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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 sensing and indicating equipment for Naval shipboard use in fresh water, seawater, waste water, diesel fuel oil, distillate fuel oil, lubricating oil, contaminated oil, refrigerants, JP-fuel oil 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
Basic type (see 1.2.1)	Sensing technique (see 1.2.2)	Application (see 1.2.3)	Pressure requirement (see 1.2.4)	Display (see 1.2.5)

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

1.2.2 Sensing technique. The sensing technique used shall be denoted by letters assigned by NAVSEA. Examples include, but are not limited to, the following:

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A
FSC 6680

AZ - Admittance/impedance
MF - Magnetic float
DP - Differential pressure

1.2.3 Application. The fluid to be measured, as specified (see 6.2), shall be indicated 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
SW - Sea water	RF - Refrigerants
FW - Fresh water, potable water	AR - Air
WW - Waste water	CA - Compressed air
JP - JP-5, JP fuels	CG - Compressed gas
LO - Lubricating oil	HO - Hydraulic oil
CO - Contaminated oil	ST - Steam
WO - Waste oil	FO - Fuel oil (diesel fuel oil, distillate fuel oil, naval distillate, F-76, cargo oil, fuel)
CF - Contaminated fuel	
SO - Synthetic oil	

1.2.4 Pressure requirements. The maximum ambient pressure under which the transducer shall operate (see 6.2) shall be designated as follows:

VP - Vacuum pressure of 30 inches mercury (762 millimeters mercury) to 100 pounds per square inch (lb/in^2) (689 kilopascals (kPa)) inclusive.
LP - From atmospheric pressure to 100 lb/in^2 (689 kPa) inclusive.
HP - From 101 lb/in^2 (696 kPa) to maximum pressure as specified (see 6.2).

1.2.5 Display. The output display required shall be designated (see 6.2) as follows:

A - Analog
D - Digital
C - Analog and digital

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 Solvent.

MILITARY

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, Electrical, 600 Volts, 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-16400 - Electronic, Interior Communication and Navigation Equipment, Naval Ship and Shore: General Specification for.

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-S-19500 - Semiconductor Devices, General Specification for.

MIL-S-22432 - Servo Motors General Specification.

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-M-38510 - Microcircuits, General Specification for.

MIL-I-46058 - Insulating Compound, Electrical (For Coating Printed Circuit Assemblies).

MIL-P-55110 - Printed-Wiring Boards 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-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-701 - Lists of Standard Semiconductor Devices.
MIL-STD-781 - Reliability Testing for Engineering Development, Qualification, and Production.
MIL-STD-1399, Section 300 - Interface Standard for Shipboard Systems, Electric Power, Alternating Current. (Metric)

(Unless otherwise indicated, copies of federal and military specifications and standards are available from the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

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.

PUBLICATIONS

NAVSEA
0967-LP-597-1011 - Electronic Equipment, Parts Application and Reliability Information for Navy.
S9086-VD-STM-000/CH-631 - Preservation of Ships In Service, Surface Preparation and Painting.

(Application for copies should be addressed to the Naval Publications and Forms Center, (ATTN: NPODS), 5801 Tabor Avenue, Philadelphia, PA 19120-5099.)

2.2 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 Qualification. The liquid level indicating equipment furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time of contract award (see 4.4 and 6.5).

3.2 General requirements. Tank level indicating equipment shall be in accordance with MIL-E-16400 and as specified herein.

3.2.1 Parts, materials and processes. The selection, usage and methods of implementation shall be in accordance with MIL-E-16400 and NAVSEA 0967-LP-597-1011 (part selection and derating). This requirement includes inductors, wiring, mechanical hardware and transformers.

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 Nonmetallic material. Nonmetals when used for seals, protective finishes, and so forth shall be flame resistant and shall not support fungus growth as specified in MIL-STD-454, and shall not be adversely affected by the ambient environments specified in the construction and performance requirements of this specification.

3.2.3 Printed wiring. Printed wiring shall be in accordance with MIL-E-16400. Printed circuits shall be conformally coated. The insulating compound shall be in accordance with MIL-I-46058, type UR.

3.2.4 Nonstandard parts. Approval for use of nonstandard components and parts shall be in accordance with MIL-E-16400.

3.2.5 Lead identification. To facilitate testing and locating faults, all leads shall be distinctly identified and follow the same general pattern throughout. Standard identification codes selected for leads shall be in accordance with MIL-E-16400.

3.2.6 Accessibility. Modular units or assemblies shall be fastened in such a manner as to allow for quick and easy removal for maintenance accessibility or replacement.

3.2.7 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 Construction. The equipment specified herein shall measure and detect the fluid level in a tank and display it as a continuous proportional analog or digital readout. Selection and installation of liquid level indicators or indicating systems for all applications on board Naval ships shall be in accordance with Drawing 803-2145532.

3.3.1 Mean time between failures (MTBF). Tank level indicator system reliability shall be assessed in a test program of statistically valid length for 20 percent nominal decision risks (OC = B = 20 percent) with discrimination ratio of 2.0 under environmental conditions as specified in MIL-STD-781 for sheltered shipboard conditions. Thus, test plan IVC or XIVC as specified in MIL-STD-781 may be used according to requirements for an estimate of true MTBF, budgeting costs of testing, and fixing test length. Under either plan, the lower test MTBF (r_1) shall be 10,000 hours and the upper test MTBF (r_o) shall be 20,000 hours. The test plan shall be selected by the contractor and approved by NAVSEA prior to the start of testing.

3.3.2 System description. Each tank liquid level system shall consist of the following:

(a) One or more transducers.
(b) A level measuring circuit which may be part of the transducer or separate from the transducer.
(c) A power supply.
(d) One or more indicators (analog or digital).
(e) 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.
(f) A means for readily checking the calibration of the overall system.

3.3.3 Output. The output shall be continuous, uninterrupted from empty to full or over that portion of the tank to be measured.

3.3.3.1 Linearizing. When specified (see 6.2), the system shall be linearized to within plus or minus 6 percent of a straight line approximation of the capacity curve of the tank. Linearization shall not be accomplished by modifications to the indicator dial and scale. Linearization of the system may be accomplished by modification to the level measuring circuit or by adding a component to the level measuring system. The use of microprocessors may be considered provided they meet the requirements as specified in MIL-M-38510, class B. The installing activity shall furnish the tank capacity curve.

