus 1 percent of the expanded portion of the span. The accuracy in the compressed portion of the span shall be plus or minus 1 percent of full span.

3.4.1.1.6 HEMPIs. The accuracy of the HEMPI shall be within plus or minus 2 percent of span for indicators with upper range limits of 5000 lb/in² and below and within plus or minus 2.5 percent of span for indicators with upper range limits above 5000 lb/in².

3.4.1.1.7 Suppressed gauges. The accuracy of suppressed scale gauges shall be within plus or minus 1 percent of span. The span is defined as the difference between the maximum and minimum scale pressures.

3.4.1.2 Friction error. For ranges above 0/60 lb/in², the friction error shall not exceed 1/2 the specified accuracy. For ranges 0/60 lb/in² and below, the friction error shall not exceed 1 minor graduation.

3.4.1.3 Reference measurement. The accuracy of the pressure gauge shall be within plus or minus the applicable percent of span specified in 3.4.1.1.1 through 3.4.1.1.7. The friction error requirement of 3.4.1.2 shall also apply.

3.4.2 Repeatability. The repeatability of the pressure gauge shall be within plus or minus 1/2 the specified accuracy.

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3.4.3 Inclination. Maximum deviation of the pressure gauge indication resulting from inclination shall be within plus or minus 1/2 of the specified accuracy (see 3.4.1) except for ranges 0/100 lb/in² and below which shall be within twice the specified accuracy (see 3.4.1).

3.4.4 Pressure integrity. The pressure gauge pressure element assembly shall show no evidence of leakage and there shall be no downscale shift in the pointer position (see 4.4.4). A downscale shift indicates a loss of pressure when the pressure gauge is pressurized first to the maximum scale reading, then to the other pressures specified (see 4.4.4). The pressure gauge shall be exposed to the pressure conditions without damage or a change in accuracy exceeding that specified in 3.4.1.3 (see 4.4.4).

3.4.5 Temperature: Temperature shall be as specified in 3.4.5.1 through 3.4.5.5.

3.4.5.1 High temperature. Pressure gauges shall be exposed continuously to a 145°F ambient temperature without damage. Accuracy of the pressure gauge indication, found from the reference measurements taken during the test specified in 4.4.5.1, shall be within plus or minus twice the specified accuracy. Accuracy of the pressure gauge indication, found from a reference measurement taken after the high temperature test, shall be as specified in 3.4.1.3.

3.4.5.2 Low temperature. The pressure gauge shall be exposed continuously to a 40°F ambient temperature without damage. Accuracy of the pressure gauge indication, found from the reference measurements taken during the test specified in 4.4.5.2, shall be within plus or minus twice the specified accuracy. Accuracy of the pressure gauge indication, found from a reference measurement taken after the low temperature test, shall be as specified in 3.4.1.3.

3.4.5.3 Seal integrity. The pressure gauge shall be exposed cyclically to a varying ambient temperature without damage or leakage of fill fluid. Accuracy of the pressure gauge indication shall be as specified in 3.4.1.3 (see 4.4.5.3).

3.4.5.4 Storage and temperature. The pressure gauge shall be exposed cyclically to a varying ambient temperature without damage. Accuracy of the pressure gauge indication shall be as specified in 3.4.1.3 (see 4.4.5.4).

3.4.5.5 Seal stability. The pressure gauge shall be exposed continuously to a 145°F ambient temperature without damage, without signs of visible chemical attack on the materials, without visible discoloration in the fill fluid and without deterioration of the pressure gauge seals. Accuracy of the pressure gauge indication shall be as specified in 3.4.1.3 (see 4.4.5.5).

3.4.6 Enclosure. The pressure gauge shall show no evidence of water leakage into the case between the dial and window. A reference measurement shall meet the accuracy requirements of 3.4.1.3 (see 4.4.6).

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3.4.7 Load (for stem mounted pressure gauges). The stem mounted pressure gauge shall show no evidence of improper operation, distortion of the case, damage or failure (see 4.4.7). A reference measurement shall exhibit no change in the accuracy and shall meet the requirements of 3.4.1.3 (see 4.4.7).

3.4.8 Salt spray. The pressure gauge shall show no evidence of visible corrosion or other damage, or exhibit improper operation. The reference measurement shall meet the accuracy requirements of 3.4.1.3 (see 4.4.8).

3.4.9 Vibration. The pressure gauge shall show no evidence of improper operation, failure, or damage (see 4.4.9). Total pointer oscillation shall not exceed plus or minus 5 percent of span (plus or minus 10 percent of span for ranges 0/100 lb/in² and below), peak to peak, at any test frequency. Center of pointer oscillation shall remain within plus or minus 1 minor graduation of the reading obtained under static conditions. The red index (see 6.7) shall not shift during the vibration test. A reference measurement shall meet the accuracy requirements of 3.4.1.3 (see 4.4.9). There shall be no significant wear on any vital part. Significant wear is defined as wear which causes dimensional changes to gear teeth visible to the naked eye or which causes increased gearing backlash. Wear to other parts is significant if it affects pressure gauge performance. Any pressure gauge behavior not covered herein which could be a serious vibration performance defect shall be cause for failure.

3.4.10 Shock. Shock requirements shall be as specified in 3.4.10.1 through 3.4.10.2.

3.4.10.1 Ranges 0/60 lb/in² and above. The pressure gauges shall show no evidence of improper operation, failure, or damage (see 4.4.10). A shift in pointer indication shall not exceed plus or minus twice the specified accuracy (see 3.4.1) for any single blow or a total shift of plus or minus three times the specified accuracy after each set of nine blows. The red index (see 6.7) shall not shift during the shock test. A reference measurement performed after the conclusion of each set of nine blows, but before a zero adjustment is made, shall not exceed plus or minus three times the specified accuracy. A second reference measurement performed after each set of nine blows shall meet the accuracy requirements of 3.4.1.3 after a zero adjustment is made.

3.4.10.2 Ranges 0/30 lb/in² and below. The pressure gauge shall show no evidence of improper operation, failure, or damage (see 4.4.10). A shift in the pointer indication shall not exceed plus or minus 10 percent of span for any single blow or a total shift of 25 percent of span after each set of nine blows. The red index (see 6.7) shall not shift during the shock test. A reference measurement performed after the conclusion of each of the nine blows, but before a zero adjustment is made, shall not exceed plus or minus 25 percent of span. A second reference measurement performed after a zero adjustment shall meet the accuracy requirements of 3.4.1.3.

3.4.11 Pressure cycling. The pressure gauge shall show no evidence of improper operation, failure or damage (see 4.4.11). A reference measurement shall be within plus or minus three times the specified accuracy (see 3.4.1) but not more than 6 percent of span. The pressure gauge shall meet the requirements of 3.4.4.

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3.4.12 Case pressure relief. The pressure relief device (pressure relief plug, blowout disc, or pressure relief back) shall be blown from the case (pressure relief plug or blowout disc), successfully open (pressure relief back), or relieve pressure from the case without causing a failure in either the case or the window (see 4.4.12).

3.5 Drawings. See 6.3.

3.6 Instruction sheets. Unless otherwise specified (see 6.2), an 8-1/2 by 11-inch installation instruction sheet shall be provided for each pressure gauge.

3.7 Identification of product. Pressure gauges and parts shall be marked for identification in accordance with MIL-STD-130.

3.8 Workmanship. Pressure gauges shall be in accordance with the dimensions, design, colors, accuracy, markings, and materials specified herein. Pressure gauges shall withstand the tests specified herein without permanent deformation or malfunction, and shall be clean and free of cracks and burrs.

3.8.1 Cleaning and surface finishes. Surfaces of castings, forgings, molded parts, stampings, machined, and welded parts shall be clean and free from sand, dirt, sharp edges, scales, flux, and other harmful or extraneous materials. These surfaces shall also be free of defects such as cracks, porosity, undercuts, voids, and gaps. 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 due to heat from welding operations. There shall also be no damage to adjacent parts resulting from the welding.

3.8.2 Assembled pressure gauge interchangeability. Dimensions; mounting; pressure connection type, length and location; scale numerals and graduations; and other interchangeability requirements shall be verified during the inspection process.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements (examinations and tests) as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to ensure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as a part of manufacturing operations, is an

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acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

- (a) First article inspection (see 4.2.1).
- (b) Quality conformance inspection (see 4.2.2).

4.2.1 First article inspection. First article inspection shall be performed prior to production. First article inspection shall be performed on samples which have been produced with equipment and procedures normally used in production. First article inspection shall consist of the examination and tests specified in table XV. Specification conformance drawings (see appendix) must have NAVSEA approval prior to first article inspection.

TABLE XV. Examination and tests.

Examination or test	Requirement	Test method	First article inspection	Quality conformance inspection	Quality conformance sampling plan
General examination	3.2, 3.3, 3.6, 3.7	4.3	X	X	B
Accuracy	3.4.1	4.4.1	X	X	B
Repeatability	3.4.2	4.4.2	X	X	B
Inclination	3.4.3	4.4.3	X	---	
Pressure integrity 1/	3.4.4	4.4.4	X	X	B
High temperature 1/	3.4.5.1	4.4.5.1	X	---	
Low temperature 1/	3.4.5.2	4.4.5.2	X	---	
Seal integrity 1/	3.4.5.3	4.4.5.3	X	---	---

See footnotes at end of table.

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TABLE XV. Examination and tests - Continued.

