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MIL-T-24448A (SHIPS)
20 April 1971

SUPERSEDING
MIL-T-24448 (SHIPS)
15 January 1971
(See 6.5)

MILITARY SPECIFICATION
TORSIONMETER (FOR MEASUREMENT OF TORQUE DEFLECTION
OF PROPELLER PROPULSION SHAFTS OF NAVAL SHIPS)

1. SCOPE

1.1 This specification covers electromechanical torque metering equipment (torsionmeter) for the measuring of the torsional deflection of a specified section of the propeller propulsion shaft used in Naval Ships. The equipment, essentially a stationary mounted sensing-indications system, is capable of determining and processing for suitable display the stress conditions of a rotating shaft.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

QQ-A-601 - Aluminum Alloy Sand Castings.

MILITARY

MIL-T-27 - Transformer and Inductors (Audio Power and High Power Pulse).
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems Requirements for.
MIL-I-983 - Interior Communication Equipment, Naval Shipboard; Basic Design Requirements For.
MIL-L-3661 - Lampholders, Indicator Lights, Indicator - Light Housing And Indicator - Light Lenses.
MIL-C-5015 - Connector, Electric, "AN" Type.
MIL-Q-9858 - Quality Program Requirements.
MIL-M-15071 - Manuals, Technical: Equipments and Systems Content Requirements For.
MIL-P-15137 - Provisioning Technical Documentation For Repair Parts For Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-M-16034 - Meters, Electric Indicating (Switchboard and Portable Types).
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts: Packaging and Packing of.
MIL-S-23284 - Steel Forgings, Carbon and Alloy, For Shafts, Sleeves, Couplings, and Stocks (Rudders and Diving Planes).

STANDARDS

MILITARY

MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-415 - Test Points and Test Facilities for Electronic Systems and Associated Equipment Design Standard For.
MIL-STD-454 - Standard General Requirements For Electronic Equipment.
MIL-STD-461 - Electromagnetic Interference Characteristics, Requirements For.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurements of.
MIL-STD-463 - Definitions and Systems of Units, Electromagnetic Interference Technology.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-831 - Test Reports, Preparation of.

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DRAWINGS

MILITARY

- RE-D2687575 - Connector, Plug, Electric Angle 90°.
- RE-D2687576 - Connector, Plug, Electric Straight.
- RE-D2687577 - Connector, Receptacle Electric Wall Mounting.
- RE-D2680780 - Clamp Support Assembly and Installation, Cable, Electrical Connector.
- RE-D2687700 - Connector, Plug, Electrical Angle 90°.
- RE-D2687701 - Connector, Plug, Electrical Straight.
- RE-D2687702 - Connector, Plug, Electrical, Cable Connecting.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
B26 - Aluminum Alloy Sand Castings

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

UNIFORM CLASSIFICATION COMMITTEE
Uniform Freight Classification Rules

(Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Boulevard, Chicago, Illinois 60606.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 First article sample. Prior to beginning production, a sample shall successfully pass the first article examination and tests specified in 4.2.

3.2 General requirements.

3.2.1 General description. This equipment shall provide a means for the measurement of torque in the shaft of a ships propulsion shafting. One complete system comprises the following components:

- (a) Sensor unit (signal detection)
- (b) Control unit (signal processing, activating-conversion power and signal distribution)
- (c) Indicator (data display)

3.2.2 Description of principle. The torque is determined by accurately measuring the twist (angular deflection) of the rotating shaft. The technique to be employed in the development and processing of the sensed signal is not necessarily restricted to a given area. However, the method of signal sensing shall be achieved based on a physical law which recognizes and treats the condition of the metal of the shaft being monitored as a function of the stress imposed thereon.

3.3 General features. The equipment shall be in accordance with the following paragraphs of MIL-I-983, in addition to the requirements specified herein. (Whenever a requirement of MIL-I-983 conflicts with a requirement in this specification, the requirement of this specification shall govern.)

