

MIL-T-16049C
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SUPERSEDING
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(See Section b)

MILITARY SPECIFICATION

TACHOMETERS: ELECTRICAL; SELF-GENERATING; MECHANICAL.

FIXED MOUNTING AND HAND HELD; AND VIBRATING REED

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers single range mechanical and electric self-generating tachometers of the types specified hereinafter for general use.

1.2 Classification. Tachometers shall be of the following types, as specified (see b.1.1):

- Type IC/APB - Chronometric, portable, single range
(0 to 10,000 revolutions per minute
(r/min))
- Type IC/BFB - Centrifugal, fixed (flexible drive)
single range
- Type IC/BPB - Centrifugal, portable, single range:
 - IC/BPB-1: 50 to 500 r/min
 - IC/BPB-2: 500 to 5,000 r/min
 - IC/BPB-3: 1,000 to 10,000 r/min
 - IC/BPB-4: 5,000 to 50,000 r/min
- Type IC/CFB - Resonant, fixed, single range:
 - IC/CFB-A: 900 to 1,200 r/min
 - IC/CFB-B: 900 to 1,500 r/min
 - IC/CFB-C: 1,200 to 1,800 r/min
 - IC/CFB-D: 1,425 to 2,175 r/min
 - IC/CFB-E: 1,625 to 2,375 r/min
 - IC/CFB-F: 2,175 to 2,875 r/min
 - IC/CFB-G: 2,250 to 3,750 r/min

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 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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1C/CFB-H: 2,050 to 4,450 r/min
 1C/CFB-I: 3,250 to 4,750 r/min
 1C/CFB-J: 4,250 to 5,750 r/min
 1C/CFB-K: 5,250 to 6,750 r/min
 1C/CFB-L: 5,500 to 8,500 r/min
 1C/CFB-M: 6,500 to 9,500 r/min
 1C/CFB-N: 9,000 to 12,000 r/min
 1C/CFB-O: 9,000 to 15,000 r/min
 1C/CFB-P: 12,000 to 18,000 r/min
 1C/CFB-Q: 15,000 to 21,000 r/min
 1C/CFB-R: 18,000 to 24,000 r/min
 Type 1C/CPB - Resonant, portable, single range:
 1C/CPB-A: 900 to 1,200 r/min
 1C/CPB-B: 900 to 1,500 r/min
 1C/CPB-C: 1,200 to 1,600 r/min
 1C/CPB-D: 1,425 to 2,175 r/min
 1C/CPB-E: 1,625 to 2,375 r/min
 1C/CPB-F: 2,175 to 2,875 r/min
 1C/CPB-G: 2,250 to 3,750 r/min
 1C/CPB-H: 2,850 to 4,350 r/min
 1C/CPB-I: 3,250 to 4,750 r/min
 1C/CPB-J: 4,250 to 5,750 r/min
 1C/CPB-K: 5,250 to 6,750 r/min
 1C/CPB-L: 5,500 to 8,500 r/min
 1C/CPB-M: 6,500 to 9,500 r/min
 1C/CPB-N: 9,000 to 12,000 r/min
 1C/CPB-O: 9,000 to 15,000 r/min
 1C/CPB-P: 12,000 to 18,000 r/min
 1C/CPB-Q: 15,000 to 21,000 r/min
 1C/CPB-R: 18,000 to 24,000 r/min
 Type 1C/EFA - Electrical, (alternating current (a.c.) voltage responsive) fixed single range (direct drive range between 500 to 5,000 r/min)
 Type 1C/EFB - Electrical, (magneto-voltmeter) fixed single range (direct drive range between 0 to 4,000 r/min)
 Type 1C/EFC - Frequency responsive, electrical (control box and voltmeter) fixed single range (direct drive range between 500 to 100,000 r/min)
 Type 1C/efd - Frequency sensitive, electrical, nonrotating (magnetic pickup) fixed single range (direct drive range between 0 to 100,000 r/min)
 1C/efd-A: Consists of three elements, a magnetic pickup, transducer, and indicator
 1C/efd-B: Consists of two elements, a magnetic pickup and a single unit housing the transducer and indicator
 Type 1C/EPC - Electrical (reactance) portable, single range
 1C/EPC-3A: 20 to 200 r/min
 1C/EPC-3B: 50 to 500 r/min

1C/EPC-2A: 100 to 1,000 r/min
1C/EPC-1A: 200 to 2,000 r/min
1C/EPC-1B: 500 to 5,000 r/min
1C/EPC-1C: 1,000 to 10,000 r/min

Type 1C/EPD - Electrical (magneto-voltmeter) portable,
single range (0 to 10,000 r/min)

Type 1C/PEC - Photo-electric, single range:

1C/PEC-1: 0 to 1,000 r/min
1C/PEC-2: 0 to 5,000 r/min
1C/PEC-3: 0 to 10,000 r/min
1C/PEC-4: 0 to 30,000 r/min

Type 1C/TDC - Tachometer, digital contact: 0 to 20,000
r/min

2. APPLICABLE DOCUMENTS

2.1 issues of documents. 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

FF-B-171 - Bearings, Ball, Annular; (General Purpose).

PPP-C-1842 - Cushioning Material, Plastic, Open Cell (for Packaging Applications).

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- MIL-P-116 - Preservation-Packaging, Methods of.
- MIL-B-117 - Bags, Sleeves and Tubing - Interior Packaging.
- 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-R-6130 - Rubber, Cellular, Chemically Blown.
- MIL-M-10304 - Meters, Electrical-Indicating, Panel Type, Ruggedized, General Specification for.
- MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).
- MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
- MIL-I-45208 - Inspection System Requirements.
- MIL-B-d1705 - Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable.
- MIL-P-81997 - Pouches, Cushioned, Flexible, Electrostatic-Free, Reclosable, Transparent.

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STANDARDS

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- MIL-STD-129 - Marking for Shipment and Storage.
- MIL-STD-461 - Electromagnetic Interference Characteristics Requirements for Equipment.
- MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
- MIL-STD-1310 - Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety.
- MS90363 - Box, Fiberboard, with Cushioning for Special Minimum Cube Storage and Limited House Applications.

DRAWING

NAVAL SEA SYSTEMS COMMAND

- NAVSHIPS 9000-S6505-73687 - Standard Dial Markings for IC Orders and Indicating Systems.

PUBLICATION

NAVAL SEA SYSTEMS COMMAND

- OD 46363 - Requirements for the Electrostatic Discharge Protection of Electronic Components and Assemblies.^{1/}

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

3. REQUIREMENTS

3.1 Qualification. The tachometers furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.2 and 6.2).

3.2 Description. A tachometer is an instrument capable of generating, transmitting, and indicating information or signal that can be converted into a function of rotational speed. For the purpose of this specification, the system and parts comprising the system are specified under the applicable types.

^{1/}Copies may be obtained from Naval Ocean Systems Center, Code 032, San Diego, CA 92152.

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3.3 General features. Tachometers 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 of this specification, the requirement of this specification shall govern.)

- General requirements
- Definitions
- Materials, general (see 3.3.1)
- Substitution of (equal or superior) materials or parts
- Fungus-inert materials
- Flammable materials
- Arc-resistant materials
- Toxic materials
- Wood
- Metals
 - Aluminum
 - Magnesium
 - Ferrous alloys
 - Nonferrous material (except aluminum)
 - Zinc
 - Springs (material)
 - Other metals)
- Plastics
- Ceramics
- Impregnating, embedding, and encapsulating compounds
- Glass
- Lubricants and lubrication (see 3.4.3)
- Painting
- Protection against corrosion
- Bolts, machine screws, studs, and nuts
- Parts - mechanical
- Gaskets
- Dials and pointers
- Dial sizes
- Locking devices
- Washers
- Ball bearings (see 3.4.3)
- Parts, electrical - general (see 3.3.2)
- Use of nonstandard parts
- Requirements for semiconductor devices
- Capacitors
- Variable resistors
- Transformers (see 3.4.8)
- Equipment mechanical zero
- Electrical tapes
- Dial illumination lamps
- Switches
- Indicator lights and lampholders
- Fuses
- Fuseholders and fuse clips
- Metallic rectifiers
- Printed wiring