Examination or test	Requirement	Test method	First article inspection	Quality conformance inspection	Quality conformance sampling plan
Storage and temperature cycling 1/	3.4.5.4	4.4.5.4	X	---	---
Seal stability 1/	3.4.5.5	4.4.5.5	X	---	---
Enclosure 1/	3.4.6	4.4.6	X	---	---
Load 1/	3.4.7	4.4.7	X	---	---
Salt spray 1/	3.4.8	4.4.8	X	---	---
Vibration 1/ 2/	3.4.9	4.4.9	X	---	---
Shock 1/ 2/	3.4.10	4.4.10	X	---	---
Pressure cycling 1/ 2/	3.4.11	4.4.11	X	---	---
Case pressure relief	3.4.12	4.4.12	X	---	---
Elastic element or joining means failure	3.3.7	4.4.13	X	---	---

1/ A reference measurement (see 4.4.1.3) shall be performed just prior to and after the conclusion of this test and the pressure gauge performance shall meet the accuracy requirements specified in 3.4.1.3.

2/ A leakage test (see 4.4.4) shall be performed before the reference measurement prior to this test and before the reference measurement after the conclusion of this test. The pressure gauge performance shall meet the requirements specified in 3.4.4.

4.2.1.1 Sample size. Two samples of each configuration shall be subjected to first article inspection. Each configuration shall include, but may not be limited to, the same elastic element and case.

4.2.1.2 Order of inspection. The sample pressure gauges shall be subjected to the inspections specified in table XV in the order listed. Any deviation in the test order must first be approved by NAVSEA.

4.2.2 Quality conformance inspection. A quality conformance inspection shall be performed by the contractor on each lot of gauges produced. Quality conformance inspection shall consist of the examination and tests specified in table XV (see 6.3).

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4.2.2.1 Inspection lot. For purposes of quality conformance inspection, a lot shall consist of all pressure gauges of the same classification (see 1.2), produced under the same conditions in the same facility from the same materials and offered for delivery at one time.

4.2.2.2 Quality conformance inspection sampling. As a minimum the contractor shall randomly select in accordance with tables XV, XVI, and XVII a sample quantity from each lot of gauges and inspect them in accordance with table XV and XVII. Sample size depends on the sampling plan code letters specified in tables XV and XVII. Minimum sample sizes for each lot size are specified in table XVI. If one or more defects are found in any sample, the entire lot shall be rejected. The contractor has the option of screening 100 percent of the lot for the defective characteristics or providing a new lot which shall be inspected in accordance with the sampling plan provided herein.

4.2.2.3 Oxygen applications. Oxygen service gauges shall not be examined on a sampling basis. One hundred percent (100%) of all oxygen service gauges shall be examined for cleanliness, marking, and packaging.

4.3 General examination. Pressure gauges shall be examined to ascertain that the material, finish, workmanship, construction, assembly, dimensions and markings conform to the requirements of this specification. Dimensional verification shall be performed in accordance with 4.3.1. Each gauge shall be examined for all defects listed in table XVII.

4.3.1 Examinations. Examinations shall be limited to the examinations that may be performed without disassembling the pressure gauge in such a manner that its performance, durability, or appearance will be affected. Examination shall also include a check of all adjustments, as applicable.

TABLE XVI. Sampling plans^{1/}

Lot size	Sample size		
	Plan A	Plan B	Plan C
2 to 8	All	All	3
9 to 15	All	8	3
16 to 25	All	8	3
26 to 50	32	8	5
51 to 90	32	8	6
91 to 150	32	12	7
151 to 280	32	19	10
281 to 500	48	21	11
501 to 1200	73	27	15
1201 to 3200	73	35	18
3201 to 10,000	86	38	22
10,001 to 35,000	108	46	29

^{1/} Sampling plan code letters specified in tables XV and XVII.

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TABLE XVII. Classification of defects.

Categories	Defects	Requirements	Sampling plan
Critical			
1	Evidence that pressure gauges for oxygen applications are not cleaned, properly marked, or properly packaged.	3.3.4, 3.3.10.1.2, 5.1.1.1.2 and 5.1.1.2.1	100%
2	Pressure gauge does not meet the pressure integrity test (see 4.4.4).	3.4.4	A
3	Safety features on the case inadequate; does not prevent blow out of window; glass window installed in lieu of plastic.	3.2, table I, 3.3.7, 3.4.12	
Major			
101	Evidence of unauthorized material.	3.2 and table I	
102	Inspection system not provided, dimensional tolerances not maintained, mounting dimensions not interchangeable, pressure connection wrong design, or dimensions erroneous.	3.3.7, 3.3.9, 4.1.1	
103	Pressure gauge does not meet accuracy test (see 4.4.1).	3.4.1	
104	Dial markings not provided or erroneous; part number, national stock number, and so forth, not provided on dial.	3.3.10	
105	Pressure gauge does not meet the repeatability test (see 4.4.2).	3.4.2	
Minor			
201	Workmanship unsatisfactory.	3.7	
202	Evidence that pressure gauges for general applications are not cleaned.	3.3.4	
204	Packaging non-conforming.	5	4

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4.3.2 Dimensional verification. Pressure gauge samples selected in accordance with 4.2.2.2 shall be subjected to dimensional verifications of the pressure connection threaded end to verify conformance to Drawing 803-1385850 (O-ring union connection), or the applicable document for the type threaded end or connection specified (see table IV). Dimensions, concentricities, and perpendicularities affecting interchangeability of parts, sealing effectiveness, and strength shall be measured to verify conformance to the applicable document. For a pressure gauge having an O-ring union pressure connection, samples of the tail piece and union nut shall also be subjected to this dimensional verification.

4.4. Test procedures. Unless otherwise specified herein, the tests shall be conducted with the equipment and instrumentation operating under the following conditions:

- (a) Ambient temperature shall be $75 \pm 10^{\circ}\text{F}$.
- (b) Relative humidity shall be 50 ± 10 percent.
- (c) Supply voltage shall be 115 ± 5 volts.
- (d) Supply frequency shall be 60 ± 2 hertz (Hz).

Definitions for these test procedures shall be in accordance with ANSI B40.1.

4.4.1 Accuracy. Accuracy shall be determined as specified in 4.4.1.1 through 4.4.1.3.

4.4.1.1 Precycling. The precycling procedure shall be performed before the start of the accuracy test.

4.4.1.1.1 General procedure. To remove friction in the movement, the pressure gauge shall be cycled over the entire span by slowly increasing then decreasing the applied pressure three times.

4.4.1.1.2 Compound pressure gauge procedure. To remove friction in the movement, a compound pressure gauge shall first be cycled three times over the vacuum portion of the span followed by the gauge being cycled three times over the pressure portion of the span. Each cycle shall consist of slowly increasing then decreasing the applied pressure over the entire span.

4.4.1.2 Accuracy procedure. Accuracy test procedure shall be as specified in 4.4.1.2.1 through 4.4.1.2.2.

4.4.1.2.1 General procedure. The accuracy test shall consist of a set of readings at five equally spaced points over the entire span for one cycle. This cycle shall consist of reading the five equally spaced points while increasing the pressure throughout the span, then reading the same five equally spaced points in the reverse order while decreasing the pressure throughout the span. These five equally spaced points shall include the high and low limits of the span. For a retarded pressure gauge, the five equally spaced points shall include the high and low limits of the expanded portion of the span. Readings shall be taken both before and after the pressure gauge is lightly tapped in the center of the

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dial. The pressure gauge indications, after tapping, for each of the five equally spaced points read while both increasing and decreasing the pressure, shall meet the accuracy requirements specified in 3.4.1.

4.4.1.2.1.1 Friction error. The difference in each reading before and after tapping is the friction error. The friction error shall not exceed the requirements specified in 3.4.1.2.

4.4.1.2.2 Compound pressure gauge procedure. The general procedure specified in 4.4.1.2.1 shall be used. The span of a compound pressure gauge shall be considered as the algebraic sum of the vacuum and pressure scales, when both are expressed in the same units. For example, the span of a 30-inch Hg vacuum (approximately minus 15 lb/in²) to 30 lb/in² pressure scale is approximately 45 lb/in². The compound pressure gauge shall meet the accuracy requirements specified in 3.4.1 and shall not exceed the friction error requirements specified in 3.4.1.2.

4.4.1.3 Reference measurement. The accuracy test procedure, including the friction error, as specified in 4.4.1.2 shall be referred to as a "reference measurement" when the test is conducted after the conclusion of another test as specified in table XV.

4.4.2 Repeatability. The accuracy test, including the friction error, as specified in 4.4.1.2 shall be performed two additional times. The difference between any two readings, after tapping, at the same pressure, approached from the same direction, taken during the accuracy and during the repeatability tests, shall be referred to as the repeatability. The data taken during the accuracy and repeatability tests shall meet the repeatability requirements specified in 3.4.2.

4.4.3 Inclination. Pressure gauges shall be pressurized so that the pointer is in a vertical position. HEMPIs shall be pressurized to midspan. The sample shall be positioned so that the dial faces the operator. The sample shall then be inclined 60 degrees to the right, left, front, and back. The sample shall remain at each of these inclined positions for at least 1 minute and shall meet the requirements specified in 3.4.3 at each of these inclined positions.

4.4.4 Pressure integrity. The pressure gauge shall be pressurized to the maximum scale value for 5 minutes and a reference measurement shall then be performed. If the pressure gauge meets the requirements specified in 3.4.4, the pressure gauge shall then be subjected to each of the applicable test conditions specified in table XVIII for 1 hour. A reference measurement shall be performed after each applicable test condition specified in table XVIII. The pressure gauge performance shall meet the requirements specified in 3.4.4 after each test condition.

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TABLE XVIII. Conditions for pressure integrity testing.

Range	Test condition
All ranges	Under pressure to equivalent of 29 inches Hg vacuum.
Up to and including 0/1000 lb/in ²	Overpressure to 50 percent of span above maximum scale value.
Above 0/1000 up to and including 0/5000 lb/in ²	Overpressure to 15 percent of span above maximum scale value for pressure gauges and 50 percent of span above maximum scale value for HEMPIs.
Above 0/5000 lb/in ²	Overpressure to maximum scale value for pressure gauges and 25 percent of span above maximum scale value for HEMPIs.