3.3.4 Calibration. Initial calibration of the tank liquid level system shall be with respect to the physical position of transducers at installation and shall require no further such physical adjustment. Calibration self-test capability shall be provided and shall not require disassembly or changes to the electrical wiring connections.

3.3.5 Control circuit. When specified (see 6.2), a control circuit shall be provided that has two (two high or 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 contact rating of 1 ampere (inductive) at 115 volts, 60 hertz (Hz). This circuit shall receive input from the tank liquid level system without affecting the accuracy of the overall system. The high level control circuit shall be adjustable from 50 to 98 percent of the indicated range and the low level control circuit shall be adjustable from 2 to 50 percent of the indicated range. Adjustments shall have restricted access to eliminate tampering and be provided with locking devices to secure settings. The accuracy of the adjustments shall be as specified in 3.4.2.2.

3.3.5.1 Fail-safe design. Any failure in the 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.

3.3.5.2 Control circuit calibration. Calibration test capability of the control circuit shall be provided and shall not require disassembly or changes to the electrical connections.

3.3.6 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). Controls and indicators shall be mounted on the front panel (see 3.3.6.1). Other functional components and parts not included in the transducer assembly shall be contained within the panel enclosure. Some components may be installed in auxiliary indicator panel assemblies as specified in 3.3.8.

3.3.6.1 Controls and indicators. The following controls and indicators shall be provided to perform the following functions and shall be located on the front panel:

(a) Power-on light (white lens).
(b) Power-on switch.
(c) Liquid level display.
(d) Calibration test switch.
(e) Fuseholder and blown fuse indicator.
(f) Alarm lights (when required).
(g) Audible alarm (when required).
(h) Alarm acknowledge switch (when required).

Multiposition switches may be used to combine and control functions. Indicators, whether primary or auxiliary, shall be fitted with protective shields equivalent to lexan or plexiglass for the displays.

3.3.6.1.1 Marking. 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 of silk screening. Decalcomania or paper labels shall not be used.

3.3.6.1.2 Protective shield. The protective shield, when required, (see 6.2) shall be equivalent to lexan or plexiglass. It shall be shatterproof, shall be constructed in such a way that moisture will not be trapped due to its presence, shall be positioned as close to the indicator as possible and be removable. It is not necessary that the shield be watertight. The shield shall effectively protect the indicators from accidental damage.

3.3.6.2 Access. Internal components and parts shall be readily accessible for maintenance and calibration. No mechanical or electrical disassembly shall be required for the purpose of obtaining access to calibration controls, control point adjustments (if required) and test points, except for removal of a cover plate.

3.3.7 Multiple indicator panel assembly. Where multiple liquid level indications are required (see 6.2), the individual indicators and their associated circuits may be combined into one panel. The enclosure shall be similar in construction to the primary indicator panel (see 3.3.6). There shall be no interaction between the individual tank liquid level system circuits except a common power supply and calibration adjustment may be utilized. Multiposition switches and controls may be used to control functions, as required.

3.3.7.1 For multiple indicator panels, microprocessors and microprocessor support circuitry may be incorporated in the equipment to perform processing and control functions. These functions may be: selection and monitoring of sensors and tanks, processing of sensor signals, monitoring power failure, monitoring and controlling alarms, linearization by using look-up tables in programmable read only memory (PROM), receiver selection and so forth. Built-in test shall be required in the form of firmware, residing in the PROM. This self-test computer software routine shall indicate basic failure modes of the equipment such as power supply failure to assist during troubleshooting. The block diagram shown on figure 1 serves as a general guide and shall not restrict the utilization of microprocessors.

3.3.8 Auxiliary indicator panel assembly. When required (see 6.2), the auxiliary panel enclosure shall be similar in construction to the primary indicator panel (see 3.3.6) and shall be arranged for bulkhead or panel mounting. Unless otherwise specified (see 6.2), the panel shall have mounted, on the front cover only, a liquid level display of the same type as in the primary indicator panel assembly. Component parts not readily included in the primary indicator panel may be contained within the auxiliary panel assembly. In the event of failure of the auxiliary panel assembly, a device shall be provided on the primary indicator panel to allow isolation of the auxiliary panel assembly. With the auxiliary panel isolated, the primary indicator panel shall continue to operate as specified herein.

3.3.9 Portable indicator assembly. Where portable readout assemblies are required (see 6.2), they shall be similar in construction to the auxiliary indicator panel assembly (see 3.3.8) except the enclosure shall be watertight and bulkhead or panel mounting provisions shall not be required.

3.3.10 Transducer assembly.

3.3.10.1 Transducer construction. The transducer shall provide protection for the primary sensing element against exposure to shipboard humidity and salt environment, against the corrosive and pressure effects of the medium whose level is being measured and against the mechanical stresses of shipboard shock and vibration. Transducers shall be fabricated from Inconel 625, Monel, or 316 stainless steel for all seawater applications. For other applications they shall be fabricated from corrosion resistant steel (CRES). Transducers shall be installed in tanks of varying configuration with numerous structural and other obstructions, with ease. Transducers of various lengths may be combined with flexible interconnections to give coverage of the complete tank or portion specified. If the transducer 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 0.1 inch, unless the stationary part is coated (see 3.3.10.5). A transducer partially or wholly outside the tank is also acceptable. 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.

3.3.10.2 Intended use. The intended use of the transducer is to transmit a signal proportional to the liquid level in the tank for 20,000 hours 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 100 degrees Celsius (°C).
(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.

3.3.10.3 Flexible interconnections. Electrical flexible interconnections 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 transducers. No interconnection junction boxes shall be installed inside of any tank. Interconnecting and penetration cables 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 $\pm$ 10 percent by volume. The final cable formulation shall meet the physical characteristics (tensile strength, elongation, bending endurances, and so forth) as specified in MIL-C-915. The cable shall be suitable for fuel and oil resistant applications and shall resist swelling in the presence of water in accordance with MIL-R-6855,

class 1. Flexible interconnections, including removable flexible interconnection assemblies, shall meet all of the requirements of this specification. Flexible interconnections that are to be used in JP or FO tanks shall resist swelling and show no evidence of liquid intrusion or evidence of mechanical or electrical damage after immersion testing as specified in 4.6.17 or hydrostatic pressure testing as specified in 4.6.14.1.

