METRIC

MIL-T-24797(SH)
22 June 1995

MILITARY SPECIFICATION

TACHOMETERS, FIBER OPTIC, (NAVAL SHIPBOARD USE), (METRIC) GENERAL SPECIFICATION FOR

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 fiber optic tachometers capable of measuring rotational speed for use in Navy shipboard applications.

1.2 Classification (see 6.2).

1.2.1 Designations. The sensor classification shall consist of a series of designations which shall be assigned and listed in the format below.

24797	-	X	-	X	-	X	-	X
Specification		Sensing Mechanism 1.2.1.1		Input Power 1.2.1.2		Opto-Electronics Module Type 1.2.1.3		Sensor Mounting Configuration 1.2.1.4

1.2.1.1 Sensing mechanism. The sensing mechanism of transduction shall be designated as follows:

1 - Reflection
2 - Beam interruption
3 - Magneto-optic effect

1.2.1.2 Input power. The input power required to operate the opto-electronics module shall be designated as follows:

DC - 28 Volts direct current (Vdc)
AC - 115 Volts alternating current (Vac)

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 03R42, 2431 Jefferson Davis Hwy., Arlington, VA 22242-5160, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6040

1.2.1.3 Opto-electronics module. The mounting of the tachometer's opto-electronics module type shall be designated as follows:

Type A - Bulkhead Mounted (See 3.4.2.1)
Type B - Console Mounted (See 3.4.2.2)

1.2.1.4 Sensor Mounting Configuration. The mounting of the tachometer's sensor shall be designated as follows:

Mount 1 (See 3.4.14.1)

2. APPLICABLE DOCUMENTS

2.1 Government Documents.

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

SPECIFICATIONS

MILITARY

MIL-S-901	-	Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MS3452	-	Connector, Receptacle, Electric, Box Mounting, Rear Release, Crimp Contact, AN Type.
MS3456	-	Connector, Plug, Electrical, Rear Release, Crimp Contact, AN Type.
MIL-C-5015	-	Connectors, Electrical, Circular Threaded, AN Type General Specification for.
MIL-E-17555	-	Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-S-19622	-	Stuffing Tubes, Nylon; and Packing Assemblies; General Specification for.
MIL-S-19622/1	-	Stuffing Tubes, Straight, Nylon.
MIL-S-19622/17	-	Stuffing Tube, Nylon, Size 2: Packing Assemblies for.
MIL-E-24142	-	Enclosures for Electrical Fittings and Fixtures, General Specification for.
MIL-E-24142/3	-	Enclosure for Electrical Fittings and Fixtures, Submersible, Size 6 by 9 (15-Foot).
MIL-M-24794	-	Material, Index Matching, Fiber Optics.

MILITARY - Continued

MIL-F-49291	-	Fiber, Optical, (Metric), General Specification for.
MIL-P-83461	-	Packings, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F (135°C)
MIL-P-83461/1	-	Packing, Preformed, Petroleum Hydraulic Fluid Resistant Improved Performance at 275°F (135°C) Sizes and Tolerances
MIL-C-83522	-	Connectors, Fiber Optic, Single Terminus General Specification for.
MIL-C-83522/16	-	Connector, Fiber Optic, Single Terminus, Plug, Adapter Style, 2.5 Millimeters Bayonet Coupling, Epoxy.
MIL-C-83522/17	-	Connector, Fiber Optic, Single Terminus, Adapter, 2.5 Millimeter Bayonet Coupling, Bulkhead Panel Mount.
MIL-C-83522/18	-	Connector Fiber Optic, Single Terminus, Adapter, 2.5 Millimeter Bayonet Coupling PC Mount.
MIL-C-85045	-	Cables, Fiber Optic, (Metric), General Specification for.

STANDARDS

MILITARY

MIL-STD-130	-	Identification Marking of U.S. Military Property.
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	-	Requirements for the Control of Electromagnetic Interference Emission and Susceptibility.
MIL-STD-462	-	Electromagnetic Interference Characteristics Measurement of.
MIL-STD-810	-	Environmental Test Methods and Engineering Guidelines.
MIL-STD-1861	-	Electrical and Electronic Assemblies, Boards, Cards, and Associated Hardware, Selection and Use of.
MIL-STD-2042	-	Fiber Optic Topology Installation, Standard Methods for Naval Ships.

HANDBOOKS

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.

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

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

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

D 3951 - Standard Practice for Commercial Packaging

(Applications for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1187.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

RS-422 - Electrical Characteristics of Balanced Voltage Digital Interface Circuit.
455-22 - FOTP-22 Ambient Light Susceptibility of Fiber Optic Components.
455-34 - FOTP-34 Interconnection Device Insertion Loss Test.

(Application for copies should be addressed to Electronic Industries Association, 2001 Eye Street, NW, Washington, DC 20006.)

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

3. REQUIREMENTS

3.1 Reliability. The reliability of the opto-electronics module, expressed in mean time between failures (MTBF), shall be no less than 40,000 hours. A reliability prediction for the opto-electronics module, in the form of a MTBF calculation, shall be performed. The computational techniques specified in MIL-HDBK-217 should be used for guidance.

3.2 First article. When specified (see 6.2) and prior to production, a sample shall be subjected to first article inspection (see 6.5), in accordance with 4.4.

3.3 Materials.

3.3.1 Metals. Unless otherwise specified herein, all metals used in the construction of the tachometer shall be corrosion-resistant and shall be in accordance with MIL-STD-454, requirement 15. Dissimilar metals shall not be used in intimate contact with each other unless suitably finished to prevent electrolytic corrosion and shall be in accordance with MIL-STD-454, requirement 16.

3.3.2 Flammable materials. Materials used in the construction of the tachometer shall, in the end configuration, be noncombustible or fire retardant in the most hazardous conditions of atmosphere, pressure, and temperature to be expected in the application. Fire retardant additives may be used provided they do not adversely affect the specified performance requirements of the basic materials. Fire retardance shall not be achieved by use of nonpermanent additives to the basic material.

3.3.3 Fungus resistant materials. Materials used in the construction of the tachometer shall be in accordance with MIL-STD-454, requirement 4, for fungus inert materials. Materials that are not in accordance with requirement 4 of MIL-STD-454 shall meet grade I classification of MIL-STD-810, method 508.

3.3.4 Solvents, adhesives, and cleaning agents. If any chemicals or cements are used in bonding of internal tachometer components, no degradation of these components shall result during in-service use. MIL-STD-454, requirement 23 may be used as guidance for epoxy and adhesives used in construction of the sensor.