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Enclosures - general
 Enclosure - accessibility
 Enclosure - degree of (see 3.5.2, 3.5.4, 3.5.5, 3.5.6, and 3.5.7)
 Enclosure - mounting
 Minimum sheet metal thicknesses (watertight enclosure)
 Cable entrance
 Cable entrance plates
 Ventilation
 Threaded devices
 Rounded corners and edges
 Internal subassembly protection
 Drilled and tapped holes
 Structural welding
 Temperature and humidity^{1/}
 Accelerated life (see 3.4.5)
 Salt spray^{1/}
 Shock (see 3.4.6), vibration (nonvital) and inclination^{1/}
 Features - electrical
 Primary power supply circuits
 Power supply tolerances
 Safety (personnel hazard)
 Soldering
 Electrical parts mounting
 Terminal boards, electrical connectors, and terminals
 Wiring
 Color coding
 Dial illumination
 Electrical insulation
 Dielectric strength and insulation resistance clearances^{2/}
 Airborne noise^{2/}
 Structureborne noise (type 3) for submarines
 Supply line voltage and frequency variation^{2/}
 Interchangeability and standardization
 Designation and marking (serial numbers are required)
 Workmanship

- ^{1/}Salt spray and inclination test required for control or accessory package for types IC/KFB, IC/EFA, IC/EFB, IC/EFC, IC/EPD, and IC/TDC. Inclination test only applies to IC/TDC.
^{2/}Applies to types IC/EFA, IC/EFB, IC/EFC, IC/EPD, IC/EPC, IC/EPD, IC/PEC, and IC/TDC.

3.5.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and shall be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and

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

3.3.2 Parts derating. Electrical and electronic parts shall not be stressed greater than 50 percent of rating at the maximum operating ambient temperature specified for the tachometer. Stress calculations shall be available for review by the command or agency concerned.

3.4 Design features.

3.4.1 The tachometers (except for types IC/APB and IC/TCD) shall instantaneously and continuously indicate information or a signal that can be converted into a function of the speed of rotation in r/min of the rotating part to which it is connected. The tachometers shall indicate, without change or adjustment, regardless of the direction of rotation of the driving part on the same scale. Means shall be incorporated in the mechanism so that compensation for errors to a minimum of 5 percent may be made without re-marking the scale. The internal mechanism shall be capable of easy removal for repair or adjustment.

3.4.2 Magnetizing. The materials employed in the construction of the tachometers shall be of such characteristics that no error, either temporary or permanent, in excess of the errors permitted under the accuracy requirements specified for the applicable type will be introduced when the tachometer is tested as specified in 4.4.3.

3.4.3 Lubrication. Facilities for lubrication shall be provided that do not require complete disassembly of the tachometer mechanism. Where sealed-for-life type bearings (in accordance with FF-B-171) are used, no lubrication features are required.

3.4.4 Dial windows. The dial and pointer assemblies for all types (except IC/APB and IC/TDC (see 3.5.1 and 3.5.12)) shall be protected by a window of high quality glass, free of flaws and defects, which does not cause parallax error.

3.4.5 Accelerated life. The tachometers shall be capable of withstanding, without damage, the accelerated life test specified in 4.4.4.

3.4.6 Shock. Types IC/EFA, IC/EFB, IC/EFC, IC/efd, exclusive of associated indicators, and all parts of type IC/BFB, shall conform to the shock requirements of type A, class 1, grade B for lightweight equipment of MIL-S-901. All other types shall be capable of withstanding the shock test of method 213 of MIL-STD-202. Separately mounted magnetos, generators, or voltage supply units shall conform to the high shock requirements of type A, class 1, grade B for lightweight equipment of MIL-S-901.

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3.4.7 Carrying case. Portable tachometers shall be furnished in a carrying case, arranged to contain the tachometer and all attendant accessories, and shall be fitted with a lock or latch. The case shall contain a durable instruction card, permanently secured therein, which shall include all necessary instructions and information for proper operation.

3.4.8 Transformers. Power supply transformers for indicator lamps and instrument illumination shall conform to the requirements specified in MIL-1-983.

3.4.9 Grounding and bonding. The provisions for grounding and bonding shall be in accordance with MIL-STD-1310.

3.4.10 Electromagnetic interference (types IC/EFA, IC/EFB, IC/EFEC, IC/EFED, IC/EPEC, IC/EPD, IC/PEC, and IC/TDC). Electromagnetic interference shall conform to MIL-STD-461.

3.4.11 Batteries. Batteries shall not be supplied with battery-operated equipment.

3.5 Special features for each type.

3.5.1 Type IC/APB chronometric tachometers. Type IC/APB tachometers shall contain in a single hand-held portable metal enclosure, the mechanism necessary to convert, by means of a chronometric feature, continuous rotary motion into angular displacement. The tachometers shall run free when the spindle is applied to a rotating shaft until a starting lever or button is actuated to start the timing element. The speed indication shall be retained on the dial after the spindle is disengaged from the driveshaft, and until the pointers are returned to zero by operating a reset button or lever, which may be the same as the starting lever or button. The tachometer mechanism shall be such that separate readings may be obtained at intervals of 10 seconds without damage to the mechanism and within the accuracy requirements specified in 3.5.1.3.

3.5.1.1 Range. Tachometers shall be of the single range type and shall be capable of indicating over the range of 0 to 10,000 r/min.

3.5.1.2 Dials, scales, and pointers. Dials, scale markings, numerals, and pointer assemblies shall be of such design and color as to facilitate quick and accurate readings. The scale shall be linear, and the minimum scale length for the "unit" r/min scale shall be not less than 5-1/4 inches as measured on the outer periphery of the scale unit markings. For the indication of r/min, dials, scales, and pointers (concentricity not required) shall be provided. One scale shall be graduated in units of "1,000" from 0 to the maximum tachometer range. The unit scale shall be graduated in units of not greater than 10 r/min from 0 to 1,000, with distinctive markings for each 10, 50 and 100 r/min and with designating numerals for each

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100-r/min increment. When the spindle is fitted with the rubber-tired wheel (see 3.5.1.5), readings of linear velocity in feet per minute (ft/min) shall be readily obtained from the r/min indicator by the application of a simple conversion factor which shall be indicated on the dial.

3.5.1.3 Accuracy. The allowable error of the type IC/APB tachometer shall be not greater than 1.0 percent of scale reading over the range of 500 to 1,000 r/min, and not greater than 0.5 percent over the range of 1,000 r/min to maximum scale reading, when in normal operating positions, vertical and horizontal over an ambient temperature range of 40°F to 149°F.

3.5.1.4 Dimensions and weight. Dimensions and weight shall not exceed the following:

Diameter, exclusive of operating
buttons, levers and spindle 3 inches
Depth 1-1/2 inches
Weight, exclusive of accessories
and carrying case 1 pound

3.5.1.5 Accessories. Each type IC/APB tachometer shall be provided with the following accessories:

One triangular steel tip (may be the drive spindle
itself)
One conical rubber tip, metal mounted
One rubber-lined metal cone tip
One rubber-tired wheel tip (suitable for taking
measurements of linear velocity)
One extension rod, approximately 4 inches long

3.5.2 Type IC/BFB centrifugal tachometers. The IC/BFB tachometers shall contain in a splashproof metal enclosure the mechanism necessary to convert, by means of a centrifugal governor, continuous rotary motion into angular displacement. The tachometer shall indicate continuous values of instantaneous speed with instantly adjusting indications to conform to changes of shaft speed. The enclosure shall be for panel or bulkhead mounting as specified (see 6.1.1).

3.5.2.1 Drive mechanism. Tachometers shall be driven by a flexible driveshaft. The transmission distance of the flexible driveshaft shall not exceed 25 feet. Unless otherwise specified (see 6.1.1), tachometers shall be considered to include the necessary drive equipment such as flexible driveshaft take off gear.

3.5.2.2 Flexible shaft assembly. The flexible driveshaft assembly shall consist of a flexible outer casing and a flexible inner core (driveshaft). The outer casing shall be equipped with ferrules and nuts for attaching the assembly to both the instrument and the speed-sensing unit.

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3.5.2.3 Range. The type IC/BFB tachometer shall have a single range as specified (see 6.1.1).

3.5.2.4 Dial, scales and pointer. The full scale shall be linear and shall be 8 inches minimum for a nominal 8-inch scale, or 12 inches minimum for a nominal 12-inch scale as measured on the periphery of scale markings. A stop shall be provided to prevent the indicating pointer from going past full scale reading. The dial shall be of metal with a dull white finish and with scale markings, numerals, and pointer painted with a dull black paint.