3.3.10.4 Mounting. Transducer mounting devices or brackets shall be supplied with the transducer assembly.

3.3.10.5 Transducer coating. If the transducer is to be used in seawater or compensated fuel oil service, the stationary parts shall be powder epoxy coated when specified (see 6.2). The minimum clearance specified in 3.3.10.1 may be reduced accordingly.

3.3.11 Maintainability. The liquid level system shall facilitate assembly, disassembly, locations of trouble sources, calibration and maintenance without the aid of special tools. Functional parts are defined as individual component parts such as resistors, capacitors, or semiconductor devices or replaceable functional assemblies such as power supplies, printed circuit boards or meters. Functional parts shall be readily identifiable, accessible and removable for replacement. Various repair times may apply to the failure modes but the 90-percentile total repair time for a maintenance event shall not exceed 2.0 hours and the mean-time-to-repair (MTTR) shall not exceed 1.5 hours. Time to repair includes preparation, fault-location, fault-correction, check-out and other subdivisions as required but not logistic time nor administrative time. For units internal to the tank, the 1.5 hours shall be applied to removal and replacement procedures only (see 6.3).

3.4 Performance.

3.4.1 Operation. During operation (see 4.6.3), equipment performance shall be as follows:

(a) Primary indicator panel assembly reading shall be in consonance with the liquid level in the tank throughout level and inclination cycling.
(b) Control and test switches shall perform functions specified (see 3.3.6.1).
(c) Indicator lamps shall perform functions specified (see 3.3.6.1).
(d) When included, control circuit shall function as specified (see 3.3.5).
(e) When furnished, auxiliary and portable indicator panel assembly readouts shall be in consonance with the primary indicator panel assembly readout.

3.4.2 Accuracy. Accuracy shall be as specified in 3.4.2.1 and 3.4.2.2.

3.4.2.1 System accuracy. System accuracy (see 4.6.4) shall be as follows:

(a) The continuous readout indicators shall indicate to within plus or minus 3 percent of full scale of the actual liquid level in the tank.
(b) Repeatability of the continuous readout indicators shall be within plus or minus 1 percent of full scale at any point on the scale.
(c) Electrical output hysteresis shall not exceed 2 percent of full scale at any point on the scale for continuous readout indicators.

3.4.2.2 Control circuit. Accuracy of adjustable control points shall be as follows:

(a) Repeatability of the control point contact shall be within plus or minus 1 percent of full scale for continuous readout systems.
(b) Hysteresis of dead band - Make and break of the control function when operated through down and up cycles shall not exceed plus or minus 3 percent including instrument hysteresis and dead band for continuous readout systems.

3.4.3 Degree of enclosure. Indicator enclosures shall be dripproof (45 degrees) in accordance with MIL-STD-108. The equipment shall operate satisfactorily and there shall be no accumulation of water within the enclosure following the enclosure test (see 4.6.5).

3.4.4 Salt fog. Indicators shall withstand the effects of the salt fog test as specified in 4.6.6. 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. Indicators shall suffer no operational damage as a result of salt fog exposure.

3.4.5 Temperature and humidity. The complete system shall comply with the temperature and humidity requirements as specified in MIL-E-16400 (see 4.6.7).

3.4.6 Accelerated life (endurance). The complete system shall comply with the accelerated life requirements as specified in MIL-E-16400 (see 4.6.8).

3.4.7 Spike voltage. The indicators shall meet the accuracy requirements specified in 3.4.2 after spike voltage is applied (see 4.6.9).

3.4.8 Insulation resistance. The system insulation resistance shall be not less than 10 megohms (see 4.6.10).

3.4.9 Power supply. The power supply shall be compatible with type I power input as specified in MIL-STD-1399, section 300 (see 4.6.9). Nominal power input voltage and frequency shall be 115 volts, 60 Hz, single phase. Power line transients and spikes with magnitude duration, repetition rates and decay

characteristics as specified in MIL-STD-1399, section 300 shall not cause equipment damage or degrade equipment performance. Changes in input voltage and frequency within plus or minus 5 percent of nominal shall have no deleterious effect on power supply and system performance.

3.4.10 System response time. The system shall indicate the liquid level for liquid level change rates up to 1 inch per second with a total system response time of 0.5 second or less with an accuracy as specified in 3.4.2 (see 4.6.12). The system response time is defined as the time difference between when a liquid achieves a specified level and when the indicator system indicates that specific level for a liquid level that is changing at a constant rate. Time constant of electrical indicators need not be considered. Indicator systems which have control circuits for actuation of alarms, pumps, and so forth, shall have a separately adjustable response time applicable to the control circuits only. That response time shall be adjustable from 0.5 second to a maximum of 20 seconds. Adjustment of the control circuit response time may be continuous, in two steps (fast for tank filling or emptying operation and slow for normal operation), or in five steps as follows: 0.5, 2, 5, 10 and 20 seconds.

3.4.11 Electromagnetic susceptibility and emission. Indicators shall meet the requirements of MIL-STD-461 class A4 and A5, for monitoring equipment and sensors (see 4.6.13): CE01, CE03, CS01, CS02, CS06, CS09, RE01, RE02, RS01, RS02 and RS03, except as modified below:

(a) Requirement CS02 shall be met as specified except as follows:

(1) At frequencies between 2 and 30 megahertz, the full output of the generator (source impedance of 50 ohms, and an output capability of 12.25 volts root mean square, or 3 watts, when connected to a 50-ohm load) shall be applied to all power and signal leads of the test sample.
(2) The calibrating resistor, or 50-ohm load, shown in the CS02 test block diagram of MIL-STD-462, shall not be connected during the test.
(3) The test sample output signal shall not vary by more than an amount equal to the static error associated with the accuracy grade (0.5 to 5 percent) of the transducer under test.

3.4.12 Hydrostatic and functional pressure. High and low pressure transducers, complete with entrance fittings and interconnection fittings, shall withstand the hydrostatic and functional pressure test (see 4.6.14) without physical or electrical damage and without any leakage or signs of leakage around any of the fittings.

3.4.13 Vibration. The complete system shall show no evidence of mechanical or electrical damage or loosening of parts, when subjected to the test of type I vibration in accordance with MIL-STD-167-1 (see 4.6.15). Operating controls shall not change status during, or as a result of the vibration test. Components of the system including tank sensors shall be mounted to simulate shipboard installations in an empty tank and shall not be restricted from normal operation and movement.