3.3.5 Refractive index matching gels, fluids, or compounds. Refractive index matching gels, fluids, or compounds shall be in accordance with MIL-M-24794.

3.4 Design and construction. The fiber optic tachometer shall be a noncontact device capable of converting a rotational speed to a continuous output signal throughout a specified measurement range. A fiber optic tachometer shall consist of a sensor head, opto-electronics module and fiber optic cable connectorized at both ends. All parts of the fiber optic tachometer shall be interchangeable with the appropriate replacement parts with respect to form, fit, and function; and shall maintain the required accuracy specified in 3.5.1.

3.4.1 Sensor head. The sensor head(s) shall be passive and detect shaft rotation through a change in optical properties. The beam interruption sensing mechanism shall consist of two sensor heads. One sensor head shall be used to transmit and one sensor head shall be used to receive an optical signal (generated from the opto-electronics module) across an air gap.

Neither electrical nor electronic components shall be used in the construction of the sensor head. The configuration and physical dimensions of the sensor head(s) shall be as specified (see 3.4.14).

3.4.2 Opto-electronics module mounting. The opto-electronics module shall be either bulkhead or console mounted as specified (see 6.2).

3.4.2.1 Bulkhead mounted (Type A). The opto-electronics module shall be housed in a junction box in accordance with MIL-E-24142 and MIL-E-24142/3.

3.4.2.2 Console mounted (Type B). The opto-electronics module shall be packaged in a circuit card which is a modular subassembly of a control console. Design and test requirements for the opto-electronics module shall be as specified (see 6.2).

3.4.3 Fiber optic cable. For integrity, the cable shall have an outer diameter of a 4 fiber cable in accordance with MIL-C-85045. In the cable there shall be no less than two times the number of fibers needed for operation of the sensor. The cable shall be supplied with a stuffing tube (size 2, military part number M19622/1-002 in accordance with and MIL-S-19622/1) and packing assembly (military part number M19622/17-0001 in accordance with MIL-S-19622/17) in accordance with MIL-S-19622, and an O-ring (military part number M83461/1-214) in accordance with MIL-P-83461/1 and MIL-P-83461, installed on each end of the cable to accomplish watertight penetration into the sensor head and opto-electronics module. Exposed single fiber OFCC shall not be used over distances greater than one meter. The length of cable shall be as specified (see 6.2).

3.4.4 Optical fiber. Optical fiber used to transmit light between the opto-electronics unit and the sensor head shall be in accordance with MIL-F-49291.

3.4.5 Fiber optic connectors, receptacles and bulkhead adapters. Fiber optic connectors, receptacles or bulkhead adapters used shall be in accordance with MIL-C-83522 and MIL-C-83522/16,17,18 respectively. Connectors shall be assembled at both ends of the fiber optic cable between the sensor head and the opto-electronics module. MIL-STD-2042 method 5B1 may be used as guidance. The connectors and receptacles shall be mounted inside the sensor head or opto-electronics module.

3.4.6 Electrical input power requirements. Nominal steady-state power supply requirements for ac shall be 115 ± 8 volts, 60 ± 2 hertz (Hz), single phase. Nominal steady-state power supply requirements for dc shall be 28 ± 4.5 volts. The tachometer shall meet all performance requirements specified herein while operating with specified power supply voltages and their tolerances.

3.4.7 Output signal. The output signal of the tachometer shall be directly proportional to the speed being measured. A means shall be provided for internal selection (within the opto-electronics module) between the following output signals: true current source of 4 to 20 milliamperes (mA), 0 to 1 mA,

0 to 2 mA, 0 to 5 mA; true voltage source of 0 to 5 volts (V) or 0 to 10 V dc; and frequency (including TTL compatibility). A means shall also be provided for internal indication of the output signal selected. The complexity of this adjustment shall be such that one individual working alone is capable of performing this adjustment. The adjustment shall not require electrical disconnection.

3.4.7.1 Current output. The 0 or 4 mA output shall correspond to the lower speed range value and the 1, 2, 5 or 20 mA output shall correspond to the upper speed range value. The current output shall remain accurate regardless of external load resistance variations over a range of 0 to 250 ohms.

3.4.7.2 Voltage output. The 0 Vdc output shall correspond to the lower speed range value and the 5 or 10 Vdc output shall correspond to the upper speed range value. The voltage output shall remain accurate regardless of external load resistances greater than 100 thousand ohms.

3.4.7.3 Optical output. When an optical output is required, all requirements shall be as specified (see 6.2).

3.4.7.4 Digital output. When an electrical digital output is required, all requirements shall be as specified (see 6.2). The electrical characteristics shall be in accordance with EIA standard RS-422 for balanced voltage digital interface circuitry, or as specified (see 6.2). The data format shall be as specified (see 6.2).

3.4.8 Electrical connectors. A single electrical connector and mating plug in accordance with MIL-C-5015 shall be used to interface the input power and linear output signal to the opto-electronics module. The appropriate connector assembly and pin designations for each of the possible tachometer configurations shall be as follows:

3.4.8.1 DC input and current or voltage output. The receptacle mounted to the opto-electronics module shall be classification MS3452W14S-5PX in accordance with MS3452. Receptacle pin "A" shall be positive 28 Vdc power input, pin "B" shall be negative 28 Vdc power input, pin "C" shall be case ground, pin "D" shall be a positive mA or Vdc signal output, and pin "E" shall be a negative mA or Vdc signal output. The mating plug shall be classification MS3456W14S-5SX in accordance with MS3456.

3.4.8.2 DC input and frequency output. The receptacle mounted to the opto-electronics module shall be classification MS3452W14S-5PX in accordance with MS3452. Receptacle pin "A" shall be positive 28 Vdc power input, pin "B" shall be negative 28 Vdc power input, pin "C" shall be case ground, pins "D" and "E" shall be frequency signal outputs. The mating plug shall be classification MS3456W14S-5SX in accordance with MS3456.

3.4.8.3 AC input and current or voltage output. The receptacle mounted to the opto-electronics module shall be classification MS3452W14S-5PX in accordance with MS3452. Receptacle pins "A" and "B" shall be 115 Vac power

input, pin "C" shall be case ground, pin "D" shall be a positive mA or Vdc signal output, and pin "E" shall be a negative mA or Vdc signal output. The mating plug shall be classification MS3456W14S-5SX in accordance with MS3456.

