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(See 6.9)

MILITARY SPECIFICATION

LIQUID LEVEL INDICATING EQUIPMENT (ELECTRICAL)

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 the requirements for electrical liquid level indicating equipment for Naval shipboard use in fresh water, feed water, potable water, seawater, waste water, diesel fuel, lubricating oil, contaminated oil, refrigerants, JP fuels and various other fluids in low pressure and high pressure tanks.

1.2 Classification. The types of liquid level indicating equipment shall be designated in the following form, as specified (see 6.2):

IC/CO	MF	SW/AR	LP	A	005/245/250
Basic type	Sensing technique	Application	Pressure range	Display	Indication range
(see 1.2.1)	(see 1.2.2)	(see 1.2.3)	(see 1.2.4)	(see 1.2.5)	(see 1.2.6)

1.2.1 Basic type. The basic type for Naval interior communication continuous output liquid level indicating equipment shall be designated by "IC/CO".

1.2.2 Sensing technique. The sensing technique shall be designated as follows:

AZ - Admittance/impedance
MF - Magnetic float
DP - Differential pressure
TD - Time domain reflectometry
CA - Capacitive
RT - Resistance tape-type

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, SEA 03R42, Naval Sea Systems Command,2531 Jefferson Davis Hwy, Arlington VA 22242-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6680

1.2.3 Application. The fluid to be measured shall be designated as follows. The first two-letter designation identifies the fluid to be measured in the tank. The second two-letter designation identifies the liquid or gas which interfaces with the measured fluid.

Fluid	Liquid or gas
CF - Contaminated fuel	
CO - Contaminated oil	
FO - Fuel (diesel fuel, cargo fuel, gasoline)	
FW - Fresh water, potable water, feed water	
HO - Hydraulic oil	
JP - JP-5, JP fuels	
LO - Lubricating oil	
RF - Refrigerants	
SO - Synthetic oil	
SW - Seawater	
TO - Turbine oil	
WO - Waste oil	
WW - Waste water, sanitary waste	AR - Air
	CA - Compressed air
	CG - Compressed gas
	ST - Steam
	SW - Seawater
	WW - Waste water

1.2.4 Pressure range. The pressure range under which the sensing device shall operate shall be designated as follows:

AP - Vacuum pressure of 29.5 inches mercury (749 millimeters mercury) to 20 pounds per square inch gauge (psig) (138 kiloPascals (kPa)) inclusive.
VP - Vacuum pressure of 29.5 inches mercury (749 millimeters mercury) to 100 psig (689 kPa) inclusive.
LP - From 0 psig (0 kPa) to 100 psig (689 kPa) inclusive.
HP - From 101 psig (696 kPa) to maximum pressure as specified (see 6.2).

1.2.5 Display. The display shall be designated as follows:

A - Analog
D - Digital
C - Analog and digital

1.2.6 Indication range. The indication range shall be designated by three numbers, separated by a "/". Each number shall represent a height in inches above the bottom of the tank. The first number shall indicate where

liquid level indication shall begin. The second number shall indicate where liquid level indication shall end. The third number shall indicate the total height of the tank.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

P-D-680 - Dry Cleaning and Degreasing Solvent.

MILITARY

MIL-C-17/127 - Cables, Radio Frequency, Flexible, Coaxial, 50 Ohms, M17/127-RG393.

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

MIL-C-915 - Cable and Cord, Electrical, for Shipboard Use, General Specification for.

MIL-C-915/8 - Cable, Power, Electrical, 600 Volts, For Outdoor Use Only (Not for Indoor Use) Types DSS, TSS, FSS and 7SS.

MIL-R-6855 - Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes, General Specification for.

MIL-F-15160 - Fuses: Instrument, Power, and Telephone.

MIL-F-15160/3 - Fuses; Instrument, Power, and Telephone (Nonindicating), Style F03.

MIL-A-15303 - Audible Signals: Alarms, Bells, Buzzers, Horns, and Sirens, Electronic, Shipboard.

MIL-S-16032 - Switches and Detectors, Shipboard Alarm Systems.

MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).

MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.

MIL-F-19207 - Fuseholders, Extractor Post Type, Blown Fuse Indicating and Nonindicating General Specification for.

MIL-F-19207/1 - Fuseholders, Extractor Post Type, Blown Fuse Indicating, Type FHL10U and FHL10G.

MIL-C-24231 - Connectors, Plugs, Receptacles, Adapters, Hull Inserts, and Hull Insert Plugs, Pressure-Proof, General Specification for.
MIL-S-24235 - Stuffing Tubes, Metal, and Packing Assemblies for Electric Cables, General Specification for.
MIL-M-24359 - Meters, Milliammeters, Direct Current Panel Mounting (Edgewise Types).
MIL-P-24423 - Propulsion and Auxiliary Control Consoles and Associated Control and Instrumentation Equipment, Naval Shipboard Use, Basic Design Requirements.
MIL-C-24712 - Coatings, Powdered Epoxy. (Metric)
MIL-M-38510 - Microcircuits, General Specification for.
MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies).
MIL-P-55110 - Printed-Wiring Board General Specification for.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Requirements for the Control of Electromagnetic Interference Emission and Susceptibility.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
DOD-STD-1399, Section 070 - Interface Standard for Shipboard systems, D.C. Magnetic Field Environment. (Metric)
MIL-STD-1399, Section 300 - Interface Standard for Shipboard Systems, Electric Power, Alternating Current. (Metric)
MIL-STD-2036 - General Requirements for Electrical Equipment.

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

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

DRAWING

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
NAVSEA 803-2145532 - Indicator/Indicating System Liquid Level Applications/Selection Guide.

(Application for copies of NAVSEA drawing should be addressed to: Commander, Portsmouth Naval Shipyard, Naval Engineering Drawing Support Activity, Code 280.6, Portsmouth, NH 03804-5000.)

PUBLICATION

NAVSEA
S9086-VD-STM-000/CH-631 - Preservation of Ships In Service, Surface Preparation and Painting.

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
B 117 - Standard Test Method of Salt Spray (Fog) Testing (DOD adopted)

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

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article testing (see 6.5) in accordance with 4.4.

3.2 General requirements. Liquid level indicating equipment shall be in accordance with the electrical and mechanical design and construction requirements of MIL-STD-2036 and as specified herein.

3.2.1 Materials and processes. The selection, usage and methods of implementation shall be in accordance with MIL-STD-2036. Materials shall not be adversely affected by the ambient environments specified in the construction and performance requirements of this specification. Nonmetals shall be flame resistant and shall not support fungus growth as specified in MIL-STD-454.

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

3.2.2 Parts. Part selection and usage shall be in accordance with MIL-STD-2036, except that an elapsed time indicator is not required.

3.2.2.1 Printed wiring boards. Printed wiring boards shall be in accordance with MIL-P-55110 and MIL-P-24423. Printed circuits shall be conformally coated. The insulating compound shall be in accordance with MIL-I-46058, type UR.

3.2.2.2 Liquid level switches. Liquid level switches shall be in accordance with MIL-S-16032.

3.2.2.3 Solid-state electronics. Only solid-state electronics shall be used.

3.2.2.4 Fuses . Fuses shall be style F03 in accordance with MIL-F-15160 and MIL-F-15160/3. Glass tube fuses shall not be used.

3.2.2.5 Fuseholders. Fuseholders shall be type FHL10U in accordance with MIL-F-19207 and MIL-F-19207/1.

3.2.3 Microprocessors. Microprocessors and microprocessor support circuitry may be incorporated in the equipment to perform processing and control functions. These functions may be: sensor and tank selection and monitoring, sensor signal processing, power failure monitoring, alarm monitoring and control, liquid level height conversion to liquid level volume using look-up tables in programmable read only memory (PROM), receiver selection, and so forth. When used, microprocessors shall be in accordance with MIL-M-38510, class B and built-in test (BIT) shall be provided in the form of firmware, residing in the PROM. To assist troubleshooting, BIT shall indicate basic failure modes of the equipment such as power supply parameters out of tolerance.

3.2.4 Testability. Testability shall be in accordance with MIL-STD-2036. No mechanical or electrical disassembly shall be required for the purpose of obtaining access to test points or adjustments, except for removal of a cover plate.

3.2.5 Safety. Liquid level indicating equipment shall be in accordance with the safety requirements of MIL-STD-2036. For JP, CF, CO, WO and FO applications, the portions of the liquid level indicating equipment inside the tank shall be in accordance with the hazardous atmosphere requirements of MIL-STD-2036.

3.2.6 Input connectors and color code. Electrical power input connector pin assignments and color code shall be in accordance with MIL-STD-2036.