General requirements
Primary requirements
NAVSEC approval
Completeness of equipment
Omissions, mistakes, discrepancies
Changes and developments

Definitions
Materials
General
 Substitution of (equal or superior) materials or parts
 Fungus-inert materials
 Flammable materials
 Arc-resistant materials
 Toxic materials
 Wood
Metals
 Aluminum
 Magnesium
 Ferrous alloy
 Nonferrous material (except aluminum)
 Zinc
 Springs (material)
 Other metals
Plastics
 Mechanical parts
 Electrical insulating parts
 Laminated thermosetting plastics
 Molted thermosetting plastics
 Thermoplastic materials
 Painted plastics
 Plastic identification plates
 Dials and transparent or translucent parts
Ceramics
 Impregnating, embedding and encapsulating compounds
 Glass
Lubricants and lubrication
Painting
Cleaning
 Undercoats
 Finish coats
 Protection against corrosion
 Corrosion resisting materials (see 3.3.13)
 Corrosion resisting treatments
 Selection of metals
 Bolts, machine screws, studs and nuts
Parts - mechanical
Gaskets
 For round dial windows
 Dials and pointers
 Dial sizes
 Locking devices
 Shaft locking devices
 Lock washers
 Washers
Bearings
 Bearings, ball
 Bearings, roller
 Bearings, sleeve-type
 Bearings, noise tested
Parts, electrical
 Use of nonstandard parts
Transients
 Electron tubes
 Electron tube or capacitor sockets
Capacitors
 Variable resistors
Transformers and inductors
 Input transformers
Relays
Synchros
 Synchro electrical zero and equipment mechanical zero
Servo motors
Electrical tapes
Batteries
 Dial illumination lamps
Switches

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Toggle switches
 Sensitive switches
 Rotary switches
 Power type switches
 Push switches
 Indicator lights and lampholders
 Indicator lights
 Lampholders (MIL-L-3661 applies)
 Fuses
 Fuseholders and fuse clips
 Fuseholders
 Fuse clips
 Printed wiring
 Features - mechanical
 Enclosures - general (see 3.3.17)
 Enclosure - accessibility
 Enclosure - degree of (see 3.3.17)
 Enclosure - mounting (see 3.3.17)
 Universal mounting
 Stand mounting
 Panel mounting
 Bulkhead mounting
 Stiffening grooves
 Minimum sheet metal thicknesses (watertight enclosures)
 Through bolting
 Cable entrance
 Ventilation
 Size - Submarines
 Threaded devices
 Head styles
 Thread cutting screws
 Flat head screws
 Threads in aluminum
 Thread projection
 Threads in plastics
 Rounded corners and edges
 Internal subassembly protection
 Drilled and tapped holes
 Structural welding
 Temperature and humidity
 Extended storage
 Accelerated life (see 3.3.12)
 Shock, vibration (see 3.3.1) and inclination
 Shock and vibration mountings
 Features - electrical
 Overload protection
 Primary power supply circuits
 Power supply tolerances (see 3.3.16)
 Safety (personnel hazard)
 Shielding and radio frequency noise reduction
 Filters
 Bonding
 Ground potential and grounding
 Permanently installed equipment
 Soldering
 Electrical parts mounting
 Internal subassembly connection
 Electrical connectors (see 3.3.11)
 Terminal boards
 Terminals
 Braided wire cable shielding
 Mounting
 Terminal and terminal board marking
 Synchro connections and markings
 Wiring
 Hook-up wire
 Transformer and inductance wire
 Leads
 Magnet wire and insulation
 Wiring arrangement

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Color coding
 Dial illumination
 Electrical insulation
 Limitations on use of classes
 Highest temperature (hot spot temperature) to which classes of insulation may be subjected
 Material standards
 Insulating electrical windings
 Choice of varnish
 Varnish restrictions
 Varnish treatment procedures
 Dielectric strength and insulation resistance clearances
 Miscellaneous requirements
 Drawings - preliminary
 Drawings - working
 Clarity and legibility
 Design changes after drawing approval
 Schematic diagrams
 Wiring diagram
 Drawing list
 Assembly drawings
 Drawings - manufacturing
 Bill of materials
 Interchangeability and standardization
 Equipment standardization
 Standard stock parts
 Proprietary parts
 Manuals (see 3.3.14.1)
 Preliminary manuals
 Manuals for developmental contracts
 Repair parts
 Special tools
 Repair parts (electronic)
 Designation and marking
 Designation of parts
 Reports
 Item names and nomenclature
 Workmanship