3.4.8.4 AC input and frequency output. The receptacle mounted to the opto-electronics module shall be an MS3452W14S-5PX in accordance with MS3452. Receptacle pins "A" and "B" shall be 115 Vac power input, pin "C" shall be case ground, pins "D" and "E" shall be frequency signal outputs. The mating plug shall be classification MS3456W14S-5SX in accordance with MS3456.

3.4.8.5 Digital output. The connector assembly for a digital output signal shall be as specified (see 6.2).

3.4.9 RPM range selection. A means shall be provided for internal selection (within the opto-electronics module) between the following rpm ranges: 0 - 1000, 0 - 5000, 0 - 10,000, and 0 - 20,000. A means shall also be provided for internal indication of the rpm range selected. The complexity of this adjustment shall be such that one individual working alone is capable of performing this adjustment. The adjustment shall not require electrical disconnection.

3.4.10 Low intensity alarm indication. The opto-electronics module shall have a red LED which shall light when the intensity of the tachometer's optical signal falls below a preset level. The LED shall be located on either the top or front of the module as it would be mounted during typical usage. The LED shall be visible in typical fluorescent room lighting. The opto-electronics alarm will allow for an indication that maintenance is required, prior to a false output signal from the tachometer.

3.4.10.1 Low intensity alarm set point adjustment. A means shall be provided for adjusting the low intensity alarm set point over no less than one half of the dynamic range of the tachometer. A means of securing this adjustment shall be provided. The low intensity alarm set point shall be capable of adjustment by one individual without the necessity for any electrical disconnection. Alarm set point adjustments shall be labeled and shall be accessible when the opto-electronics enclosure cover is removed.

3.4.11 Sensitivity adjustment. The tachometer shall have a sensitivity adjustment for increasing or decreasing the electrical pulse height of the optical signal. The tachometer's sensitivity shall be adjustable by one individual without the necessity for any electrical disconnection. Sensitivity adjustments shall be labeled and shall be accessible when the opto-electronics enclosure cover is removed. A means shall be provided for adjusting the sensitivity over the dynamic range of the tachometer. A means of securing this adjustment shall be made.

3.4.12 Printed circuit boards. Printed circuit boards shall be in accordance with MIL-STD-1861.

3.4.13 Fuses. The opto-electronics module shall not be fused.

3.4.14 Sensor mounting configuration. The tachometer's sensor shall be mounted according to the mount requirement type below (see 1.2.1.4).

3.4.14.1 Mount 1. The dimensions of the mount 1 sensor shall be as specified in table I and figure 1. The mass per unit length shall be no greater than .02 kg per millimeter(mm).

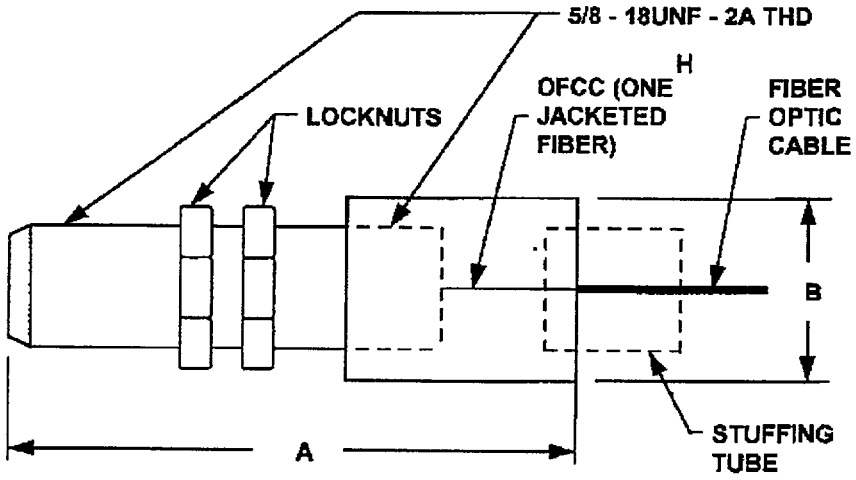

FIGURE 1. Sensor head construction.

TABLE I. Mount 1 dimensions

Sensor head dimensions in mm	
A	200.0 Max
B	50.0 Max

3.4.15 Mass. Unless otherwise specified (see 6.2), the mass of the opto-electronics module shall be not greater than 5 kilograms.

3.4.16 Target. The target description including items such as material, size, multiple reflectors and surface features shall be as specified (see 6.2).

3.5 Performance requirements.

3.5.1 Accuracy. The error (see 6.8.1) of the opto-electronics module shall not be greater than plus or minus 1.0 percent of the output span (see 6.8.2) over an ambient temperature range of 5 to 65°C (see 4.7.1).

3.5.2 Repeatability. The opto-electronics module outputs shall be within 0.5 percent of span during the repeatability test (see 4.7.2).

3.5.3 Reference measurement. The referenced accuracy of each of the output signals of the opto-electronics module shall be within plus or minus 1.0 percent of the output span. Measurements shall be made at 10, 50, and 90 percent intervals of span without any alignments or adjustments (see 4.7.3).

3.5.4 Sensitivity. The ratio of the opto-electronics module output in percentage change of span to speed input in percentage change of span shall not be less than 0.75 nor more than 1.25 (see 4.7.4).

3.5.5 Response time. The time for the opto-electronics module output signal to indicate a value equivalent to 5000 rpm shall not be greater than 2 seconds after the test standard attains a steady-state speed (see 4.7.5).

3.5.6 Warm-up time. The opto-electronics module shall attain an output value within plus or minus 1 percent of the output span. Output shall reach this band in not greater than 1 minute after the tachometer is energized and shall remain in this band (see 4.7.6).

3.5.7 Dynamic range. The dynamic range of the opto-electronics module shall be not less than 35 dB for tachometers using the beam interruption sensing mechanism (see 4.7.7.1). The dynamic range of the opto-electronics module shall be not less than 16 dB for tachometers using the reflection and magneto-optic sensing mechanism (see 4.7.7.2).

3.5.8 Ambient light susceptibility. This test is applicable for tachometers using the reflection and beam interruption sensing mechanism only. Monitored tachometer output during the ambient light susceptibility test shall show no deviation greater than plus or minus 1 percent of the output span (see 4.7.8).

3.5.9 Steady-state supply voltage and frequency (ac) or supply voltage (dc). The fiber optic tachometer shall exhibit no damage and shall meet the requirements of 3.5.3 during each of the specified test conditions (see 4.7.9).

3.5.10 Transient voltage and frequency (ac) or voltage (dc). The fiber optic tachometer shall exhibit no damage and reference measurements shall meet the requirements of 3.5.3 following each of the transient conditions (see 4.7.10).