3.5.2.5 Accuracy. The allowable error of the tachometers shall be not greater than 2 percent of full scale reading, for any ambient temperature over the range of 40°F to 149°F for any position of operation within 60 degrees of the vertical position and when driven through its own drive mechanism.

3.5.2.6 Damping. With the tachometer driveshaft accelerating at one-half of the full scale range, the indicating pointer shall steady within the accuracy limits specified in 3.5.2.5, within 2 seconds after the driveshaft assumes a constant speed, and at any ambient temperature of 40°F to 149°F.

3.5.2.7 Dimensions and weight. Type IC/BFB tachometers shall not exceed the dimensions and weight shown in table 1.

TABLE 1. Dimensions and weight (type IC/BFB).

Nominal scale length min	Diameter		Depth max	Weight ^{1/} max
	Bezel max	Body max		
Inches	Inches	Inches	Inches	Pounds
8	4	3-1/2	4-1/2	2-1/2
12	6	5-1/2	4-1/2	6

^{1/}Exclusive of carrying case.

3.5.3 Type IC/EPB centrifugal tachometers. The type IC/EPB tachometers shall contain in a hand-held portable metal enclosure, the mechanism necessary to convert, by means of a centrifugal governor, continuous rotary motion into angular displacement. The tachometer shall continuously indicate instantaneous values of speed during the period the spindle is engaged with the driveshaft. Provision shall be made for retention of the pointer indication, at the operator's option, or for the retention of a secondary hand which shall be equivalent to pointer indication upon disengaging the spindle from the driveshaft.

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3.5.3.1 Type IC/BPB tachometers shall conform to one of the following single ranges:

Type IC/BPB-1: 50 to 500 r/min
 Type IC/BPB-2: 500 to 5,000 r/min
 Type IC/BPB-3: 1,000 to 10,000 r/min
 Type IC/BPB-4: 5,000 to 50,000 r/min

3.5.3.2 Dials, scales, and pointers. The dial and pointer assembly shall consist of a single dial and a single pointer. Dials shall be white with black markings for r/min. Pointers shall be black. Scale markings, divisions, and numerals shall be such as to facilitate quick and accurate readings. The scale shall be substantially linear and the diameter of the scale, measured to the outer periphery of the unit markings, shall be not less than 2-3/4 inches. When the spindle is fitted with the proper accessory (see 3.5.3.6) readings of linear velocity in ft/min shall be readily obtained from the r/min indications by the application of a simple conversion factor which shall be indicated on the dial.

3.5.3.3 Accuracy. The allowable error of the tachometers shall be not greater than 1 percent of the full scale reading at any ambient temperature between 40°F and 149°F when in a normal (horizontal or vertical) operating position.

3.5.3.4 Damping. The tachometer pointer shall be steady within the accuracy limits specified in 3.5.3.3 within 5 seconds after the spindle, starting from reset, is engaged with a driveshaft rotating at a constant speed approximately equal to the full scale reading of the tachometer, and at any temperature from 40°F to 149°F.

3.5.3.5 Dimensions and weight. Dimensions and weight shall not exceed the following:

Length (exclusive of operating spindle)	5 inches
Width	3-1/2 inches
Depth	2-1/2 inches
Weight (exclusive of carrying case and accessories)	1-1/2 pounds

3.5.3.6 Accessories. Each type IC/BPB tachometer shall be provided with the following accessories:

One triangular steel tip (which may be the drive spindle itself)
 One conical rubber tip, metal mounted
 One rubber-lined metal cone tip
 One rubber-tired wheel tip (suitable for taking measurements of linear velocity)
 One extension rod, approximately 4 inches long

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3.5.4 Types IC/CFB and IC/CPB resonant tachometers. The tachometers shall be of the vibrating reed resonant type and shall indicate continuously instantaneous values of r/min instantly adjusting indications to conform to changes of speed. The tachometer enclosure shall be of commercial brass or cast aluminum alloy, and shall be of splashproof construction. The exterior surface shall be of a durable grey or black finish. The amplitude of motion of a reed tip when vibrating in resonance shall be not less than 1/4 inch, and not more than 1/2 inch its total excursion. Means shall be incorporated in the mechanism to prevent damage to the reed assembly resulting from violent vibration of the instrument. Type IC/CPB tachometer shall be a portable type for hand use. Type IC/CFB tachometer shall be of the fixed or permanent mounting type for panel or bracket mounting as specified (see 6.1.1).

3.5.4.1 Range. The types IC/CFB and IC/CPB tachometers shall conform to the applicable ranges and normal reed intervals shown in table 11.

TABLE 11. Ranges and normal reed intervals for types IC/CFB and IC/CPB.

Type IC/CFB	Type IC/CPB	Nominal operating speed (r/min)	Scale range (r/min)	Normal interval between reeds (r/min)
IC/CFB-A	IC/CPB-A	1,000	900 - 1,200	10
IC/CFB-B	IC/CPB-B	1,200	900 - 1,500	20
IC/CFB-C	IC/CPB-C	1,500	1,200 - 1,800	20
IC/CFB-D	IC/CPB-D	1,800	1,425 - 2,175	25
IC/CFB-E	IC/CPB-E	2,000	1,625 - 2,375	25
IC/CFB-F	IC/CPB-F	2,500	2,175 - 2,875	25
IC/CFB-G	IC/CPB-G	3,000	2,250 - 3,750	50
IC/CFB-H	IC/CPB-H	3,600	2,850 - 4,350	50
IC/CFB-I	IC/CPB-I	4,000	3,250 - 4,750	50
IC/CFB-J	IC/CPB-J	5,000	4,250 - 5,750	50
IC/CFB-K	IC/CPB-K	6,000	5,250 - 6,750	50
IC/CFB-L	IC/CPB-L	7,000	5,500 - 8,500	100
IC/CFB-M	IC/CPB-M	8,000	6,500 - 9,500	100
IC/CFB-N	IC/CPB-N	10,000	9,000 - 12,000	100
IC/CFB-O	IC/CPB-O	12,000	9,000 - 15,000	200
IC/CFB-P	IC/CPB-P	15,000	12,000 - 18,000	200
IC/CFB-Q	IC/CPB-Q	18,000	15,000 - 21,000	200
IC/CFB-R	IC/CPB-R	20,000	18,000 - 24,000	200

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3.5.4.2 Accuracy.

3.5.4.2.1 Reed frequency. The peak resonant frequency for each reed shall not vary in excess of the following:

Plus or minus 0.5 percent from the frequency indicated on the scale at an ambient temperature of 75°F, and for the applicable position of operation specified hereinafter.

Plus or minus 1.0 percent from the frequency indicated on the scale for any ambient temperature over the range of 40°F to 149°F, for the applicable position of operation as specified hereinafter:

- (a) Type IC/CFB - Within 60 degrees of the normal operating position
- (b) Type IC/CPB - Any position of operation

3.5.4.2.2 Reed frequency interval. At an ambient temperature of 75°F, the actual interval between adjacent reeds shall not exceed the normal interval between reeds (see 3.5.4.1), plus 0.5 percent of the scale indicated value of either reed. As the speed is varied, reeds shall vibrate in proper sequence over an ambient temperature range of 40°F to 149°F.

3.5.4.3 Dimensions and weight. Dimensions and weight shall not exceed the following:

	<u>Type IC/CFB</u>	<u>Type IC/CPB</u>
Length	9 inches	7 inches
Width	6 inches	3 inches
Depth	5 inches	5 inches
Weight (excluding carrying case)	5 pounds	3 pounds

3.5.5 Type IC/EFA. The type IC/EFA shall be an a.c. voltage responsive tachometer and shall consist of a permanent magnet type a.c. generator, a rectifier-control or accessory component and an indicator of the d.c. permanent-magnet, moving coil type with current sensitivity and resistance, to provide continuous instantaneous indications of shaft speed. This system shall be for fixed mounted type of installations where speeds from 500 to 5,000 r/min are encountered. The indicator shall be for panel or bulkhead mounting (see 6.1.1). The generator and indicator shall be of watertight construction.