3.2.7 Thermal design and construction. Thermal design and construction shall be in accordance with MIL-STD-2036.

3.2.8 Size and weight. Unless otherwise specified (see 6.2), the maximum height of any individual component shall be 120 inches. Overall shape and dimensions shall meet requirements for surface ship and submarine installations in accordance with MIL-STD-2036. Unless otherwise specified (see 6.2), the maximum weight of any individual component shall be 35 pounds.

3.2.9 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 Description. Each liquid level indicating equipment shall consist of the following components:

(a) One or more sensing devices.
(b) Flexible interconnections, if needed.
(c) Primary indicator panel assembly.
(d) Auxiliary indicator panel assembly, when required (see 6.2).
(e) Portable indicator assembly, when required (see 6.2).

Selection and installation of liquid level indicating equipment for Naval shipboard applications shall be in accordance with Drawing 803-2145532.

3.4 Construction.

3.4.1 Sensing device. Sensing device material shall be capable of withstanding exposure to shipboard humidity and salt environment, the corrosive and pressure effects of the medium whose level is being measured and the mechanical stresses of shipboard shock and vibration. Sensing device material shall not corrode nor deteriorate in the intended environment. Sensing devices installed in seawater shall be fabricated from Inconel 625, Monel, or 316 stainless steel and then powder epoxy coated. For other

applications the sensing device material shall be fabricated from corrosion resistant steel (CRES). Other materials may be used, if demonstrated to be acceptable to Navsea. Toxic materials shall not be used in potable water applications. Sensing devices shall be easily installed regardless of tank configuration and structural and other obstructions. Sensing devices may be combined with flexible interconnections to give coverage of the complete tank or portion specified. If the sensing device uses a part exposed to tank contents which moves on a stationary part (for example, float), the clearance between the moving part and stationary part shall be a minimum of 0.10 inch, even when epoxy coated (see 3.4.7). Tank penetrations for cables shall be through stuffing tubes in accordance with MIL-S-24235 for low pressure applications. Hull connectors or bulkhead type connectors shall be used in accordance with MIL-C-24231 for high pressure applications.

3.4.1.1 Sensing device operation. The sensing device shall not use any part of the tank structure as part of the sensing device. The sensing device operational technique shall be as specified herein (see 1.2.2).

3.4.1.1.1 Admittance and impedance (AZ). Admittance and impedance sensing technique shall use the apparent resistance to the current flow of an alternating current in the sensing device circuit or its reciprocal with respect to the level of the measured fluid in the tank.

3.4.1.1.2 Magnetic float (MF). Magnetic float sensing technique shall use a float with embedded magnets to change the circuit status of the sensing device and produce an electrical signal proportional to the float's position with respect to the level of the measured fluid in the tank.

3.4.1.1.3 Differential pressure (DP). Differential pressure sensing technique shall use the pressure difference regardless of the ambient pressure to change the circuit status of the sensing device and produce an electrical signal proportional to the level of the measured fluid in the tank.

3.4.1.1.4 Time domain reflectometry (TD). Time domain reflectometry sensing technique shall use high frequency pulse amplitude and timing information to measure reflected energy from the sensing device to determine the level of the measured fluid in the tank.

3.4.1.1.5 Capacitive (CA). Capacitive sensing technique shall use the change in capacitance of the sensing device to produce an electrical signal proportional to the level of the measured fluid in the tank.

3.4.1.1.6 Resistance tape-type (RT). Resistance tape-type sensing technique shall use the change in circuit resistance in the sensing device to produce an electrical signal proportional to the level of the measured fluid in the tank.

3.4.2 Flexible interconnections. Electrical flexible interconnections, including tank penetration cables, shall have high pressure pin connections in accordance with MIL-C-24231 on high pressure tank penetrations. Flexible interconnections shall permit easy repair, replacement, substitution or bypassing of sensing devices. No interconnection boxes or junction boxes shall be installed inside of any tank. Flexible interconnections shall be type I or type II as specified herein.

3.4.2.1 Type I flexible interconnections. Type I flexible interconnections shall be used in FO, CF, CO, WO and JP applications. For sensing techniques other than TD, the cable shall be shielded, water blocked cable consisting of watertight primary conductors, insulated with cross-linked (XL) modified polyalkene and with an outer layer of XL modified polyvinylidene fluoride. The primary conductors shall be waterblocked and wrapped with polyester tape. The shield shall be tin plated copper and water blocked and wrapped with another polyester tape layer. The cable jacket shall be XL modified ethylene-tetrafluoroethylene copolymer. The final cable formulation shall meet the physical characteristics (tensile strength elongation, bending endurance, and so forth) as specified in MIL-C-915. For TD sensing techniques, the cable shall be FEP jacketed coax cable in accordance with MIL-C-17/127.

3.4.2.2 Type II flexible interconnections. Type II flexible interconnections shall be used in applications other than FO, CF, CO, WO and JP applications. For sensing techniques other than TD, type II flexible interconnections shall be of watertight flexing construction in accordance with MIL-C-915 and MIL-C-915/8, type DSS, TSS, FSS and 7SS. The cable outer jacket shall be butadiene copolymer with an acrylonitrile content of 40 ± 10 percent by volume. The final cable formulation shall meet the physical characteristics (tensile strength, elongation, bending endurance, and so forth) as specified in MIL-C-915. For TD sensing techniques, the cable shall be FEP jacketed coax cable in accordance with MIL-C-17/127.

3.4.3 Primary indicator panel assembly. The primary indicator panel assembly shall be as small and lightweight as practicable, of sheet metal or cast aluminum, dripproof construction, and arranged for bulkhead or panel mounting as specified (see 6.2). Unless otherwise specified (see 6.2), the primary indicator panel assembly shall provide only a single liquid level display. The primary indicator shall consist of the following:

(a) Regulated power supply
(b) Signal conditioner(s)
(c) When specified (see 6.2), a control circuit to be used for actuating an external device, such as an alarm or pump, when liquid level reaches predetermined points.
(d) Controls and indicators (see 3.4.3.4).
(e) Protective shield, when required (see 6.2)

Other functional components and parts not included in the sensing device assembly shall be contained within the panel enclosure. Where multiple displays are combined on a single primary panel, there shall be no interaction between the individual tank liquid level indicating equipment circuits except a common power supply and operational test device may be utilized.

3.4.3.1 Power supply. The power supply shall be a regulated power supply and shall be in accordance with MIL-STD-2036.

3.4.3.2 Signal conditioner. The signal conditioner shall provide a continuous output signal from 0-200 microamperes (μadc), 4-20 milliamperes dc (madc), 0-10 vdc, or 1-5 vdc. The signal conditioner output shall be uninterrupted from empty to full or over that portion of the tank to be measured. Unless volumetric accuracy is specified (see 6.2), the output signal shall be proportional to the actual liquid level height in the tank. When volumetric accuracy is specified, the output of the signal conditioner shall be proportional to the actual liquid level volume in the tank and the contracting activity will furnish the tank capacity curve. Volumetric accuracy shall not be accomplished by modifications to the indicator dial or scale.

3.4.3.3 Control circuit. When specified (see 6.2), a control circuit shall be provided that has two (two high, two low, or one high and one low), or four (two high and two low) independently adjustable settings, each of which controls a 2-pole double throw switching device with a contact rating of 1 ampere (inductive) at 115 volts, 60 hertz (Hz).

3.4.3.3.1 Control circuit setpoints. The high level control circuit setpoints shall be adjustable from 50 to 98 percent of the indicated range. The low level control circuit setpoints shall be adjustable from 2 to 50 percent of the indicated range. Setpoint adjustments shall have restricted access to eliminate tampering and shall be provided with locking devices to secure settings. No mechanical or electrical disassembly shall be required to access the control circuit setpoint adjustments except for removal of a cover plate. A control circuit test means shall be provided to verify the alarm setpoints and control circuit operation.

3.4.3.4 Controls and indicators. The following controls and indicators shall be mounted on the front panel of the primary indicator assembly:

(a) Power-on light (white lens).
(b) Power-on switch.
(c) One or more liquid level displays.
(d) Operational test device.
(e) Fuseholder and blown fuse indicator.
(f) When required, alarm lights (see 6.2).
(g) When required, audible alarm and alarm acknowledge switch (see 6.2).

Multiposition switches and controls may be used to combine functions.

3.4.3.5 Protective shield. The protective shield, when required, (see 6.2) shall be rigid, transparent, shatterproof and positioned as close to the indicator as possible to protect the indicator from accidental damage. The protective shield shall not trap moisture and shall be easily removable.