3.5.11 Insulation resistance. The insulation resistance of the opto-electronics module shall not be less than 10 megohms (see 4.7.11).

3.5.12 Power interruption. The fiber optic tachometer shall exhibit no damage and shall meet the requirements of 3.5.3 when power is reapplied following each of the power interruption intervals (see 4.7.12).

3.5.13 Short circuit. The fiber optic tachometer shall exhibit no damage and shall meet the requirements of 3.5.3 following the short circuit test (see 4.7.13).

3.5.14 Line voltage reversal (dc input). The fiber optic tachometer shall exhibit no damage and shall meet the requirements of 3.5.3 following the line voltage reversal test (see 4.7.14).

3.5.15 Temperature. During the temperature test, monitored tachometer output shall show no deviation greater than plus or minus 1 percent of the output span. Following this test, the fiber optic tachometer shall meet the requirements of 3.5.3 (see 4.7.15).

3.5.16 Humidity. The fiber optic tachometer shall meet the requirements of 3.5.3 without any alignments or adjustments. After testing is completed there shall be no evidence of physical degradation, such as corrosion of metal parts or distortion of plastic parts (see 4.7.16).

3.5.17 Enclosure. There shall be no evidence of water penetration into the fiber optic tachometer components either during or at the conclusion of the enclosure test. During the enclosure test, monitored tachometer output shall show no deviation greater than plus or minus 1 percent of the output span. The fiber optic tachometer shall meet the requirements of 3.5.3 following the enclosure test (see 4.7.17).

3.5.18 Salt Spray. Following this test, the fiber optic tachometer shall show no appreciable corrosion or other damage, either optical, mechanical or electrical that will effect its operation and it shall meet the requirements of 3.5.3 (see 4.7.18).

3.5.19 Vibration. Monitored tachometer output during all phases of the vibration test shall show no deviation greater than plus or minus 1 percent of the output span. Pre and post-test reference measurements shall meet the requirements of 3.5.3. The tachometer shall show no evidence of physical damage that impairs its operation as a result of the vibration test (see 4.7.19).

3.5.20 Shock. Monitored tachometer output during all phases of the shock test shall show no deviation greater than plus or minus 1 percent of the output span. Pre and post-test reference measurements shall meet the requirements of 3.5.3. The fiber optic tachometer shall show no evidence of physical damage that impairs its operation as a result of the shock test (see 4.7.20).

3.5.21 Electromagnetic interference (EMI) emission and susceptibility. Monitored tachometer output during all phases of the EMI test shall show no deviation greater than plus or minus 1 percent of the output span. Pre and post-test reference measurements shall meet the requirements of 3.5.3. The tachometers shall be in accordance with MIL-STD-461 requirement CE101, CE102, CS101, CS114, CS116, RE101, RE102, RS101, RS103 and RS105 (see 4.7.21).

3.5.22 Magnetizing. This test is applicable for magneto-optic sensing mechanism only. Monitored tachometer output during the magnetizing test shall show no deviation greater than plus or minus 1 percent of the output span. Post test reference measurements shall meet the requirements of 3.5.3 (see 4.7.22).

3.6 Cleaning and surface finishes. Surfaces of castings, forgings, molded parts, stampings, machined and welded parts shall be free of defects such as cracks, porosity, undercuts, voids, and gaps as well as sand, dirt, fins, sharp edges, scale, flux, and other harmful or extraneous materials. External surfaces shall be smooth and edges shall be either rounded or beveled. There shall be no burn-through. There shall be no warpage or dimensional change due to heat from welding operation. There shall also be no damage to adjacent parts resulting from welding.

3.7 Identification marking. The fiber optic tachometers shall be permanently and legibly marked in accordance with MIL-STD-130. The following information shall be provided:

Opto-electronics module.
(a) Contractor's name and serial number.
(b) Type designation (see 1.2.1).
(c) Contract number.
(d) National stock number.
(e) Technical manual number.
(f) Contractor's part number.

Sensor head.
(a) Contractor's name and serial number.
(b) Type designation (see 1.2.1).
(c) Contractor's part number.

3.8 Labeling. A visible label shall be affixed to the outside of the opto-electronics module cover and shall contain the following:

NOTICE
UNTERMINATED OPTICAL CONNECTIONS MAY EMIT LASER RADIATION
DO NOT VIEW BEAM WITH OPTICAL INSTRUMENTS
AND AVOID DIRECT EXPOSURE TO THE BEAM

A visible label shall be affixed to the sensor head and the inside of the opto-electronics module and shall contain the following:

WARNING
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO THE BEAM

The labels shall be yellow lettering on a black background.

3.9 Workmanship. Workmanship of the fiber optic tachometers shall be in accordance with requirement 9 of MIL-STD-454.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

(a) First article inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions. Unless otherwise specified in the test method, the tests in this specification shall be performed with the equipment and instrumentation operating under the following conditions:

(a) Ambient temperature: 25 ± 5° Celsius
(b) Relative humidity: 50 ± 20 percent.
(c) Atmospheric pressure: 725 ± 75 mm of mercury.
(d) Supply voltage shall be 115 volts (nominal) for input power designation ac, or 28 volts (nominal) for input power designation dc.
(e) Supply frequency shall be 60 Hz (nominal) for input power designation ac or direct current for input power designation dc.
(f) Distance from sensor head to target shall be 10 mm for the reflection and beam interruption sensing mechanisms.

(g) Distance from sensor head to target shall be 2 mm for the magneto-optic sensing mechanism unless specified otherwise (see 6.2).
(h) Electrical output setting: 0 - 10 volts
(i) Speed range setting: 0 - 20,000 rpm

4.4 First article inspection. When a first article inspection is required (see 3.2 and 6.2), samples shall be inspected as specified in table II. Failure of any tachometer to meet the requirements of this specification shall be cause for rejection.

TABLE II. First article inspection.

