INCH-POUND

MIL-G-18997E(SH)
w/ AMENDMENT 2
14 March 2006

SUPERSEDING
MIL-G-18997E
w/ AMENDMENT 1
1 June 1995
(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:

Pressure gauge design	Symbol
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 indicates is designated by one of the following symbols:

Type of pressure	Symbol
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:

Dial size	Case design	Symbol
2	Stem mounted	1
2½	Stem mounted	2
3½	Flush/surface mounted	3
4½	Flush/surface mounted	4
8½	Flush/surface mounted	8
1¼ (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.

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

Elastic element style	Symbol
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 bourdon tube (gear drive), helical bourdon tube (gear drive), or helical bourdon tube (direct drive) – manufacturer option	N

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 is 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:

Dial color	Symbol
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.

Pressure connection	Symbol
O-ring union	R
¼ NPT (male)	P
Welded nipple	W
Threaded vent (caisson only)	K
Flareless (bite type) 7/16-20 UNF-2A	C
7/16-20 UNF-2B (HEMPI only)	H
Boundary gauge 7/16-20 UNF-2A	B

Connection location	Symbol
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).

Liquid fill	Symbol
None	N
Silicone	S

Vibration category	Symbol
Category A	A
Category B	B
Category C	C

1.2.8 Cleanliness. Deleted.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 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 cited in the solicitation or contract.

FEDERAL SPECIFICATIONS

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)
TT-P-645	-	Primer, Paint, Zinc-Molybdate, Alkyd Type

FEDERAL STANDARDS

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

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-PRF-5425 - Plastic Sheet, Acrylic, Heat Resistant
MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys
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-C-15726 - Copper-Nickel Alloy, Sheet, Plate, Strip, Bar, Rod and Wire
MIL-T-16420 - Tube, Copper-Nickel Alloy, Seamless and Welded (Copper Alloy Numbers 715 and 706)
MIL-PRF-24635 - Enamel, Silicone Alkyd Copolymer
MIL-P-25732 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Limited Service at 275 °F (135 °C)
MIL-PRF-28800 - Test Equipment for Use with Electrical and Electronic Equipment, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment
MIL-STD-130 - Identification Marking of U.S. Military Property
MIL-STD-777 - Schedule of Piping, Valves, Fittings, and Associated Piping Components for Naval Surface Ships

(Copies of these documents are available online at http://assist.daps.dla.mil/quicksearch/ or http://assist.daps.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 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 of these documents are those cited in the solicitation or contract.

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

(Copies of these documents are available from the Commander, Naval Sea Systems Command, ATTN: SEA 05Q, 1333 Isaac Hull Avenue, SE, Stop 5160, Washington Navy Yard DC 20376-5160 or by email at commandstandards@navsea.navy.mil.)

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

NAVSEA S9074-AR-GIB-010/278 – Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels
NAVSEA 0900-LP-001-7000 - Fabrication and Inspection of Brazed Piping Systems

(Copies of these documents are available from the Naval Logistics Library, 5450 Carlisle Pike, Mechanicsburg, PA 17055 or online at http://nll.ahf.nmci.navy.mil.)

CODE OF FEDERAL REGULATIONS

40 CFR 355, Appendix A - Protection of Environment – Emergency Planning and Notification – The List of Extremely Hazardous Substances and Their Threshold Planning Quantities.

(Copies of this document are available from the Superintendent of Documents, U.S. Government Printing Office, Washington DC 20401 or online at www.gpoaccess.gov/index.html.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASME INTERNATIONAL

B40.l - Gauge - Pressure Indicating Dial Type - Elastic Element (DoD adopted)

(Copies of this document are available from ASME International, 22 Law Drive, PO Box 2900, Fairfield, NJ 07007-2900 or online at www.asme.org.)

ASTM INTERNATIONAL

A 167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip (DoD adopted)
A 276 - Standard Specification for Stainless Steel Bars and Shapes (DoD adopted)
A 473 - Standard Specification for Stainless Steel Forgings (DoD adopted)
A 480/A 480M - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip (DoD adopted)
A 581/A 581M - Standard Specification for Free-Machining Stainless Steel Wire and Wire Rods (DoD adopted)
A 582/A 582M - Standard Specification for Free-Machining Stainless Steel Bars (DoD adopted)
B 26/B 26M - Standard Specification for Aluminum-Alloy Sand Castings (DoD adopted)
B 36/B 36M - Standard Specification for Brass Plate, Sheet, Strip, And Rolled Bar (DoD adopted)
B 85 - Standard Specification for Aluminum-A1loy Die Castings (DoD adopted)
B 117 - Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD adopted)
B 124/B 124M - 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) and Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219) Plate, Sheet, and Strip (DoD adopted)
B 637 - Standard Specification for Precipitation-Hardening Nickel Alloy Bars, Forgings, and Forging Stock for High-Temperature Service (DoD adopted)
D 788 - Standard Classification System for Poly (Methyl Methacrylate) (PMMA) Molding and Extrusion Compounds (DoD adopted)
D 2109 - Standard Test Methods for Nonvolatile Matter in Halogenated Organic Solvents and Their Admixtures (DoD adopted)
D 5363 - Standard Specification for Anaerobic Single-Component Adhesives (AN) (DoD adopted)
F 331 - Standard Test Method for Nonvolatile Residue of Solvent Extract from Aerospace Components (Using Flash Evaporator)

(Copies of these documents are available from ASTM International, 100 Barr Harbor Dr., PO Box C700, West Conshohocken, PA 19428-2959 or online at www.astm.org.)

