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SUPERSEDING
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MILITARY SPECIFICATION

BORESCOPE ASSEMBLIES, CYLINDER INSPECTION

This specification is approved for use by the Armament Research and Development Engineering Center (Tool and Equipment Engineering Division, Standardization and Specification Engineering Branch), Department of the Army, and is available for use by all Departments and Agencies of the Department of Defense.

1 SCOPE

1.1 Scope. This specification covers borescope assemblies (optical devices) with integral light source for visual inspection of internal combustion engine cylinders. The devices are for insertion through a fuel injection nozzle hole or other opening.

1.2 Classification. Borescope assemblies shall be of the following types as specified in the contract or order (see 6.2.1).

Type I - Rigid borescope probe
Type II - Flexible borescope probe

2 APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards 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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Armament Research and Development Center, ATTN: SMCAR-EST-S, Rock Island, IL 61299-7300 by using a self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6650

SPECIFICATIONS

FEDERAL

J-C-580 - Cord, Flexible, And Wire, Fixture (Electrical, 0 to 600 Volt Service)
PPP-B-601 - Boxes, Wood, Cleated-Plywood
PPP-B-636 - Box, Shipping, Fiberboard
PPP-C-843 - Cushioning Material, Cellulosic

MILITARY

MIL-B-121 - Barrier Material, Greaseproofed, Waterproofed, Flexible
MIL-P-116 - Preservation, Methods of
MIL-B-22191 - Barrier Materials, Transparent, Flexible, Heat Sealable

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards for Federal Services

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-130 - Identification Marking of US Military Property
MIL-STD-454 - Standard General Requirements for Electronic Equipment
MIL-STD-889 - Dissimilar Metals

(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.)

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D3951 - Standard Practice for Commercial Packaging
ASTM E380 - Standard for Metric Practice

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

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3 REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.3 and 6.2.1).

3.2 Design. The borescope assembly shall be new and of the manufacturer's latest design which shall meet the requirements specified herein. The borescope assembly shall be comprised of a borescope with an eyepiece at one end and optics designed for right angle viewing at the other end. A light source connected by a fiber optic light guide cable to the borescope shall be provided. A carrying case for all the components shall also be provided.

3.2.1 Type I. The type I borescope assembly shall have a fixed borescope probe capable of being rotated 360 degrees.

3.2.2 Type II. The type II borescope assembly shall have a flexible borescope probe.

3.2.3 Measurement system. The US Customary System of Units (US) or the International System of Units (SI) may be used in the design and construction of the light assembly. In this specification, all measurements, dimensions, sizes, and capacities are given in the US system. These measurements may be converted to the SI system by using the conversion factors and methods specified in ASTM E380.

3.3 Material. Materials not specifically designated herein or in the contract shall be of a quality commensurate with commercial practice within the manufacturing industry, shall be suitable for the intended purpose in the design of the end item, and shall meet all requirements specified herein. Materials shall be free from defects which would adversely affect the performance or maintainability of the individual components or the overall assembly. It shall not be permissible to use reclaimed parts as is, or rebuilt from scrap or other used equipment. When dissimilar metals are used in contact with each other, suitable protection against galvanic corrosion shall be applied in accordance with MIL-STD-889.

3.4 Construction. Construction of the borescope assembly shall be free from any characteristics or defects that shall prevent the borescope assembly from passing the examination or any of the tests in section 4. The borescope assembly shall be complete and capable of performing the operations specified herein. Surfaces of all parts shall be clean and free from extraneous materials. External surfaces shall be smooth and free from the sharp edges.

3.4.1 Welding, brazing, and soldering. Welding, brazing, and soldering shall be of a quality which shall sustain all requirements of the welded, brazed, or soldered parts. These operations shall not be employed as repair measures for defective parts.