Inspection	Requirement paragraph	Test method paragraph
Group I: one sample required		
General examination	3.3, 3.4, 3.6-3.9	4.6
Accuracy	3.5.1	4.7.1
Repeatability	3.5.2	4.7.2
Reference measurement	3.5.3	4.7.3
Sensitivity	3.5.4	4.7.4
Response time	3.5.5	4.7.5
Warm-up time	3.5.6	4.7.6
Dynamic range	3.5.7	4.7.7
Ambient light susceptibility	3.5.8	4.7.8
Steady-state supply voltage and frequency (ac) or supply voltage (dc)	3.5.9	4.7.9
Transient voltage and frequency (ac) or voltage (dc)	3.5.10	4.7.10
Insulation resistance	3.5.11	4.7.11
Power interruption	3.5.12	4.7.12
Short circuit	3.5.13	4.7.13
Line voltage reversal	3.5.14	4.7.14
Temperature	3.5.15	4.7.15
Humidity	3.5.16	4.7.16
Enclosure	3.5.17	4.7.17
Salt Spray	3.5.18	4.7.18
Vibration	3.5.19	4.7.19
Shock	3.5.20	4.7.20
Magnetizing	3.5.22	4.7.22
Group II: one sample required		
General examination	3.3, 3.4, 3.6-3.9	4.6
Accuracy	3.5.1	4.7.1

Inspection	Requirement paragraph	Test method paragraph
Repeatability	3.5.2	4.7.2
Insulation resistance	3.5.11	4.7.11
Electromagnetic effects	3.5.21	4.7.21

4.4.1 Sample size. Two fiber optic tachometers of each lot (see 4.4.2) shall be subjected to first article inspection. One sample shall be subjected to the tests of Group I and one sample shall be subjected to the tests of Group II. Each sample shall be supplied with the length of cable required for the intended application, but shall be not less than 30 meters.

4.4.2 Inspection lot. An inspection lot shall consist of all fiber optic tachometers of the same classification (see 1.2), produced under essentially the same conditions, in the same facility from the same materials and offered for delivery at the same time.

4.4.3 Order of inspection. The sample tachometers shall be subjected to the inspections specified in table II in the order listed except that the steady-state supply voltage and frequency inspection (see 4.7.9) may be performed concurrently with the temperature inspection (see 4.7.15). Any other deviation in the test order must first be approved by NAVSEA.

4.4.5 Disposition of first article units. Samples subjected to first article inspection shall be considered consumed and nondeliverable as part of the contract. Final disposition of samples shall be as specified (see 6.5).

4.5 Quality conformance inspection. Quality conformance inspection shall consist of the tests as specified in table III.

TABLE III. Quality conformance inspection.

Inspection	Requirement	Test method
Group A inspection		
General examination	3.3, 3.4, 3.6 through 3.9	4.6
Accuracy	3.5.1	4.7.1
Repeatability	3.5.2	4.7.2
Dynamic Range	3.5.9	4.7.9
Group B inspection		
Steady-state supply voltage and frequency (ac) or supply voltage (dc)	3.5.9	4.7.9
Insulation resistance	3.5.11	4.7.11
Temperature	3.5.15	4.7.15
Enclosure	3.5.17	4.7.17

4.5.1 Group A inspection. Each tachometer in each lot offered for delivery shall be subjected to the group A inspection shown in table III in the order listed. Failure of any tachometer to meet the requirements of this specification shall be cause for rejection.

4.5.2 Group B inspection. Sample fiber optic tachometers shall be selected in accordance with table IV. Each sample selected shall be subjected to the group B inspection specified in table III. Failure of any tachometer to meet the requirements of this specification shall be cause for rejection.

TABLE IV. Group B inspection sample size.

Lot or batch size	Sample size	Lot or batch size	Sample size
2 to 8	2	151 to 280	32
9 to 15	3	281 to 500	50
16 to 25	5	501 to 1200	80
26 to 50	8	1201 to 4200	125
51 to 90	13	4201+	3 per 100
91 to 150	20		

4.6 General Examination. Each fiber optic tachometer shall be given a thorough examination to determine conformance to the requirements of this specification with respect to material, finish, workmanship, construction, assembly, dimensions, and identification marking. Examination shall be

limited to the examinations that may be performed without disassembling the units. Examination shall also include a check of all adjustments (see 3.3, 3.4, 3.6 through 3.9).

4.7 Methods of inspection.

4.7.1 Accuracy. The sensor head shall be placed at position 1 as specified in table V. The accuracy verification shall be comprised of taking a reading of each of the output signals with the target in a standstill position and at 10 percent intervals over the full range of each of the four rpm ranges of the tachometer. This procedure shall then be repeated (for one rpm range only) with the sensor head placed at positions 2 through 5 as specified in table V. At each position a reference accuracy measurement shall be performed. The tachometer shall meet the requirements of 3.5.1.

TABLE V. Accuracy test target distances.

Sensor head position	Distance to target - measured in mm	
	Reflection and Beam interruption	Magneto-optic effect
1	10	2
2	5	1
3	10	2
4	20	3
5	25	4

4.7.2 Repeatability. The fiber optic tachometer shall be energized and operational at a speed range setting of 0 - 20,000 rpm. A measurement of each of the outputs of the opto-electronics module shall be performed at the following speeds: 5,000, 10,000, 15,000, and 20,000 rpm. This measurement shall be performed three successive times for each of the opto-electronics module outputs (see 3.4.7). The maximum difference between any two output values at the same speed for each of the opto-electronics module output signal selections shall be referred to as the repeatability. Performance shall meet the requirements of 3.5.2.

4.7.3 Reference measurement. The fiber optic tachometer shall be energized and operational at a electrical output setting of 0 - 10V and a speed range setting of 0 - 20,000 rpm. An output signal measurement shall be made at 10, 50, and 90 percent intervals of span both upscale and downscale. The accuracy at all points in the reference measurement shall meet the requirements of 3.5.3.

4.7.4 Sensitivity. The sensitivity factor shall be determined using the following procedure. The tachometer shall be energized and operational at an output signal, of the 0 - 10V setting, corresponding to a speed of 3000 rpm.

The tachometer's speed range setting shall be 0 - 10000 rpm. Measure both the shaft speed and the opto-electronics module output signal. Increase the shaft speed by an amount not greater than 1 percent of the output span. Measure both the new shaft speed and the opto-electronics module output signal. Calculate the change in both the shaft speed and the opto-electronics module output signal as a percentage of the output span. Determine the ratio of the output percentage change to applied shaft speed percentage change in terms of the output span. Repeat this procedure for a shaft speed decrease not greater than 1 percent of the output span. Performance shall meet the requirements of the requirements of 3.5.4.

4.7.5 Response time. The response time shall be determined by the following procedure. Energize the fiber optic tachometer and set the position of the sensor head (see 4.3). Adjust the tachometer's output signal to the 0 - 10V setting and the rpm setting to the 0 - 10000 rpm range. Energize the test standard and increase the speed of its rotating target to 5000 rpm. The test standard shall reach 5000 rpm within 2 seconds. Monitor the output signal of the tachometer and the test standard during this test. Performance shall meet the requirements of 3.5.5.