3.4.14 Shock. The complete system shall conform to the grade A, class I, type A shock requirements as specified in MIL-S-901 (see 4.6.16), 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. Components of the system including tank sensors shall be mounted to simulate shipboard installation in an empty tank and shall not be restricted from normal operation and movement.

3.5 Detail requirements.

3.5.1 Electrical indicating meters. Electrical indicating meters shall be 0 to 200 microamperes, 4 to 20 milliamperes (mA) or 10 to 50 mA; high impact shock resistant; and watertight or sealed 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.

3.5.1.1 Indicator dials. Unless otherwise specified (see 6.2), indicator 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 indicator without disturbing the pointer or other parts of the indicator. The dial surface shall be suitable for marking by an installing activity after the system has been calibrated to a particular tank. When graduations are specified, they shall extend uniformly over the full range of the indicator 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. The following additional information shall be clearly identified on the dial: tank number, tank contents, total tank capacity, alarm setpoints marked in red, termination points of suction, fill, stripping, pipes, if within the operating range of the indicator, and so forth.

3.5.1.2 Primary indicator. Unless otherwise specified (see 6.2), the primary indicator shall have black letters, numerals and graduations on a white background for all surface ship applications. The indicator pointer shall be black or red silhouetted against the dial. For all submarine applications, 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.

3.5.1.2.1 Red illumination. Red illumination, if specified (see 6.2), shall be by the duo-panel or reflux system or other system as approved by NAVSEA. The lighting circuit shall be ungrounded and shall be energized from a 6-volt supply with separate external terminals.

3.5.1.3 Auxiliary and portable indicators. The auxiliary and portable indicators shall have black letters, numerals and graduations on a white background. There shall be no internal illumination.

3.5.2 Digital readout. Where a digital readout device is used in lieu of an analog indicating meter, the digital readout shall be a high impact shock resistant type approved by NAVSEA. Light emitting diode type is preferred.

3.5.3 Audible signals. Where 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 transducer or a device adjusted to a predetermined level (see 3.3.5).

3.5.4 Printed wiring board. The printed wiring boards, whenever used, shall comply with the requirements as specified in MIL-P-55110 or MIL-P-24423, as applicable.

3.5.4.1 Spacing of adjacent tracks on printed wiring boards shall be in accordance with MIL-STD-454.

3.5.4.2 Power line and noise bypass capacitors may be incorporated as required but shall not exceed the limits specified in MIL-STD-461 and MIL-STD-1399, section 300.

3.5.4.3 Unless otherwise recommended by the integrated circuit manufacturer, AWG number 20 or larger wire shall be used for all digital integrated circuit power and common lines.

3.5.4.4 Where complementary metal oxide semiconductor devices are used, a note on the printed wiring board shall indicate to handle the board with special care due to electrostatic discharge.

3.5.5 Liquid level switches. Liquid level switches, if used, shall be in accordance with MIL-S-16032.

3.5.6 Solid state electronics. Only solid state electronics shall be used.

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

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

3.5.9 Servomotors. Servomotors, if used, shall be in accordance with MIL-S-22432.

3.5.10 Semiconductors. Semiconductors, if used, shall be in accordance with MIL-S-19500 (JANTX) and shall be selected in accordance with MIL-STD-701.

3.6 Marking. Unless otherwise specified (see 6.2), designation and marking shall comply with the requirements as specified in MIL-E-16400 and MIL-C-915.

3.7 Workmanship. The workmanship shall be in accordance with requirement 9 of MIL-STD-454. The equipment shall comply with the general examination as specified (see 4.6.1).

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) Qualification inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions specified in MIL-STD-202. Unless otherwise specified in the individual test procedure, performance tests shall be conducted with the equipment operating under the following conditions:

(a) Ambient temperature shall be 23 $\pm$ 1.4°C.
(b) Relative humidity shall be 50 $\pm$ 5 percent.
(c) Supply voltage shall be 115 volts plus or minus 5 percent.
(d) Supply frequency shall be 60 Hz plus or minus 5 percent.
(e) Controls shall be in the neutral or normal position.

4.4 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to NAVSEA on sample units produced with equipment and procedures normally used in production. Qualification tests shall consist of the examination and tests specified in table I.

TABLE I. Qualification examination and tests.

Examination or test	Requirement	Examination or test
General examination	3.3	4.6.1
Operation	3.4.1	4.6.3
Insulation resistance	3.4.8	4.6.10
Accuracy	3.4.2	4.6.4
System response time	3.4.10	4.6.12
Supply line voltage and frequency variation	3.4.9	4.6.11
Spike voltage	3.4.7	4.6.9
Temperature and humidity	3.4.5	4.6.7
Accelerated life	3.4.6	4.6.8
Enclosure	3.4.3	4.6.5
Salt fog	3.4.4	4.6.6
Hydrostatic and functional pressure test	3.4.12	4.6.14
Vibration	3.4.13	4.6.15
Shock	3.4.14	4.6.16
Electromagnetic interference	3.4.11	4.6.13
Immersion	3.3.10.3	4.6.17

4.4.1 Sample size. One tank liquid level indicating equipment of each type (that is, sensing technique, application and pressure) shall be subjected to qualification inspection.

4.4.2 Inspection routine. 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	3.3	4.6.1
Insulation resistance	3.4.8	4.6.10
Group B		
Accuracy	3.4.2	4.6.4
Supply line voltage and frequency variation	3.4.9	4.6.11
System response time	3.4.10	4.6.12
Group C		
Transducer operation test	3.4.1	4.6.3
Spike voltage	3.4.7	4.6.9
Temperature and humidity	3.4.5	4.6.7
Accelerated life	3.4.6	4.6.8
Enclosure	3.4.3	4.6.5
Salt fog	3.4.4	4.6.6
Hydrostatic and functional pressure test	3.4.12	4.6.14
Vibration	3.4.13	4.6.15
Shock	3.4.14	4.6.16
Immersion	3.3.10.3	4.6.17

4.5.1 Inspection lot. An inspection lot shall consist of all tank liquid level indicating equipment of each type (that is, sensing technique, application and pressure) produced under essentially the same conditions, and offered for inspection at the same time.

4.5.1.1 Sampling for group A inspections. A random sample of each equipment shall be selected from each lot in accordance with table III and shall be subjected to the group A inspections specified in table II to determine conformance with this specification. Failure to conform to the requirements of this specification for any group A 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.

TABLE III. Sampling for group A inspections.