3.3.1 Shock and vibration. The equipment shall satisfactorily withstand grade B, class I, type A shock in accordance with MIL-S-901; vibration tests, type I, with vibration up to and including 40 Hz, table entitled "Vibratory displacement of environmental vibration" of MIL-STD-167. The indicator case shall be certified in accordance with grade B of MIL-S-901 with a dummy load installed to represent the meter movement.

3.3.2 Airborne and structureborne noise. Airborne and structureborne noise requirements shall conform to MIL-STD-740. The airborne acceptance criteria specified in MIL-STD-740 shall be modified as shown in table I. The structureborne requirement, type 3 applies for all components of the torsionmeter equipment. The equipment shall be viewed as "solidly-mounted".

Table I - Airborne noise acceptance levels (sound pressure levels).

Torsionmeter components	Frequencies								
	37.5 75	75 150	150 300	300 600	600 1200	1200 2400	2400 4800	4800 9600	SIL Value
Sensor	90	85	80	80	75	75	75	75	
Indicator control unit	90	85	80	SIL Value requirement			75	75	62

3.3.3 Reliability. The reliability requirement of 4.5.4 shall be complied with for all components working simultaneously as a system during the verification testing of the first article sample.

3.3.4 Burn-in. All components shall function as a simulated operational system when tested as specified in 4.5.6.

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3.3.5 Magnetic permeability of components. The magnetic permeability level of each component, except for those applications where the function of the components requires the use of magnetic material, shall receive particular attention during the design stage to insure a lowest practical permeability.

3.3.6 Transformers. Transformers shall be in accordance with grade 4 or 5, class S of MIL-T-27, and shall have life expectancy X.

3.3.7 Semiconductor devices. Semiconductor devices shall be in accordance with requirement 30 of MIL-STD-454.

3.3.8 Test points. Test points, in accordance with MIL-STD-415, conveniently located to facilitate maintenance for checkout shall be provided for both the sensor and control units.

3.3.9 Electronic circuitry. The electrical/electronic circuit features of the control unit shall be solid state and arranged on plug-in-boards to simplify corrective maintenance. Accessory storage space shall be provided for one each of the associated circuit test extender boards which shall be included with each production control unit.

3.3.10 Voltage transients. The equipment shall be designed such that no damage will be sustained under any mode of operational switching of the equipment including "ON" and "OFF", or with an input supply voltage as specified in 4.5.3.

3.3.11 Electrical connectors. Electrical connectors, receptacles and plugs shall be in accordance with requirement 10 of MIL-STD-454 and conform to the requirements of MIL-C-5015. Selection shall be from Drawings RE-D2687575, RE-D2687576, RE-D2687577, RE-D2680780, RE-D2687700, RE-D2687701, and RE-D2687702.

3.3.12 Accelerated life. The equipment shall satisfactorily withstand the accelerated life test (endurance specified in 4.5.5).

3.3.13 Corrosion-resisting material. External hardware items such as nuts, screws, bolts, and lock washers shall be of copper-nickel alloy.

3.3.14 Hardware. Except as otherwise specified herein, hardware shall conform to requirement 12 of MIL-STD-454.

3.3.14.1 Service manual. Service manual unless otherwise specified, shall conform to type I of MIL-M-15071.

3.3.15 Time meter. A four-digit running time meter shall be installed in the enclosure of the equipment control unit enclosure. The device shall operate whenever the equipment is electrically excited for operation. The time meter shall provide accumulated hours of service.

3.3.16 Power supply tolerances. The system shall be electrically excited from a normal power source of 115 volts, single phase, 60 Hz (plus or minus 5 percent voltage and frequency bus).