4.4.5 Temperature. Temperature shall be tested in accordance with 4.4.5.1 through 4.4.5.4.

4.4.5.1 High temperature. The pressure gauge shall be placed in a temperature test chamber and pressurized to midspan. The temperature test chamber shall be brought to $145 \pm 5^\circ\text{F}$ and allowed to stabilize. After the temperature test chamber has stabilized at $145 \pm 5^\circ\text{F}$, the pressure gauge shall remain in the temperature test chamber for at least 4 hours while pressurized at midspan. After this minimum 4-hour period, a reference measurement shall be performed while the pressure gauge remains at $145 \pm 5^\circ\text{F}$ inside the temperature test chamber. The pressure gauge shall then be unpressurized and removed from the temperature chamber, and allowed to stabilize at the ambient conditions (see 4.4) for at least 4 hours. A second reference measurement shall then be performed. The pressure gauge performance shall meet the requirements specified in 3.4.5.1.

4.4.5.2 Low temperature. The pressure gauge shall be subjected to the same test procedure as 4.4.5.1 except that the temperature chamber shall be set for a temperature of $40 \pm 5^\circ\text{F}$. The pressure gauge performance shall meet the requirements specified in 3.4.5.2.

4.4.5.3 Seal integrity. The seal integrity test shall only be performed on liquid filled pressure gauges. The pressure gauge shall be placed in a temperature test chamber and shall remain unpressurized during the test. The pressure gauge shall be subjected to 20 complete temperature cycles, each of which is 6 hours in duration. Each cycle shall consist of the pressure gauge being subjected to the different temperature conditions specified in table XIX. After completion of the twentieth temperature cycle, the pressure gauge shall be removed from the temperature test chamber and allowed to stabilize at the ambient

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conditions (see 4.4) for at least 4 hours. A reference measurement shall then be performed. The pressure gauge shall meet the requirements specified in 3.4.5.3.

TABLE XIX. Seal integrity test cycle.

Step	Temperature condition	Step duration
1	Increasing temperature ^{1/} from 75 ± 5°F to 145 ± 5°F	0.75 hour maximum
2	Constant temperature of 145 ± 5°F	2 hours minimum
3	Decreasing temperature from 145 ± 5°F to 0 ± 5°F	1.5 hours maximum
4	Constant temperature of 0 ± 5°F	2 hours minimum
5	Increasing temperature from 0 ± 5°F to 75 ± 5°F	0.75 hour maximum

^{1/} Ambient temperature for the first cycle.

4.4.5.4 Storage and temperature cycling. The pressure gauge shall be placed in a temperature test chamber and shall remain unpressurized during this test. This test shall subject the pressure gauge to five complete temperature cycles, each of which is 48 hours in duration. Each cycle shall consist of the pressure gauge being subjected to the temperature conditions specified in table XX. The steps in each cycle shall be performed in the sequences specified in table XX. After completion of the fifth temperature cycle, the pressure gauge shall be removed from the temperature test chamber and allowed to stabilize at the ambient conditions (see 4.4) for at least 4 hours. A reference measurement shall then be performed. The pressure gauge shall meet the requirements specified in 3.4.5.4.

TABLE XX. Storage and temperature cycling test variables.

Step	Temperature condition ^{2/}	Step duration cycle 1	Step duration cycles 2-5
1	Increasing temperature ^{1/} from 75 ± 5°F to 145 ± 5°F	3 hours maximum	1 hour maximum
2	Constant temperature of 145 ± 5°F	18 hours minimum	22 hours minimum
3	Decreasing temperature from 145 ± 5°F to TMIN	6 hours maximum	2 hours maximum
4	Constant temperature of TMIN	18 hours minimum	22 hours minimum
5	Increasing temperature from TMIN to 75 ± 5°F	3 hours maximum	1 hour maximum

^{1/} Ambient temperature for the first cycle.

^{2/} Cycle 1: TMIN - minus 10 ± 5°F, Cycles 2-5: TMIN - 40 ± 5°F

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4.4.5.5 Seal stability. The seal stability test shall only be performed on liquid filled pressure gauges. The pressure gauge shall be placed in a temperature test chamber and shall remain unpressurized during this test. The temperature test chamber shall be brought to $145 \pm 5^\circ\text{F}$ and allowed to stabilize at this temperature. After the temperature test chamber has stabilized at $145 \pm 5^\circ\text{F}$, the pressure gauge shall remain in the temperature test chamber for at least 480 hours. After this minimum 480-hour period, the pressure gauge shall be removed from the temperature test chamber and allowed to stabilize at the ambient conditions of the room for at least 4 hours. A reference measurement shall then be performed. The pressure gauge shall meet the requirements specified in 3.4.5.5.

4.4.6 Enclosure. The pressure gauge shall be subjected to a splashproof enclosure test as specified in MIL-STD-108 using the test criteria specified in MIL-STD-108 for the splashproof degree of enclosure. This test shall be performed with the pressure gauge secured to the mounting surface in the surface mounted configuration. A reference measurement shall be performed after the conclusion of this test. The pressure gauge shall meet the requirements specified in 3.4.6.

4.4.7 Load. The load test shall only be performed on stem mounted pressure gauges for range 150 lb/in^2 and above. The pressure gauge shall be threaded into a plate and securely held in place. A constant load of 150 pounds shall be applied to the pressure gauge case as shown on figure 3 for 5 minutes. A reference measurement shall be performed after the conclusion of this test. The pressure gauge shall meet the requirements specified in 3.4.7.

4.4.8 Salt spray. The pressure gauge shall be subjected to a salt spray test in accordance with ASTM B 117. The test shall be conducted for a duration of 96 hours. The salt solution shall consist of a 5 ± 1 percent concentration (five parts by weight of salt in 95 parts by weight of water). The pressure gauge pressure connection shall be sealed by any suitable means that does not prevent future use of the pressure connection. The sealed pressure connection shall not permit salt spray penetration into the interior of the pressure element assembly. A reference measurement shall be performed after the conclusion of this test. The pressure gauge shall meet the requirements specified in 3.4.8.

4.4.9 Vibration. The vibration test shall consist of the exploratory test, the variable frequency test, the endurance test and, when applicable, the component wear test. Three categories (see 4.4.9.1) are defined for different pressure gauge configurations or applications.

4.4.9.1 Test categories. Each pressure gauge shall be tested under the conditions designated for its category. The three categories are:

(a) Category A:

- (1) Flush/surface mounted pressure gauges with the exception of those pressure gauges contained in category C.

(b) Category B:

- (1) Flush/surface mounted pressure gauges that contain electrical contacts or other electrical devices.

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(c) Category C:

- (1) All stem mounted pressure gauges.
- (2) Flush/surface mounted pressure gauges that are liquid filled or mounted directly to machinery without resilient mounts.
- (3) All liquid filled pressure gauges.

4.4.9.2 Test classification. Vibration testing shall consist of a series of tests which identify resonant frequencies and those frequencies which cause wear. These tests shall also determine if the equipment will withstand the imposed vibratory conditions.

4.4.9.2.1 Exploratory test. The pressure gauge shall be subjected to an exploratory test to identify and quantify resonant behavior likely to occur during subsequent portions of the vibration test. Cover plates, and so forth, shall be removed during this test so that the pressure gauge interior components can be observed. A determination shall be made during this test as to the locations where additional vibration measurements or observations shall be taken and what instrumentation is required to conduct these measurements. This instrumentation shall then be used during the variable frequency test.

4.4.9.2.2 Variable frequency test. During the variable frequency test, all of the pressure gauge components shall be observed to identify, locate, and quantify specific resonances that occur on any component at any test frequency. Enough time shall be spent at each test frequency to thoroughly inspect the pressure gauge. The more complex the pressure gauge, the more time that may be required. The time duration at each frequency is given as a guideline only and may be exceeded when necessary. With the following exceptions, the cover plates, shall not be removed during this test. As a resonance that was found during the exploratory test is approached, the cover plates, shall be removed. After the resonance has been passed, the cover plates, shall be reinstalled. If a resonance is suspected that was not observed during the exploratory test, the cover plates, shall be removed. The cover plates, shall be reinstalled after the test engineer is satisfied that there is no resonance or after the resonance has passed. Operational tests or other functional checks shall be performed to ensure proper pressure gauge operation. At each test frequency at which a resonance is found, the resonance site shall be located and the magnitude of the displacement determined. All resonances found shall be recorded for use in the endurance test.

4.4.9.2.3 Endurance test. The endurance test shall be performed to determine the effect of continual vibration at all resonant frequencies. A 2-hour endurance run shall be performed at each resonance that was found during either the exploratory test or during the variable frequency test. Cover plates shall not be removed during this test. Operational tests or other functional checks shall be performed to ensure proper pressure gauge operation.

4.4.9.2.4 Component wear test. The component wear test shall be performed to determine if the pressure gauge will exhibit significant wear or damage when subjected to the resonant frequency that was observed to produce the most wear or damage potential during the exploratory, variable frequency, or endurance tests.

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For mechanical test instruments, this is generally the resonant frequency that produces the greatest pointer oscillation or the most severe motion of the linkage or movement. When no resonance has been observed, this test shall be performed at a specified frequency. Normally, a frequency is selected that would either cause the most visible wear for the duration of the test or one that would simulate the conditions to be found in actual service. Operational tests or other functional checks shall be performed to ensure proper pressure gauge operation.

4.4.9.3 Mounting considerations. The pressure gauge under test shall be secured to the vibration table in the same manner that it will be secured in service. In the case of flush/surface mounting, the panel shall be sufficiently rigid to ensure that its motions will be essentially the same as the motion of the platform of the vibration machine. Vibration machine input (displacement) shall be monitored at a point adjacent to the pressure gauge mounting.