4.7.6 Warm-up time. The warm-up time shall be determined by the following procedure. Allow the tachometer output signal to stabilize at a value, of the 0 - 5V setting, corresponding to a measurand operating speed of 800 rpm. The tachometer's speed range setting shall be 0 - 1000 rpm. Deenergize the tachometer for not less than 2 hours. Reenergize the tachometer and monitor the opto-electronics module output as necessary to ensure the tachometer meets the requirements of 3.5.6.

4.7.7 Dynamic range. The dynamic range of the opto-electronics module shall be tested in accordance with the following procedures:

4.7.7.1 Beam interruption. A calibrated optical attenuator with two jumpers shall be tested for insertion loss in accordance with EIA-455-34. The attenuator shall then be connected between the opto-electronics module and the sensor head of the transmitting optical signal via two jumper cables. The tachometer's sensitivity shall be adjusted to the maximum setting. The attenuation shall be increased from 0 dB (encompassing insertion loss of attenuator and jumpers) to 35 dB. The tachometer shall be operating at an output signal value, of the 0 - 5V setting, corresponding to an operating speed of 800 rpm. The tachometer's speed range setting shall be 0 - 1000 rpm. The dynamic range will be exceeded when the output signal drops to a value equivalent to 0 rpm. Performance shall meet the requirements of 3.5.7.

4.7.7.2 Reflection and Magneto-optic effect. A calibrated optical attenuator with two jumpers shall be tested for insertion loss in accordance with EIA-455-34. The attenuator shall be connected between the opto-electronics module and the sensor head via the two jumper cables. The tachometer's sensitivity shall be adjusted to the maximum setting. The attenuation shall be increased from 0 dB (encompassing insertion loss of attenuator and jumpers) to 16 dB. The tachometer shall be operating at an output signal value, of the

0 - 5V setting, corresponding to an operating speed of 800 rpm. The tachometer's speed range setting shall be 0 - 1000 rpm. The dynamic range will be exceeded when the output signal drops to a value equivalent to 0 rpm. Performance shall meet the requirements of 3.5.7.

4.7.8 Ambient light susceptibility. The ambient light source and general test conditions shall be in accordance with EIA-455-22. The tachometer shall be energized and placed in the beam of the light source for a 10 minute duration. During the test the tachometer shall be energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. This output shall be monitored during the test. Performance shall meet the requirements of 3.5.8.

4.7.9 Steady-state supply voltage and frequency (ac) or supply voltage (dc). This test may be performed in conjunction with the temperature test (see 4.7.15). For ac powered tachometers, a reference measurement shall be performed at 0°, 25°, and 65°C for each of the conditions (A through E) specified in table VI. For dc powered tachometers, a reference measurement shall be performed at 0°, 25°, and 65°C for each of the conditions (A through C) specified in table VII. The tachometer shall be allowed to stabilize at each testing temperature before the reference measurements are performed. Performance shall meet the requirements of 3.5.9.

TABLE VI. Steady-state voltage and frequency (for ac powered tachometers).

Condition	Voltage			Frequency		
	Lower limit	Normal	Upper Limit	Lower limit	Normal	Upper limit
A (Reference Condition)		115			60	
B	107			58		
C			123	58		
D			123			62
E	107					62

TABLE VII. Steady-state voltage (for dc powered tachometers).

Condition	Voltage		
	Lower limit	Normal	Upper limit
A (Reference Condition)		28	
B	23.5		
C			32.5

4.7.10 Transient voltage and frequency (ac) or voltage (dc). Ac powered tachometer shall be tested in accordance with 4.7.10.1 and 4.7.10.2.Dc powered tachometers shall be tested in accordance with 4.7.10.3.

4.7.10.1 Transient voltage (ac).

4.7.10.1.1 Upper limit. With the tachometer operating at the steady-state voltage of 123 Vac, the voltage shall be increased to 138 Vac, and then decreased back to the steady-state voltage of 123 Vac in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.10.1.2 Lower limit. With the switch operating at a steady-state voltage of 107 Vac, the voltage shall be decreased to 92 Vac, and then increased back to the steady-state voltage of 107 Vac in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.10.2 Transient frequency (ac).

4.7.10.2.1 Upper limit. With the tachometer operating at a steady-state frequency of 62 Hz, the frequency shall be increased to 63.5 Hz, and then decreased back to the steady-state frequency of 62 Hz in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.10.2.2 Lower limit. With the tachometer operating at a steady-state frequency of 58 Hz, the frequency shall be decreased to 56.5 Hz, and then increased back to the steady-state frequency of 58 Hz in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.10.3 Transient voltage (dc).

4.7.10.3.1 Upper limit. With the tachometer operating at a steady-state voltage of 32.5 Vdc, the voltage shall be increased to 34.5 Vdc, and then decreased back to the steady-state voltage of 32.5 Vdc in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.10.3.2 Lower limit. With the tachometer operating at a steady-state voltage of 23.5 Vdc, the voltage shall be decreased to 21.5 Vdc, and then increased back to the steady-state voltage of 23.5 Vdc in a 2 second period. A reference measurement shall then be performed. The tachometer shall meet the requirements of 3.5.10.

4.7.11 Insulation resistance. The insulation resistance of the opto-electronics module shall be determined by applying 50 Vdc between electrical input and output circuits and between these circuits and ground. The temperature shall be 25 ± 5°C and the relative humidity shall be 50 ± 10 percent. The insulation resistance measurement shall be made immediately after a 2 minute period of uninterrupted test voltage application. If the indication of insulation resistance meets the specified limit (see 3.5.11) and is steady or increasing, the test may be terminated before the end of the 2 minute period. The tachometer shall meet the requirements of 3.5.11.

4.7.12 Power interruption. With the tachometer operating within the steady-state tolerances of voltage and frequency, the external power supply shall be suddenly interrupted, and after an interval between 3 and 4 seconds, the power supply, within the steady-state tolerances, shall be reapplied. After the tachometer has been operated long enough to detect any major performance degradation, the power shall be interrupted for an interval of not less than 30 seconds. This cycle, (3 to 4 second interruption, monitor, then not less than 30 second interruption) shall be repeated three times (four total cycles). Following each of the power interruption intervals a reference measurement (see 4.7.3) shall be made. The tachometer shall meet the requirements of 3.5.12.