AMERICAN WELDING SOCIETY (AWS)

AWS C3.4 - Specification for Torch Brazing (DoD adopted)
AWS C3.5 - Specification for Induction Brazing (DoD adopted)

AWS C3.6 - Specification for Furnace Brazing (DoD adopted)
AWS C3.7 - Specification for Aluminum Brazing (DoD adopted)

(Copies of these documents are available from the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126 or online at www.aws.org.)

NCSL INTERNATIONAL

ANSI/NCSL Z540.1 - Calibration & Measurement & Test Equipment General Requirements (DoD adopted)

(Copies of this document are available from the NCSL International, 2995 Wilderness Place, Suite 107, Boulder, Colorado 80301-5404 or online at www.ncsli.org.)

SAE INTERNATIONAL

SAE AMS-3216	-	Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 70-80 (DoD adopted)
SAE AMS-3218	-	Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 85-95 (DoD adopted)
SAE AMS-7259	-	Rings, Sealing, Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 85-95 (DoD adopted)
SAE AMS-7276	-	Rings, Sealing, Fluorocarbon (FKM) Rubber, High-Temperature-Fluid Resistant, Low Compression, Set 70-80 (DoD adopted)
SAE AMS-P-83310	-	Plastic Sheet, Polycarbonate, Transparent (DoD adopted)
SAE AMS-P-83461	-	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275 °F (135 °C) (DoD adopted)
SAE J514	-	Hydraulic Tube Fittings (DoD adopted)
SAE J1926/1	-	Connections for General Use and Fluid Power – Ports and Stud Ends with ISO 725 Threads and O-Ring Sealing – Part 1: Threaded Port with O-Ring Seal in Truncated Housing (DoD adopted)

(Copies of these documents are available from SAE World Headquarters, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or online at www.sae.org.)

UNDERWRITERS LABORATORIES INC. (UL)

UL 404 - Standard for Gauges, Indicating Pressure, for Compressed Gas Service (DoD adopted)

(Copies of this document are available from COMM 2000, 1414 Brook Drive, Downers Grove, IL 60515 or online at www.ul.com.)

2.4 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.

TABLE I. Indicating assembly materials.

Part	Material	Material specification	Remarks
Case	Aluminum[1/]	ASTM B 26/B 26M 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/B 36M ASTM B 124/B 124M	6/
Dial	Aluminum[1/]	ASTM B 209	See 1.2.3, 1.2.5
	Corrosion-resisting steel[1/]	ASTM A 167	
	Plastic	SAE AMS-P-83310	HEMPI only
Window	Plastic	ASTM D 788 MIL-PRF-5425 SAE AMS-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/A 581M ASTM A 582/A 582M (300 or 400 series)	7/
Washers	Corrosion-resisting steel	ASTM A 276 ASTM A 480/A 480M	
Gaskets	Neoprene	MIL-R-6855	Class 4, type A, Class 2, type A[12/]
O-rings	Fluorocarbon rubber	SAE AMS-7276 SAE AMS-7259 SAE AMS-3216 SAE AMS-3218	O-rings, type 1
	Nitrile rubber (Buna N) (180 °F max)	MIL-P-25732 MIL-P-83461	
Elastic element[10/]	K-monel UNS-N05500[11/]	QQ-N-286	
	Inconel UNS-N07750[11/]	ASTM B 637	Inconel X750
	Inconel UNS-N06625	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	

TABLE I. Indicating assembly materials – Continued.

NOTES:

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 primer in accordance with TT-P-645 and a gray enamel finish coat. The finish coat shall be in accordance with type II, class 2 or 3 of MIL-PRF-24635.

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 ASME 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 that are exposed to the process fluid. These components shall be in accordance with ASME B40.l.

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/in^2) and below.

7/ Unless otherwise specified herein, retaining compound in accordance with grade C of ASTM D 5363 shall be used.

8/ Aluminum alloy shall be selected to meet shock test requirements (see 3.4.10).

9/ Deleted.

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

11/ Material specification is for material composition only.

12/ Class 2, type A gasket material is not compatible with window material per MIL-PRF-5425.

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 that have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.2.2 Restricted materials. The pressure gauge shall not contain restricted material as defined in MIL-PRF-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 fi1l 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.

3.3.4 Cleaning. Pressure gauges shall be cleaned in accordance with the requirements of 3.3.4.1 through 3.3.4.4.

3.3.4.1 Gauge cleanliness. The exterior and interior of the pressure gauge case and associated gauge parts shall be free of loose scale, rust, grit, filings, mercury, calibration liquids, oil, grease, solvents, or other organic materials.