4.4.9.4 Operational consideration. The pressure gauge shall be pressurized to midspan during the vibration test.

4.4.9.5 Test procedures.

- (a) Category A and B tests. Category A and B tests shall consist of the exploratory test, the variable frequency test, and the endurance test, conducted in the sequence listed. Each of these three tests shall be conducted in each of the three mutually perpendicular axes. All three tests shall be completed in one axis before performing the tests in another axis. For each classification of pressure gauge samples submitted (see 4.2.1.1), one pressure gauge sample shall be secured to the fixture (panel) in a flush mounted configuration and the other pressure gauge sample in a surface mounted configuration.
- (b) Category C tests. Category C tests shall consist of the exploratory test, the variable frequency test, the endurance test and the component wear test, conducted in the sequence listed. Each of the four category C tests shall be conducted along one axis only using the mounting fixture configuration and vibration direction shown on figure 4. The exploratory test, variable frequency test, and endurance test shall be conducted in this order twice. During the first set of tests, the pressure gauge shall be oriented as shown on figure 4. During the second set of tests, the pressure gauge shall be oriented in a direction perpendicular to that shown on figure 4 so that the pressure gauge dial would be seen on the figure. The component wear test shall follow the second set of tests and shall be performed in the orientation and at the frequency that produces the most wear damage potential.

4.4.9.5.1 Exploratory test. The pressure gauge shall be subjected to an exploratory test. The frequencies and locations where resonance occur during this test shall be noted. This test shall also be performed as specified in 4.4.9.2.1. Pressure gauge performance shall meet the requirements of 3.4.9 and testing shall be terminated if the pressure gauge exceeds the performance limits. The test criteria for the different category pressure gauges shall be as follows:

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(a) Category A:

- (1) Each discrete frequency from 5 to 60 Hz at 1-Hz intervals shall be maintained for a minimum of 15 seconds, or a sweep rate that shall not exceed 4 Hz per minute.
- (2) Displacements shall be as specified in table XXI.

(b) Category B:

- (1) Each discrete frequency from 5 to 100 Hz at 1-Hz intervals shall be maintained for a minimum of 15 seconds, or a sweep rate that shall not exceed 4 Hz per minute.
- (2) Displacements or accelerations shall be as specified in table XXII.

(c) Category C:

- (1) Each discrete frequency from 5 to 200 Hz at 1-Hz intervals shall be maintained for a minimum of 15 seconds, or a sweep rate that shall not exceed 4 Hz per minute.
- (2) Displacement or accelerations shall be as specified in table XXIII.

TABLE XXI. Vibratory displacement criteria - category A.

Frequency range (Hz) (inclusive)	Table displacement (inches, peak to peak)	
	Exploratory test	Variable frequency test
5 to 15	0.020 ± 0.004	0.060 ± 0.012
16 to 25	.020 ± .004	.040 ± .008
26 to 33	.020 ± .004	.020 ± .004
34 to 40	.005 ± .001	.010 ± .002
41 to 60	.005 ± .001	.005 ± .001

TABLE XXII. Vibratory displacement criteria - category B.

Frequency range (Hz) (inclusive)	Table displacement (inches, peak to peak)	
	Exploratory test	Variable frequency test
5 to 20	0.020 ± 0.004	0.060 ± 0.012
21 to 50	.010 ± .002	.040 ± .008
51 to 100	.005 ± .001	.020 ± .004

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TABLE XXIII. Vibratory displacement criteria - category C.

Frequency range (Hz) (inclusive)	Table displacement (inches, peak to peak)	
	Exploratory test	Variable frequency test
5 to 20	0.0200 ± 0.0040	0.060 ± 0.012
21 to 50	.0100 ± .0020	.040 ± .008
51 to 100	.0050 ± .0010	.020 ± .004
101 to 200	.0010 ± .0002	.004 ± .001

4.4.9.5.2 Variable frequency test. The pressure gauge shall be subjected to a variable frequency test. The frequencies and locations where resonance occurs during this test shall be noted. This test shall also be performed in accordance with 4.4.9.2.2. Pressure gauge performance shall meet the requirements specified in 3.4.9 and testing shall be terminated if the pressure gauge exceeds the performance limits. The test criteria for the different category pressure gauges shall be as follows:

(a) Category A:

- (1) Discrete frequency interval of 1 Hz.
- (2) Frequency range from 5 to 60 Hz.
- (3) Each discrete frequency shall be maintained for a minimum of 5 minutes.
- (4) Displacements shall be as specified in table XXI.

(b) Category B:

- (1) Discrete frequency interval of 1 Hz.

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- (2) Frequency range from 5 to 100 Hz.
- (3) Each discrete frequency shall be maintained for a minimum of 5 minutes.
- (4) Displacements shall be as specified in table XXII.

(c) Category C:

- (1) Discrete frequency interval of 1 Hz.
- (2) Frequency range from 5 to 200 Hz.
- (3) Displacements or accelerations shall be as specified in table XXIII.
- (4) For every observed resonance a detailed search shall be conducted within the 5-Hz interval to determine the resonant frequency.

4.4.9.5.3 Endurance test. The pressure gauge shall be subjected to a 2-hour endurance run at each resonance. This test shall also be performed in accordance with 4.4.9.2.3. Pressure gauge performance shall meet the requirements specified in 3.4.9 and testing shall be terminated if the pressure gauge exceeds the performance limits. The test criteria for the different category pressure gauges shall be as follows:

(a) Category A:

- (1) Displacements or accelerations shall be as specified for the variable frequency test specified in table XXI.
- (2) A reference measurement shall be performed after the conclusion of the endurance test.
- (3) If no resonance is found, a 2-hour endurance run shall be performed at 50 Hz.

(b) Category B:

- (1) Displacements or accelerations shall be as specified for the variable frequency test specified in table XXII.
- (2) A reference measurement shall be performed after the conclusion of the endurance test.
- (3) If no resonance is found, a 2-hour endurance run shall be performed at 100 Hz.

(c) Category C:

- (1) Displacements or accelerations shall be as specified for the variable frequency test specified in table XXIII.
- (2) A reference measurement shall be performed after the conclusion of the endurance test.
- (3) If no resonance is found, the endurance test shall not be performed and the vibration test shall continue with the component wear test after a reference measurement is performed.

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4.4.9.5.4 Component wear test. The component wear test shall be performed on category C pressure gauges only. The pressure gauge shall be vibrated for at least 20 hours at the resonant frequency that was observed to produce the most wear or damage potential. If no resonance is found, the component wear test shall be performed at 200 Hz. The table vibration displacement for the frequency in which the pressure gauge is vibrated shall be in accordance with the variable frequency test displacements in table XXIII. This test shall also be performed in accordance with 4.4.9.2.4. A reference measurement shall be performed after the conclusion of this test. Pressure gauge performance shall meet the requirements specified in 3.4.9 and testing shall be terminated if the pressure gauge exceeds the performance limits.

4.4.10 Shock. Pressure gauges shall be subjected to a shock test in accordance with MIL-S-901, grade A, class I, except for duplex pressure gauges which shall be grade B. Pressure gauge ranges 0/60 lb/in² and above shall be subjected to two sets of nine blows. Pressure gauge ranges 0/30 lb/in² and below shall be subjected to one set of nine blows. Flush and surface mounted pressure gauges shall be mounted on a 6D-1 adapter plate. Stem mounted pressure gauges shall be mounted on a 4C-2 adapter plate. The pressure gauges shall be mounted no less than 3 inches from the sides or rear of the adapter plate. For each classification of flush or surface mounted pressure gauge samples submitted (see 4.2.1.1), one pressure gauge sample shall be secured to the adapter plate in a flush mounted configuration and the other pressure gauge sample in a surface mounted configuration. Throughout this test, the pressure gauge shall be pressurized to midspan. A reference measurement shall be performed just prior to the first set of blows. A reading shall be taken after each blow. A reference measurement shall then be conducted after each set of nine blows without any adjustments performed. Pressure gauge performance and shift in pointer indication shall meet the requirements specified in 3.4.10. If the pressure gauge meets the requirements in 3.4.10 but is not within the accuracy requirements specified in 3.4.1.3, a zero adjustment shall be made and another reference measurement shall be performed. Pressure gauge performance, after the zero adjustment is made, shall meet the requirements specified in 3.4.10.

4.4.11 Pressure cycling. The pressure cycling test shall be performed using a pressure cyler that shall subject the pressure gauge to the following criteria:

- (a) A cycle from 20 ± 4 to 80 ± 4 percent of span for pressure ranges 0/3000 lb/in² and below. A cycle from 40 ± 4 to 60 ± 4 percent of span for pressure ranges 0/5000 lb/in² and above.
- (b) Unless otherwise specified, within a frequency of 0.5 through 1.5 Hz when cycling only gauge pressure (no vacuum portion).
- (c) A total of 260,000 cycles for pressure ranges 0/3000 lb/in² and below. A total of 50,000 cycles for pressure ranges 0/5000 lb/in² and above.
- (d) The application and release of pressure shall be as smooth as practicable, so as not to subject the pressure gauge pressure element assembly and movement to excessive upscale or downscale accelerations or high amplitude impulse (pressure spikes).

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- (e) Suitable fluid shall be used to cycle pressure gauges with ranges greater than 0/200 lb/in².

A reference measurement shall be performed after the conclusion of the test. Pressure gauge performance shall meet the requirements specified in 3.4.11.

4.4.11.1 Vacuum gauges. The pressure gauge shall be cycled by pulling a vacuum between 20 ± 4 to 80 ± 4 percent of the span.

4.4.11.2 Compound gauges. The range for a compound pressure gauge shall be as defined in 4.4.1.2.2. For compound pressure gauges in which the range of the pressure side is 0/60 lb/in² or less, the pressure and vacuum portions shall be cycled separately. A total of 130,000 cycles shall be performed between 20 ± 4 to 80 ± 4 percent of the range for each portion.

4.4.11.3 Retarded gauges. The pressure gauge shall be cycled from 20 ± 4 to 80 ± 4 percent of the expanded portion of the span.