Number of indicating equipment in inspection lot	Sample size	Number of indicating equipment nonconforming	
		Acceptance number	Rejection number
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

4.5.1.2 Sampling for group B inspections. A random sample of each equipment shall be selected from each lot in accordance with table IV and shall be subjected to the group B inspections specified in table II to determine conformance with this specification. Failure to conform to the requirements of this specification for any group B inspection 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. Group B inspections shall be made on sample units which have passed the group A inspections.

TABLE IV. Sampling for group B inspections.

Number of indicating equipment in inspection lot	Sample size	Number of indicating equipment nonconforming	
		Acceptance number	Rejection number
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

4.5.1.2.1 Disposition of sample units. Sample units which have passed all the group B inspections may be delivered on the contract, if the lot is accepted and the sample units are still within the electrical tolerances specified herein.

4.5.1.3 Sampling for group C inspections. Group C inspections shall be conducted when the basic design of the equipment, the operating characteristics, or the material of a vital part has been changed. One complete tank liquid level indicating equipment system shall be randomly selected and subjected to the group C inspections specified in table II. Group C inspections shall be made on sample units which have passed the groups A and B inspections. Sample units which have been subjected to group C inspections shall not be delivered on the contract.

4.5.1.3.1 Failures. If the sample unit fails to pass any of the group C inspections, the sample shall be considered to have failed, and the lot represented by the sample shall be rejected.

4.5.2 Noncompliance. If a sample fails to pass group C inspections, the contractor shall notify the qualifying 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 qualifying activity has been taken. After the corrective action has been taken, group C inspection shall be repeated on additional sample units (all tests and examinations or the test which the original sample failed, at the option of the qualifying activity). Groups A and B inspections may be reinstituted; however, final acceptance and shipment shall be withheld until the group C inspections have shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure shall be furnished to the cognizant inspection activity and the qualifying activity.

4.6 Inspections.

4.6.1 General examination. Each sample equipment shall be subjected to a general examination to ascertain that the material, workmanship, design, proper cable harness dress, creepage and clearance distances, safety requirements and treatment for prevention of corrosion are in conformance with this specification and in accordance with approved manufacturer's drawings. 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 include a check of all controls, adjustments, reliability, system description, output, calibration, control circuit (including failsafe design), primary indicator and panel assembly, multiple indicator panel assembly, auxiliary indicator panel assembly, portable indicator panel assembly, transducer design and maintainability as applicable (see 3.3).

4.6.2 Transducer reference measurement. When specified in the individual test, a reference calibration shall be conducted consisting of measurements of the indicated level versus actual tank level. The measurements shall be made at a minimum of 10 equal increments, plus or minus 1/2 percent for both increasing (upscale) and decreasing (downscale) level. 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 be in accordance with the requirements of 3.4.2.1(a) (see 6.3).

4.6.3 Transducer operation. The transducer shall be tested in a 3-foot by 3-foot by 7-foot high carbon steel test tank. The steel surfaces of the tank shall be coated in accordance with NAVSEA S9086-VD-STM-000/CH-631 requirements for surface ships seawater tank. One side of the test tank shall consist of a transparent panel where the liquid level can be visually observed over the operating test range. Unless otherwise specified in an individual test method, testing shall be conducted in the test tank described herein with the transducer under test positioned in the horizontal center of the test tank along the tank's vertical centerline. The transducer under test shall be configured to indicate 0 to 100 percent over a vertical distance of 50 inches.

4.6.3.1 Variable fluid level. The transducer shall be mounted in the test tank and shall be configured to indicate 0 to 100 percent liquid level over a vertical distance of 50 inches. The fluid/gas or fluid/water used for this test shall be the same as the intended application specified in 6.1, except that ordinary tap water may be substituted for seawater interface applications. The fluid temperature shall be 25 $\pm$ 10°C.

4.6.3.1.1 Fluid/gas interface systems. The transducer shall be conditioned first by raising and lowering the fluid level between 0 and 100 percent for three consecutive cycles. Three reference measurements (see 4.6.2) shall then be made in succession. Level cycling and reference measurement performance shall be in accordance with 3.4.1 and 3.4.2.

4.6.3.1.2 Fluid/water interface systems. The transducer shall be conditioned first by raising and lowering the water level between 0 and 100 percent for three consecutive cycles. Three reference measurements shall then be made in succession. The following conditions for these three reference measurements shall apply:

(a) The tank shall be filled over the entire 50-inch vertical distance. 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 system shall indicate 0 percent when the tank is full of water.
(c) The system shall indicate 100 percent 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.

Level cycling and reference measurement performance shall be in accordance with 3.4.1 and 3.4.2.

4.6.3.2 Transducer inclination. The transducer test conditions shall be the same as specified in 4.6.3.1 except that the test tank shall be inclined 45 degrees to each side of vertical along both the fore-and-aft and athwartship axes of the tank, for a total of four positions. The inclination angle shall be increased to 60 degrees for submarine equipment. A reference measurement 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 3.4.1 and 3.4.2. Differential pressure transducer performance may be modified to compensate for hydrostatic pressure changes created by the inclined geometry but only as approved by NAVSEA.

4.6.3.3 Transducer temperature.

4.6.3.3.1 Standard temperature range transducers. The transducer shall be mounted in a test tank and operated in water to determine that it can be operated over the standard temperature range of 0 to 100°C. The water level shall be continuously cycled while the water temperature is decreased to 2 ± 2°C. Level cycling shall be maintained at 2°C for 4 hours after which time a reference measurement shall be taken. While level cycling is maintained, the water temperature shall be increased to 98 ± 2°C. Level cycling shall be maintained at 98°C for 4 hours after which time a reference measurement shall be taken. While level cycling is maintained, the water temperature shall be reduced to 23 ± 2°C. Level cycling shall be maintained at 23°C for 1 hour after which time a reference measurement (see 4.6.2) shall be taken. Level cycling is defined as the continuous raising and lowering of the liquid level between the 0 and 100 percent test points at a rate not less than 1 foot per minute. Temperature changes will occur at a rate not less than 20°C per hour. The dimensions and material of the test tank may be changed to reduce the heating or cooling requirements when approved by NAVSEA. Performance shall be in accordance with 3.4.1 and 3.4.2.

4.6.3.3.2 Optional temperature range transducers. Transducers specified for a temperature range other than 0 to 100°C shall be subjected to tests developed by NAVSEA on a case basis.