3.3.4.2 Elastic element cleanliness. Cleaning of the pressure gauge elastic element and connection interior (that portion which, contacts the service media) shall be in accordance with 3.3.4.2.1 through 3.3.4.2.2.

3.3.4.2.1 General application. Unless otherwise specified (see 6.2), pressure gauge elastic element and connection interior shall meet the following cleanliness requirements:

Maximum allowable particulate size: 15 micrometers (µm)
Maximum allowable non-volatile residue: 10 milligrams per 0.1 square meter ($mg/0.1m^2$)*

*0.1 square meter (m^2) equals 1.0 square foot (ft^2)

3.3.4.2.2 Caution label. Each pressure gauge shall have the following CAUTION label affixed to its shipping bag. The manufacturer shall specify the cleaning solvent in place of the double asterisk.

CAUTION

This gauge was cleaned with ___**___ to general application standards of 15 µm particulate size and 10 mg/0.1 m^2 allowable non-volatile residue. If this gauge is to be used in any system which requires greater cleanliness, such as oxygen, divers mixed gas, or divers air, it must be re-cleaned to the increased cleanliness level of that system prior to use.

3.3.4.3 Cleaning solvent selection.

3.3.4.3.1 Soil removal. The cleaning solvent selected shall achieve the cleanliness levels of 3.3.4.2.1.

3.3.4.3.2 Material compatibility. Metallic and non-metallic material normally wetted by the cleaning solvent during the cleaning process shall be compatible.

3.3.4.3.3 Toxicity. The cleaning solvent shall have no known carcinogenic or potentially carcinogenic materials identified by Occupational Safety and Health Administration (OSHA) as regulated carcinogens, or International Agency for Research on Cancer (IARC) latest monographs, or the latest annual report of the National Toxicology Program (NTP); shall have no Navy occupational chemical reproductive hazards; and shall have no extremely hazardous substances (EHS) identified in Appendix A to Section 40 Code of Federal Regulations 355, The List of Extremely Hazardous Substances, shall have no benzene compounds (defined as any compound which contains benzene, shall have no chlorohydrocarbon compounds (defined as any compound whose only constituents are chlorine and carbon, such as tricholoethylene), and shall not contain chlorodifluoromethane (HCFC-22, CAS No. 75-45-6).

3.3.4.4 Deviation from cleaning requirements. Any deviation from the requirements of the 3.3.4 through 3.3.4.3.3 shall be obtained in writing from NAVSEA (see 6.2).

3.3.5 Welding and brazing. Internal pressure containing parts shall be joined by welding or brazing. Welding shall be in accordance with NAVSEA S9074-AR-GIB-010/278, brazing shall be in accordance with NAVSEA 0900-LP-001-7000, and brazing using nickel-chromium based filler materials (e.g., Nicrobraz or equal) shall be in accordance with AWS C3.4, AWS C3.5, AWS C3.6, and AWS C3.7.

3.3.5.1 General applications. Joints shall be either brazed using nickel-chromium based filler materials or welded. Depending on the pressure range, NAVSEA S9074-AR-GIB-010/278, class P-1 or P-2 shall apply for welding. Class P-3 shall apply for brazing using nickel-chromium based filler materials.

3.3.5.2 Oxygen applications. Joints shall be welded for all ranges, NAVSEA S9074-AR-GIB-010/278, 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 2½-inch dial sizes for ranges 0/100 lb/in^2 and below.

3.3.7 Case. Pressure gauge cases shall be safety solid front as defined in ASME B40.l. 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, and A17 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
3½	$4^{15}/_{32}$	4¼	$^{7}/_{32}$	10-24
4½	$5^{19}/_{32}$	5⅜	$^{7}/_{32}$	10-24
8½	$9^{29}/_{32}$	9⅝	$^{9}/_{32}$	¼-20

3.3.7.1.2 Stem mounted case. Cases with the stem mounted configuration shall be only used with 2- and 2½-inch dial sizes. The 2- and 2½-inch dial size pressure gauges shall have a maximum case diameter of 2¼ and 2¾ 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 that 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/in^2 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	3 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 connections". A complete assembly, including the threaded end, the union nut, the tailpiece 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	9/16-18 UNF-3A	Drawing 803-1385850	For new construction retrofit, and replacement.
Taper pipe thread	1/4-18 NPT-2A	FED-STD-H28	For use in stem mounted pressure gauges with ranges 0/100 lb/in^2 or below (see MIL-STD-777).
¼-inch nps, nickel-copper pipe nipple, 6 inches long	Welded (see NAVSEA S9074-AR-GIB-010/278)	MIL-T-1368, schedule 80	For oxygen systems for welding the pressure connection to adjacent piping.
Flareless (bite type)	7/16-20 UNF-2A	SAE J514 – Male 7/16-20 thread, 6000 psi for ¼-inch OD tubing	For use in existing submarine service applications where conversion to an O-ring union connection is not appropriate.
O-ring union (HEMPI)	7/16-20 UNF-2B	SAE J1926/1	For HEMPI application only.
Secondary boundary gauge connection, 4 inches long, flareless (bite-type)	7/16-20 UNF-2A	SAE J514 - Male 7/16-20 thread, 6000 psi for ¼-inch OD tubing	For use in reactor plant secondary containment boundary applications.