3.4.2 Electronic connections. Connections of conductors and terminal parts shall be of the screw, pressure, or solder type. Soldered connections of the conductors and terminal parts shall be mechanically secured before soldering. Soldering shall be in conformance with MIL-STD-454. Only rosin base fluxes shall be used in soldering operations. Connections to screw-type terminals shall be mechanically secured with means to prevent loss of tightness.

3.4.3 Interchangeability. All parts shall be manufactured to definite standards, clearances, and tolerances in order that any such parts of a particular type or model may be replaced, interchanged, and adjusted without modification of the replacement parts or any other parts of the unit. When practical, all parts shall be permanently and legibly marked in accordance with MIL-STD-130.

3.4.4 Threads. Threads shall conform to FED-STD-H28 and the applicable "Detailed Standard" section referenced therein.

3.5 Carrying case. The borescope assembly shall be delivered in a sturdy case of wood, metal or fiberglass. The case shall have interior partitions and inserts to securely hold the components of the borescope assembly to prevent damage during handling and storage. The case shall have two or more snaplocks or other positive-acting fasteners of sufficient design to prevent inadvertent opening during transporting, storage, or handling. The case shall be equipped with one or more handles large enough to provide ease in handling. The case shall be painted or protective finish applied in accordance with the industries commercial practice.

3.6 Performance characteristics.

3.6.1 Light source. The light source shall be capable of varying the light intensity at the borescope from 0 to at least 250 candlepower. The light source shall use 110-120 volt alternating-current (AC) at 50-60 hertz (Hz).

3.6.2 Cable. A fiber optic cable shall transmit the light from the light source to the borescope.

3.6.3 Borescope type I and type II. The borescope shall have the center line of the eyepiece lens in the same line as the longitudinal axis of the borescope probe. The entrance pupil of the borescope shall be designed for viewing 90 degrees from the longitudinal axis of the borescope probe/eyepiece and have a cone vision not less than 50 degrees. The borescope shall have the optical capability of delivering a 1:1.0 to 1.2 image to the eyepiece without distortion when the object is located 2.75 inches from the entrance pupil. The eyepiece and accompanying optics shall be corrected for spherical and chromatic aberration and shall have a resolution of 80 lines pairs per millimeter using a low contrast target placed 3.000 to 3.125 inches from the entrance pupil. The image transmitted to the eyepiece shall be at least 0.50 inch diameter measured at the eyepiece.

3.7 Details of components.

3.7.1 Light Source. The light source shall be equipped with the following:

(a) A ground 3-conductor insulated cord of at least 18AWG wire conforming to J-C-580 for flexible or semiflexible cords. The cord shall have a standard commercial 3-prong grounding plug having two parallel blades.
(b) A switch to turn off the power when not in use.
(c) A pilot light to indicate when the power is on.
(d) A voltage control knob and output voltage indicator permanently marked to show the direction of voltage increase and decrease.

3.7.2 Cable. A fiber optic cable contained within a flexible metal cable for maximum durability. The cable shall be of not less than six feet long with connections to the light source and to the borescope.

3.7.3 Borescope type I. The type I borescope shall have a rigid probe constructed of stainless steel that is durable enough to resist wear, tear and breakage. The probe shall have a working length of at least 14 1/2 inches and a diameter of not more than 0.216 inch. The borescope shall have a rotary collar that allows rotation of the borescope probe without rotation of the light guide cable. The borescope shall have a built-in rotation of the light guide cable. The borescope shall have a built-in, easy-snap connector assembly on the handle to protect the light guide cable.

3.7.4 Borescope type II. The type II borescope shall have a flexible fiberscope probe with a protective cover. The probe with cover shall have a working length of at least 30 inches and a diameter of not more than 0.216 inch. The borescope shall have a built-in, easy-snap connector assembly on the handle to protect the light guide cable.

3.8 Weight. Total weight of all components of the borescope assembly, exclusive of case, shall be not more than 18 pounds.

3.9 Identification marking. The borescope assembly and case shall be marked for identification in accordance with MIL-STD-130 and, unless otherwise specified (see 6.2.1), shall include the National Stock Number.