4.6.3.4 Surface oil effect. This test shall determine the ability of the system under test to function properly when a small layer of oil is present on the surface of water. This test is especially applicable to systems intended for seawater, waste water, and contaminated oil service. Systems for oil or seawater interface applications may omit this test if approved by NAVSEA.

4.6.3.4.1 The transducer shall be mounted in a test tank and an initial reference measurement made using oil-free water as the test fluid. There shall be no evidence of oil on the tank wall, on the transducer under test, or on the water surface during the initial reference measurement. Symbol 2190 lube oil shall then be added to the test tank to form a distinct surface layer 3 ± 1/4 inches thick. Without adjusting the system under test, a reference measurement shall then be made by adding or draining water slowly at the bottom of the tank so as not to disturb the oil layer and measuring the actual level at the oil or air interface. The fluid temperature for this test shall be 25 ± 10°C. Level change rates shall be 1/2 foot per minute or faster and incremental readings shall be taken in 30 seconds or less. System performance shall be in accordance with 3.4.1 and 3.4.2. The test tank dimension may be reduced to minimize test fluid contamination if approved by NAVSEA.

4.6.3.5 Specific gravity.

4.6.3.5.1 Fluid/gas interface systems. Two variable fluid level tests (see 4.6.3.1) 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 system under test shall not be altered, modified, adjusted or recalibrated during each variable fluid level test or between the two variable fluid level tests. Performance for both test fluids shall be in accordance with 3.4.1 and 3.4.2. Failure to meet the requirements of this test disqualifies the system for any fluid/gas application where the measured fluid or specific gravity changes by more than plus or minus 1 percent including fuel or air interface.

4.6.3.5.2 Fluid/water interface systems. Two variable fluid level tests (see 4.6.3.1) 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 system under test shall not be altered, modified, adjusted or recalibrated during each variable fluid level test or between the two variable fluid level tests. Performance for both tests shall be in accordance with 3.4.1 and 3.4.2. Failure to meet the requirements of this test disqualifies the system for any fluid/water application in which the specific gravity changes by more than plus or minus 1 percent, including fuel or seawater applications.

4.6.3.6 Fluid conductivity. The system shall be subjected to three variable fluid level tests (see 4.6.3.1) using water with different electrical conductivities for each test. The three test conductivities shall be 3 ± 2 microsiemens per centimeter (μS/cm), 500 ± 50 μS/cm, and 1000 ± 50 μS/cm. The conductivity of the water shall be controlled by varying the concentration of sodium chloride (NaCl) in solution with the water. The system under test shall retain the same calibration adjustment for all three tests. Performance shall be in accordance with 3.4.1 and 3.4.2. Failure to meet the requirements of this test will restrict the system under test to the intended applications established by NAVSEA after review of the test report.

4.6.3.7 Tank wall proximity. The transducer under test shall be subjected to a variable fluid level test (see 4.6.3.1) except that the location of the transducer within the test tank shall be changed to determine if the tank walls can affect the system performance. The transducer 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 transducer and the wall or shall be the minimum distance specified by the transducer manufacturer. Reference measurement performance shall be in accordance with 3.4.1 and 3.4.2.

4.6.4 Accuracy.

4.6.4.1 System calibration and accuracy. The accuracy, repeatability, hysteresis and deadband shall be checked by varying (or simulating the variation of) the liquid level over the range of empty to full. Indicator levels versus actual (or simulated) liquid level shall be recorded upscale and downscale at a minimum of five equally spaced intervals of full scale for continuous output

systems or at each discrete level for discrete point output systems. This shall be accomplished by performing three successive cycles to determine repeatability. If a test tank is utilized, it shall have a 4-foot minimum distance between empty and full indications. The tank shall be equipped with a sight glass or similar device with sufficient resolution and accuracy to determine the accuracy, repeatability, hysteresis and deadband requirements as specified in 3.4.2.

4.6.4.2 Control circuit accuracy. The high and low control circuit set points shall be adjusted to each of their setpoint limits as specified in 3.3.5 and their operation verified at each limit by varying (or simulating the variation of) the liquid level. The high level control circuit shall then be set at 75 percent tank capacity and the low level control circuit shall be set at 25 percent tank capacity. The liquid level shall be varied (utilizing the same method used in the performance of the system calibration and accuracy test (see 4.6.4.1)) above and below each detection point three successive times. The control circuit accuracy shall meet the requirements as specified in 3.4.2.2.

4.6.4.2.1 Following the accuracy test, the control circuit fail-safe capability shall be checked by simulating an open circuit (or loss of power).

4.6.5 Enclosure. The indicators shall be subjected to the drip test (45 degrees) in accordance with MIL-STD-108. When specified that (during the test) the equipment shall be operating, empty to full level cycles shall be simulated so that failure of the indicator can readily be detected. Performance shall be as specified in 3.4.3.

4.6.6 Salt fog. The indicators shall be subjected to the salt fog test in accordance with method 101 of MIL-STD-202 using a 5 percent salt solution. A reference measurement shall be taken prior to the salt fog test. Duration of the test shall be 96 hours after which time a reference measurement shall be taken. Performance shall be as specified in 3.4.4.

4.6.7 Temperature and humidity. Equipment shall be tested in accordance with the temperature and humidity test specified in MIL-E-16400. Performance during and after test shall be as specified in 3.4.5. At the conclusion of the test, system accuracy and response time shall be measured.

4.6.8 Accelerated life. The accelerated life test shall be conducted in accordance with MIL-E-16400. Performance requirements during the test shall be as specified in 3.4.6. At the conclusion of the test, system accuracy and response time shall be measured.

4.6.9 Spike voltage. The indicator 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 indicator is operating. The indicator shall operate normally as specified in 3.4.7 immediately following the test.

4.6.10 Insulation resistance. Equipment shall be tested in accordance with method 302 of MIL-STD-202. The following details and exceptions shall apply:

(a) Equipment less transducer - Test condition B (500 volts).
Transducer assembly - Test condition A (100 volts).
(b) Examination after test - Equipment and transducer assembly shall be in accordance with 3.4.8.

At the conclusion of the test, the system accuracy and response time shall be measured.

4.6.11 Supply voltage and frequency variation. Indicating system shall be operated at the configurations of normal, maximum and minimum steady state voltages and frequencies specified in 3.4.9. The indicating system shall remain at each configuration for 15 minutes. A reference measurement shall be performed before and after each transition.