4.4.12 Case pressure relief. The pressure gauge shall be subjected to the tests specified in 4.4.12.1 and 4.4.12.2 using a pressure gauge from which the elastic element has been removed. The pressure gauge performance during both of these tests shall meet the requirements specified in 3.4.12.

4.4.12.1 Rupture. The pressure gauge shall be connected to a pressure receiver having at least 10 times the volume of the pressure gauge case. Connection shall be made using a short length of pipe or tubing of suitable wall thickness to withstand the required pressure. The pipe or tubing between the gauge and receiver shall include a union fitted with a frangible blowout disc. Sudden rupture of the elastic element in the pressure case shall be simulated by gradually raising the pressure in the receiver with nitrogen or air until the frangible disc ruptures. A quick opening valve may be substituted for the frangible blowout disc if the valve can be fully opened from the closed position in less than 25 milliseconds. Pressure in the receiver shall be monitored by another pressure gauge or pressure transducer. Gauges shall be tested to the pressures specified in table XXIV.

TABLE XXIV. Rupture test pressure limits.

Maximum gauge range	Pressure limit
Up to and including 1000 lb/in ²	50 percent of span above maximum scale value.
Above 1000 lb/in ² up to and including 5000 lb/in ²	15 percent of span above maximum scale value.
Above 5000 lb/in ²	Maximum scale value.

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4.4.12.2 Slow leak. The pressure relief device shall be refitted properly in the pressure gauge case. The pressure gauge shall be connected to the receiver without a frangible disc in between. A slow leak in the elastic element shall be simulated by gradually raising the receiver pressure to 50 lb/in².

4.4.13 Elastic element or joining means failure. Nonsolid front gauges with ranges 0/60 lb/in² and above shall be subjected to the internal explosion test as specified in UL 404 for each unique case design. The nonsolid front gauges shall meet the requirements of 3.3.7 when subjected to this test.

4.5. Test standards. Test standards shall be in accordance with 4.5.1 through 4.5.2.

4.5.1 Test gauge. A test gauge, as specified in ANSI B40.1, shall be used to check the accuracy of the pressure gauges. The accuracy of the test gauge shall be within plus or minus 1/4 percent of span or better. The test gauge shall be maintained in accordance with MIL-STD-45662.

4.5.2 Other standards. Upon receiving prior approval from NAVSEA, another type of pressure standard may be used. The NAVSEA-approved pressure standard shall be at least four times more accurate than the pressure gauge being tested or shall provide results in local environment within one-fourth tolerance specified for the pressure gauge being tested. The NAVSEA-approved pressure standard shall be maintained in accordance with MIL-STD-45662.

4.6 Case seal material acceptance procedure. Selected gaskets and O-rings (see 3.2.3) shall be fully immersed in individual beakers containing a liquid fill case fluid as specified in 3.3.8. The beakers shall be placed in a temperature test chamber. The temperature test chamber shall be brought to 145 ± 5°F and allowed to stabilize at this temperature. After the temperature test chamber has stabilized at 145 ± 5°F, the beaker shall remain in the temperature test chamber for at least 120 hours. After this minimum 120-hour period, the fill fluid in the beaker shall be observed. Any visible discoloration of this fill fluid is sufficient cause for rejection of the entire lot of gaskets and O-rings.

4.7 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.6.)

5.1 Preservation. Preservation shall be level A, C, or commercial, as specified (see 6.2).

5.1.1 Level A. Level A preservation shall be as specified in 5.1.1.1 through 5.1.1.3.

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5.1.1.1 Cleaning and drying. Cleaning and drying shall be as follows:

5.1.1.1.1 General applications. Unless otherwise specified (see 6.2), cleaning and drying of pressure gauges shall be in accordance with MIL-STD-1622.

5.1.1.1.2 Oxygen applications. Pressure gauges shall be cleaned and dried in accordance with MIL-STD-1330.

5.1.1.1.3 Substitution of cleaning agents. Any cleaning agent used shall not be detrimental to the parts or materials. Written approval shall be obtained from NAVSEA to use other than the specified cleaning agent. A letter shall be written to NAVSEA requesting this approval. This letter shall contain justification (such as Environmental Protection Agency requirements). Technical and health information on both the specified and recommended substitute cleaning agents shall also be provided.

5.1.1.2 Unit protection. Preservatives shall not be used.

5.1.1.2.1 Bagging. General applications pressure gauges shall be individually placed in a bag conforming to MIL-B-117, type I, class B, style 2 having a minimum thickness of 0.004 inch. Oxygen application pressure gauges shall be individually placed in a bag conforming to MIL-B-117, type I, class E, style 2 having a minimum thickness of 0.006 inch. Pressure gauges threads shall be protected by a plastic cap to prevent puncture of the plastic bag. Any sharp edges and protrusions of the pressure gauges shall be cushioned before placing in the plastic bag.

5.1.1.2.2 Boxing. Each bagged pressure gauge shall be individually unit packed in a box conforming to PPP-B-566, variety 2, process II, PPP-B-636 class weather-resistant, PPP-B-665 class 2 or PPP-B-676 with box selection and style at the contractor's option. Box closure and sealing shall conform to the requirements for water-proofing or weather-resistant as specified in the applicable box specification or appendix thereto.

5.1.1.2.2.1 Flush mounting ring and associated hardware. When applicable (see 3.3.7.1), the flush mounting ring and associated hardware shall be placed in either a cloth bag having a draw string or a plastic "zip-loc" bag. The bag shall be placed in the same box as the pressure gauge.

5.1.1.3 Intermediate packing. Pressure gauges, unit packed as specified in 5.1.1.2.1, shall be intermediate packed in close-fitting fiberboard boxes conforming to PPP-B-636, type CF, class weather-resistant, style optional. Intermediate packs shall contain uniform quantities. Boxes shall be closed method V in accordance with the appendix to the box specification.

5.1.2 Level C. Cleaning and drying, unit protection and boxing shall be as specified for level A (see 5.1.1) except that boxes may be of the nonwater-proof domestic class or variety.

5.1.3 Commercial. Pressure gauges shall be cleaned, dried and bagged as specified for level A (see 5.1.1) with boxing in accordance with ASTM D 3951.

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5.2 Packing. Packing shall be level B, C, or commercial, as specified (see 6.2).

5.2.1 Level B. Pressure gauges preserved as specified in 5.1 shall be packed in fiberboard containers conforming to PPP-B-636, class weather-resistant or PPP-B-640, class 2 with container selection at the option of the contractor. Containers shall be closed, sealed and reinforced, with reinforcement utilizing nonmetallic banding or pressure sensitive reinforced tape. Box closure for PPP-B-636 containers shall conform to method V of the appendix to the box specification. Intermediate containers conforming to 5.1.1.3 herein require no further overpacking.

5.2.2 Level C. Pressure gauges preserved as specified in 5.1 shall be packed as specified for level B (see 5.2.1) except that containers shall be of the nonweather-resistant class. Containers shall be closed as specified in the appendix to the container specification with method I closure applicable to PPP-B-636 containers.

5.2.3 Commercial. Pressure gauges preserved as specified in 5.1 shall be packed in accordance with ASTM D 3951.

5.3 Cushioning, filler, dunnage, and wrapping material. Cushioning, filler, dunnage and wrapping shall be as follows (see 6.2).

5.3.1 Levels A, B, and C. Use of excelsior, newspaper, shredded paper (all types, including wax paper) and similar hygroscopic or nonneutral materials and all types of loose-fill materials for applications such as cushioning, filler, stuffing, and dunnage for materials destined for shipboard stowage and use is prohibited. Cushioning and wrapping materials selected shall have properties and characteristics for resistance to fire; examples are:

UU-P-268	- Paper, kraft wrapping, type II, grade C or D
PPP-C-850	- Polystyrene, expanded, grade SE, type I or II only
PPP-C-1120	- Bound fiber, uncompressed, type III or IV, class A
MIL-R-6130	- Cellular rubber, grade A
MIL-R-20092	- Cellular rubber, class 5
MIL-P-26514	- Polyurethane foam (rigid or flexible)

5.3.2 Commercial preservation and packing. When loose fill type materials are used for preservation and packing applications such as cushioning, filler, and dunnage, all containers (unit, intermediate, and shipping) shall be marked or labelled with the following information:

"CAUTION

Contents cushioned with loose-fill material shall not be taken on board ship. Remove and discard loose-fill material. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material."

Cushioning, filler, dunnage, and wrapping materials selected, shall exhibit improved performance for resistance to fire.

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5.4 Marking. In addition to any special marking required (see 6.2), interior unit packs and exterior shipping containers for levels A, B, and C shall be marked in accordance with MIL-STD-129 including the bar-code markings specified therein. Oxygen applications unit packs (see 5.1.1.2.1) shall be marked with a warning label as specified in MIL-STD-1330 inserting "oxygen" and so forth, as applicable for the system use. The labels shall be green paper and shall match FED-STD-595, color no. 14187. Lettering shall be black. Packaging and packing shall also be marked as follows:

"CONTAINS FRAGILE INSTRUMENT HANDLE WITH CARE"

"SHIPPING AND STORAGE TEMPERATURE LIMITS: -10 TO 150°F".

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. Pressure gauges specified herein are intended for the following applications.

6.1.1 Installation. Pressure gauges furnished under this specification are intended to be installed and connected to piping in accordance with Drawing 803-1385850.

6.1.1.1 Pressure connection. The type of pressure connections shall be selected in accordance with the intended use column of table IV.

6.1.1.2 Pressure connection location. Back and bottom connections are the preferred configuration. The 5 o'clock connection is intended for installations where space limitations restrict the use of the back or bottom connected configurations.

6.1.2 Stem mounted case design. Pressure gauges with 2- and 2-1/2 inch dial sizes are intended for direct mounting to machinery.