3.10 Workmanship. Workmanship of the borescope assembly and case shall be of the best quality prevailing among manufacturers of this type of equipment. All components shall be free from imperfections which will adversely affect the general appearance, function or serviceability.

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 specifications where such inspections are deemed necessary to assure supplies and services conform to the prescribed requirements.

4.1.1 Responsibility for compliance. All items must 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 assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall be applied to the preproduction model or initial production item (see 3.1). Unless otherwise specified (see 6.2.1), first article inspections shall consist of the examination in 4.6 and all tests under 4.7. Failure of the first article to pass the examination or any of the tests shall be cause for rejection.

4.4 Quality conformance inspection. Unless otherwise specified (see 6.2.1), quality conformance inspection shall be applied to production items offered for acceptance under the contract. Unless otherwise specified (see 6.2.1), quality conformance inspection shall consist of (a) through (c) below. Failure of any item to pass an examination shall be cause for rejection of the item.

(a) Product examination (see 4.6).
(b) Test (see 4.7).
(c) Packaging inspection (see 4.8).

4.5 Sampling. Unless otherwise specified (see 6.2.1), sampling for quality conformance inspection shall be in accordance with MIL-STD-105, at the inspection level and Acceptable Quality Level (AQL) as follows:

Inspection	Inspection Level	AQL
Product examination (see 4.6)	II	1.0
Electrical test (see 4.7.2)	II	1.0
Field of vision test (see 4.7.3)	II	1.0
Illumination test (see 4.7.4)	II	1.0
Magnification test (see 4.7.5)		
Spherical and chromatic aberrations and resolution test (see 4.7.6)	II	2.5
Packaging inspection (see 4.8)	S-4	4.0

4.6 Product examination. Visually, manually, and dimensionally examine the borescope to determine conformance with the requirements of 3.2 through 3.4.2, 3.4.4 through 3.5 and 3.7 through 3.10. Visual examination shall include verification of completeness of manufacture and assembly, conformance to specified standards, adequacy of markings, proper cleaning, and freedom from identified defects. Manual examination shall include the operation of movable parts by hand to assure proper functioning. Dimensional examination shall include verification and the unit may be applied at the earliest practical point in manufacture at which it is feasible to inspect for acceptance without risk to change in the characteristic by subsequent operations. Failure of the contractor to provide objective evidence that the unit has passed the visual, manual, and dimensional verifications prescribed for it by the contractor's inspection system shall be cause for rejection. In addition, failure of the contractor to provide objective evidence that all parts are manufactured to definite standards, clearances, and tolerances so that no replacement part will degrade the form, fit, or function of the end item, shall be cause for rejection.

4.7 Test. Measuring instruments used in performing the listed tests shall be more accurate by a factor of 10 than the specified limits, and shall be traceable to the National Bureau of Standards. Failure of the borescope to meet test requirements shall be cause for rejection.

4.7.1 Interchangeability test. The borescope shall be assembled using components of at least three different borescope assemblies to determine compliance with interchangeability requirements (see 3.4.3).

4.7.2 Electrical test. The borescope assembly shall be connected to a 110-120 Volt AC at 50-60 Hz power source. The light source shall be capable of varying the light intensity from 0 to a minimum of 250 candlepower at the borescope (see 3.6.1 and 3.6.2).

4.7.3 Field of vision test. The entrance pupil shall be tested for its capacity for viewing 90 degrees from the longitudinal axis of the borescope tube/eyepiece and providing a cone of vision not less than 50 degrees (see 3.6.3).

4.7.4 Illumination test. The borescope assembly shall be tested for its capability to provide 250 foot-candle illumination at 3 inches from the face of the light, measured along a line at right angles to the principal axis of vision of the borescope (see 3.6.1 and 3.6.3).

4.7.5 Magnification test. The borescope assembly shall be tested for optical capability of delivering a 1:1.0 to 1.2 image from 2.75 inches from the face of the entrance pupil to an eyepiece at the opposite end of the probe without distortion (see 3.6.3). The image transmitted by the entrance pupil shall be a minimum diameter of 0.50 inch, measured at the eyepiece (see 3.6.3).