3.3.17 Enclosure-degree of. The degree of enclosure for the control unit shall be watertight, dripproof for the indicator unit and dripproof protected for the sensor. Further the electrical/electronic and wiring arrangements of the sensor unit shall be impregnated-protected as necessary to insure long range protection from salt air (ambient conditions). The enclosure for the control unit shall be fabricated of cast aluminum alloy conforming to alloy 365, temper T6 of QQ-A-601 or alloy SG T6A of ASTM B26. The control unit enclosure shall be arranged for three point bulkhead mounting.

3.3.18 Electromagnetic interference characteristics. The electromagnetic interference characteristics of the equipment shall conform to the requirements of MIL-STD-461, class IIB. Terminology and test report format shall be as specified in MIL-STD-463 and MIL-STD-831 respectively.

3.3.19 The equipment shall be capable of measuring changes in the magnetostrictive properties in propeller shafts that are fabricated of steel conforming to MIL-S-23284.

3.3.20 The equipment shall be capable of resolving the torque in the shaft within limits of full power torque as specified in 3.3.23.

3.3.21 Repeatability of readout data through the full range of the equipment measurement shall be within limits of full power torque as specified in 3.3.23.

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3.3.22 The sensor unit shall be of a toroidal arrangement. Its axial length shall not exceed its respective propeller shaft diameter by 2/3 percent. The radius of its maximum circumferential dimension shall not exceed the radius of its associated propeller shaft by approximately 12 inches. Magnetostriction techniques shall be employed for signal detection/development. No sliding contact, light responsive or antenna transfer principles will be permitted for transferring of either signal or power requirements.

3.3.23 Accuracy. The accuracy of the equipment, all components functioning as a torque indicating system, shall be within plus or minus 1 percent when scale reading is between the upper 30 percent of scale length and within plus or minus 5 percent when scale reading is between the lower 70 percent of scale length, when demonstrated on a digital voltmeter type indicator. When demonstrated on a dial and pointer type indicator (MIL-M-16034) the accuracy of the indicated reading shall be within plus or minus 3 percent and plus or minus 5 percent for the 70-100 percent and 0-70 percent of scale respectively. Repeatability shall be within plus or minus 0.2 percent when scale readings are between 70-100 percent of scale length and ambient temperature (75°F.). Repeatability data for 0-70 percent of scale length shall be recorded.

3.3.23.1 Zero torque readings for the system shall not shift more than 1 percent of full torque over a one year period.

3.3.24 Calibration. The method of determining, setting and checking the torque calibration shall be such as to demonstrate that the system is capable of measuring torque within the specified limits.

3.3.25 The control unit shall contain built-in alignment/circuit fault analyzing features so as to enable periodic maintenance checking and general trouble shooting of all components of the equipment.

3.3.25.1 The control unit shall be arranged to drive simultaneously up to five indicator units while maintaining herein noted accuracy requirements. Also, it shall be designed and arranged to remotely drive and display on a digital voltmeter readings of actual torque data being developed by the torsionmeter equipment.

3.3.25.2 Onboard repair parts. Onboard repair parts shall be in accordance with MIL-P-15137 (see 6.4). One each of the production equipment power and signal circuit plug-in boards shall be provided for each ship-set torsionmeter(s).

3.3.26 A standard Navy switchboard meter conforming to MIL-M-16034 (General Electric Type DB 18 or equivalent) shall be used as the basic meter movement for the dial and pointer type indicator.

3.3.26.1 A special meter face(s) shall be provided wherein the meter scale range will be marked so as to provide the ship-torque information specified in the procurement documentation.

3.3.26.2 The indicator shall be arranged for panel mounting and capable of being remotely operated up to 1000 feet from the control unit.

3.3.26.3 The indicator (dial and pointer) shall be inherently accurate to within plus or minus 1 percent. Special precautions shall be incorporated, if necessary, to limit or restrict dial-face-pointer electro static effects.

3.3.27 Shaft alterations. Physical alteration of the propeller shafting will not be permitted as a condition of the sensor design installation.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 The supplier shall submit a proposed agenda covering the required first article and quality conformance inspection and shall proceed with inspection only after such agenda has been approved by the Naval Ship Engineering Center (NAVSEC).