3.5.5.1 Generator. The generator shall be an a.c. voltage type and shall be of commercial design. The type of drive mechanism for driving the generator shall be as specified (see 6.1.1). The generator shall consist of a spin-tested permanent-magnet rotor and a stator incorporating a pickup coil or coils which can be mounted to or incorporated in the stationary frame of the tachometer generator. The number of poles of the rotor

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and stator and the size of the rotor may be varied to suit the specific speed requirements. The method of mounting or adapting the stator may be varied to suit the machinery details. Bearingless generators may be used.

3.5.5.2 Indicator. The indicator shall be a d.c. permanent-magnet, moving coil type with a current sensitivity and resistance. The scale of this instrument shall be essentially linear, and shall be 8 inches minimum for a nominal 8-inch scale length or 12 inches minimum for a nominal 12-inch scale length as measured on the periphery of scale markings. The scale range shall be made to suit the application allowing measurement of speeds approximately 10 percent above the maximum of service. Dial and pointers assembly shall be of commercial design. The dial markings shall be in accordance with Drawing 9000-S6505-73687 with pointer extending to inner edge of graduations. The indicator shall have self-contained red illumination. The indicator meter movement shall be a 4-1/2-inch (long scale) 250-degree or more high shock switchboard type in accordance with MIL-M-16034 or 2-1/2 to 4-1/2 inches diameter in accordance with MIL-M-10304. The rectifier-control or accessory component shall be mounted in the indicator enclosure and shall be of the full wave bridge type. The bridge shall be completed by resistors to decrease temperature effects and shall provide protection to rectifiers in the event of open circuit of the load.

3.5.5.3 Accuracy. The accuracy of the tachometer shall be not less than 2-1/2 percent of full scale reading at any ambient temperature between 40°F and 149°F at any part of the scale when driven through its own drive mechanism under conditions specified in 4.4.1.

3.5.5.4 Damping. The accuracy requirements of 3.5.5.3 shall be met within 2 seconds after the driveshaft operating the tachometer assumes a constant rate of speed, approximately equal to the full scale reading of the tachometer and at any temperature between 40°F and 149°F.

3.5.5.5 Dimensions and weight.

3.5.5.5.1 Generator. Dimensions and weight of the generator shall be as shown in table III.

TABLE III. Dimensions and weight (generators).

	Diameter max	Depth max	Weight max
Rotor	inches 1-1/4	inches 1	Ounces 4
Stator	3	1-1/2	5

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3.5.5.5.2 Indicator. Dimensions and weight of the indicator shall be as shown in table IV.

TABLE IV. Dimensions and weight (indicators).

Nominal scale length minimum	Height max	Width max	Depth max	Weight max
Inches	Inches	Inches	Inches	Pounds
8	5-1/2	5-1/2	6	8
12	9	9	7	14

3.5.6 Type IC/EFB. The type IC/EFB tachometer shall employ the magneto generator-voltmeter principle and shall indicate continuously instantaneous values of speed instantly adjusting indications to conform to changes of shaft speed. The tachometer shall be of the fixed-mounted type, consisting of a magneto transmitter with a drive mechanism and a voltmeter indicator. The magneto generator shall be of commercial design. The type of drive mechanism for driving the magneto transmitter shall be as specified (see 6.1.1). The voltmeter indicator shall be for panel or bulkhead mounting as specified (see 6.1.1). The transmitter and indicator shall be of watertight construction.

3.5.6.1 Indicator. The indicator shall be a d.c. permanent-magnet, moving-coil type with suitable current sensitivity and resistance. The scale shall be essentially linear, and shall be 8 inches minimum for a nominal 8-inch scale length, or 12 inches minimum for a nominal 12-inch scale length as measured on the periphery of scale markings. The scale range shall be made to suit the application allowing measurement of speeds approximately 10 percent above the maximum of the service. The dial and pointer assembly shall be of commercial design. The dial markings shall be in accordance with Drawing 9000-S6505-73667 with pointer extending to the inner edge of graduation. When specified (see 6.1.1) the indicator shall have self-contained red illumination. The indicator voltmeter movement shall be a 4-1/2 inch (long scale) 250-degree or more, high shock switchboard type element in accordance with MIL-M-16034 or 2-1/2 to 4-1/2 inches in diameter conforming to MIL-M-10304. Scale lengths shall be as specified in 3.5.6.4. Magneto generator maximum armature speed shall be in the range 0 to 4,000 r/min, but gear reductions may be used to operate from higher shaft speeds to permit other scale ranges. The indicators shall be for panel or bulkhead mounting as specified (see 6.1.1).

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3.5.6.2 Accuracy. The accuracy of the tachometer shall be not less than 2 percent of full scale reading at any part of the scale, at any ambient temperature over the range of 40°F to 149°F and for any position of operation within 60 degrees of the vertical operating position.

3.5.6.3 Damping. The accuracy requirements specified in 3.5.6.2 shall be met within 2 seconds after the driveshaft operating the tachometer reaches constant rate of speed, and at any ambient temperature over the range of 40°F to 149°F.

3.5.6.4 Dimensions and weight. Indicators shall not exceed the dimensions and weight shown in table V.

TABLE V. Dimensions and weight.

Scale length, min inches	Height, inches max		Width, inches max		Depth, inches max		Weight, pounds max	
	Illuminated	Nonilluminated	Illuminated	Nonilluminated	Illuminated	Nonilluminated	Illuminated	Nonilluminated
6 12	7 9-3/4	5-1/2 9	7 9-3/4	5-1/2 9	7-1/2 6	6 7	13 16	8 14

3.5.7 Type IC/EFC. The type IC/EFC shall be a frequency responsive tachometer and shall consist of a permanent magnet type a.c. generator, control box to produce d.c. output proportional to generator frequency plus an indicator of the d.c. permanent-magnet, moving-coil type with current sensitivity and resistance, to provide continuous instantaneous indications of shaft speed. This tachometer shall be for fixed mounted type of installations where direct drive range from 500 to 100,000 r/min are encountered. The indicator shall be designed for panel or bulkhead mounting (see 6.1.1). Unless otherwise specified (see 6.1.1), the generator, control box, and indicator shall be of dripproof construction.

3.5.7.1 Generator. The generator shall consist of a spin-tested permanent-magnet rotor for mounting on integral shaft end which is ground to centers, plus a stator incorporating pickup coil or coils which can be mounted to or incorporated in the stationary frame of the machinery. The number of poles of the rotor and stator, and the size of the rotor may be varied to suit the specific speed requirements. The method of mounting or adapting the stator may be varied to suit the machinery details.

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3.5.7.2 Control box. The control box shall be bulkhead mounted and shall include a saturable core transformer, adjustable resistance, and full wave bridge type rectifier. The rectifier bridge shall be completed by resistors to decrease temperature effects and provide protection to rectifiers in the event of open circuit of the load.

3.5.7.3 Indicator. The indicator shall be a d.c. permanent-magnet, moving-coil type with current sensitivity and resistance. The scale shall be essentially linear, and shall be 12 inches minimum in length as measured on the periphery of scale markings. The scale range shall be made to suit the application allowing measurement of speeds approximately 10 percent above the maximum of the service. Dial and pointer assembly shall be of commercial design. The dial markings shall be in accordance with Drawing 9000-S6505-73687 with pointer extending to inner edge of graduations. The indicator shall have self-contained red illumination. The indicator voltmeter movement shall be a 4-1/2-inch (long scale) 250-degree or more, high shock switchboard type element in accordance with MIL-M-10304. The indicators shall be for panel or bulkhead mounting as specified (see 6.1.1).

3.5.7.4 Accuracy. The accuracy of the tachometer shall be not less than 2 percent of full scale reading at any part of the scale when driven through its own drive mechanism at any ambient temperature between 40°F and 149°F and shall conform to the magnetizing requirement of 3.4.2 and the accelerated life requirement of 3.4.5.

3.5.7.5 Damping. The accuracy requirements of 3.5.7.4 shall be met within 2 seconds after the driveshaft operating the tachometer reaches a constant rate of speed and at any temperature between 40°F and 149°F.

3.5.7.6 Dimensions and weight. Components shall not exceed the dimensions and weight shown in table VI.

TABLE VI. Dimensions and weight of type IC/EFC.

	Diameter or height max	width max	Depth max	Weight max
	inches	inches	inches	
Generator, rotor	1-1/4 (diameter)	---	1	4 ounces
Generator, stator	3 (diameter)	---	1-1/2	5 pounds
Control box	7 (height)	3	5	10 pounds
Indicator	9 (height)	9	7	14 pounds

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3.5.8 Type 1C/EFD.