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 ¼-inch NPT male fitting.

3.3.9.1.2 Stem mounted case. The pressure connection shall be threaded with ¼-inch NPT male threads as specified in Table IV for ranges 0/100 lb/in^2 and below.

3.3.9.1.3 HEMPI case. The pressure connection shall be in accordance with SAE J1926/1. 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 ⅛-inch tubing.

3.3.9.2 Oxygen service. Pressure connection shall be a monel pipe nipple, ¼-inch nominal pipe size (nps) with 0.109-inch minimum wall thickness, 6 inches long, welded to the socket in accordance with NAVSEA S9074-AR-GIB-010/278. Connection location shall be at the lower back or bottom of the case.

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 ease. 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, (4.0 ± 0.3 inches for secondary boundary gauge applications). 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 1ocation (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 3½-inch dial size, 3.8 ± 0.3 inches for the 4½-inch dial size, and 5.8 ± 0.3 inches for the 8½-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 ASME 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 bank diameter (min) (inches)
2	⅛	$1^{13}/_{16}$	2
2½	$^{5}/_{32}$	$2^{5}/_{16}$	$2^{9}/_{16}$
3½	$^{7}/_{32}$	3	$3^{5}/_{16}$
4½	$^{9}/_{32}$	4⅛	$4^{5}/_{16}$
8½	½	7¾	8¼

3.3.10.1.2 Markings. Dial markings shall include:

a. Manufacturer's name or trademark.

b. Military specification classification (see 1.2). (When NN designation is ordered, mark with the letters of the actual element material and style provided by the manufacturer, e.g., "IC" for an Inconel C-type bourbon tube elastic element.)

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/in^2 gauge shall be marked "PSIG".

h. Markings for submarine seawater service shall be single scale. Depth gages shall be graduated in feet of seawater; other submarine seawater gauges shall be graduated in lb/in^2.

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/in^2.

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 ⅛ inch (minimum) in height. The scale shall be ¾ inch (maximum) in width. At least ⅛ inch of the dial blank, measured from the left hand edge, shall remain blank along its entire length.

3.3.10.2.2 Dial markings. Dial markings shall include:

a. HEMPIs with scales calibrated in lb/in^2 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 1b/in^2 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.

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 [3/] (lb/in^2)	Minor graduation						Range designator (see 1.2.5)
	2-inch size	2½-inch size	3½-inch size	4½-inch size	8½-inch size	HEMPI	
0/15[1/]	½	½	½	¼	¼	--	15P
0/30[1/]	1	½	½	½	¼	½	30P
0/60[1/]	2	1	1	1	½	1	60P
0/100[1/]	2	2	2	1	1	2	1hP
0/200[1/]	--	5	5	2	1	5	2hP
0/300[1/]	--	5	5	5	2	5	3hP
0/400[1/]	--	10	10	5	2	10	4hP
0/600[1/]	--	10	10	10	5	10	6hP
0/800[1/]	--	10	10	10	5	20	8hP
0/1000[1/]	--	20	20	10	5	20	1kP
0/1500[2/]	--	20	20	20	10	25	15hP
0/2000[2/]	--	20	20	20	20	50	2kP
0/3000[2/]	--	50	50	50	20	50	3kP
0/5000[2/]	--	--	100	50	25	100	5kP
0/8000[2/]	--	--	100	100	50	200	8kP
0/10000[2/]	--	--	200	100	50	200	10kP

NOTES:

[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	2½-inch size	3½-inch size	4½-inch size	8½-inch size	
0/30	1	½	½	½	¼	V

TABLE VIII. Compound pressure ranges and minor graduations.

Ranges		Minor graduations						Range designator 1/ 2/ (see 1.2.5)
Vacuum scale (inches Hg)	Gauge pressure scale (lb/in^2)	3½ inch and 4½ inch		8½ inch		HEMPI		
		Vacuum	lb/in^2	Vacuum	lb/in^2	Vacuum	lb/in^2	
30	0/15	1	½	½	¼	2	1	15C
30	0/30	1	½	½	¼	5	2	30C
30	0/60	2	1	1	½	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

NOTES:

1/ Refrigerant identification symbol and a separate temperature degrees Fahrenheit (°F) equiva1ent scale in red printing in addition to the pressure scale in lb/in^2, 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
R134A	5

TABLE IX. Suppressed pressure ranges and minor graduations, 8½-inch size.

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

TABLE X. Retarded pressure ranges and minor graduations, 4½-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	¼ lb/in^2	10/30	5	R1
30	0/30	30 inches 0/5 lb/in^2	1 inch ¼ lb/in^2	5/30	5	R2
30	0/150	30 inches 0/75 lb/in^2	1 inch 1 lb/in^2	75/150	5	R3

TABLE XI. Caisson pressure ranges and minor graduations.