6.1.3 Caisson gauge. Caisson gauges are intended for use in submarine escape trunks and decompression chambers.

6.1.4 Receiver gauge. Receiver gauges are intended for use with pneumatic transmitters.

6.1.5 Cruising range gauge. The cruising range pressure gauge contains a specially marked scale that is intended to indicate safe operating steam pressure or vacuum pressure limits on the main engine.

6.1.6 Dial sizes. Dial sizes should conform to the mounting configuration (case design):

<u>Circular dial size (inches)</u>	<u>Case design</u>
2, 2-1/2	Stem mounted
3-1/2, 4-1/2, 8-1/2	Flush/surface mounted

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6.1.7 Liquid fill. Liquid filled pressure gauges are intended for the stem mounted configuration with a C-type bourdon tube. Liquid filled pressure gauges are also intended for flush and surface mounted configurations with C-type bourdon tubes that are directly mounted to machinery without resilient mounts.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- (a) Title, number, and date of this specification.
- (b) Type of pressure gauge required (see 1.2).
- (c) When special dial color is required (see 1.2.5 and 3.3.10.1.2).
- (d) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1, 2.2, and appendix).
- (e) When first article is required (see 3.1)
- (f) When flush mounting ring is not to be provided with surface/flush mounted pressure gauge configuration (see 3.3.7.1.1).
- (g) Pressure connection type, if other than the type specified in Drawing 803-1385850 (see 3.3.9.1).
- (h) Ranges and minor graduations specified (see 3.3.10.4).
- (i) When a red index is required (see 3.3.12).
- (j) When instruction sheets are not required (see 3.6).
- (k) Level of preservation, and packing required (see 5.1, and 5.2).
- (l) Cleaning and drying procedures required (see 5.1.1.1.1).
- (m) Special marking required (see 5.4).
- (n) When special wrapping is specified (see 5.3).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

<u>Reference Paragraph</u>	<u>DID Number</u>	<u>DID Title</u>	<u>Suggested Tailoring</u>
3.5 and appendix	DI-DRPR-80651	Engineering drawings	Level 3
4.2.2	DI-T-2072	Reports, test	---

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

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6.4 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.2.1. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.5 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.5.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.6 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Definitions. Terminology in this specification is consistent with ANSI B40.1.

- (a) Five o'clock position. The position of the pressure connection which is established after rotating 30 degrees counterclockwise, in the plane parallel to the dial, from the bottom connected position. This position is determined while facing the front of the pressure gauge (the dial).
- (b) Pounds per square inch - lb/in^2 - psi - psig.
- (c) Red index. An adjustable marker (painted red) which is hand set at a significant system pressure value, usually the maximum expected operating pressure.

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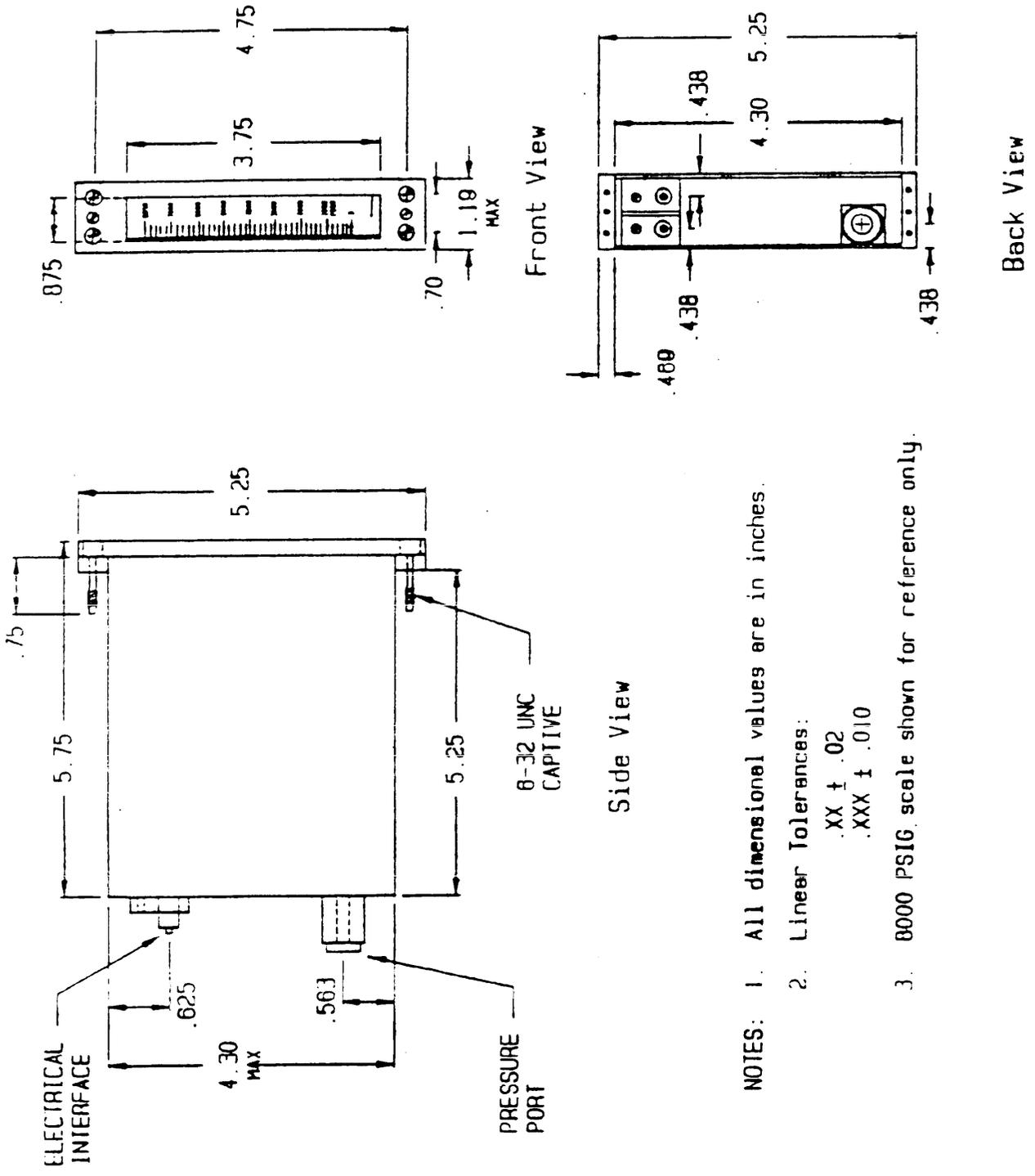
6.8 Subject term (key word) listing.

Caisson gauge
Cruising range gauge
Flush/surface mounted gauge
HEMPI
Stem mounted gauge
Submarine depth gauge
Vacuum gauge

6.9 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Preparing activity:
Navy - SH
(Project 6685-N839)

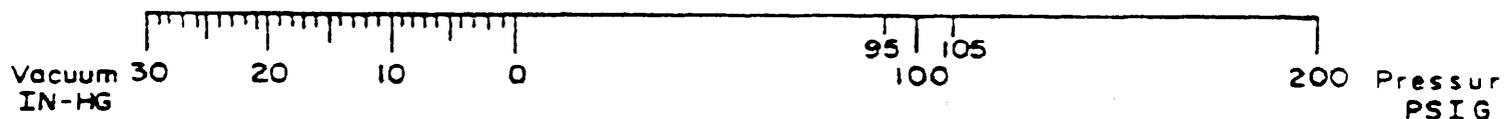
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- NOTES:
1. All dimensional values are in inches.
 2. Linear Tolerances:
 .XX ± .02
 .XXX ± .010
 3. 8000 PSIG scale shown for reference only.

FIGURE 1. HEMPI dimensional requirements.

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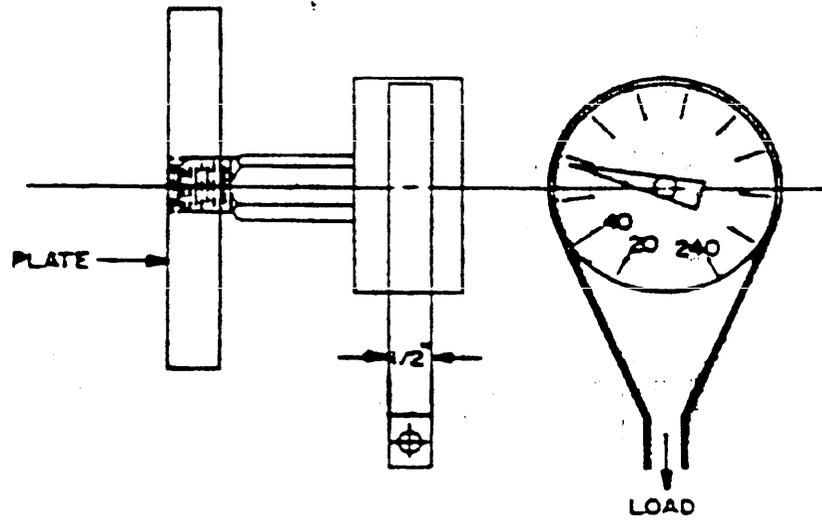
SAFE RANGE CRUISING COMBINATION	
SAFE RANGE	DANGER ZONE H.P. TURBINE COMBINATION
H.P. TURBINE COMB.	SLOW DOWN TO 200 R.P.M. SHUT CROSSOVER VALVE

NOTES:

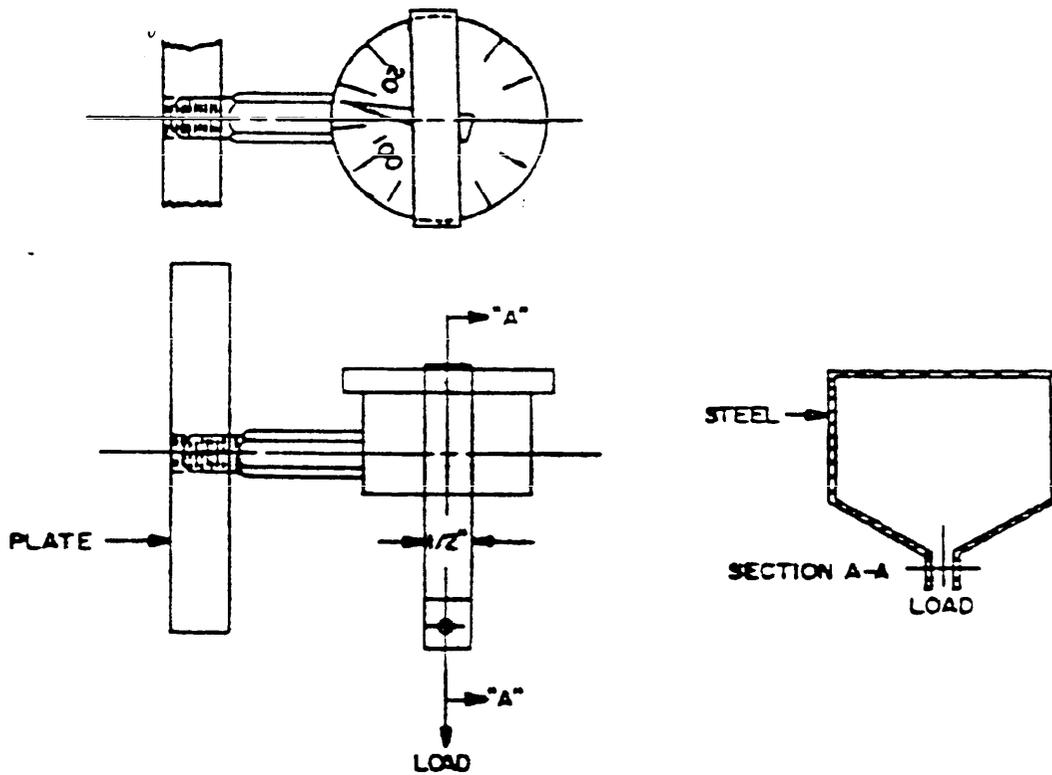
1. Dial shall contain a black background with white graduations.
2. "Safe range cruising combination" shall contain a black background with white letters.
3. "Safe range H.P. Turbine Comb." shall contain a green background with white letters.
4. "Danger Zone H.P. Turbine Combination. Slow down to 200 R.P.M. shut crossover valve" shall contain a red background with white letters.

FIGURE 2. Cruising range gauge scale.

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BACK CONNECTED CONFIGURATION



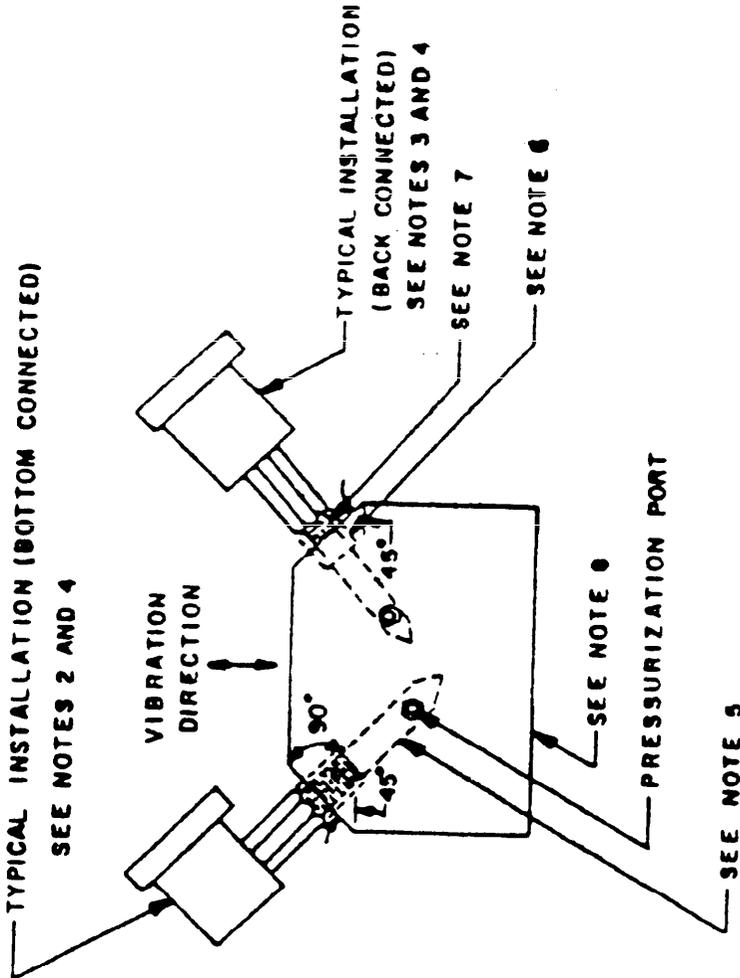
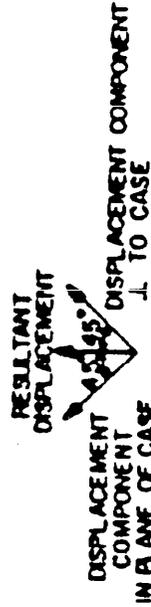
BOTTOM CONNECTED CONFIGURATION

FIGURE 3. Load test.

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NOTES:

1. Method of fastening block to exciter table is optional but should not reduce setup rigidity.
2. Bottom connected pressure gauges shall be inclined 45 degrees and face up with respect to the vertical axis.
3. Back connected and 3 o'clock position pressure gauges shall be inclined 45 degrees backward and face up with respect to the vertical axis.
4. Pressure gauge mounting configuration and vibration direction shall produce the vibration components shown below:



5. Block bored to permit pressurization of gauge. Depth to suit position of pressure fitting.
6. Mounting port to suit gauge pressure connection.
7. To ensure proper orientation, short rigid adapter fittings may be used to mount pressure gauge configurations with a straight thread pressure connection.
8. Resonant frequency of block shall be at least 1000 Hz. Block shall withstand 150 percent of gauge full scale pressure rating.

FIGURE 4. Mounting fixture and orientation for category C pressure gauges undergoing vibration testing.

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APPENDIX

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix contains the format and content preparation instructions for the development of and revision to a conformance verification drawing. It is not intended that each requirement contained herein should be applied to every type of instrumentation. Portions of this appendix are subject to deletion tailoring depending upon the material, construction, and principle of operating requirements that are specified in the individual instrumentation specification or acquisition document. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

MILITARY

MIL-I-45208 - Inspection System Requirements.

STANDARDS

MILITARY

MIL-STD-17-1 - Mechanical Symbols (Other Than Aeronautical, Aerospacecraft and Spacecraft Use) Part-1.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

20.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

200 - Standard Reference Designations for Electrical and Electronics Parts and Equipment. (DoD adopted)
Y14.1 - Drawing Sheet Size and Format. (DoD adopted)

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(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

30. CONFORMANCE VERIFICATION DRAWING FOR INSTRUMENTATION

30.1 Purpose. The conformance verification drawing contains the information necessary to verify that the instrumentation meets the requirements specified in the applicable instrumentation specification and acquisition document.

30.2 Content and format. One conformance verification drawing shall be developed for each specific type of instrumentation. It shall include all ranges, sizes, connections and other variations. The conformance verification drawing shall include the following minimum information (except as specified in 10.1) and shall be developed to the following format:

30.3 Descriptive data.

- (a) Instrument identification numbering system for instrumentation.
This numbering system shall include, but may not be restricted to, the classification variables.
- (b) Instrumentation identification number system for replaceable parts
- (c) Size, operating data, ranges, scale markings, and other data for proper selection.
- (d) Test approval data, presenting the following information in tabular form.
 - (1) Specification classification (unique alphanumeric variables to designate instruments).
 - (2) Test report number and date.
 - (3) Facility where test was conducted.
 - (4) Authorized Government activity (NAVSEA) approval letter and date.
- (e) A statement that instrumentation is in accordance with the requirements of the applicable instrumentation specification or acquisition document and to referenced specifications.
- (f) Conformance verification drawing acceptance data, presenting the following information in tabular form:
 - (1) Authorized Government activity (NAVSEA) acceptance letter and date.
 - (2) Revision number.

30.4 Details of construction.

- (a) Two or more representative assembly views, as required, to show clearly the details of the design, construction, and assembly of the instrumentation and to identify each part and its location.

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Identification of parts shall correspond to the list of materials. Assembly shall show how all mechanical parts are joined or attached.

- (b) Sectional views or notes as necessary to show internal details.
- (c) Details such as entrance provisions, gaskets, fastening techniques, welding symbols, mounting requirements, and other details as applicable.
- (d) Module enclosure requirements for separately mounted modules.
- (e) Dimensions required to ensure interchangeability.
- (f) Schematic of indicating system.
- (g) Description of the nature and purpose of any adjustments.
- (h) Welding procedures with acceptance data, including acceptance letter, report numbers, and dates.
- (i) Any special features.
- (j) Complete weight.
- (k) Location, size, and type of connections.
- (l) Identification of quality control documents which show conformance with MIL-I-45208 or the quality control specification that is listed in the applicable instrumentation specification or acquisition document. The acceptance letter shall be referenced.

30.5 Parts list. The following information shall be presented in tabular form:

- (a) Item number (corresponding to flag number identifying the part on the conformance verification drawing).
- (b) Quantity of each part required per assembly.
- (c) Name of part with sufficient information to readily identify the part (for example, screws: thread size, length and type of head, shall be specified).
- (d) Material of part.
- (e) Material specification (military, federal, or commercial specification number or Government activity (NAVSEA) drawing number).

NOTE: When substitution of a material specification is made, it is the responsibility of the contractor to provide written documentation to substantiate that the substituted material is equivalent to the specified material.