3.5.8.1 Type 1C/EFD-A. Type 1C/EFD-A shall consist of three elements: a magnetic reluctance pickup, a transducer to convert pulse received from a magnetic reluctance pickup to a proportional d.c. output, and an indicating d.c. instrument to show speed of rotation. One or two additional individual indicators shall be furnished when specified (see 3.5.8.6 and 6.1.1). The pickup shall consist of a magnetized central core, around which is wound a coil of wire. The projecting end shall be placed quite close to the rotating shaft to be sensed. At the pickup point, the shaft will facilitate shallow holes spaced equal distances apart. When operating, the reluctance of the magnetic path formed by the shaft and pickup and varied as a hole in the shaft shall be moved under the pickup, and a voltage pulse shall be induced in the coil of wire. Another reverse pulse shall be generated as the solid part of the shaft again passes under the pickup head. These pulses shall be amplified, equalized, and demodulated in the necessary unit, producing a direct current which is proportional to the frequency of these pulses and hence proportional to the speed of the shaft. A measure of the direct current shall be a measure of the speed of the shaft.

3.5.8.2 Type 1C/EFD-B. Type 1C/EFD-B shall be similar to the type 1C/EFD-A but shall consist of two elements: a magnetic reluctance pick-up and a single unit housing both the transducer and indicator. One or two additional individual indicators shall be furnished when specified (see 3.5.8.6 and 6.1.1).

3.5.8.3 Range. The range shall be 0 to 10,000 r/min. The tachometer (including all associated components) shall be calibrated to receive a specific number of pulses per second corresponding to full scale deflection of the indicator.

3.5.8.4 Magnetic pick-up. The magnetic pick-up shall have a magnetized core and surrounding coil, and shall be capable of being bulkhead mounted from 0.010 to 0.030 inch radially from the rotating shaft, and shall generate pulses at a frequency proportional to the shaft speed (see 6.1.1). The pick-ups shall be selected from readily available commercial stock, the characteristics of which shall best suit the intended equipment operational environment (see 6.1.1), and of such design that operation will not be influenced by stray magnetic fields.

3.5.8.5 Transducer. The transducer shall convert the voltage pulses from the magnetic pick-up into a d.c. output proportional to the pulse frequency. The transducer shall be packaged as a self-contained unit consisting of transducer and indicator for the type 1C/EFD-B or separate for bulkhead mounting for the type 1C/EFD-A.

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3.5.8.6 Indicator. The indicator shall be class H.1. shock direct current permanent-magnet moving coil type in accordance with MIL-M-16034 and MIL-M-16034. The meter shall have a 250-degree scale and shall be a 4-1/2 inch size. The indicator shall be packaged as a self-contained unit consisting of the transducer and indicator for type IC/EFD-B or separate for flange or panel mounting as specified (see 6.1.1) for type IC/EFD-A. One or two additional indicators for flange or panel mounting shall be furnished when specified (see 6.1.1).

3.5.8.7 Accuracy. The accuracy of the tachometer system shall be not less than 1-1/4 percent of full scale reading at any point on the scale at any ambient temperature between 40°F and 149°F.

3.5.8.8 Damping. The accuracy requirements of 3.5.8.7 shall be met within 2.5 seconds after the driveshaft operating the tachometer reaches a constant rate of speed.

3.5.8.9 Dimensions and weight. Components shall not exceed the dimensions and weight shown in table VII.

TABLE VII. Dimensions and weight of type EFD.

Components	Height max	Width max	Depth max	Weight max
Magnetic pickup IC/EFD-A:	Inches 3/4	Inches ----	Inches 1-1/4	1 ounce
Transducer	2-3/4	7-1/2	4	3 pounds
Indicator	4-1/2	----	2-1/16	1-1/2 pounds
IC/EFD-B: Self-contained transducer and indicator	4-1/2	4-1/2	5-1/2	4 pounds

3.5.9 type IC/EPC tachometer. The type IC/EPC tachometer shall be of the hand-held portable type, employing the electrical reactance principle, to continuously indicate instantaneous values of r/min instantly adjusting indications to conform to changes of speed. The tachometer shall consist of two components, the head component, which shall be placed in contact with the moving object, and the indicating component. The two components shall be connected by a flexible electrical cable. The head component shall consist of a rotating shaft which operates a set of contacts through a positive cam mechanism. The indicating component shall consist of a reactance circuit, milliammeter, and a flashlight cell battery power supply. The

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indicating component shall also contain a knob for selecting speed ranges and a knob for checking the battery and compensating for reduced battery voltage.

3.5.9.1 Range, r/min. The type 1C/EPC tachometers shall indicate over the normal speed ranges shown in table VIII. When fitted with the applicable adapter, (see 3.5.9.6) the tachometer shall indicate over the low or high speed range shown in table VIII.

TABLE VIII. Speed ranges (type 1C/EPC).

Type	Normal speed	With low speed adapter	With high speed adapter
	r/min	r/min	r/min
1C/EPC-3A	20 - 200	2 - 20	200 - 2,000
1C/EPC-3B	50 - 500	5 - 50	500 - 5,000
1C/EPC-2A	100 - 1,000	10 - 100	1,000 - 10,000
1C/EPC-1A	200 - 2,000	20 - 200	2,000 - 20,000
1C/EPC-1B	500 - 5,000	50 - 500	5,000 - 50,000
1C/EPC-1C	1,000 - 10,000	100 - 1,000	10,000 - 100,000

3.5.9.2 Range, linear velocity. The tachometers, when fitted with the applicable adapter (see 3.5.9.6) shall provide readings of linear velocity in ft/min indications by the application of a simple conversion from r/min factor which shall be indicated on the instruction card and on the speed changing adapter.

3.5.9.3 Accuracy. The error of the tachometer shall be not greater than 1 percent of full scale reading for any ambient temperature over the range 40°F to 149°F.

3.5.9.4 Damping. The accuracy requirements specified in 3.5.9.3 shall be met within 2 seconds after the driveshaft operating the tachometer reaches a constant rate of speed, and at any ambient temperature over the range of 40°F to 149°F.

3.5.9.5 Dimensions and weight. The type 1C/EPC tachometers shall not exceed the following dimensions and weight:

Length 9 inches
 Width 4-3/4 inches
 Depth 2-5/8 inches
 Weight (excluding accessories
 and carrying case) 3 pounds

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3.5.9.6 Accessories. Each tachometer shall be provided with the following accessories:

- Two - External cone tips for shaft centers
- One - Internal cone tip for live centers and small shafts
- One - 1 foot circumference rubber-tired roller
- One - 0.1 foot circumference rubber-tired roller
- One - Extension rod for reaching inaccessible rotating member.
- Adapters - One each for low and high speed (r/min) and one each for measuring linear velocity in ft/min in the following ranges (as applicable):

<u>Type</u>	<u>Low speed</u> <u>r/min</u>	<u>High speed</u> <u>r/min</u>
1C/EPC-3A	2 to 20	200 to 2,000
1C/EPC-3B	5 to 50	500 to 5,000
1C/EPC-2A	10 to 100	1,000 to 10,000
1C/EPC-1A	20 to 200	2,000 to 20,000
1C/EPC-1B	50 to 500	5,000 to 50,000
1C/EPC-1C	100 to 1,000	10,000 to 100,000

3.5.10 Type IC/EPD tachometer. The type IC/EPD tachometer shall be of the hand-held portable type, employing the magneto generator-voltmeter principle and shall indicate continuously instantaneous values of r/min instantly adjusting indications to conform to changes in speed. The tachometer shall consist of two components, the head component, which shall be placed in contact with the moving object, and the indicating component. The two components shall be connected by a flexible electric cable 5 feet long. The head component shall consist of a magneto generator. The indicating component shall consist of a voltmeter and a switch for selecting speed ranges from 0 to 10,000 r/min.

3.5.10.1 Range, dial, and pointer assembly. The full scale shall be linear and shall be not less than 2-7/16 inches in length as measured on the periphery of the scale markings. The scale range shall be as specified (see 6.1.1). The dial markings shall be in accordance with MIL-1-983. The voltmeter movement shall be in general accordance with MIL-M-16034.

3.5.10.2 Accuracy. The accuracy of the tachometer shall be not less than 1 percent of full scale reading at any part of the scale, at any ambient temperature range of 40°F to 149°F and for any position, and when energized through its own magneto generator.