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4.1.2 Quality program. The supplier shall provide and maintain a quality program acceptable to the Government for supplies and services covered by this specification. The quality program shall be in accordance with MIL-Q-9858 (see 6.1 and 6.4).

4.2 First article inspection. One equipment under the contract or order shall be subjected to the examination and tests specified in table II. The examination and tests shall be performed in the order listed.

Table II - First article inspection.

Inspection	Requirement paragraph	Inspection reference
General examination	3.3	MIL-I-983
Operating	3.3.23	4.5.1
Supply line voltage and frequency variation	3.3	MIL-I-983
Electromagnetic interference characteristics	3.3.18	4.5.2
Airborne and structureborne noise	3.3.2	MIL-STD-740
Temperature and humidity	3.3	MIL-I-983
Inclination	3.3	MIL-I-983
Accelerated life	3.3	4.5.5, 4.5.5.1
Dielectric strength and insulation resistance	3.3	MIL-I-983
Enclosure degree of	3.3, 3.3.17	MIL-I-983
Vibration	3.3, 3.3.1	4.5.7
Shock	3.3.1	MIL-S-901

4.3 Sampling for quality conformance inspection.

4.3.1 Inspection lot. All equipment presented for delivery at one time shall be considered a lot. The lot may include the entire contract quantity or it may be the production of any convenient time period.

4.3.2 Group A examination and tests. All equipment covered on the contract or order shall be subjected to the group A examination and tests specified in 4.4. The results of each test shall be compared with specification requirements. Failure to conform to this specification for any group A examination or test shall be counted as a defect and the equipment shall not be offered for delivery.

4.3.3 Sampling for group B tests. A sample number of equipments shall be selected from each inspection lot in accordance with table III and subjected to the group B tests in 4.4. The results of each test shall be compared with specification requirements. Failure to conform to the specification requirements for any group B test shall be counted as a defect and the equipment shall not be offered for delivery. If the number of such nonconforming equipments in any sample exceeds the acceptance number for that sample, this shall be cause for rejection of the lot represented by that sample.

Table III - Sampling for group B tests.

Number of equipments in inspection lot	Number of equipments in sample	Number of equipments nonconforming on group B tests	
		Acceptance number	Rejection number
5 and under	1	-	-
6 to 20	2	0	1
21 to 40	5	0	1
41 to 110	7	0	1

4.3.4 Sampling for group C tests. Group C tests will be required by NAVSUC when the basic design of the equipment or the material of a vital part has been changed. One complete equipment shall be selected and subjected to the group C tests listed in 4.4. The results of each test shall be compared with specification requirements. Failure to conform to this specification for any group C test shall be counted as a defect and the equipment shall not be offered for delivery.

4.4 Quality conformance inspection. The equipments selected in accordance with 4.3 shall be subjected to the examination and tests specified in table IV. Tests shall be performed in the order listed.

Table IV - Quality conformance inspection.

Inspection	Requirement reference	Inspection reference
<u>Group A</u>		
General examination	3.3	MIL-I-983
Operating	3.3.23	4.5.1
Dielectric strength and insulation resistance	3.3	MIL-I-983
Burn-in	3.3.4	4.5.6
<u>Group B</u>		
Supply line voltage and frequency variation	3.3	MIL-I-983
<u>Group C</u>		
Airborne and structureborne noise	3.3.2	MIL-STD-740
Temperature and humidity	3.3	MIL-I-983
Inclination	3.3	MIL-I-983
Accelerated life	3.3	4.5.5, 4.5.5.1
Reliability	3.3.3	4.5.4, 4.5.4.1
Enclosure - degree of	3.3, 3.3.17	MIL-I-983
Electromagnetic interference characteristics	3.3.18	4.5.2
Vibration	3.3, 3.3.1	4.5.7,
Shock	3.3.1	MIL-S-901
Operating	3.3.23	4.5.1
Voltage transients	3.3.10	4.5.3

4.5 Tests.

4.5.1 Operating test. An operating test shall be conducted to demonstrate the accuracy requirement of 3.3.23.

4.5.2 Electromagnetic interference characteristics. The electromagnetic interference characteristics shall conform to requirements specified herein when determined in accordance with MIL-STD-462.