Ranges [1/ 2/]		Minor graduation						Range designator (see 1.2.5)
		3½ inch		4½ inch		8½ 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

NOTES:
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)		
Percent scales (percent)	Pressure ranges (lb/in^2)	2½ inch	3½ inch	Range designator (see 1.2.5)
0/100	3/15	1	1	15N
0/100	3/27	1	1	27N
0/100	0/60	1	1	60N

NOTES:
1/ Receiver gauges shall include five equally spaced referenced pressure graduations in lb/in^2 on the graduated scale in addition to the scale graduations and markings in units for the range of the primary sensing transmitter, when applicable.

TABLE XIII. Oxygen service ranges and minor graduations.

Ranges lb/in^2	Minor graduations		Range designator (see 1.2.5)
	3½-inch size	4½-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, 8½-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 seawater system pressure gauges that 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).

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. 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 size - 2½ inch. The accuracy of 2½-inch dials shall be within plus or minus 2 percent of span.

3.4.1.1.3 Dial sizes - 3½, 4½ and 8½ inch. The accuracy of 3½-, 4½- and 8½-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/in^2) 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 10 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/in^2 and below and within plus or minus 2.5 percent of span for indicators with upper range limits above 5000 lb/in^2.

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/in^2, the friction error shall not exceed ½ the specified accuracy. For ranges 0/60 lb/in^2 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 ½ the specified accuracy.

3.4.3 Inclination. Maximum deviation of the pressure gauge indication resulting from inclination shall be within plus or minus ½ of the specified accuracy (see 3.4.1) except for ranges 0/100 lb/in^2 and below which shall be within twice the specified accuracy (see 3.4.l).

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).

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/in^2 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 that 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/in^2 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/in^2 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 tota1 shift of 25 percent of span after all nine blows. The red index (see 6.7) shall not shift during the shock test. A reference measurement performed after the conclusion 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.

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 8½- 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 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	---	---
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	---	---
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	---	

TABLE XV. Examination and tests – Continued.

Examination or test	Requirement	Test method	First article inspection	Quality conformance inspection	Quality conformance sampling plan
Elastic element or joining means failure	3.3.7	4.4.13	X	---	---
Cleaning	3.3.4.2.1 & 3.3.4.3.1	4.4.8 & 4.4.9	X	---	---

NOTES:
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).

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 that 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. Samp1ing plans.[1/]

	Sample size		
Lot 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

NOTES:
[1/] Sampling plan code letters specified in Table XV.

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	
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 tolerance 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 nonconforming.	5	4

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 tailpiece 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 ±10 °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 ASME 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. For first article testing, 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 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. For quality conformance inspection, the accuracy test shall consist of three equally spaced pointes over the entire span for one cycle.

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 limits. For example, the span of a 30-inch Hg vacuum (approximately minus 15 lb/in^2) to 30-lb/in^2 pressure scale is approximately 45 lb/in^2. 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 1minute 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.

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 ± 5 °F and allowed to stabilize. After the temperature test chamber has stabilized at 145 ± 5 °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 ± 5 °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 ± 5 °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 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

NOTES:
[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

NOTES:
[1/] Ambient temperature for the first cycle.
[2/] Cycle 1: TMIN - minus 10 ± 5 °F, Cycles 2-5: TMIN - 40 ± 5 °F.

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 ± 5 °F and allowed to stabilize at this temperature. After the temperature test chamber has stabilized at 145 ± 5 °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.
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 that 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 at 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 exp1oratory, variable frequency, or endurance tests. 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 occurs 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:

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) Disp1acements 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 41	.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

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.
   (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.
   (5) Displacements or accelerations shall be as specified in Table XXIII.
   (6) For every observed resonance a detailed search shall be conducted within the 5-Hz interval to determine the resonant frequency.

c. Category C:
   (1) Discrete frequency interval of 5 Hz. Each discrete frequency shall be maintained for a minimum of 2 minutes.

(2) Frequency range from 5 to 200 Hz.

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.

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 opponent 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-90l, grade A, class I, except for duplex pressure gauges which shall be grade B. Pressure gauge ranges 0/60 lb/in^2 and above shall be subjected to two sets of nine blows. Pressure gauge ranges 0/30 lb/in^2 and below shall be subjected to one set of nine blows. Flush and surface mounted pressure gauges shall be mounted on a 6D-l 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 cycler 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/in^2 and below. A cycle from 40 ± 4 to 60 ± 4 percent of span for pressure ranges 0/5000 lb/in^2 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/in^2 and below. A total of 50,000 cycles for pressure ranges 0/5000 lb/in^2 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).

e. Suitable fluid shall be used to cycle pressure gauges with ranges greater than 0/200 lb/in^2.

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 he 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/in^2 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 IV. 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

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/in^2.

4.4.13 Elastic element or joining means failure. Nonsolid front gauges with ranges 0/60 lb/in^2 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 ASME 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 ¼ percent of span or better. The test gauge shall be maintained in accordance with ANSI/NCSL Z540.1.

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 ANSI/NCSL Z540.1.