3.5.10.3 Damping. The accuracy requirements specified in 3.5.10.2 shall be met within 2 seconds after the magneto generator reaches a constant rate of speed, and at any ambient temperature over the range of 40°F to 149°F.

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3.5.10.4 Dimensions and weight. The tachometer shall not exceed the dimensions and weight shown in table IX.

TABLE IX. Dimensions and weight of type IC/EPD.

	Height max	Width max	Depth max	Diameter max	Length max	Weight max
Indicator	Inches 4-3/4	Inches 3-1/2	Inches 2-1/2	Inches ----	Inches ----	Ounces 22
Generator	----	----	----	1-3/4	3-3/4	10

3.5.11 Type IC/PEC photo-electric cell. The type IC/PEC tachometer shall be a portable, self-contained unit which is capable of indicating the r/min of a rotating object without mechanical or wire connections to the object. The instrument shall employ a cadmium sulphide photo-electric cell (or equal) which shall be activated by pressing a pushbutton switch and aiming the unit at a marker placed in the object whose r/min is being connected. The cell shall respond to the slight light changes caused by the machine on the rotating object transmitting a signal to a pulse triggered computer which counts the light change rate, computes the r/min, then projects the figures on the direct reading meter.

3.5.11.1 Range. The tachometers shall conform to the applicable range shown in table X.

TABLE X. Ranges for type IC/PEC.

Type	Scale range
	r/min
IC/PEC-1	0 - 1,000
IC/PEC-2	0 - 3,000
IC/PEC-3	0 - 10,000
IC/PEC-4	0 - 30,000

3.5.11.2 Photo-electric cell. The cell shall be cadmium sulphide (or equal) and shall be capable of responding to the slight light change caused by a contrasting marker placed on a rotating or reciprocating object.

3.5.11.3 Computer and electronic component. The computer shall be designed to receive the signal from the photo-electric cell, count the light change rate, compute the r/min and project this reading in the indicator.

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3.5.11.4 Indicator. The indicator shall be a direct reader ruggedized meter conforming to MIL-M-10304. The meter shall have a 250-degree scale and deflection.

3.5.11.5 Accuracy. Accuracy of the system shall be not less than plus or minus 2 percent of the full scale reading at any point on the scale at any ambient temperature between 40°F and 149°F.

3.5.11.6 Damping. The accuracy requirements specified in 3.5.11.5 shall be met within 2 seconds after the object whose speed is being measured, a constant rate of speed at any temperature between 40°F and 149°F.

3.5.11.7 Dimensions. Overall dimensions of the unit shall not exceed 6 inches by 3 inches by 4 inches.

3.5.12 Type IC/TDC, digital contact. The type IC/TDC tachometer shall contain in a single hand-held portable plastic or metal case, the mechanism to convert continuous rotary motion into information for digital display. The tachometer shall run free when the spindle is applied to a rotating shaft until a button is depressed and maintained to activate the counting mechanism. The speed indication shall not be seen on the display after the button has been released but it shall have a memory button to recall the last speed reading. The tachometer mechanism shall be such that separate readings may be obtained at intervals of 10 seconds without damage to the mechanism and within the accuracy requirements of 3.5.12.3.

3.5.12.1 Range. The type IC/TDC shall be capable of indicating over the following ranges:

0 to 20,000 r/min
0 to 2,000 ft/min (with rubber-tired wheel (see 3.5.12.7))

3.5.12.2 Display. The display shall have five LCD digits. The digits shall be of size and color as to facilitate quick and accurate readings. The display shall give the r/min reading directly and when the spindle is fitted with a rubber-tired wheel (see 3.5.12.7), readings of linear velocity in ft/min shall be readily obtained from the r/min indicator by the application of a simple conversion factor, which shall be indicated on the dial.

3.5.12.3 Accuracy. The allowable error of the IC/TDC tachometer shall be not greater than plus or minus 1 r/min for the entire range of the tachometer when in a vertical or horizontal position at any ambient temperature between 40°F and 149°F. The display shall update any fluctuations in speed once every second.

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3.5.12.4 Damping. The accuracy requirement specified in 3.5.12.3 shall be met within 2 seconds after the object whose speed is being measured reaches a constant rate of speed at any temperature between 40°F and 149°F.

3.5.12.5 Dimensions and weight. The dimensions and weight of the IC/TCD tachometer shall not exceed the following:

Length (from base to tip) - 10-1/4 inches
 Width - 4 inches
 Depth - 3 inches
 Shaft diameter - 0.275 inch
 Weight (including batteries but excluding carrying case and other accessories) - 24 ounces

3.5.12.6 Power source. The type IC/TCD tachometers shall be powered by four AA 1.5-volt batteries. A "low batteries" indicator shall also be provided.

3.5.12.7 Accessories. Each type IC/TCD tachometer shall be provided with the following accessories:

- (a) One triangle steel tip (may be the drive spindle itself)
- (b) One conical rubber tip, metal-mounted
- (c) One rubber-lined metal cone tip
- (d) One rubber-tired wheel tip (for obtaining measurements of linear velocity)
- (e) One extension rod approximately 4 inches long

3.6 Technical data. The contractor shall prepare technical data in accordance with the data ordering documents specified (see 6.1.2).

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Inspection system. The contractor shall provide and maintain an inspection system acceptable to the Government for supplies and services covered by this specification. The inspection system shall be in accordance with MIL-I-45208 (see 6.1.2).

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4.2 Qualification inspection. Qualification inspection shall be conducted at a laboratory satisfactory to the Naval Sea Systems Command (NAVSEA). One sample tachometer shall be subjected to the examination and tests specified in table XI.

TABLE XI. Qualification inspection.

Examination and test	Requirement paragraph	Test paragraph
General examination	3.3	MIL-1-983
Accuracy (initial)	3.5.1.3, 3.5.2.5, 3.5.3.3, 3.5.4.2, 3.5.5.3, 3.5.6.2, 3.5.7.4, 3.5.8.7, 3.5.9.3, 3.5.10.2, 3.5.11.5, and 3.5.12.3	4.4.1
Damping	3.5.2.6, 3.5.3.4, 3.5.5.4, 3.5.6.3, 3.5.7.5, 3.5.8.8, 3.5.9.4, 3.5.10.3, 3.5.11.6, and 3.5.12.4	4.4.2
Supply line voltage and frequency variation ^{1/}	3.3	MIL-1-983
Electromagnetic interference ^{1/}	3.4.10	4.4.6
Airborne noise ^{1/}	3.3	MIL-1-983
Magnetizing	3.4.2	4.4.3
Structureborne noise for submarine equipment	3.3	MIL-1-983
Temperature and humidity	3.3	MIL-1-983
Inclination ^{2/}	3.3	MIL-1-983
Accelerated life	3.3 and 3.4.5	4.4.4
Dielectric strength and insulation resistance ^{1/}	3.3	MIL-1-983
Enclosure	3.5.2, 3.5.4, 3.5.5, 3.5.6, and 3.5.7	MIL-1-983
Salt spray ^{2/}	3.3	MIL-1-983
Vibration (nonvital)	3.3	MIL-1-983
Shock	3.4.6	4.4.5
Accuracy (final)	3.5.1.3, 3.5.2.5, 3.5.3.3, 3.5.4.2, 3.5.5.3, 3.5.6.2, 3.5.7.4, 3.5.8.7, 3.5.9.3, 3.5.10.2, 3.5.11.5, and 3.5.12.4	4.4.1

See footnotes at top of next page.

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- 1/ Applies to types 1C/EFA, 1C/EFB, 1C/EFC, 1C/efd, 1C/EPC, 1C/EPD, and 1C/PEC.
- 2/ Inclination and salt spray tests required for control or accessory package for types 1C/EFB, 1C/EFA, 1C/EFB, 1C/EFC, and 1C/efd. Inclination test required for 1C/TCB.

4.2.1 Extension of qualification approval (types 1C/BPP, 1C/CFB, 1C/CPE, 1C/EPC, and 1C/PEC). If a manufacturer desires qualification approval for a complete range of tachometers under the types 1C/EPE, 1C/CFB, 1C/CPE, 1C/EPC, and 1C/PEC, the following samples will be required:

- (a) Types 1C/BPP, 1C/EPC, and 1C/PEC. One sample of the lowest range and one of the highest range.
- (b) Types 1C/CFB and 1C/CPE. One sample of the lowest range, one mid range and one of the highest range.