4.5.3 Voltage transients. The voltage transient protection survival requirement (see 3.3.10) may be developed and demonstrated in any manner elected by the supplier, subject to concurrence by the procuring activity at time the proposed "Test agenda" is approved for use. A 7-10 microsecond pulse of a magnitude sufficient to provide 600 percent over voltage of the peak supply voltage shall be superimposed as the supply voltage. The equipment shall sustain no damage as a result of this voltage application and the output voltage of the equipment power supply(ies) shall not vary by more than 20 percent when tested as specified.

4.5.4 Reliability. The contractor shall demonstrate reliability of the system by running the equipment continuously for 2,000 hours. During this test period, if a failure should occur, the contractor shall record it, determine and correct the failure, continue the test and notify the procuring activity and NAVSHIPS. A failure is defined as the inability of the system to perform in accordance with specifications referenced herein. For this test all components comprising the system shall be connected and operated as they would normally be onboard ship. At various times during the test (at least 10) the contractor shall conduct and record an operating test (see 4.5.1). Acceptance under this test is achieved if the equipment operates 2000 hours without failure and the recordings obtained verify conformance with accuracy requirements of this specification. If there is an equipment failure during the test which causes loss of or faulty signal output the contractor shall extend the test running time to 2500 hours which, if achieved without additional failure, will qualify the system for acceptance. For each additional failure the test running time shall be increased by 500 hours. If more than three failures occur, the test shall be considered failed and the contractor shall run the entire test again after appropriated approved redesign has been accomplished.

4.5.4.1 Reliability performance testing. The reliability testing requirement of 4.5.4 shall be initiated not later than 3 days after the completion of the accelerated life test specified in 4.5.5. Test operational time accrued under the accelerated life test may be substituted for the initial portion of the reliability test of 4.5.4.

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4.5.5 Accelerated life test. The accelerated life test shall be conducted for a period of 500 hours. The 500-hour test shall be divided approximately as shown in table V.

Table V - Accelerated life test.

Hours	Ambient temperature during test	Angle of tilt
0 to 50	Conduct initial operating test ^{1/} 75°F. nominal (room temperature)	Normal
50 to 175	50°F. at approximately 90 percent relative humidity for at least 50 percent of period	Normal
175 to 300	149°F. at approximately 90 percent ^{2/} relative humidity for at least 50 percent of period	Normal
300 to 308	75°F. nominal (room temperature)	Incline 60 degrees forward from vertical
308 to 316	75°F. nominal (room temperature)	Incline 60 degrees back from vertical
316 to 324	75°F. nominal (room temperature)	Incline 60 degrees left from vertical
324 to 332	75°F. nominal (room temperature)	Incline 60 degrees right from vertical
332 to 500	75°F. nominal (room temperature)	Normal

^{1/} At end of 50 hours, conduct operating test and short test runs (1/2 hour each) at under-voltage and underfrequency and at overvoltage and overfrequency.

^{2/} A start and stop condition that will duplicate actual in-service operation shall be introduced for this phase of the test. A minimum of 20 "start-stops" at the end of each hour's test is required. The de-energized period shall be of sufficient duration so as to permit the equipment under test to come to a complete test. The rest period shall not exceed 30 seconds.

4.5.5.1 Accelerated life performance results. At the end of the 500-hour period, an operating test shall be conducted as specified in 4.5.1. Results shall meet the requirements stated therein.