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 Determination of non-volatile residue. The non-volatile residue shall be as specified in 3.3.4.2.1. A recommended procedure for determination of non-volatile residue in a solvent is ASTM D 2109 or ASTM F 331. Solvents addressed in ASTM D 2109 or ASTM F 331, which are excluded by 3.3.4.3.3, shall not be used.

4.8 Solvent cleaning ability verification. The ability of the solvent to achieve the required cleanliness levels shall be as specified in 3.3.4.3.1. A recommended procedure to verify ability of the cleaning solvent to achieve the cleanliness levels of 3.3.4.2.1 is to clean a pressure gauge elastic element with the selected cleaning solvent after the element has been artificially contaminated to 50 mg/0.1 m^2 with representative soil.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

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 is 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 2½-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):

Circular dial size (inches)	Case design
2, 2½	Stem mounted
3½, 4½, 8½	Flush/surface mounted

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. When first article is required (see 3.1).
e. Deleted.
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. Special cleanliness requirements (see 3.3.4.2.1).
j. When instruction sheets are not required (see 3.6).
k. When deviating from cleaning requirements (see 3.3.4.4), a letter to NAVSEA with a justification is required.
l. Deleted.
m. Deleted.
n. Deleted.
o. Packaging requirements (see 5.1).

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 (DIDs) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DIDs 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.

Reference Paragraph	DID Number	DID Tit1e	Suggested Tailoring
3.5 and appendix	DI-DRPR-80651	Engineering drawings	Level 3
4.2.2	D1-T-2072	Reports, test	---

The above DIDs 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 DIDs are cited on the DD Form 1423.

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 ASME 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.

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 Amendment notations. The margins of this specification are marked with vertical lines to indicate modifications generated by this amendment. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

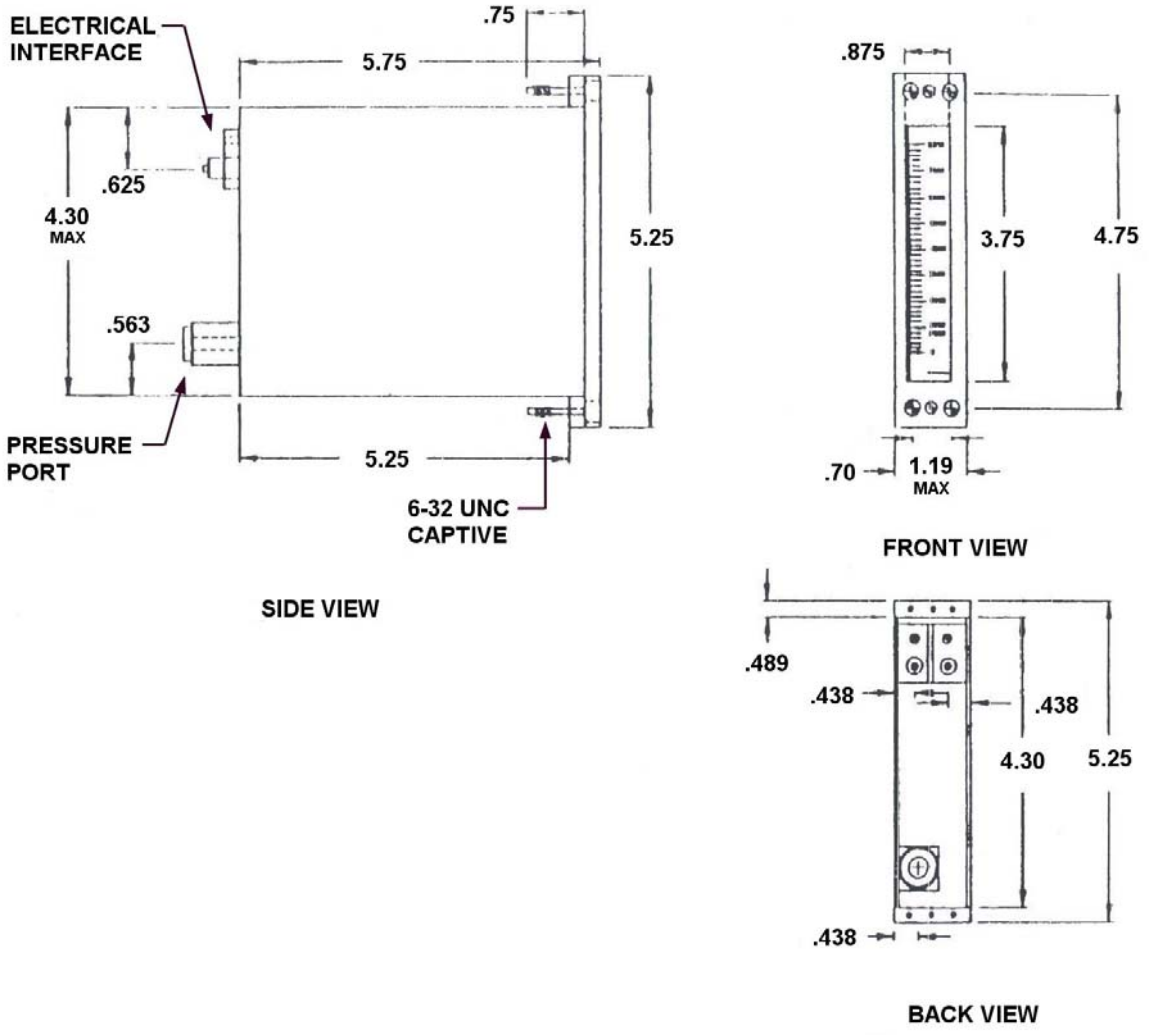


FIGURE 1. HEMPI dimensional requirements.