3.4.4 Auxiliary indicator panel assembly. When required (see 6.2), the auxiliary panel enclosure shall be as small and lightweight as practicable, of sheet metal or cast aluminum, dripproof construction, and arranged for bulkhead or panel mounting as specified (see 6.2). Unless otherwise specified (see 6.2), only a liquid level display shall be mounted on the front panel. The liquid level display shall be of the same type as on the primary indicator panel assembly. In the event of failure of the auxiliary indicator panel assembly, a device shall be provided on the primary indicator panel assembly to allow isolation of the auxiliary indicator panel assembly. With the auxiliary indicator panel assembly isolated, the primary indicator panel assembly shall continue to operate as specified herein.

3.4.5 Portable indicator assembly. When required (see 6.2), the portable indicator assemblies shall meet the requirements of the primary indicator panel assembly (see 3.4.3) except the enclosure shall be watertight and bulkhead or panel mounting provisions are not required.

3.4.6 Mounting. Mounting shall be in accordance with MIL-STD-2036. Component mounting devices or brackets shall be supplied with the liquid level indicating equipment.

3.4.7 Coating. For all seawater applications and when required (see 6.2), the stationary metallic parts of the liquid level indicating equipment which may come in contact with the fluid to be measured, excluding flexible interconnections, shall be powder epoxy coated in accordance with MIL-C-24712, type II.

3.4.8 Maintainability. The liquid level indicating equipment shall facilitate assembly, disassembly, fault isolation, operational test (for example, setting or checking alarm setpoints and setting or checking full scale meter deflection), and preventative maintenance without the aid of special tools or special purpose equipment. The use of special purpose equipment (any device physically separate from the liquid level indicating equipment) shall be minimized. Unless otherwise specified (see 6.2), special purpose equipment required for initial setup, equipment change, or troubleshooting shall be provided with the liquid level indicating equipment. Functional parts shall be readily identifiable, accessible and removable for replacement. Functional parts are defined as replaceable individual component parts such as resistors, capacitors, or semiconductor devices or replaceable functional assemblies such as power supplies, printed circuit boards or meters.

3.5 Detail requirements.

3.5.1 Liquid level display. Liquid level displays shall be 0 to 200 μa, 4 to 20 madc, 0 to 10 vdc, or 1 to 5 vdc; high impact shock resistant; and watertight or sealed electrical indicating meter types in accordance with one of the following:

(a) 4-1/2 inches, 250 degrees with nominal scale length meter in accordance with MIL-M-16034.
(b) Panel mounted, edgewise meter in accordance with MIL-M-24359.
(c) Digital bargraph type panel meter with minimum 4 digit display and minimum 51 segment (101 segment preferred) analog display. Light emitting diode type preferred.
(d) Digital panel display with 3-1/2 digits graduated 0 to 100 percent only. Light emitting diode type preferred.

3.5.1.1 Dials. Unless otherwise specified (see 6.2), liquid level display dials shall be furnished blank, except for minimum and maximum travel points. The dial shall be readily removable and replaceable from the front of the liquid level display without disturbing the pointer or other parts of the liquid level display. The dial surface shall be suitable for marking by an installing activity after the liquid level indicating equipment has been calibrated to a particular tank. When graduations are specified, they shall extend uniformly over the full range of the liquid level display and shall be multiples of 1, 2, 5, 10, 20, 50, and so forth. Multiples of any other numbers or fractions are not permitted. The minimum number of graduations per dial shall be 24 and the maximum number of graduations shall be 200. Dials shall begin and end with a numbered graduation. Markings such as "0" and "F" shall not be used. When required (see 6.2), additional information shall be identified on the dial as specified by the contracting activity. Unless otherwise specified (see 6.2), dials shall have black letters, numerals and graduations on a white background. The indicator pointer shall be black.

3.5.1.2 Red illumination. When red illumination is specified (see 6.2), the primary indicator shall have white letters, numerals and graduations on a black background and shall contain internal red illumination. The letters, numerals and graduations shall appear white under ambient white light and red under ambient and internal red light. The indicator pointer shall be either red illuminated or silhouetted against the dial. Red illumination shall be in accordance with MIL-STD-2036. The lighting circuit shall be ungrounded and shall be energized from a 6-volt supply with separate external terminals.

3.5.1.3 Display visibility. The display shall be clearly visible from a distance of 3 feet and from a viewing angle of 45 degrees from normal; both vertically and horizontally.

3.5.3 Audible signals. When audible signals are required for any remote station (see 6.2), the signals shall be in accordance with MIL-A-15303. The audible signal shall be actuated by the signal conditioner output or a control circuit adjusted to a predetermined level (see 3.4.3.2 and 3.4.3.3).

3.6 Performance.

3.6.1 Operation. During operation (see 4.8.1), equipment performance shall be as follows:

(a) Liquid level display readings shall be in consonance with the liquid level in the tank throughout level cycling.
(b) The power on switch shall turn the power on and off.
(c) Power on light shall be illuminated only when power is on.
(d) The operational test device shall test for the proper operation of the associated liquid level display.
(e) Blown fuse indicator shall illuminate when fuse is blown.
(f) When included, the control circuit shall not affect the accuracy of the overall liquid level indicating equipment. Any failure in the sensing device, transducer and associated sensing circuits, or the control circuit shall result in the actuation of the control function or result in a change of the readout that can be interpreted as a failed condition.
(g) When provided, the high level control circuit setpoint shall be the liquid level where the switching device is activated or deactivated. The switching device shall be activated when the actual liquid level is above the control circuit setpoint and shall be deactivated when the actual liquid level is below the control circuit setpoint.
(h) When provided, the low level control circuit setpoint shall be the liquid level where the switching device is activated or deactivated. The switching device shall be activated when the actual liquid level is below the control circuit setpoint and shall be deactivated when the actual liquid level is above the control circuit setpoint.
(i) When provided, alarm lights shall illuminate only when the control circuit switching device is activated and shall be extinguished only when the control circuit switching device is deactivated.
(j) When provided the audible alarm shall sound only when the associated control circuit switching device is activated. The audible alarm shall be silenced when either the alarm acknowledge switch is operated or when the control circuit switching device is deactivated.
(k) When a control circuit is provided, the control circuit test means shall verify the alarm setpoint and control circuit operation.

3.6.2 Accuracy. Accuracy shall be as specified in 3.6.2.1 and 3.6.2.2 (see 4.8.1).

3.6.2.1 Liquid level indicating equipment accuracy. Liquid level indicating equipment accuracy shall be as follows:

(a) Unless volumetric accuracy is specified (see 6.2), the liquid level displays shall indicate the actual liquid level height in the tank within plus or minus three percent of full scale. When volumetric accuracy is specified the indicated liquid volume shall be the actual liquid level volume in the tank within plus or minus three percent of full scale.
(b) Repeatability of the indicators shall be within plus or minus one percent of full scale at any point on the scale.

3.6.2.2 Control circuit. Accuracy of adjustable control circuit setpoints shall be as follows:

(a) Hysteresis of dead band - Make and break of the control function when operated through down and up cycles shall not exceed plus or minus three percent including instrument hysteresis and dead band.
(b) Repeatability of the control point contact shall be within plus or minus one percent of full scale.

3.6.3 Response time.

3.6.3.1 Indication response time. Liquid level indicating equipment shall have an indication response time of 0.5 seconds or less for liquid level change rates up to one inch per second (see 4.8.2.1). Indication response time is defined as the time difference between when a liquid achieves a specified level and when the liquid level display indicates that specified level within the accuracy requirements of 3.6.2. Operation shall be in accordance with 3.6.1.

3.6.3.2 Control circuit response time. Control circuit response time shall be adjustable and shall have a minimum control circuit response time of 0.5 second and a maximum control circuit response time of 20 seconds (see 4.8.2.2). Adjustment of the control circuit response time shall be continuous or in five steps as follows: 0.5, 2, 5, 10 and 20 seconds. The indication response time shall be in accordance with 3.6.3.1 regardless of control circuit response time setting. Control circuit response time is defined as the time difference between when a liquid reaches a setpoint level and when the control circuit activates or deactivates the switching device associated with that setpoint level. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.4 Insulation resistance. The liquid level indicating equipment insulation resistance shall be not less than 10 megohms (see 4.8.3). Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 after measurement of insulation resistance.

3.6.5 Specific gravity. For applications where the fluid is FO, CO, WO, CF or JP, operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 when subjected to changes in specific gravity in accordance with the specific gravity test (see 4.8.4). Manual adjustments shall not be permitted or required to obtain accuracy.

3.6.6 Fluid conductivity. For applications where water of any type is present, operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 when the water conductivity is in the range of 3 microsiemens per centimeter (μS/cm) to 10,000 μS/cm (see 4.8.5). Manual adjustments shall not be permitted or required to obtain accuracy.

3.6.7 Tank wall proximity. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 when the distance from the sensing device to the tank walls is reduced (see 4.8.6).