- (f) Type, class, grade, size, military designation, or other classification of any referenced specification.
- (g) Part number or identification assigned by assembly supplier.
- (h) Name of actual manufacturer or part (when applicable).
- (i) Part number or identification assigned by part supplier (when applicable).
- (j) Onboard repair parts. Parts that are appropriate for, or are supplied as, onboard repair parts shall be indicated by a symbol in this column.
- (k) Remarks column. Finishes, platings, or coatings along with the applicable specification or other requirements should be specified in this column.

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30.6 Table for special tools. Special tools required for the instrumentation shall be presented in the following tabular form:

- (a) Item number (corresponding to flag number identifying the tool on the conformance verification drawing).
- (b) Quantity of each tool required per instrument.
- (c) Name (description) of tool (include generic name).
- (d) Tool specification (military, federal, or commercial specification number or Government activity (NAVSEA) drawing number).
- (e) Tool number or identification assigned by assembly supplier.
- (f) Name of actual manufacturer of tool (when applicable).
- (g) Tool number or identification assigned by tool supplier (when applicable).
- (h) Description of tool's application.
- (i) Remarks column. Special techniques or other usage requirements should be explained in this column.

30.7 Fluid and electrical system schematics. Fluid (piping) and electrical schematics shall be included in the verification conformance drawing when applicable. A complete schematic shall contain all the parts in the fluid or electrical systems. When confusion over its function could result, a simplified schematic containing only the major components shall also be provided. This simplified schematic may be presented in block diagram format.

- (a) Complete fluid system schematic. A single schematic shall present clearly the operation and functions of the fluid system within the instrumentation. This schematic shall contain all parts (including valves, fittings, hoses, and tubing) which make up the piping or fluid system. The following features shall be incorporated into the schematic:
 - (1) A simplified, clear schematic in preference to one showing the physical placement or parts.
 - (2) A thin, broken line shall be used to represent the boundaries of each subassembly.
 - (3) Arrows adjacent to the parts shall indicate direction of flow.
 - (4) Each part shall be identified by the schematic part designation. The numbers shall be assigned in a logical sequence observing flow paths through the system.
 - (5) All inlet and outlet ports shall be identified.
 - (6) The methods of attachment for each part shall be designated by an appropriate label or symbol.
 - (7) The symbol used to designate a part shall be in accordance with MIL-STD-17-1 when applicable.
 - (8) A brief description of the fluid system operation shall be provided.
 - (9) Maximum operating pressure of the system and maximum pressure drop through the system (when operating at maximum pressure) shall be specified.
 - (10) Table for pressure rating and connection of fluid system parts. Supplementary information on parts found in the fluid (piping) system schematic shall be contained in tabular form.

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One column shall contain the schematic part designation for each fluid system part, for example, valve V-1 and other similar designations. The other columns shall contain the following information:

- a. Item number.
 - b. Description.
 - c. Type (size).
 - d. Pressure ratings (including operating, proof, and burst).
 - e. Method of attachment, including, brazing or welding procedure, bonding agent, and seal.
 - f. End connections, fittings, and adapters.
 - g. Relief valve ratings (include cracking and set pressure).
- (b) Complete electrical system schematic. A single schematic shall represent clearly the operation and the function of the electrical circuitry within the instrumentation. The schematic shall contain all parts (including components, connectors, and alarms) which make up the electrical system. The following features shall be incorporated into the schematic:
- (1) In preparation of the schematic, emphasis shall be placed on simplicity and ease of understanding of circuit operation. Physical placement of components and connecting wiring may be ignored in the interest of simplicity and clarity of this diagram.
 - (2) A thin, broken line shall be used to represent the boundaries of each unit or subassembly. Terminals, to which external connections are made, shall be shown within these boundaries, with the numbers, markings, type of signal, power and ground, as appropriate.
 - (3) Each part (such as resistors, capacitors, relays, etc.) shall be given a unique reference designation consisting of a letter denoting the type of part (as required by ANSI/IEEE 200) and a number assigned consecutively. The numbers shall be assigned in a logical sequence of electrical current or signal flow through the circuit.
 - (4) In addition to the reference designation, parts not conforming to a military specification [see 30.7(b)(30)], shall have the following information noted adjacent to the part. Where numerical values are given, a code shall be noted to designate the units used:
 - a. Resistors - Resistance, power rating, and tolerances. If variable, an arrow to indicate clockwise rotation of the control shaft.
 - b. Capacitors - Capacitance, voltage rating and tolerance.
 - c. Reactors - Inductance and voltage rating.
 - d. Semi-conductors - type number (JEDDC number is adequate).
 - e. Integrated circuits - Operational symbol diagram of input-output relationship, terminal numbering corresponding to a representative schematic and type number.

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- (5) Supply voltages, phases, and frequencies and transformer terminal voltage shall be indicated and labeled as to purpose.
- (6) Table for troubleshooting of electrical system. The content table shall include each test point, as identified on the electrical system schematic, with voltage, waveform or other electrical parameter that should be measured at each test point.

30.8 Selection and installation considerations.

- (a) Performance data.
 - (1) Accuracy (in percent of span).
 - (2) Shock and vibration classification.
 - (3) Degree of water tightness of the enclosure.
 - (4) Electromagnetic interference and pulse susceptibility.
- (b) Dimensional outline of the instrumentation showing overall and principle dimensions in sufficient detail to establish space requirements in all directions necessary for installation, servicing, exclusive of space required for operator observation of the indication.
- (c) Special considerations which may affect selection or installation.
 - (1) Ambient temperature range.
 - (2) Calibration points and adjustments.
 - (3) Orientation.
 - (4) Location of instrumentation relative to vibrating equipment.
 - (5) Protection of the instrumentation from pulsations and spikes in the parameter being measured.
 - (6) Selection of the instrumentation range relative to the operating range of the system.
 - (7) Application for each type connection.
 - (8) Cleaning procedure or reference to the cleaning procedure used.
 - (9) Selection of the instrumentation for compatibility (materials, temperature, and pressure) with the ambient environment and with the parameter being measured.

30.9 Drawing format.

- (a) Unless otherwise approved by the authorized Government activity, a maximum of three sheets shall be allotted for single functioned system instrumentation and a maximum of ten sheets for instrumentation containing a multiple functioned system. A single functioned system is one that performs only one operation such as: expands/contracts a pressure elastic element, steps up/steps down the voltage, conditions one electrical signal, or winds/unwinds a bimetallic element. A multiple functioned system is one that contains two or more single functioned systems.
- (b) Each shall be zoned.

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- (c) A title block shall be included on each drawing sheet and shall include the following information.
- (1) Title, drawing number, and revision letter. Each sheet shall contain the same title, drawing number and revision letter.
 - a. Title - The title shall consist of the name by which the instrumentation is known.
 - b. Drawing number - The drawing number shall consist of alphanumeric characters which may be separated by dashes or slashes. The total number of characters in the drawing number (including dashes and/or slashes) shall not exceed 15. Blank spaces are not permitted within the drawing number.
 - c. Revision letter - The revision letter shall denote the latest approved version of the drawing. The revision letter of conformance verification drawing shall not be changed until all the changes under that revision have been accepted in writing by the authorized Government activity (NAVSEA). No changes made to the conformance verification drawing shall be considered a revision until after the initial version of the conformance verification drawing has been accepted in writing by the authorized Government activity. After initial submittal of the conformance verification drawing, no changes shall be made during the initial drawing review process unless the change is either requested by the authorized Government activity or the change is documented in written correspondence the contractor.
 - (2) Sheet _____ of _____.
 - (3) Tolerance on dimensions for fractions, decimals, and angles. Units of the dimensions specified on the conformance verification drawing.
 - (4) Contractor acceptance block (appropriate signatures and dates).
 - (5) Commercial and Government Entity (CAGE) code for manufacturer.
 - (6) Scale.
 - (7) Reference drawings.
 - (8) Manufacturer's name and address.
 - (9) Drawing size.
- (d) Revision block. The revision block shall be included on each sheet of the conformance verification drawing and shall contain the following information in tabular form:
- (1) Revision letter.
 - (2) Description of revision.
 - (3) Acceptance letter serial number and originator identification.
 - (4) Acceptance date.
- (e) Form. Sheet size and format not specified herein shall be in accordance with ANSI Y14.1.

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- (f) **Classification designations.** No Government security classification designation such as confidential or secret shall appear on the conformance verification drawing unless a particular classification is specified by the Government.

40. **CONFORMANCE VERIFICATION DRAWING ACCEPTANCE**

40.1 **Acceptance.** Acceptance shall be granted by the authorized Government activity only after the conformance verification drawing is found to meet all the requirements specified in 20. through 40.1.

50. **INSTRUCTIONS**

50.1 **Acquisition document instructions.** The acquisition document should contain provisions that address submission, review, extension, disapproval, default, acceptance, and waiver of conformance verification drawings in addition to the effects on the delivery schedule due to delays in conformance verification drawing acceptance. NAVSEA shall be designated as the activity that accepts or disapproves the conformance verification drawing.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:		1. DOCUMENT NUMBER MIL-G-18997E(SH)	2. DOCUMENT DATE (YYMMDD) 1991 November 18
3. DOCUMENT TITLE GAUGE, PRESSURE, DIAL INDICATING			
4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)			
5. REASON FOR RECOMMENDATION			
6. SUBMITTER			
a. NAME (Last, First, Middle Initial)		b. ORGANIZATION	
c. ADDRESS (Include Zip Code)		d. TELEPHONE (Include Area Code)	
e. PREPARING ACTIVITY		(1) Commercial	
a. NAME Technical Point of Contact (TOPC): Mr. Donald Strawser (SEA 56Z44)		(2) AUTOVON TPOC: 703-602-6064 8-332-6064	
PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS:			
ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command Department of the Navy (SEA 55Z32) Washington, DC 20362-5101		IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	