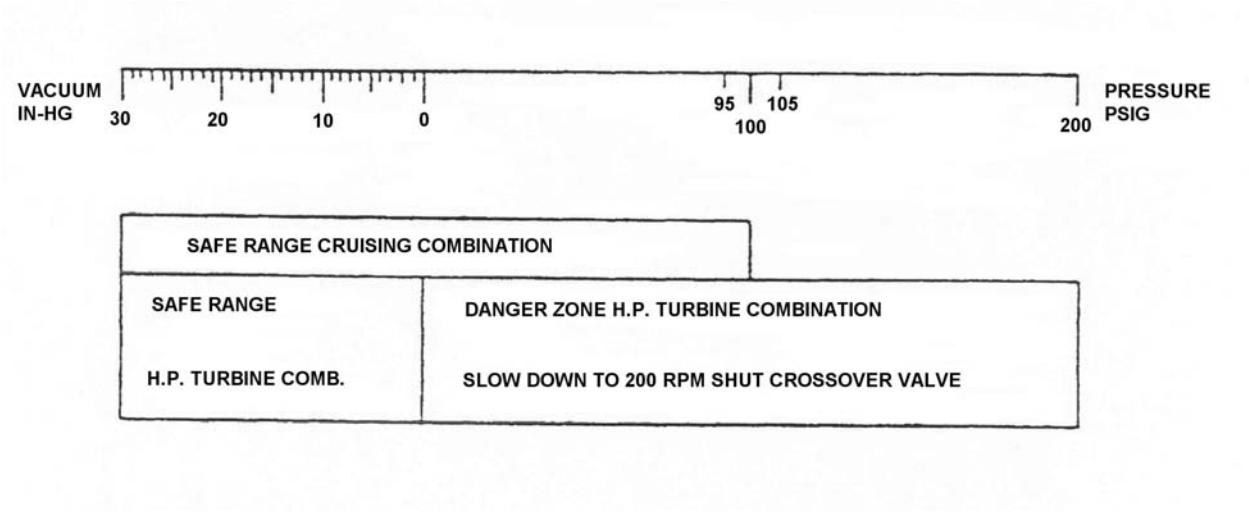
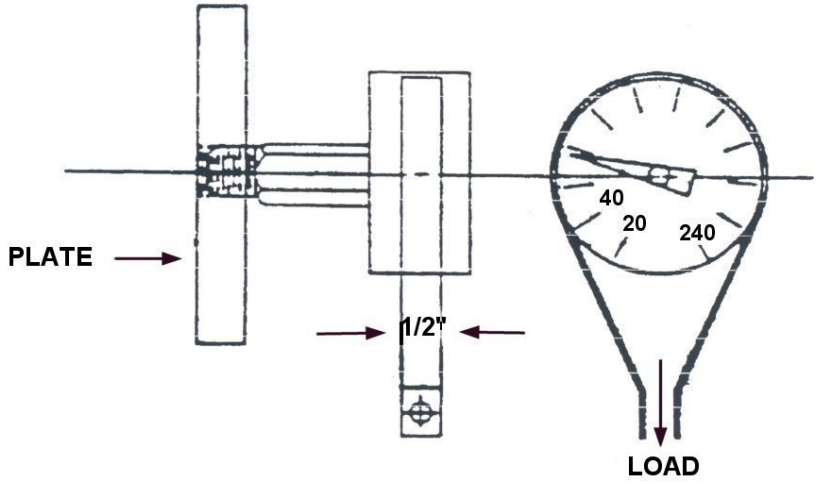