3.6.8 Inclination. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 when the liquid level indicating equipment is inclined (see 4.8.7). Differential pressure sensing devices with ranges less than 20 inches of water may compensate for hydrostatic pressure changes created by the inclined geometry.

3.6.9 Spike voltage. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2 after spike voltage is applied (see 4.8.8).

3.6.10 Accelerated life (endurance). The liquid level indicating equipment shall withstand the effects of the accelerated life test (see 4.8.9). The temperature range shall be 0 to 60°C except for ST (steam) applications where the temperature range shall be 0 to 100°C. Performance parameters shall be operation and accuracy and these parameters shall be in accordance with 3.6.1 and 3.6.2 throughout the test. After completion of the test and cleaning, the base metal shall not be visible through the finish, nor shall there be any evidence of blistering, softening, separation from the base metal, corrosion or other coating failures. Flexible interconnections shall not exhibit any signs of deterioration nor corrosion of connector pins and housings. Upon completion of the accelerated life tests, operation, accuracy and response time shall be in accordance with 3.6.1, 3.6.2, and 3.6.3.

3.6.10.1 Power supply. The power supply shall be compatible with type I power input as specified in MIL-STD-1399, section 300 (see 4.8.9 and 4.8.18). Nominal power input voltage and frequency shall be 115 volts, 60 Hz, single

phase. Changes in input voltage and frequency within plus or minus 5 percent of nominal shall have no deleterious effect on the power supply. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.11 Degree of enclosure. Liquid level indicating equipment to be installed partially or totally outside the tank shall be dripproof to 45 degrees in accordance with MIL-STD-108. Portable liquid level indicating equipment shall be watertight in accordance with MIL-STD-108. Operation shall be in accordance with 3.6.1 and there shall be no accumulation of water within the enclosure (see 4.8.10).

3.6.12 Salt fog. Liquid level indicating equipment to be installed partially or totally outside of the tank shall withstand the effects of the salt fog test (see 4.8.11). After completion of the test and cleaning, the base metal shall not be visible through the finish, nor shall there be any evidence of blistering, softening, separation from the base metal, corrosion or other coating failures. Flexible interconnections shall not exhibit any signs of deterioration nor corrosion of connector pins and housings. The reference measurement shall meet the requirements of 3.6.1 and 3.6.2.

3.6.13 Pressure. Sensing devices which may be exposed to seawater or the fluid being measured, complete with entrance fittings and interconnection fittings, shall withstand the pressure test (see 4.8.12) without physical or electrical damage and without any leakage or signs of leakage around any of the fittings. Flexible interconnections shall show no evidence of liquid intrusion or evidence of mechanical or electrical damage. The specified pressure for the test shall be as follows:

(a) AP pressure range sensing devices shall be subjected to 30 psig.
(b) VP and LP pressure range sensing devices shall be subjected to 150 psig.
(c) HP pressure range sensing devices shall be subjected to 150 percent of the maximum pressure specified (see 6.2).

Operation and accuracy of all readings shall be in accordance with 3.6.1 and 3.6.2 throughout the test and for the post inspection reference measurement.

3.6.14 Vibration. Liquid level indicating equipment shall show no evidence of mechanical or electrical damage or loosening of parts, when subjected to the type I vibration test in accordance with MIL-STD-167-1 (see 4.8.13). Operating controls shall not change status and there shall be no transfer of switch contacts during, or as a result of, the vibration test. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.15 Shock. Liquid level indicating equipment shall conform to grade A, class I, type A shock requirements of MIL-S-901 (see 4.8.14), and shall show no evidence of mechanical or electrical damage or loosening of parts.

Operating controls shall not change status and there shall be no transfer of switch contacts as a result of shock tests. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.16 DC magnetic field. Unless otherwise specified (see 6.2), liquid level indicating equipment shall meet the 400 Ampere-turns/meter (A/m) DC magnetic field environment requirement of DOD-STD-1399 Section 070-Part 1 (see 4.8.15). Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.17 Electromagnetic interference. Liquid level indicating equipment shall meet the requirements of MIL-STD-461 for surface ships and submarines (see 4.8.16). Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

3.6.18 Flexible interconnection. Type I cables shall resist swelling and show no evidence of liquid intrusion or evidence of mechanical or electrical damage in accordance with MIL-R-6855, class 1 after immersion testing in JP-5 (see 4.8.17). Removable flexible interconnections shall meet the insulation resistance test requirements of 3.6.4 after completion of immersion testing.

3.7 Marking. Unless otherwise specified (see 6.2), designation and marking shall comply with the requirements as specified in MIL-STD-2036 and MIL-C-915. Marking shall be permanent and legible. The markings on plastic or metallic materials shall be made by stamping, engraving, stenciling or rubber stamping with smudgeproof ink covered with a coat of clear lacquer or silk screening. Decalcomania or paper labels shall not be used. Manufacturers part number and serial number shall be marked on the front of the indicator panel.

3.8 Workmanship. The workmanship shall be in accordance with requirement 9 of MIL-STD-454 (see 4.6).

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 this 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 part of the 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 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified in the individual test procedure, performance tests shall be conducted with the liquid level indicating equipment operating under the following conditions:

(a) Ambient temperature shall be 23 ± 1.0°C.
(b) Relative humidity shall be 50 ± 5 percent.
(c) Supply voltage shall be 115 volts ± 5 percent.
(d) Supply frequency shall be 60 Hz ± 5 percent.
(e) Controls shall be in the neutral or normal position.
(f) Liquid level indicating equipment shall be mounted to simulate shipboard installation and to measure the liquid level along the vertical centerline of the test tank (see 4.3.1).
(g) Liquid level indicating equipment shall be configured to indicate liquid level height over a vertical distance equal to the normal operating range (height) of the sensing device.
(h) The fluid/gas or fluid/water used shall be the same as the intended application (see 1.2.3), except that ordinary tap water having a minimum conductivity of 400 µS may be substituted for seawater interface applications. For CF applications, the fluid used for testing shall be JP-5. For CO and WO applications, the fluid used for testing shall be lube oil 2190. For CF/AR and CO/AR applications, the fluid used for testing shall be water having a minimum conductivity of 400µS with a 3 inch ± 0.25 inch layer of JP-5 for CF/AR and symbol 2190 lube oil for CO/AR applications.
(i) The fluid temperature shall be 25 ± 10°C.

4.3.1 Test tank. The test tank shall be a carbon steel test tank, coated in accordance with NAVSEA S9086-VD-STM-000/CH-631 requirements for surface ship seawater tanks. The test tank shall be large enough to exercise

the liquid level indicating equipment through the normal operating range (height) of the sensing device for tests specified herein. The tank shall have a sight glass or similar device with sufficient resolution and accuracy to determine the accuracy, repeatability, hysteresis and deadband requirements of 3.6.2.

4.4 First article inspection. First article inspection shall be performed on sample units produced with equipment and procedures normally used in production. First article tests shall consist of the examination and tests specified in table I.

TABLE I. First article inspection.

Examination or test	Requirement	Examination or test
General examination	3.4 and 3.5	4.7
Accuracy	3.6.2	4.8.1
Response time	3.6.3	4.8.2
Insulation resistance	3.6.4	4.8.3
Specific gravity 1/	3.6.5	4.8.4
Fluid conductivity 1/	3.6.6	4.8.5
Tank wall proximity	3.6.7	4.8.6
Inclination	3.6.8	4.8.7
Spike voltage	3.6.9	4.8.8
Accelerated life	3.6.10	4.8.9
Enclosure	3.6.11	4.8.10
Salt fog	3.6.12	4.8.11
Pressure	3.6.13	4.8.12
Vibration	3.6.14	4.8.13
Shock	3.6.15	4.8.14
DC Magnetic field	3.6.16	4.8.15
Electromagnetic interference	3.6.17	4.8.16
Immersion 1,2/	3.6.18	4.8.17

1/ Test has limited applicability. See appropriate examination or test paragraph.
2/ Order of test not applicable

4.4.1 Sample size. One liquid level indicating equipment of each type (that is, sensing technique, application, pressure range, display, and indication range, see 1.2) shall be subjected to first article inspection.

4.4.2 Order of inspection. The sample shall be subjected to the inspections specified in table I and in the order listed.

4.5 Quality conformance inspection. Quality conformance inspection shall be as specified in table II.

TABLE II. Quality conformance inspection.