4.5.6 Burn-in test. Upon successful completion of the group A examination and tests (see 4.4) and prior to its acceptance for delivery, a burn-in test shall be conducted on each production equipment. The burn-in test shall consist of a continuous 100-hour test divided into four 25-hour consecutive phases as follows: (a) at 149°F., (b) at room temperature, (c) at 149°F., and (d) at room temperature. During each of these phases the equipment shall be energized and continuously operated as specified in table VI. No calibration, alignment, modification or replacement of any module, subassembly, component or part is permitted during this test, except replacement of light bulbs used for instrument illumination. An equipment shall be considered as having failed the test if it does not meet the accuracy requirement specified herein, if any part, component, subassembly or module requires replacement, adjustment, or calibration, or if for any reason it fails to operate continuously for the specified time. NAVSJC shall be notified of any failure, together with the contractors proposed corrective action, and approval obtained prior to applying the correction and continuing the test. Such corrective action proposal shall include: description of the failure, reason for the failure, recommended remedy for the trouble and an analysis of how the reliability and maintainability requirements will be affected by applying the proposed corrective action. Any failure occurring prior to the completion of phase (c) shall require, after correction, the re-run of the entire test. A failure occurring during phase (d) shall require, after correction, repetition of tests consisting of phases (c) and (d). If as many as three failures occur in an equipment during the tests, testing shall be discontinued, a design re-evaluation conference convened and the procuring activity shall then determine what further tests shall be performed on the re-designed equipment. Any redesign approved by the procuring activity to correct deficiencies shall be applied to all equipments on the contract or order. Upon successful completion of the burn-in test, each equipment shall be refurbished, if and as necessary, and accepted for shipment.

Table VI - Burn-in operation (simulated loading).

Phase	Hours	Temperature	Indicators	Rpm Percent (rated)
(a)	25	149°F.	1	25
(b)	25	Room temperature	2	75
(c)	25	149°F.	1	50
(d)	25	Room temperature	2	100

4.5.7 Vibration. The vibration tests shall be conducted in accordance with MIL-I-983 and MIL-STD-167 with frequency range up to and including 40 Hz.

4.5.8 Inspection of preparation for delivery. The preservation, packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.2.)

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts.

5.1.1 Torsionmeter.

5.1.1.1 Preservation and packaging. Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation and may conform to the supplier's commercial practice when such meets these requirements.

5.1.1.2 Packing. Packing shall be accomplished in a manner which will insure acceptance by common carrier and will afford protection against physical and mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules or other carrier regulations as applicable to the mode of transportation and may conform to the supplier's commercial practice when such meets these requirements.

5.1.1.3 Marking. Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal Stock number or manufacturer's part number, contract or order number, contractor's name and destination.

5.1.2 Onboard repair parts. Onboard repair parts shall be cleaned, preserved and packaged level A; packed level C and marked level A in accordance with MIL-E-17555.

5.2 Domestic shipment and storage or overseas shipment. The requirements and levels of preservation and packaging, packing and marking for shipment shall be specified (see 6.1).

5.2.1 The following provides various levels for protection during domestic shipment and storage or overseas shipment which may be required when procurement is made.

5.2.1.1 Preservation, packaging, packing and marking. The equipment and accessories, repair parts and technical publications shall be preserved and packaged levels A or C; packed levels A or B and marked in accordance with MIL-E-17555.)

6. NOTES

6.1 Ordering data. Procurement documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Specify the following as applicable to the ship class or ship type for which the torsionmeter is required:
 - (1) Number and type of indicators required for each shaft.
 - (2) Full power shaft horsepower.
 - (3) Full power revolutions per minute.
 - (4) Full power torque (foot-pounds).

MIL-T-24448A (SHIPS)

- (5) Full power shear stress (pounds per square inch).
- (6) Outside diameter (inches).
- (7) Inside diameter (inches).
- (8) Shaft material (shall be MIL-S-23284, class I unless otherwise specified).
- (c) Quality assurance requirements (see 4.1.2).
- (d) Preservation, packaging, packing and marking required if other than specified in 5.1 (see 5.2).

6.2 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.3 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured 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 procurement.

6.4 Management control systems documents. The following management control system documents should be included on DD Form 1660:

- (a) MIL-P-15137 (see 3.3.25.2).
- (b) MIL-Q-9858 (see 4.1.2).

6.5 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "*" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

Preparing activity:
Navy - SH
(Project 6695-N027)

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
INSTRUCTIONS		
This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).		
SPECIFICATION		
ORGANIZATION (Of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?		
A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE?		
<input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
SUBMITTED BY (Printed or typed name and activity)		DATE

FOLD

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