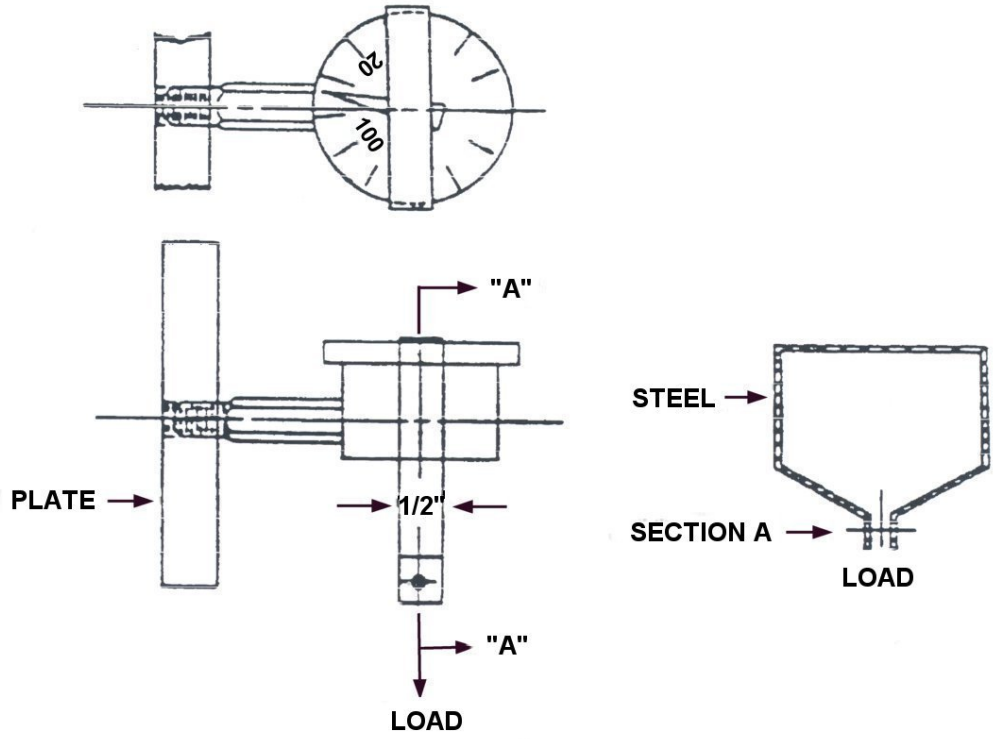
FIGURE 2. Cruising range gauge scale.

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 RPM shut crossover valve" shall contain a red background with white letters.

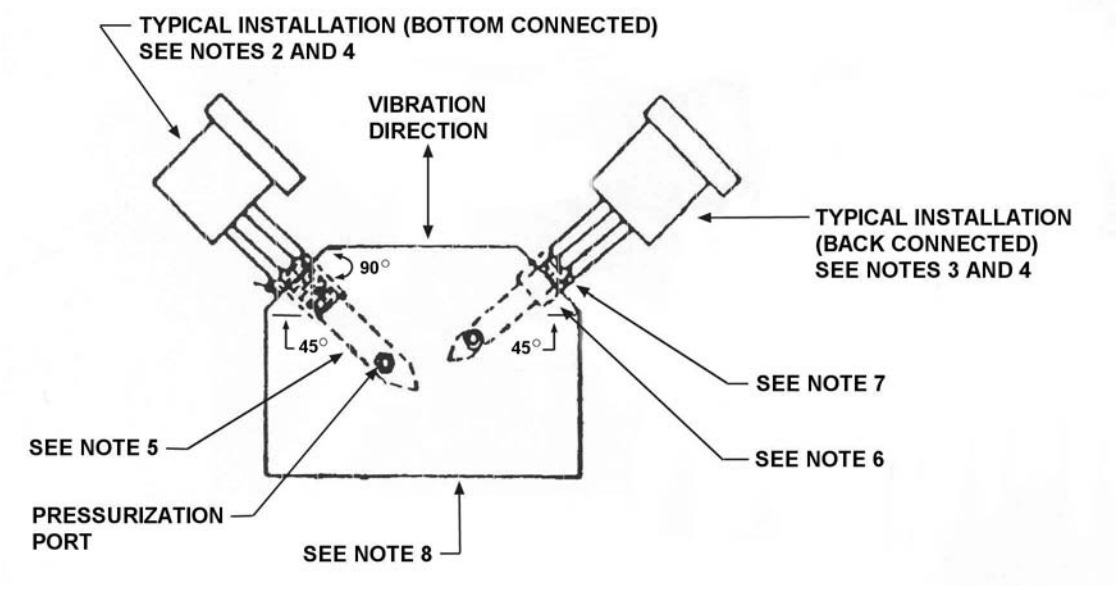


BACK CONNECTED CONFIGURATION



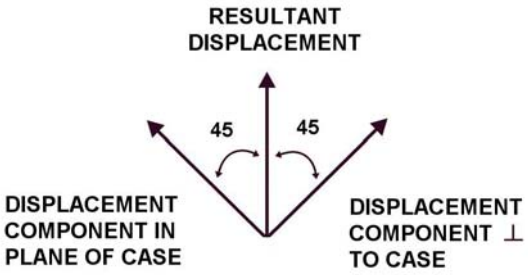
BOTTOM CONNECTED CONFIGURATION

FIGURE 3. Load test.



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 5 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.

ENGINEEING 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 Applicable documents for the requirements of symbols, designations, drawing format and size shall be those documents used by the manufacturer in the preparation of drawings for their commercial products.

20.2 Deleted.

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. 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 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.

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) Standard symbols shall be used to designate a part.
(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. 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) that 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 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) Resisters - 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.
(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 that 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 rang 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.

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 that 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 manufacturer's standard practice.

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 the delays in conformance verification drawing acceptance. NAVSEA shall be designed as the activity that accepts or disapproves the conformance verification drawing.

Preparing Activity:
Navy – SH
(Project 6685-0067-000)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at http://assist.daps.dla.mil.