Examination or test	Requirement	Examination or test
Group A		
General Examination	3.4 and 3.5	4.6
Insulation Resistance	3.6.4	4.8.3
Group B		
Accuracy	3.6.2	4.8.1
Supply line voltage and frequency variation	3.6.10.1	4.8.18

4.5.1 Inspection lot. An inspection lot shall consist of all liquid level indicating equipment of each type (that is, sensing technique, application, pressure range, display, and indication range) produced under the same conditions, and offered for inspection at the same time. Sampling and acceptance for Group A and Group B testing shall be as specified (see 6.2). Failure to conform to the requirements of this specification for any group A or group B test shall be counted as a defect and the equipment shall be rejected. When the number of such nonconforming equipment, in any sample, exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.5.2 Noncompliance. If a sample fails to pass quality conformance inspections, the manufacturer shall notify the contracting activity and the cognizant inspection activity of such failure and take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same materials and processes, and which are considered subject to the same failure. Acceptance and shipment of the product shall be discontinued until corrective action, acceptable to the contracting activity has been taken. After the corrective action has been taken, quality conformance inspection shall be repeated. Final acceptance and shipment shall be withheld until the quality conformance inspections have shown that the corrective action was successful.

4.6 General examination. Each sample equipment shall be subjected to a general examination to ascertain that the material, parts, testability, input connectors and color code, size and weight, accessibility, workmanship, design, proper cable harness dress, creepage and clearance distances, safety requirements and treatment for prevention of corrosion are in conformance with this specification. The fit of parts shall be observed with particular reference to the interchangeability of such parts as are likely to require replacement during the normal service life of the equipment. Examination shall also check all controls, adjustments, displays, indicators, liquid level indicating equipment description, mounting devices, signal conditioner, operation, control circuit (including failsafe design), primary indicator panel assembly, auxiliary indicator panel assembly, portable indicator panel assembly, protective shield, sensing device design, and maintainability as applicable (see 3.4, 3.5 and 3.8).

4.7 Reference measurement. When specified in the individual test, a reference measurement shall consist of measurements of the indicated level versus actual tank level. (When volumetric accuracy is required (see 6.2), the actual tank levels and the indicated levels shall be converted to volumetric levels using the capacity curve supplied by the contracting activity.) The measurements shall be measured at a minimum of 10 equal increments, plus or minus 1/2 percent of full scale for both increasing (upscale) and decreasing (downscale) level (see 6.3). The liquid level shall be maintained at each checkpoint for a time sufficient to obtain a stable measurement but not longer than 30 seconds. Reference measurement accuracy shall meet the requirements of 3.6.2.1(a). For fluid/water interface liquid level indicating equipment the following conditions shall apply:

(a) The tank shall be filled over the entire normal operating range (height) of the sensing device. The tank shall be full of water, full of the measured fluid or full of some combination of water and the measured fluid.
(b) The liquid level indicating equipment shall indicate 0 percent of the sensing device's normal operating range (height) when the tank is full of water.
(c) The liquid level indicating equipment shall indicate 100 percent of the sensing device's normal operating range (height) when the tank is full of the measured fluid.
(d) The two fluids shall not be agitated in any way to create an emulsion. The two fluids shall be allowed to separate and form a distinct interface before any measurements are taken.

4.8 Tests.

4.8.1 Accuracy.

4.8.1.1 Liquid level indicating equipment operation and accuracy. The sensing device shall be conditioned first by raising and lowering the level between 0 and 100 percent of the sensing device's normal operating range (height) for three consecutive cycles. Three reference measurements (see 4.7) shall then be made in succession. Operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.

4.8.1.2 Control circuit accuracy. The detection points for the high control circuit setpoints shall be tested at 50, 75, and 98 percent of the sensing device's normal operating range (height). The detection points for the low control circuit set points shall be tested at 2, 25 and 50 percent of the sensing device's normal operating range (height). The liquid level shall be raised above then lowered below each detection point three successive times. The control circuit operation and accuracy shall be in accordance with 3.6.1 and 3.6.2.2 at each control circuit setpoint tested.

4.8.1.2.1 Fail-safe test. Following the accuracy test, the control circuit fail-safe capability shall be verified by simulating an open circuit condition in the sensing device and by simulating a loss of power condition. Operation shall be in accordance with 3.6.1.

4.8.2 Response time tests. The test tank (see 4.3.1) shall be used to subject the sensing device to changes in liquid level at a constant rate. Where it is impractical to achieve the fill/empty rate specified, this test may be performed by simulating the change in fluid level (for example, raising or lowering the sensing device by means of a pneumatic cylinder) at the same rate specified.

4.8.2.1 Indication response time test. This test is applicable to all liquid level indicating equipment. When an adjustable response time is provided, the liquid level indicating equipment shall be adjusted to its minimum response time setting. The actual fluid level and the level indicated by the liquid level displays shall be monitored. The test point levels shall be 20, 50 and 80 percent of the liquid level indicating equipment's normal operating range (height). The fluid level shall be increased at a constant rate of 1 ± 0.01 inch per second through the test points and then decreased at the same rate through the test points. The elapsed time from when the actual fluid level reaches a test point level to when the liquid level indication equipment indicates the test point level, within the specified accuracy requirements (see 3.6.3.1), shall be measured both upscale and downscale. The maximum elapsed time shall be the indication response time. Operation and performance shall be in accordance with 3.6.3.1.

4.8.2.2 Control circuit response time test. This test is applicable only to liquid level indicating equipment with control circuit(s). When two high control circuits are provided, one setpoint shall be set at 50 percent and one at 80 percent of the liquid level indicating equipment's normal operating range (height). When two low control circuits are provided, one

setpoint shall be set at 20 percent and one at 50 percent of the liquid level indicating equipment's normal operating range (height). When one high and one low control circuit is provided, their setpoints shall be set at 80 and 20 percent of the liquid level indicating equipment's normal operating range (height), respectively.

4.8.2.2.1 Minimum control circuit response time test. The control circuit shall be adjusted to its minimum response time setting. The fluid level shall be increased at a constant rate of 1 ± 0.01 inch per second through the test points and then decreased at the same rate through the test points. The elapsed time from when the actual fluid level reaches a test point level to when the control circuit activates or deactivates the switching device associated with that setpoint level shall be measured both upscale and downscale. The maximum elapsed time shall be the minimum control circuit response time. Operation and performance shall be in accordance with 3.6.3.2. This test may be done concurrently with 4.8.2.1.

4.8.2.2.2 Maximum control circuit response time test. The control circuit shall be adjusted to its maximum response time setting. The fluid level shall be increased at a constant rate of 0.25 ± 0.005 inch per second through the test points and then decreased at the same rate through the test points. The elapsed time from when the actual fluid level reaches a test point level to when the control circuit activates or deactivates the switching device associated with that setpoint level, and the elapsed time from when the actual fluid level reaches a test point level to when the liquid level indication equipment indicates the test point level within the specified accuracy requirements (see 3.6.3.2) shall be measured both upscale and downscale. The maximum elapsed time between when the actual fluid level reaches a test point level to when the control circuit activates or deactivates the switching device associated with that setpoint level shall be the maximum control circuit response time. The maximum elapsed time between when the actual fluid level reaches a test point level to when the liquid level indication equipment indicates the test point level within the specified accuracy requirements (see 3.6.3.2) shall be the indication response time. Liquid level indicating equipment performance shall be in accordance with 3.6.3.2.

4.8.3 Insulation resistance test. The insulation resistance of the liquid level indicating equipment shall be determined by applying 50Vdc between electrical input and output circuits and between these circuits and ground. The insulation resistance measurement shall be made immediately after a 2 minute period of uninterrupted test voltage application. However, if the indication of insulation resistance meets the specified limit (3.6.4) and is steady or increasing, the test may be terminated before the end of the 2 minute period. The accuracy (see 4.8.1) test shall be performed after completion of the insulation resistance measurements. Insulation resistance and performance shall be in accordance with 3.6.4.

4.8.4 Specific gravity test.

4.8.4.1 Fluid/gas interface test. This test applies only to fluid/gas interface applications where the fluid is FO, CO, WO, CF or JP. Two accuracy tests (see 4.8.1) shall be performed, one using water as the test fluid and the other using an organic fluid with a specific gravity of 0.86 ± 0.02 such as lube oil. The liquid level indicating equipment shall not be altered, modified, or manually adjusted during each accuracy test or between the two accuracy tests. Performance shall be in accordance with 3.6.5.

4.8.4.2 Fluid/water interface test. This test applies only to fluid/water interface applications where the fluid is FO, CO, WO, CF or JP. Two accuracy tests (see 4.8.1) shall be performed, the first using water and an organic fluid with a specific gravity of 0.86 ± 0.02 such as lube oil as the test fluids, and the second using water and another fluid with a specific gravity of 0.78 ± 0.02 such as kerosene or Stoddard solvent in accordance with type 1 of P-D-680 as the test fluids. The liquid level indicating equipment shall not be altered, modified, or manually adjusted during each accuracy test or between the two accuracy tests. Performance shall be in accordance with 3.6.5.