4.7.13 Short circuit. The tachometer shall be deenergized and the positive and negative electrical output leads or terminals of the opto-electronics module shall be connected directly together, with no load resistance. The tachometer shall be energized for five minutes, then deenergized and the short circuit removed. The tachometer shall be energized and a reference measurement (see 4.7.3) shall be made at ambient temperature. The tachometer shall meet the requirements of 3.5.13.

4.7.14 Line voltage reversal (for dc powered tachometers). A positive 28 Vdc signal shall be applied to connector pin "B". The dc reference signal shall be applied to connector pin "A". The power supply shall be energized for a period of 10 minutes, and then shall be disconnected. The power supply shall then be correctly applied (pin A positive, pin B negative) and a reference measurement (see 4.7.3) shall be made. The tachometer shall meet the requirements of 3.5.14.

4.7.15 Temperature. The tachometer shall be positioned in an environmental chamber in a energized state, and shall be subjected to the following test procedure. Performance shall meet the requirements of 3.5.15.

(a) Hold test temperature at 0 ± 2°C for not less than 24 hours.
(b) Increase test temperature in steps of 10 degrees each, at 30 minutes for each step, until plus 65 ± 2°C is reached and hold at that temperature for not less than 24 hours.
(c) Reduce test temperature in steps of 10 degrees each, at 30 minutes for each step, until plus 25 ± 2°C is reached and hold at that temperature for not less than 24 hours.

During the last hour of operation at each temperature plateau (0°C, 65°C, and 25°C) the tachometer electrical output signal, of the 0 - 5V setting, shall be measured corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. After the temperature test, a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.15.

4.7.16 Humidity. The tachometer shall be subjected to the conditioning and tests specified in 4.7.16.1 through 4.7.16.5. The tachometer shall be energized throughout the test. Performance shall meet the requirements of 3.5.16.

4.7.16.1 Conditioning. In order to establish a reference condition for the measurement of operating parameters and a valid basis for comparison of the effects of the conditioning to follow, the complete equipment shall be dried at a temperature not less than 40°C or more than 50°C for not less than 2 hours.

4.7.16.2 Reference measurements. Following the conditioning (see 4.7.16.1) a reference measurement (see 4.7.3) shall be made at 25 ± 5°C and 50 ± 5 percent relative humidity. Performance shall meet the requirements of 3.5.16.

4.7.16.3 Temperature cycling. The tachometer shall then be subjected to four 24-hour cycles of temperature variation consisting of 18 hours at 65 ± 5°C and 6 hours at 25 ± 5°C. The relative humidity shall be maintained at 90 to 95 percent (noncondensing) during the steady-state conditions. The transitions between temperatures shall be accomplished within the 6-hour period so that the time at the high temperature is 18 hours. Each transition shall be not greater than 1 hour if the tachometer remains in the chamber, or 15 minutes if a two chamber method is employed. The relative humidity need not be controlled during the transition periods.

4.7.16.4 Measurement during cycling. During the second cycle, a reference measurement (see 4.7.3) shall be made at the end of the high temperature period with the tachometer remaining in the chamber at 65 ± 5°C. The tachometer shall be energized for as brief a period as required to complete the measurements.

4.7.16.5 Measurements after temperature cycling. After the four complete cycles, a reference measurement (see 4.7.3) shall be made at 25 ± 5°C with the tachometer remaining in the chamber. Performance shall meet the requirements of 3.5.16.

4.7.17 Enclosure. The tachometer shall be placed or mounted in a position typical of that for which it was designed. The surface upon which the equipment is placed or mounted (supporting surface) shall extend not less than 1 meter beyond the equipment on all sides so that splashing may be produced by directing the water stream on the supporting surface. The water stream shall be a coarse spray with a flow rate of not less than 55 liters per minute and a head pressure of not less than 3 meters. A head pressure of 3 meters is defined as sufficient water pressure so that if directed straight up, the stream of water shall rise to a height of 3 meters. The distance from the nozzle to the enclosure under test shall be approximately 2 meters. The time of the test shall be not less than 5 minutes with approximately equal portions of time for spray on each surface, including joints of the enclosure and at the supporting surface. During the test the tachometer shall be energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. This output signal shall be monitored during the test. The equipment shall meet the requirements of 3.5.17.

4.7.18 Salt spray. Before the salt spray test, a reference measurement (see 4.7.3) shall be made. The fiber optic tachometer shall be deenergized and tested in accordance with method 101 of MIL-STD-202. Duration of the test shall be 96 hours. The tachometer's major components shall be disassembled at the immediate conclusion of the test and examined for corrosion and moisture penetration. At the completion of the test, the tachometer shall be energized and a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.18.

4.7.19 Vibration. Before the vibration test, a reference measurement (see 4.7.3) shall be made. The tachometer shall then be subjected to the type I vibration test in accordance with MIL-STD-167-1. During the vibration test, the tachometer shall be energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. This output signal shall be monitored during the test. After the vibration test, a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.19.

4.7.20 Shock. Before the shock test, a reference measurement (see 4.7.3) shall be made. The fiber optic tachometer equipment shall be tested in accordance with MIL-S-901, grade A, type C, class I. The equipment shall be mounted on fixture 4A simulating shipboard installation. During the shock test, the tachometer shall be energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. This output signal shall be monitored during the test. After the shock test, a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.20.

4.7.21 Electromagnetic interference (EMI) emission and susceptibility. EMI tests shall be in accordance with MIL-STD-462. During the EMI test, the tachometer shall be energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. This output signal shall be monitored during the test. After the EMI test, a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.21.

4.7.22 Magnetizing. With the fiber optic tachometer energized and operational at an output signal, of the 0 - 5V setting, corresponding to a speed of 3000 rpm. The tachometer's speed range setting shall be 0 - 10000 rpm. The tachometer sensor head shall be placed in varying positions in a unidirectional magnetic field having a flux density in free air of 5 gauss. The tachometer's output shall be monitored during this test. After this test a reference measurement (see 4.7.3) shall be made. Performance shall meet the requirements of 3.5.22.

4.8 Inspection of packaging. The sampling and inspection of the preservation, packing, and container marking shall be in accordance with MIL-E-17555.

5. PACKAGING

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

5.1 Packaging requirements. Fiber optic tachometer equipment shall be preserved level A, C, or commercial, packed level A, B, C or commercial as specified (see 6.2) and marked in accordance with MIL-E-17555 and shall include bar codes and applicable packaging acquisition options therein as specified (see 6.2).

5.2 Marking. In addition to any special marking required (see 6.2), unit and intermediate packs and shipping containers and palletized unit loads shall be marked in accordance with ASTM-D-3951.