4.7.6 Spherical and chromatic aberrations and resolution test. The eyepiece of the probe and the accompanying optics shall be tested to ensure lens system correction for spherical and chromatic aberrations and a resolution of 80 line pairs per millimeter using a low contrast target placed 3.000 to 3.125 inches from the entrance pupil (see 3.6.3).

4.8 Packaging inspection. Packaging inspection shall be conducted before and after packaging to determine compliance with the requirements of section 5.

5 PACKAGING

5.1 Preservation. Preservation shall be Level A or Industrial as specified in the contract (see 6.2.1).

5.1.1 Level A.

5.1.1.1 Cleaning and drying. The borescope assembly with all component parts and accessories shall be cleaned in accordance with process C-1 and dried in accordance with procedures D-1 and D-4 of MIL-P-116.

5.1.1.2 Unit protection. Technical data issued with the borescope assembly shall be packaged in accordance with method IC-1 for MIL-P-116 and close by heat sealing or stapling. Place the borescope, components and technical data in their respective storage compartments in the carrying case. All components, in the carryng case, shall be securely cushioned with material conforming to PPP-C-843, type II. Each borescope assembly, in the carrying case, shall be packaged in accordance with method IC-2 of MIL-P-116, utilizing a fiberboard box conforming to PPP-B-636, class domestic, as the unit container. Fasteners and hinges, on the case, shall be taped over or cushioned before placing in the unit box in accordance with the box specification and the appendix thereto. Barrier material shall conform to MIL-B-22191, type II or MIL-B-121 for waterproof bag.

5.1.2 Industrial. Industrial preservation shall be as specified in ASTM D3951.

5.2 Packing. Packing shall be Level A, Level B, or Industrial as specified in the contract (see 6.2.1).

5.2.1 Level A. The borescope assemblies shall be packed in boxes conforming to PPP-B-601, overseas type. Closure shall be in accordance with the appendix of the container specification.

5.2.2 Level B. The borescope assemblies shall be packed in boxes conforming to PPP-B-601, domestic type, style A, B, or J. Closure shall be in accordance with the appendix of the container specification.

5.2.3 Industrial. Industrial packing shall be as specified in ASTM D3951.

5.3 Marking. Marking shall be Military or Industrial as specified in the contract (see 6.2.1).

5.3.1 Military marking. Military marking shall be as specified in MIL-STD-129.

5.3.2 Industrial marking. Industrial marking shall be as specified in ASTM D3951.

6 NOTES

6.1 Intended use. The borescope assembly covered by this specification is intended for use for visual internal inspection of cylinder walls of internal combusion engines, and other similar items for the purpose of detecting defects such as corrosion, pits, and scratches, without the necessity of disassembling any part of the equipment,

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) First article, when required for inspection and approval (see 3.1 and 4.3).
(c) Identification marking, if different (see 3.9).
(d) Quality conformance inspection, if different (see 4.4).
(e) Sampling inspection, when specified (see 4.5).
(f) Preservation, packing and marking as required (see 5.1, 5.2, and 5.3 respectively).

6.2.2 Contract data requirements. Required technical data, such as operator's manuals, parts lists, and other instructions for operations and maintenance, as identified on a numbered DD Form 1664, should be specified on a DD Form 1423 incorporated into the contract.

6.3 Safety and health requirements. In order that equipment integrated into the user's environment will comply with OSHA limitations and control of noise levels, radiation, electromagnetic emission, noxious vapors, heat, etc., as applicable, specific requirements concerning such points of operation, and other health and safety requirements, should be specified by the user.

6.4 Subject term (key word) listing.

Borescope
Candlepower
Chromatic aberration
Fiber optic
Light intensity
Spherical aberration

6.5 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.

Custodian:

Army - AL
Navy - AS

Preparing Activity

Army - AL

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