4.8.5 Fluid conductivity test. This test applies only to SW, FW, WW, CO, CF, and WO applications. Three accuracy tests (see 4.8.1) shall be performed using water with different electrical conductivities for each test. The three test conductivities shall be 3 ± 2 µS/cm, 500 ± 50 µS/cm, and 10,000 ± 50 µS/cm. The conductivity of the water shall be controlled by varying the concentration of sodium chloride in solution with the water. The liquid level indicating equipment shall not be altered, modified, or manually adjusted during each accuracy test or between the accuracy tests. Performance shall be in accordance with 3.6.6.

4.8.6 Tank wall proximity test. The sensing device shall be located at a corner of the tank that is formed by two continuous steel walls, and shall be equidistant from each of the two adjoining walls. The distance to each wall shall either provide 1 inch of clearance between the sensing device and the wall or shall be the minimum distance specified by the manufacturer up to a maximum of 4 inches. An accuracy test (see 4.8.1) shall be performed. Performance shall be in accordance with 3.6.7.

4.8.7 Inclination. The accuracy test (see 4.8.1) shall be performed except that the liquid level indicating equipment and the test tank shall be inclined 45 degrees, unless otherwise specified (see 6.2), to each side of vertical along both the fore-and-aft and athwartship axes of the tank, for a total of four positions. Reference measurements (see 4.7) shall be taken in each of the four inclined positions. The actual liquid level shall be measured at the inclined vertical tank centerline. Performance shall be in accordance with 3.6.8.

4.8.8 Spike voltage test. The liquid level indicating equipment shall be subjected to an input supply line voltage spike of 2500 volts positive peak amplitude; the voltage waveshape shall correspond with that of the figure for the "spike voltage (short time transient) waveshape" in accordance with section 300 of MIL-STD-1399. This spike shall be impressed at normal supply line voltage and frequency while the liquid level indicating equipment is operating. The accuracy test (see 4.8.1) shall be performed at the conclusion of the test. Performance shall meet the requirements of 3.6.9.

4.8.9 Accelerated life test. Liquid level indicating equipment shall be subjected to the accelerated life test as specified herein. Throughout the test, the temperature of the fluid in the test tank shall be within plus or minus 5°C of the required test chamber temperature. The liquid level in the tank shall be continuously cycled from empty to full throughout the test. If the test tank is sealed from the ambient environment, the humidity inside the test tank need not meet the test chamber humidity requirements. Perform a physical examination of the liquid level indicating equipment upon completion of the accelerated life test. Appearance, operation, accuracy and response times shall be in accordance with 3.6.10.

4.8.9.1 Initial test conditions.

(a) Equipment set up in a temperature-controlled chamber at 25 ± 5°C and relative humidity of 90 to 100 percent.
(b) Equipment energized and frequency specified.
    (1) Nominal line voltage and frequency specified (see 4.3).
    (2) Fully operational for 2 hours.
(c) When equipment internal temperature has stabilized, performance parameters shall be measured as reference test data for comparison with subsequent tests.

4.8.9.2 Temperature conditions.

(a) Reduce chamber temperature, at a uniform rate in not less than 4 hours, to the lowest operating temperature of the range specified and maintain relative humidity of 90 to 100 percent.
(b) Maintain chamber temperature at the lowest operating temperature of the range for 4 hours.
(c) Near the end of the 4th hour, measure the performance parameters.
(d) Increase chamber temperature, at a uniform rate in not less than 6 hours, to the highest operating temperature of the range specified and maintain humidity at 90 to 100 percent.
(e) Maintain chamber temperature at the highest operating temperature of the range specified for 4 hours.
(f) Near the end of the 4th hour, measure the performance parameters.
(g) Reduce chamber temperature, at a uniform rate in not less than

6 hours, to the lowest operating temperature of the range specified and maintain humidity at 90 to 100 percent.

(h) Maintain chamber temperature at the lowest operating temperature of the range specified for 2 hours.

4.8.9.3 Voltage and frequency cycling conditions.

(a) After completion of the 2-hour low temperature conditioning period specified in 4.8.9.2(h), decrease the input voltage to the lowest limit of the equipment voltage tolerance band.

(b) Maintain chamber temperature at the lowest operating temperature and input voltage at the lowest limit for 1-hour while equipment continues to operate, then measure performance parameters.

(c) Return input voltage to nominal value. Decrease input frequency to the lower limit of the equipment frequency tolerance band.

(d) Maintain chamber temperature at the lowest operating temperature and input frequency at the lowest limit for 1 hour while equipment continues to operate, then measure performance parameters.

(e) Return input frequency to nominal value.

(f) Increase temperature to 25 ± 5°C and maintain relative humidity at 90 to 100 percent. Maintain this condition for 2 hours.

(g) With equipment operating at 25 ± 5°C and relative humidity at 90 to 100 percent, decrease input voltage and frequency to the lower limits of the equipment voltage and frequency tolerance bands. Maintain this condition for 1 hour and then measure performance parameters.

(h) Repeat 4.8.9.3(g) with input voltage at the upper limit of the equipment voltage tolerance band and input frequency at the lower limit of the equipment frequency tolerance band.

(i) Repeat 4.8.9.3(g) with input voltage and frequency at the upper limits of the equipment voltage and frequency tolerance bands.

(j) Repeat 4.8.9.3(g) with input voltage at the lower limit of the equipment voltage tolerance band and input frequency at the upper limit of the equipment frequency tolerance band.

(k) Repeat uniform temperature rise test of 4.8.9.2(d).

(l) Measure performance parameters at the end of the uniform temperature rise test of 4.8.9.3(k).

(m) With equipment operating at the highest operating temperature of the range specified and relative humidity at 90 to 100 percent, increase input voltage to the upper limit of the equipment voltage tolerance band, maintaining input frequency at the upper limit of the equipment frequency tolerance band.

(n) Operate for 4 hours at this condition and measure performance

parameters.

(o) Maintain input frequency at the upper limit of the equipment frequency tolerance band but decrease input voltage to the lower limit of the equipment voltage tolerance band.

(p) Operate for 1 hour at this condition and measure performance parameters.

(q) Maintain high temperature and humidity conditions but return input voltage and frequency to nominal values.

(r) Operate for 1 hour at this condition and measure performance parameters.

(s) Reduce temperature to 25 ± 5°C and maintain relative humidity at 90 to 100 percent. Maintain this condition for 2 hours.

(t) Repeat temperature, voltage and frequency cycling tests of 4.8.9.3(g) through (s) with relative humidity at 90 to 100 percent for not less than 8 cycles.

(u) Repeat uniform temperature rise test of 4.8.9.2(d).

(v) Repeat temperature, voltage and frequency cycling tests of 4.8.9.3(m) through (r) with relative humidity at 10 to 20 percent for not less than 10 cycles.

(w) Reduce chamber temperature, at a uniform rate in not less than 6 hours, reduce relative humidity to 45 to 55 percent and return temperature, voltage and frequency to nominal values specified in 4.8.9.1.

(x) Operate for 2 hours at this condition and perform accuracy (see 4.8.1) and response time (see 4.8.2) tests.

4.8.10 Enclosure test. Components of the liquid level indicating equipment to be installed partially or totally outside the tank shall be subjected to the drip test (45 degrees) in accordance with MIL-STD-108. The portable indicator assembly shall be subjected to the watertight test in accordance with MIL-STD-108. The equipment shall be operating and empty to full level cycles shall be simulated so that failure of the indicator can readily be detected. Performance shall be in accordance with 3.6.11.

4.8.11 Salt fog test. Components of the liquid level indicating equipment to be installed partially or totally outside the tank shall be subjected to the salt fog test in accordance with ASTM B117. 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 part by weight of water.) The liquid level indicating equipment shall be physically examined and a reference measurement (see 4.7) shall be performed after the conclusion of this test. Performance and physical examination results shall be in accordance with 3.6.12.

4.8.12 Pressure test. The components of the liquid level indicating equipment, including flexible interconnections, subject to immersion in the measured fluid shall be installed in a pressure vessel to simulate actual tank installation so that all parts of the components, especially connections and

fittings, are submerged and remain submerged except when test conditions state otherwise. Prior to testing, the pressure vessel with the liquid level indicating equipment installed shall be filled and allowed to soak for 1 hour at atmospheric pressure. Except for the AP pressure range, the rate of pressure change shall not be less than 10 pounds per square inch per second. For the AP pressure range, the rate of pressure change shall not be less than 5 pounds per square inch per second.