6. NOTES

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

6.1 Intended use. The fiber optic tachometer covered by this specification is a noncontact device capable of detecting and indicating shaft rotation via an optical signal on systems such as gas generators, power turbines, propulsion shafts and gas and ships steam turbine generators.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Tachometer classification required (see 1.2).
(c) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(d) When first article inspection is required (see 3.2, 4.4, and 6.5).
(e) Opto-electronics module type A requirements (see 3.4.2. If Type B, specify requirements (see 3.4.2.2).
(f) Cable length required (see 3.4.3).
(g) Requirements for optical output (see 3.4.7.3).
(h) Requirements including data format for digital output (see 3.4.7.4).
(i) If mass requirements are other than specified (see 3.4.15)
(j) Description of target required (see 3.4.16).
(k) The connector assembly when digital output is required (see 3.4.8.5).
(l) Distance from sensor head to target for the magneto-optic sensing mechanism, if other than 2 mm (see 4.3).
(m) Levels of preservation and packing required (see 5.1).
(n) Applicable acquisition requirements of MIL-E-17555 (see 5.1).
(o) Special marking required (see 5.2).

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
Appendix	DI-DRPR-80651	Engineering Drawings	Level 3
4.4	DI-NDTI-80809	Tests/Inspection Reports	---

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

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards which have been

cleared and listed in DoD 5010.12-L (AMSDL) must be listed on a separate CDRL (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

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

6.7 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract. When ordering spare parts or repair parts for the equipment covered by this specification, the 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.

6.8 Definitions.

6.8.1 Error. The error for a given value of the input variable (measurand) is the difference between the measured value of the output signal and the expected value of the output signal. The expected value of the output signal for any value of the measurand shall be represented by a straight line whose end points are given by:

(a) The specified value of the output signal at the minimum input value of the measurand (for example, 4 mA at the minimum specified rotational speed).
(b) The specified value of the output signal at the maximum input value of the measurand (for example 20 mA at the maximum specifed rotational speed).

6.8.2 Output span. Output span is the algebraic difference between the maximum and minimum values of the opto-electronics module output signal (for example 16 mA for a specified 4 mA to 20 mA output).

6.9 Subject term (key word) listing.

Beam interruption
Opto-electronics module
Reflection
Sensor head
Rotation
Measure

Preparing activity:
Navy - SH
(Project 6040-N003)

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

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

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

SPECIFICATION

MILITARY
MIL-I-45208 - Inspection System Requirements.

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

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
Y14.1 - Drawing Sheet Size and Format. (DOD adopted)
200 - Standard Reference Designations for Electrical and Electronics Parts and Equipments. (DOD adopted)

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

30. CONFORMANCE VERIFICATION DRAWING FOR INSTRUMENTATION

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

30.2 Content and format. One conformance verification drawing shall be developed for each specific type of instrumentation. It shall include all ranges, sizes, connections and other variations. The conformance verification drawing shall include the following minimum information (except as specified in 10.1) and shall be developed to the format in 30.3 through 30.9. A complete symbol list shall accompany all drawings and schematics.

30.3 Descriptive data.

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

30.4 Details of construction.

(a) Two or more representative assembly views, as required, to show clearly the details of the design, construction, and assembly of the instrumentation and to identify each part and its location. Identification of parts shall correspond to the list of materials. Assembly shall show how all mechanical parts are joined or attached.
(b) Sectional views or notes as necessary to show internal details.
(c) Details such as entrance provisions, gaskets, fastening techniques, welding symbols, mounting requirements, and other details as applicable.

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

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

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

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

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

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

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

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

(a) Complete electrical system schematic. A single schematic shall represent clearly the operation and the function of the electrical circuitry within the instrumentation. The schematic shall contain all parts (including components, connectors, alarms, and so forth) which make up the electrical system. The following features shall be incorporated into the schematic.
    (1) In preparation of the schematic, emphasis shall be placed on simplicity and ease of understanding of circuit operation. Physical placement of components and connecting wiring may be ignored in the interest of simplicity and clarity of this diagram.
    (2) A thin, broken line shall be used to represent the boundaries of each unit or subassembly. Terminals, to which external connections are made, shall be shown within these boundaries, with the numbers, markings, type of signal, power and ground, as appropriate.
    (3) Each part (such as resistors, capacitors, relays, and so forth) shall be given a unique reference designation consisting of a letter denoting the type of part (as required by ANSI 200) and a number assigned consecutively. The numbers shall be assigned in a logical sequence of electrical current or signal flow through the circuit.
    (4) In addition to where the reference designation, parts not conforming to a military specification, where permitted, shall have the following information noted adjacent to the part.

Where numerical values are given, a code shall be noted to designate the units used:

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

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

30.8 Selection and installation considerations.

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

30.9 Drawing format.

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

(b) Each sheet shall be zoned.

(c) Title block shall be included on each drawing sheet and shall include the following information:

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

a. Title - the title shall consist of the name by which the instrumentation is known.

b. Drawing number - the drawing number shall consist of alphanumeric characters which may be separated by dashes or slashes. The total number of characters in the drawing number (including dashes and slashes) shall be not greater than 15. Blank spaces are not permitted within the drawing number.

c. Revision letter - the revision letter shall denote the latest approved version of the drawing. The revision letter of conformance verification drawing shall not be changed until all the changes under that revision have been accepted in writing by the authorized Government activity (NAVSEA). No changes made to the conformance verification drawing shall be considered a revision until after the initial version of the conformance verification drawing has been accepted in writing by the authorized Government activity. After initial submittal of the conformance verification drawing, no changes shall be made during the initial drawing review process unless the change is either requested by the authorized Government activity or the change is documented in written correspondence by the contractor.

(2) Sheet _____ of _____.

(3) Tolerance on dimensions for fractions, decimals, and angles. Units of the dimensions specified on the conformance verification drawing.

(4) Contractor acceptance block (appropriate signatures and dates).

(5) Commercial and Government entity (CAGE) code for manufacturer.

(6) Scale.

(7) Reference drawings.

(8) Manufacturer's name and address.

(9) Drawing size.

(d) A revision block shall be included on each sheet of the conformance verification drawing and shall contain the following information in tabular form:
(1) Revision letter.
(2) Description of revision.
(3) Acceptance letter serial number and originator identification.
(4) Acceptance data.

(e) Sheet size and format not specified herein shall be in accordance with ANSI Y14.1.

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

40. CONFORMANCE VERIFICATION DRAWING ACCEPTANCE

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

50. INSTRUCTIONS

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