4.6.12 System response time. The test tank (see 4.6.3) shall be used to subject the transducer to a 100 percent change in liquid level at a constant rate to determine the system response time. The test shall be conducted using the fluids intended for the specified fluid/gas or fluid/water application and also using water as the measured fluid when fluid/gas application is specified. The test fluid temperature shall be ambient 25 $\pm$ 10°C. Tests shall be conducted for all systems (see 4.6.12.1). Systems with adjustable time response shall also be tested (see 4.6.12.2) to determine the response time at the maximum setting.

4.6.12.1 Minimum response time. The test tank shall be configured to increase the fluid level at a constant rate from 0 to 100 percent (50 inches) in 10 $\pm$ 1 seconds. The actual fluid level and the level indicated by the system shall be monitored. The elapsed time from when the actual fluid level reaches 20 percent (10 inches) to when the system indicates 20 percent shall be recorded and the elapsed time from when the actual fluid level reaches 50 percent (25 inches) to when the system indicates 50 percent shall be recorded and the elapsed time from when the actual level reaches 80 percent (40 inches) to when the system indicates 80 percent shall be recorded. The test tank shall then be configured to decrease the fluid level at a constant rate from 100 percent (50 inches) to 0 percent in 10 $\pm$ 1 seconds. The elapsed time from when the actual fluid level reaches 80 percent (40 inches) to when the system indicates 80 percent shall be recorded and elapsed time from when the actual level reaches 50 percent (25 inches) to when the system indicates 50 percent shall be recorded and the elapsed time from when the actual level reaches 20 percent (10 inches) to when the system indicates 20 percent shall be recorded. The maximum elapsed time in the tests specified herein shall be recorded as the system response time. System performance shall be as specified in 3.4.10. Where it is impractical to achieve the fill/empty rate specified, this test may be performed by changing the vertical position of the transducer relative to a fixed tank level (for example, raising or lowering the transducer by means of a pneumatic cylinder) at the same rate specified above. Use of this or any alternative method shall be approved by NAVSEA.

4.6.12.2 Adjustable system response time. When an adjustable system response time is provided, the system shall be adjusted to its maximum response time setting. The test shall be performed in accordance with 4.6.12.1 except that the fill/empty rate shall be adjusted to achieve a 100 percent fluid level change in 200 $\pm$ 5 seconds. The maximum elapsed time recorded shall be the maximum system response time. Performance shall be in accordance with 3.4.10.

4.6.13 Electromagnetic susceptibility and emission. The indicating system shall be subjected to the limits specified in 3.4.11. Tests shall be conducted in accordance with MIL-STD-462.

4.6.14 Hydrostatic and functioning pressure. The transducer assemblies shall be installed in a pressure vessel to simulate actual tank installation and to ensure that all components of the assembly, especially all connections and fittings, are submerged and remain submerged except when test conditions state otherwise. The test fluid shall be water having a minimum conductivity of 400 μS (average tap water) when specified. Distilled water shall not be used. The specified pressure for the test shall be as follows:

(a) High pressure transducers shall be subjected to 150 percent of the pressure specified in 1.2.4.
(b) Low pressure and vacuum pressure transducers shall be subjected to 150 lb/in^2.

4.6.14.1 Hydrostatic test. For the hydrostatic pressure test, the pressure vessel shall be filled with water and allowed to soak for 1 hour at atmospheric pressure. The hydrostatic test shall consist of three successive applications of the specified pressure then reducing the pressure to atmospheric. The specified pressure shall be held for 1 hour and atmospheric pressure for 10 minutes during each cycle. The rate of pressure change shall be not less than 10 lb/in^2 per second. During the third pressure cycle an insulation resistance measurement shall be made on the transducer at both the specified pressure and at atmospheric pressure.

4.6.14.2 Functional test. The functioning pressure test shall consist of three successive fill and empty cycles. The pressure vessel shall be filled with water in 10 equal increments at atmospheric pressure and level readings taken at each increment. The specified pressure shall then be applied and held for 15 minutes. 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 and the cycle repeated twice. Upon completion of all cycles, all readings shall be within plus or minus 3 percent of full scale.

4.6.14.3 Post test inspection. Upon completion of 4.6.14.1 and 4.6.14.2, the transducer shall then be removed from the pressure vessel and disassembled to the maximum extent possible without affecting transducer performance or integrity. The transducer shall be examined for any physical or electrical damage and leakage or signs of leakage. The transducer shall then be reassembled and a reference measurement taken. Performance requirements shall be as specified in 3.4.12.

4.6.14.4 Interconnections. Removable flexible interconnections assemblies, if not tested as a part of the transducer assembly qualification above, shall be subjected to the tests of 4.6.14.1 using test fixtures to replace transducers. Test fixtures shall be fully described and approved. Upon completion of this test, the assembly shall meet the insulation resistance test requirements of MIL-E-16400 and the performance requirements specified in 3.3.10.3.

4.6.15 Vibration. Equipment shall be tested in accordance with type I vibration of MIL-STD-167-1. The equipment under test shall be energized in the normal manner. Performance requirements shall be as specified in 3.4.13. At the conclusion of the test and prior to any adjustments, the system accuracy shall be measured as specified in 4.6.4.

4.6.16 Shock. 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 equipment under test shall be energized in the normal manner. Performance requirements shall be as specified in 3.4.14. At the conclusion of the test and prior to any adjustments, the system accuracy shall be measured as specified in 4.6.4.

4.6.17 Immersion. When intended for use in tanks containing fuel oil (FO) or JP type fuels, flexible interconnections shall be submerged in JP-5 or in the intended fluid for a continuous period of 45 days. The test fluid temperature shall be maintained at 25 $\pm$ 10°C. At the end of the testing period, performance requirements shall be as specified in 3.3.10.3. Removable interconnection assemblies may be tested with a simulated shipboard installation using test fixtures to replace transducers. Test fixtures shall be fully described. Removable interconnection assemblies shall meet the insulation resistance test requirements of MIL-E-16400 after completion of immersion testing.

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

5. PACKAGING

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

5.1 Packaging. 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 following types of liquids present in tanks on board Navy ships:

(a) Seawater and air interface.
(b) Seawater and compressed air interface.
(c) Fresh water (potable water) and air interface.
(d) Fresh water (potable water) and steam interface.
(e) Waste water and air interface.
(f) Waste water and compressed air interface.
(g) Fuel oil (diesel, distillate) and air interface.
(h) JP fuel oil and air interface.