4.8.12.1 Pressure test procedure. The pressure test shall consist of three successive fill and empty cycles. The pressure vessel shall be filled in 10 equal increments through the sensing device's normal operating range (height) at atmospheric pressure and level readings taken at each increment. The specified pressure (see 3.6.13) shall then be applied and held for 1 hour. While maintaining the specified pressure with compressed gas, the pressure vessel shall be emptied in 10 equal increments and level readings shall be taken at each increment. The pressure shall then be reduced to atmospheric for 10 minutes and the cycle repeated twice. During the third pressure cycle an insulation resistance measurement shall be made on the sensing device at both the specified pressure and at atmospheric pressure.

4.8.12.2 Post test inspection. Upon completion, the sensing device shall then be removed from the pressure vessel and disassembled to the maximum extent possible without affecting sensing device performance or integrity. The sensing device shall be examined for any physical or electrical damage and leakage or signs of leakage. The sensing device shall then be reassembled and a reference measurement (see 4.7) taken. Performance and physical requirements shall be in accordance with 3.6.13.

4.8.13 Vibration test. Liquid level indicating equipment shall be tested in accordance with type I vibration of MIL-STD-167-1. Components of the liquid level indicating equipment including sensing devices shall be mounted to simulate shipboard installations in an empty tank and shall not be restricted from normal operation and movement. The equipment under test shall be energized in the normal manner. At the conclusion of the test and prior to any adjustments, accuracy shall be measured (see 4.8.1). Liquid level indicating equipment shall be physically examined for evidence of mechanical or electrical damage or loosening of parts. Performance and physical appearance shall be in accordance with 3.6.14.

4.8.14 Shock test. Liquid level indicating equipment shall be tested in accordance with H.I. shock test for grade A, class 1, type A equipment specified in MIL-S-901. The liquid level indicating equipment shall be energized in the normal manner. Components of the liquid level indicating equipment including sensing devices shall be mounted to simulate shipboard installation in an empty tank and shall not be restricted from normal operation and movement. If individual components of the liquid level indicating equipment must be shock tested separately because of size or weight, the complete liquid level indicating equipment shall be connected

together (electrically and mechanically) as designed, energized and the output and control circuit signals monitored during the test. At the conclusion of the test and prior to any adjustments, the accuracy shall be measured as specified in 4.8.1. The liquid level indicating equipment shall be physically examined for evidence of mechanical or electrical damage or loosening of parts. Performance and physical appearance shall be in accordance with 3.6.15.

4.8.15 DC magnetic field. Liquid level indicating equipment shall meet the performance requirements of 3.6.16 when tested in accordance with DOD-STD-1399 Section 070 - Part 1. Unless otherwise specified (see 6.2), the magnetic field strength shall be 400 A/m.

4.8.16 Electromagnetic interference tests. EMI tests shall be in accordance with the test methods specified in MIL-STD-462. Upon completion of the EMI tests an accuracy test (see 4.8.1) shall be performed. Performance shall be in accordance with 3.6.17.

4.8.17 Flexible interconnection immersion test. When intended for use in tanks containing CF, CO, WO, FO or JP type fuels, flexible interconnections shall be submerged in JP-5 for a continuous period of 45 days. The test fluid temperature shall be maintained at 25 ± 10°C. Removable flexible interconnections may be tested with a simulated shipboard installation using test fixtures to replace sensing devices. After completion of immersion testing, the flexible interconnection shall undergo a physical examination and insulation resistance test (see 4.8.3). Physical examination results and performance shall be in accordance with 3.6.18.

4.8.18 Supply line voltage and frequency variation. Liquid level indicating equipment shall be operated at normal, maximum and minimum steady state voltages and frequencies (see 3.6.10.1). The liquid level indicating equipment shall remain at each configuration for 15 minutes. A reference measurement (see 4.7) shall be performed before and after each transition. Performance shall be in accordance with 3.6.10.1.

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.7.)

5.1 Packaging requirements. The requirements for packaging shall be level A or C in accordance with MIL-E-17555, as specified (see 6.2).

6. NOTES

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

6.1 Intended use. Liquid level indicating equipment will be used to indicate either the level, weight or the volume of the liquids in 6.1.1 on board Navy ships under the conditions of 6.1.2.

6.1.1 Intended applications

(a) Seawater and air interface (SW/AR).
(b) Seawater and compressed air interface (SW/CA).
(c) Fresh water (potable water) and air interface (FW/AR).
(d) Fresh water (potable water) and steam interface (FW/ST).
(e) Fresh water and compressed air interface (FW/CA).
(f) Waste water and air interface (WW/AR).
(g) Waste water and compressed air interface (WW/CA).
(h) Fuel (diesel) and air interface (FO/AR).
(i) Fuel and seawater interface (FO/SW).
(j) Gasoline and seawater interface (FO/SW).
(k) Gasoline and compressed gas interface (FO/CG).
(l) JP fuel and air interface (JP/AR).
(m) JP fuel and seawater interface (JP/SW).
(n) Lubricating oil and air interface (LO/AR).
(o) Contaminated oil and air interface (CO/AR).
(p) Contaminated oil and seawater interface (CO/SW).
(q) Contaminated oil and waste water interface (CO/WW).
(r) Refrigerant and air interface (RF/AR).
(s) Refrigerant and compressed gas interface (RF/CG).
(t) Waste oil and air interface (WO/AR).
(u) Waste oil and seawater interface (WO/SW).
(v) Waste oil and waste water interface (WO/WW)
(w) Synthetic oil and air interface (SO/AR).
(x) Hydraulic oil and air interface (HO/AR).
(y) Hydraulic oil and compressed gas interface (HO/CG).
(z) Hydraulic oil and compressed air interface (HO/CA).
(aa) Contaminated fuel and air interface (CF/AR).
(bb) Contaminated fuel and waste water interface (CF/WW).
(cc) Turbine oil and air interface (TO/AR).

6.1.2 Intended conditions. The liquid level indicating equipment will be designed for 20,000 hours operation under the following conditions:

(a) H.I. shock.
(b) Vibration.
(c) Hydrostatic pressure.
(d) Immersion in any of the liquids (or gases) specified.

(e) Temperature variations in the liquids (or gases) from 0 to 60 degrees Celsius (°C) (0 to 100°C for steam applications).
(f) Surging and turbulence of liquids due to rapid filling and draining of tanks.
(g) Contaminant buildup, marine growth, biological growth, deposits and other fouling that may occur in shipboard tanks.
(h) Sloshing of fluid in the tank caused by ship's rolling up to 45° (60° for submarines) and pitching up to 30°(45° for submarines).

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number and date of the specification.
(b) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(c) Basic type, sensing technique, application, pressure range, display, and indication range (see 1.2).
(d) If pressure range is HP, the maximum pressure required (see 1.2.4 and 3.6.13).
(e) When first article is required (see 3.1, 6.5).
(f) If the maximum height of any individual component is other than 100 inches or maximum weight of any individual component is other than 35 pounds (see 3.2.8).
(g) If auxiliary indicator panel assembly is required. Either panel or bulkhead mounting, and what is required in addition to a liquid level display (see 3.3 and 3.4.4).
(h) If portable indicator assembly is required (see 3.3 and 3.4.5).
(i) If panel or bulkhead mounting or more than one liquid level display is required for the primary indicator panel assembly (see 3.4.3).
(j) If a control circuit is required and whether settings are to be two high, two low, one high and one low, or two high and two low (see 3.4.3 and 3.4.3.3).
(k) If a protective shield is required for primary or auxiliary assemblies (see 3.4.3, 3.4.3.5, and 6.6).
(l) If volumetric accuracy is required (see 3.4.3.2, 3.6.2.1, 4.7, and 6.7).
(m) If alarm lights are required on primary indicator panel (see 3.4.3.4).
(n) If audible alarm and alarm acknowledge switch are required on primary indicator panel (see 3.4.3.4).
(o) If epoxy coating is required (see 3.4.7).
(p) If special purpose equipment is not to be provided (see 3.4.8).
(q) If indicator dial is not to be furnished blank or if additional information is to be identified on the dial or if dials are to have other than black letters, numerals and graduations on a

white background (see 3.5.1.1 and 6.8).

(r) If red illumination is required for liquid level display (see 3.5.1.2).

(s) If audible signals are required for any remote station (see 3.5.3).

(t) If DC magnetic field strength requirement is other than 400 A/m (see 3.6.16, 4.8.15 and 6.9).

(u) If designation and marking is to be other than that specified in MIL-STD-2036 and MIL-C-915 (see 3.7).

(v) Sampling and acceptance numbers for group A and group B testing (see 4.5.1 and 6.10).

(w) If the inclination angle is other than 45 degrees (see 4.8.7 and 6.11).