When the samples have been tested and approved, qualification approval will be extended to cover the complete range for the applicable type.

4.3 Quality conformance inspection. Quality conformance inspection shall consist of the group A inspection of 4.3.1 and the group B inspection of 4.3.2.

4.3.1 Group A inspection. Each tachometer shall be subjected to the group A inspection shown in table XII. The results of each examination and test shall be compared to the requirements of this specification. If any tachometer fails in the examination or in any test, it shall be rejected.

TABLE XII. Quality conformance inspection.

Examination and test	Requirement paragraph	Test paragraph
<u>Group A</u>		
General examination	3.3	MIL-1-983
Accuracy (initial)	3.5.1.3, 3.5.2.5, 3.5.3.3, 3.5.4.2, 3.5.5.3, 3.5.6.2, 3.5.7.4, 3.5.8.7, 3.5.9.3, 3.5.10.2, 3.5.11.5, and 3.5.12.3	4.4.1 (75°F (ambient))
Damping	3.5.2.6, 3.5.3.4, 3.5.5.4, 3.5.6.3, 3.5.7.5, 3.5.8.8, 3.5.9.4, 3.5.10.2, 3.5.11.6, and 3.5.12.4	4.4.2 (75°F (ambient))
Dielectric strength and insulation resistance ^{1/}	3.3	MIL-1-983

See footnotes at end of table.

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TABLE XII. Quality conformance inspection. - Continued

Examination and test	Requirement paragraph	Test paragraph
<u>Group B</u>		
Supply line voltage and frequency variation ^{1/}	3.3	MIL-I-983
Structureborne noise for submarine equipment	3.3	MIL-I-983
Airborne noise ^{1/}	3.3	MIL-I-983
Electromagnetic interference ^{1/}	3.4.10	4.4.6
Accuracy (initial)	3.5.1.3, 3.5.2.5, 3.5.3.3, 3.5.4.2, 3.5.5.3, 3.5.6.2, 3.5.7.4, 3.5.8.7, 3.5.9.3, 3.5.10.2, 3.5.11.5, and 3.5.12.3	4.4.1
Temperature and humidity	3.3	MIL-I-983
Inclination ^{2/}	3.3	MIL-I-983
Accelerated life	3.4.5	4.4.4
Enclosure	3.5.2, 3.5.4, 3.5.5, 3.5.6, and 3.5.7	MIL-I-983
Salt spray ^{2/}	3.3	MIL-I-983
Vibration (nonvital)	3.3	MIL-I-983
Damping	3.5.2.6, 3.5.3.4, 3.5.5.4, 3.5.6.3, 3.5.7.5, 3.5.8.8, 3.5.9.4, 3.5.10.3, 3.5.11.6, and 3.5.12.4	4.4.2
Magnetizing	3.4.2	4.4.3
Shock	3.4.6	4.4.5
Accuracy (final)	3.5.1.3, 3.5.2.5, 3.5.3.3, 3.5.4.2, 3.5.5.3, 3.5.6.2, 3.5.7.4, 3.5.8.7, 3.5.9.3, 3.5.10.2, 3.5.11.5, and 3.5.12.3	4.4.1

^{1/}Applies to types IC/EFA, IC/EFB, IC/EFC, IC/EFD, IC/EPC, IC/EPD, and IC/PEC.

^{2/}Inclination and salt spray tests required for control or accessory package for types IC/EFB, IC/EFA, IC/EFB, IC/EFC, and IC/EFD. Inclination test required for IC/TDC.

4.3.2 Group B inspection. Group B inspection shall be conducted when the basic design of the tachometer or material of a vital part has been changed. One complete tachometer shall be selected and subjected to the Group B tests shown in table XII.

4.3.3 Quality conformance inspection report. A quality conformance inspection report shall be prepared in accordance with the data ordering documents (see 6.1.2).

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4.4 Tests.4.4.1 Accuracy tests.

4.4.1.1 Types 1C/APP, 1C/EPF, 1C/EPP, 1C/EPA, 1C/EPF, 1C/EEC, 1C/EED, 1C/EPC, 1C/EPD, 1C/PEC, and 1C/TDC. Accuracy tests shall be conducted utilizing test equipment capable of maintaining exact driveshaft speeds. The speed of the driveshaft shall be governed by a synchronous motor operating on a power source with a frequency controlled to one part in 20,000 or by equivalent means. Speed changing gears or other equivalent means shall provide driveshaft speeds (in both clockwise and counterclockwise directions) over the range of the tachometer in steps of 100 to 1,000 r/min, 1,000 to 10,000 r/min, and 10,000 to 50,000 r/min. For the type 1C/EPF tachometer, steps of 100 r/min over the range of the tachometer shall be provided. The tachometers shall meet the accuracy requirements for the applicable type. Accuracy of type 1C/EFD may be determined and verified by use of an oscillator signal device of 0.1 percent accuracy, provided, proof that the complete tachometer will function accurately from signals derived from a mechanical signal source.

4.4.1.2 Types 1C/CFB and 1C/CPB. Accuracy tests shall be conducted on the types 1C/CFB and 1C/CPB tachometers utilizing a variable frequency oscillator and electro-magnetic drive for excitation of the tachometer. A second variable frequency oscillator shall be accurately calibrated for use as a standard of measurement. A cathode ray oscilloscope with one set of plates connected to the excitation oscillator and the other set of plates connected to the calibrated oscillator, shall be used to maintain an accurate fixed ratio between the outputs of the oscillators using Lissajou's figures. The tachometers shall meet the accuracy requirements of 3.5.4.2.

4.4.1.3 Temperature. Accuracy tests shall be conducted at 40°F, 75°F, and 149°F. The accuracy shall be checked at a minimum of five equally spaced operating speeds over the range of the tachometer. The tachometer shall conform to the applicable requirement (see table XIII).

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TABLE XIII. Temperature/accuracy and damping.

Type	Accuracy and temperature	Damping
1C/APB	3.5.1.3	-----
1C/BFB	3.5.2.5	3.5.2.6
1C/BPB	3.5.3.3	3.5.3.4
1C/CFB and 1C/CPB	3.5.4.2	-----
1C/EFA	3.5.5.3	3.5.5.4
1C/EFB	3.5.6.2	3.5.6.3
1C/EFC	3.5.7.4	3.5.7.5
1C/EFD	3.5.8.7	3.5.8.8
1C/EPC	3.5.9.4	3.5.9.4
1C/EPD	3.5.10.2	3.5.10.3
1C/PEC	3.5.11.5	3.5.11.6
1C/IDC	3.5.12.3	3.5.12.4

4.4.2 Damping tests. Damping tests shall be conducted on the following types to determine conformance with the applicable requirements (see table XIII).

4.4.3 Magnetizing. While operating at a constant speed of approximately 50 percent of full scale range, the tachometer shall be placed in varying positions in a unidirectional magnetic field having a flux density in free air of approximately 5 gauss. The error of tachometers shall be within the requirements specified in 3.4.2.

4.4.4 Accelerated life. Tachometers shall be operated at a constant speed approximately equal to the midpoint of their range for four periods. The periods for the different types shall be as follows:

- (a) Types 1C/APB, 1C/PEC, and 1C/IDC - 1 hour
- (b) Types 1C/BPB, 1C/BFB, 1C/CPB, 1C/CFB, 1C/EPC, 1C/EPD, 1C/EFA, 1C/EFB, 1C/EFC, and 1C/EFD - 25 hours each

The first and fourth period tests shall be conducted at room temperature (nominal 75°F). The second period tests shall be conducted at 40°F and the third period at 149°F with relative humidity varying during both periods between approximately 50 and 90 percent in alternate hour periods. All tachometers shall operate satisfactorily during these tests within their required accuracy. Type 1C/APB, 1C/BPB, and 1C/BFB tachometers shall be lubricated at 2-hour intervals during accelerated life tests.

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4.4.5 Shock. Types 1C/EFA, 1C/EFB, 1C/EFC and 1C/EPD, exclusive of associated indicators, all components of type 1C/BFB and separately mounted magnetos, generators, controls and voltage supply units shall be subjected to the type A, grade B, class 1, lightweight equipment test of MIL-S-901. All other types shall be subjected to the shock test of method 212, test condition 1 of MIL-STD-202. Types 1C/APB and 1C/PEC shall be shock tested while in the carrying case.