(i) JP fuel oil and seawater interface.
(j) Lubricating oil and air interface.
(k) Contaminated oil and air interface.
(l) Contaminated oil and seawater interface.
(m) Gasoline and seawater interface.
(n) Gasoline and compressed gas interface.
(o) Refrigerant and air interface.
(p) Refrigerant and compressed gas interface.
(q) Waste oil and air interface.
(r) Waste oil and seawater interface.
(s) Synthetic oil and air interface.
(t) Hydraulic oil and air interface.
(u) Hydraulic oil and compressed gas interface.
(v) Refrigerant and air interface.
(w) Refrigerant and compressed gas interface.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number and date of this 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).
(c) Basic type, sensing technique, application, pressure requirement and display (see 1.2).
(d) If a control circuit is required and whether settings are to be two high and two low or one high and one low (see 3.3.2 and 3.3.5).
(e) If system linearizing is required (see 3.3.3.1).
(f) If indicator is to be panel or bulkhead mounted (see 3.3.6).
(g) If a protective shield is required (see 3.3.6.1.2).
(h) If multiple indicator panel is required (see 3.3.7).
(i) If auxiliary indicator is required and display type (see 3.3.8).
(j) If portable indicator assembly is required (see 3.3.9).
(k) If epoxy coating is required (see 3.3.10.5).
(l) If indicator dial graduations are required (see 3.5.1.1 and 3.5.1.2).
(m) If indicator illumination is required (see 3.5.1.2.1).
(n) If audible signals are required (see 3.5.3).
(o) If marking is required other than as specified (see 3.6).
(p) 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	Suggested tailoring
3.3.11	DI-R-7103	Maintainability program plan	----
4.6.2	DI-T-5329	Inspection and test 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 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 23886 whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 and information pertaining to qualification of products may be obtained from that activity. Application for qualification tests must be made in accordance with "Provisions Governing Qualification SD-6" (see 6.5.1).

6.5.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

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

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

6.7 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.

6.8 Subject term (key word) listing.

Lead identification
Nonmetallic material
Printed wiring
System response time
Transducer assembly

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

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

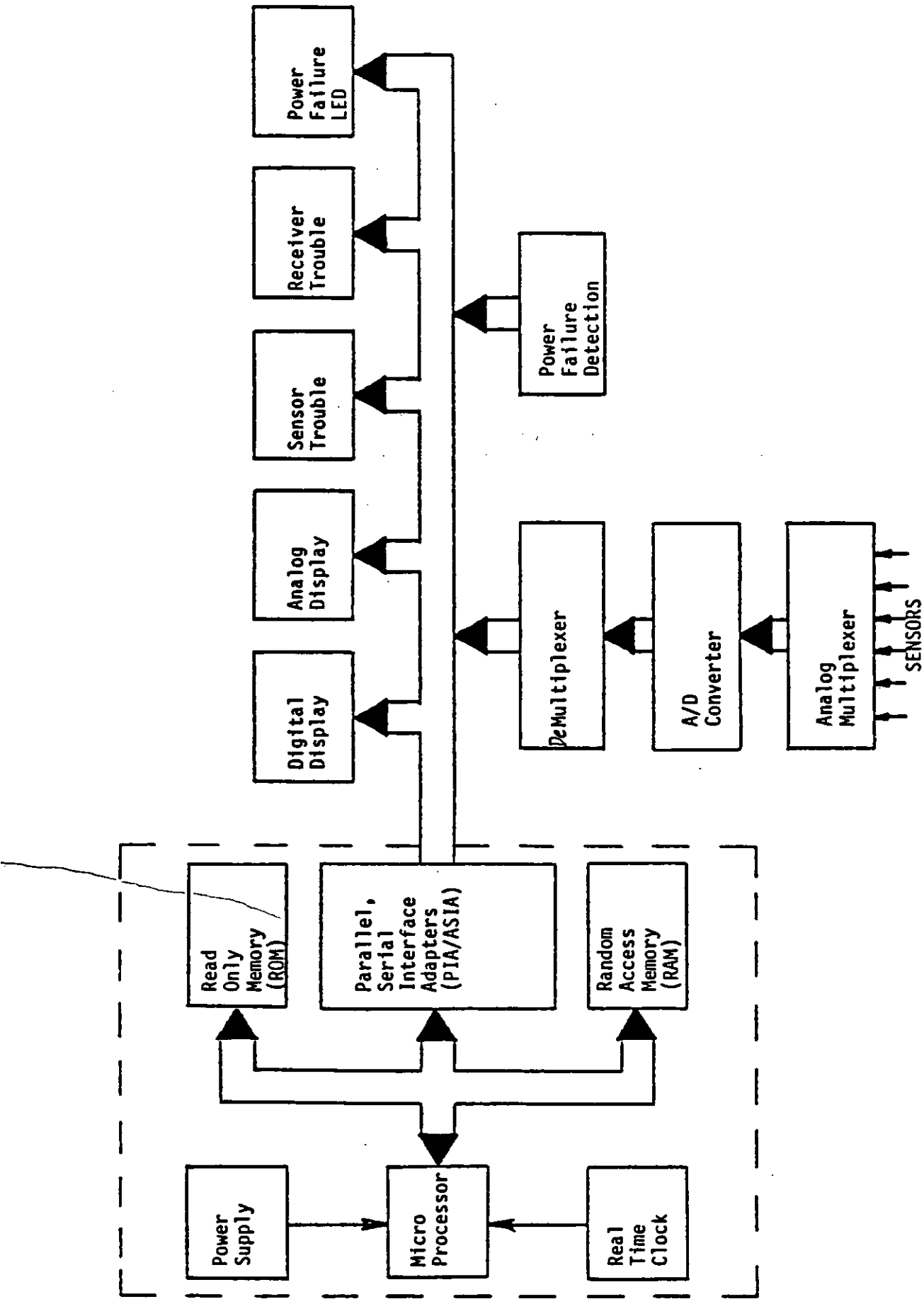

FIGURE 1. Block diagram of microprocessor design.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-L-23886B(SH)	LIQUID LEVEL INDICATING EQUIPMENT (ELECTRICAL)

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ USER
- ☐ MANUFACTURER
- ☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.

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