(x) Packaging required (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 title	Option
3.6.14, 4.8.13	UDI-23762	Report, vibration testing	MIL-STD-167-1
3.6.15, 4.8.14	DI-ENVR-80708	Shock test report	MIL-S-901
3.3, 3.4	DI-DRPR-80651	Engineering Drawings	-----
4.1	DI-QCIC-81110	Inspection and test plan	-----
4.7	DI-NDTI-80809	Test/inspection reports	-----

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 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data

Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.5 First Article. When first article inspection is required (see 6.2), 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 4.4. 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. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.6 Protective shield. A protective shield (see 6.2) should be required when the indicator panel is to be located in a hazardous location such as machinery spaces, pump rooms, shaft alleys, high traffic areas, and so forth.

6.7 Volumetric accuracy. When volumetric accuracy is specified (see 6.2), the contracting activity must furnish the tank capacity curve(s).

6.8 Additional dial marking. Consideration should be given to requiring additional information on the dial (see 6.2) such as: tank number; tank contents; total tank capacity; alarm setpoints (to be marked in red); termination points of suction, fill stripping, pipes, if within the operating range of the indicator.

6.9 Magnetic field strength. A DC magnetic field requirement (see 6.2) greater than 400 A/m should be considered for liquid level indicating equipment for installation on ships which contain degaussing or mine neutralization equipment, and liquid level indicating equipment which is located near magnetic field generating equipment such as electrical power cables, generators, motors, welding circuits or electrical power switchboards and control equipments in accordance with MIL-STD-2036 and DOD-STD-1399 section 070.

6.10 Sampling. To determine conformance with this specification, the following sampling requirements are recommended. A random sample from each lot in accordance with table III should be subjected to the inspections specified in table II.

TABLE III. Sampling for group A and B inspections.

Number of indicating equipment in inspection lot	Sample size	Number of nonconforming equipment	
		Acceptance number	Rejection number
Group A			
7 and under	All	-	-
8 to 15	7	0	1
16 to 40	10	0	1
41 to 110	15	0	1
111 to 300	25	1	2
301 to 500	35	1	2
501 and over	50	2	3
Group B			
3 and under	All	-	-
4 to 15	3	0	1
16 to 40	5	0	1
41 to 110	7	0	1
111 to 300	10	0	1
301 to 500	15	1	2
501 and over	25	2	3

6.11 Inclination angle. The inclination angle (see 6.2) should be increased to 60 degrees for submarine equipment.

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

6.12.1 Spare parts. 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. Contractor's parts that are intended to function with parts of another manufacturer should be tested as a complete liquid level indicating equipment with the other manufacturer's parts in order to determine compliance with this specification. The contractor should be responsible for providing parts from other manufacturers that are required for testing.

6.13 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.

6.14 Subject term (key word) listing.

Level indicator
Liquid level
Response time
Sensing device
Tank level

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

Preparing activity:
Navy - SH
(Project 6680-N203)

Engineering Drawings Technical Content Requirements

10. SCOPE

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

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standards. The following documents form a part of this appendix to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-I-45208 - Inspection System Requirements

STANDARDS

MILITARY

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

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

20.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the documents cited in the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
Y 14.1 - Drawing Sheet Size and Format.
ANSI/IEEE 200 - Standard Reference Designations for Electrical and Electronics Parts and Equipment.

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

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

30. CONFORMANCE VERIFICATION DRAWING FOR INSTRUMENTATION

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

30.2 Content and format. One conformance verification drawing shall be developed for each specific type of instrumentation. It shall include all sensing techniques, application, pressure range, display, indication range, 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 is not 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 in tabular form to include:

(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 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 applicable details.
(d) Module enclosure requirements for separately mounted modules.
(e) Dimensions required to ensure interchangeability.
(f) Schematic of indicating system.
(g) Description of the nature and purpose of any adjustments.
(h) Welding procedures with acceptance data, including acceptance letter, report numbers and dates.
(i) Any special features.
(j) Complete weight.
(k) Location, size, and type of connections.
(l) Identification of quality control documents which show conformance with MIL-I-45208 or the quality control specification listed in the acquisition document. The acceptance letter shall be referenced.

30.5 Parts list. The following information shall be 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 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 assembly supplier identification assigned.

(h) Name of actual manufacturer of part (when applicable).
(i) Part number or part supplier identification (when applicable).
(j) Onboard repair parts. Parts appropriate for, or 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 tool supplier identification (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 in the schematic:

(1) A simplified, clear schematic in preference to one showing the physical placement or parts.
(2) A thin, broken line shall be used to represent the boundaries of each subassembly.
(3) Arrows adjacent to the parts shall indicate direction of flow.
(4) Each part shall be identified by the schematic part

designation. The numbers shall be assigned in a logical sequence observing flow paths through the system.

(5) All inlet and outlet ports shall be identified.

(6) The methods of attachment for each part shall be designated by an appropriate label or symbol.

(7) The symbol used to designate a part shall be in accordance with MIL-STD-17-1 when applicable.

(8) A brief description of the fluid system operation.

(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 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, as applicable, brazing or welding procedure, bonding agent, and seal (gasket, O-ring, and so forth.).
(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, alarms, and so forth) which make up the electrical system. The following features shall be in 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.

(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, and so forth) shall be given a unique reference designation consisting of a letter denoting the type of part (as required by ANSI/IEEE 200) and a number assigned consecutively. The numbers shall be assigned in a logical sequence of electrical current or signal flow through the circuit.

(4) In addition to the reference designation, parts not conforming to a military specification, where permitted, shall have the following information noted adjacent to the part. Where numerical values are given, a code shall be noted to designate the units used:

(a) Resistors - Resistance, power rating, and tolerances. If variable, an arrow to indicate clockwise rotation of the control shaft.
(b) Capacitors - Capacitance, voltage rating and tolerance.
(c) Reactors - Inductance and voltage rating.
(d) Semi-conductors - type number (JEDDC number is adequate).
(e) Integrated circuits - Operational symbol diagram of input-output relationship, terminal numbering corresponding to a representative schematic and type number.

(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 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.
(2) Shock and vibration classification.
(3) Degree of water tightness of the enclosure.
(4) Electromagnetic interference and pulse susceptibility.
(5) DC magnetic field environment.

(b) Dimensional outline of the instrumentation showing overall and principle dimensions in sufficient detail to establish space

requirements in all directions needed for installation and servicing, exclusive of space required for observing the indication.

(c) Special considerations which may affect selection or installation.

(1) Ambient temperature range.
(2) Calibration points and adjustments.
(3) Orientation.
(4) Location of instrumentation relative to vibrating equipment.
(5) Selection of the instrumentation range relative to the operating range of the system.
(6) Fluid applications.
(7) Cleaning procedure or reference to the cleaning procedure used.
(8) Selection of the instrumentation for compatibility (materials, temperature, pressure, and so forth) 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 sheet shall be zoned.
(c) Title block shall be included on each drawing sheet and shall include the following information.

(1) Title, drawing number, and revision letter. Each sheet shall contain the same title, drawing number and revision letter.

(a) Title - The title shall consist of the name by which the instrumentation is known.
(b) Drawing number - The drawing number shall consist of alphanumeric characters which may be separated by dashes or slashes. The total number of characters in the drawing number (including dashes and 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 by 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) Federal supply code for manufacturer (FSCM).
(6) Scale.
(7) Reference drawings.
(8) Manufacturer's name and address.
(9) Drawing size.

(d) Revision block. The revision block shall be included on each sheet of the conformance verification drawing and shall contain the following information in tabular form:

(1) Revision letter.
(2) Description of revision.
(3) Acceptance letter serial number and originator identification.
(4) Acceptance date.

(e) Form. Sheet size and format not specified herein shall be in accordance with ANSI Y14.1.
(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. Acquisition document instructions. The acquisition document should contain provisions that address submission, review, extension, disapproval, default, acceptance, and waiver of conformance verification drawings in addition to the effects on the delivery schedule due to delays in conformance verification drawing acceptance. NAVSEA shall be designated as the activity that accepts or disapproves the conformance verification drawing.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

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

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

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-L-23886C(SH)	94/08/09

3. DOCUMENT TITLE
LIQUID LEVEL INDICATING EQUIPMENT (ELECTRICAL)

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (Last, First, Middle Initial)	b. ORGANIZATION	
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code) (1) Commercial (2) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY TECHNICAL POINT OF CONTACT TOPC:

a. NAME	b. TELEPHONE (Include Area Code)	
Milt Spivack (03J4)	(1) Commercial	(2) AUTOVON
c. CORRESPONDENCE SHOULD BE SENT TO:	(703) 602-6137	332-6137
c. ADDRESS (Include Zip Code) Commander, Naval Sea Systems Command SEA 03R42, 2531 Jefferson Davis Hwy., Arlington, VA 22242-5160	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	