4.4.6 Electromagnetic interference (types 1C/EFA, 1C/EFB, 1C/EFC, 1C/EPD, 1C/EPC, 1C/EPD, 1C/PEC, and 1C/TCD). The tachometers shall be subjected to the electromagnetic interference test of MIL-STD-462.

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisitions. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation-packaging, packing, and marking. The equipment, accessories, manuals and data shall be preserved-packaged level A or C, packed level A, B, or C as specified (see 6.1.1) and marked in accordance with MIL-E-17555.

5.2 Sensitive electronic item protection. Items such as, but not limited to, diodes, transistors, integrated circuits, and equipments incorporating such items which are susceptible to damage from electrostatic, electromagnetic, magnetic or radioactive field forces shall be protected against such damage as follows:

5.2.1 General requirements.

- (a) Lead and terminal protection. Leads or terminals configuration shall be maintained as manufactured without causing loads or stresses capable of causing damage to the item. Protection shall be by means of a carrier, container design, or inserts of suitable noncorrosive electrostatic-free supporting materials. Materials used to maintain item position and lead or terminal configuration shall permit item removal and replacement without damage to the item.

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(1) Carrier. Carriers, when used for additional protection of miniature electronic items, shall be of sufficient strength to withstand vibration and shocks expected in the handling and transportation environment without introducing damaging resonances, shocks, and electrostatic charges to the sensitive item(s). Anchoring or securing of the item, leads or terminals within the carrier by means of tape or adhesive is prohibited. The carrier shall maintain physical separation and manufactured configuration of the item leads or terminals during packaging, handling, transportation, storage/stowage and for testing operations. The carrier shall permit safe and easy removal, inspection, and item replacement, and shall have no sharp edges which could damage the item and packaging material/method.

(b) Wraps and cushioning. Wraps and cushioning, when required for additional protection, shall be noncorrosive and in compliance with the requirements of MIL-P-116, and shall not crumble, flake, powder or shed. Wraps or cushioning in direct contact with electrostatic sensitive item(s) shall conform to the electrostatic protection requirements specified herein.

5.2.2 Specific requirements.

5.2.2.1 Electrostatic protection. Item(s) adversely affected by electrostatic field forces shall be provided an initial wrap of material conforming to type II of MIL-B-81705 or cushioned in material conforming to type III, style A or E, of PPP-C-1042, and unit packaged in heat-sealed bags conforming to type 1, class F, style 1 of MIL-B-117. Alternatively, reclosable cushioned pouches conforming to type 1 or II of MIL-P-81997 may be used in lieu of the initial wrap or cushioning. Noncorrosive conductive material(s) shall be applied to all exposed leads and connector pins to maintain a common potential and to protect the item(s) from electrostatic charge(s) that may be encountered during handling. Packaging materials currently covered by title, scope, or intended use under Government specification(s), but modified as electrostatic-free material(s), or newly developed electrostatic-free packaging material(s) not covered by a Government packaging material specification(s) are encouraged for use. Use of such modified or newly developed electrostatic-free packaging material(s) will be permitted subject to the contracting officer's determination

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that (a) the physical properties of such material(s) are equal to or better than similar constructed material(s) covered under a required Government packaging material specification and, (b) that such materials satisfy the electrostatic properties (decay rate) requirement of MIL-E-81705. The material manufacturer or contractor shall furnish to the Government inspector, for review, documented proof of conformance to the requirements specified herein, certified by an acceptable testing laboratory. Upon submission for acceptance, copies of the contractor's documented proof shall be forwarded to the contracting officer packaging activity. The decision of the contracting officer shall be final as the acceptability or nonacceptability of the packaging material and that decision shall not be subject to review under the disputes clause of the contract. When such materials are acceptable, unit packaging shall be in accordance with the procedures for electrostatic protection.

5.2.2.2 Electromagnetic protection. Unless otherwise specified (see 6.1.1), item(s) subject to damage by electromagnetic forces shall be unit packaged in heat-sealed, barrier bags conforming to type I or II, class E, style 1 or type I, class F, style 1 of MIL-B-117. When type I or II, class E, style 1 bags of MIL-B-117 are selected and used, the barrier material shall also contain a laminate of aluminum foil as well as meeting the requirements of MIL-B-117.

5.2.2.3 Electromagnetic and electrostatic protection. When the item(s) requires both electromagnetic and electrostatic protection, unit packaging shall be as specified under "Electrostatic protection".

5.2.2.4 Magnetic protection. Protection against magnetic fields (as opposed to electrostatic or electromagnetic forces) shall be accomplished by completely enclosing the item(s) in ferrous material or ferritic compositions of sufficient thickness to prevent item degradation.

5.2.2.5 Radioactivity protection. Protection against radioactivity shall be accomplished by completely enclosing the item in lead or lead filled compositions of sufficient thickness to prevent item degradation.

5.2.2.6 Marking. In addition, to the markings required by MIL-STD-129 and the contract, the MIL-STD-129 markings for sensitive electronic items shall apply except as follows: The sensitive electronic device caution label 2 inches by 2 inches, or less, specified for intermediate packages shall be used for unit packages in lieu of the device symbol. In addition, special caution markings shall be placed on all unit and intermediate

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(interior) packages and shipping containers. Electrostatic sensitive item caution markings may be placed adjacent to the MIL-STD-129 sensitive electronic device caution label. Caution markings shall be as follows:

"CAUTION--ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See NAVSEA OD 46363 for protective handling or testing measures for this item."

5.3 Cushioning, cushioning-materials, and dunnage. The requirements for cushioning, cushioning-materials, and dunnage (loose-fill) shall be as specified in MIL-R-196 and shall also apply to 5.1.

5.4 Talc/talcum. Talc/talcum used in the packaging process of item(s) shall be free of asbestos and asbestiform like materials.

6. NOTES

6.1 Ordering data.

6.1.1 Acquisition requirements. Acquisition documents should specify the following:

- (a) Title, number, and date of this specification.
- (b) Type required (see 1.2).
- (c) Whether panel or bulkhead mounting is required (see 3.5.2, 3.5.4, 3.5.5, 3.5.6, 3.5.6.1, 3.5.7, 3.5.7.3, and 3.5.8.6).
- (d) If drive equipment is not required for type IC/BFB (see 3.5.2.1).
- (e) Range required for type IC/BFB (see 3.5.2.3).
- (f) Type of drive mechanism required (see 3.5.5.1 and 3.5.6).
- (g) When self-contained red illumination is required (see 3.5.6.1).
- (h) Whether generator, control box, and indicator should be other than drip-proof construction (see 3.5.7).
- (i) If one or two additional indicators are required (see 3.5.8.1, 3.5.8.2, and 3.5.8.6).
- (j) Shaft speed and equipment-operational environment for type IC/EPD-A and IC/EPD-B (see 3.5.8.4).
- (k) Scale range required for type IC/EPD (see 3.5.10.1).
- (l) Levels of preservation-packaging and packing required (see 5.1).
- (m) Unit packaging other than specified (see 5.2.2.2).

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6.1.1.1 Provisioning. Provisioning technical documentation and provisioning parts should be furnished as specified in the contract.

6.1.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

<u>Paragraph</u>	<u>Data requirements</u>	<u>Applicable D1D</u>	<u>Option</u>
3.6	Drawings	DI-E-7031	Level 3
3.6	Operating and maintenance data	UDI-M-23461	
4.1.1	Inspection system plan	DI-R-4803	
4.3.3	Quality conformance inspection report	UDI-T-23741	
5.2.1	Packaging and transportation support data	UDI-P-23506	

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.1.2.1 The data requirements of 6.1.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/ acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.2 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable Qualified Products List QPL 16049 whether or not such products have actually been so listed by that date. The attention of

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the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is Naval Sea Systems Command, Department of the Navy, Washington, DC 20362, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification, SD-6" (see 6.2.1).

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

6.3 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue, due to the extensiveness of the changes.

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

6.5 Superseding data. The multiple range tachometers of MIL-T-16049B have been replaced by single range units as follows:

<u>This specification</u>	<u>MIL-T-16049B</u>
1C/APB	1C/APA
1C/BPB	1C/EPA
1C/EPC	1C/EPA
1C/EPD	1C/EPB

Custodians:
Navy - SH
Air Force - 99

Preparing activity:
Navy - SH
(Project 6680-0181)

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