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**Storage, Use, and Care of Borescopes and Fibrescopes
(Flexible Borescopes)**

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

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FOREWORD

Changes in this revision are format/editorial only.

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1. SCOPE:

This aerospace recommended practice (ARP) addresses the care, use, and training required to employ an effective borescope inspection program. Five subsections are included that cover training, storage, preoperational inspections, operation, and postoperational care related to both rigid and flexible borescopes.

Throughout this ARP, proper borescope system nomenclature and terminology are utilized as specified in SAE ARP4022, Borescope Inspection System Definitions.

1.1 Purpose:

This document is intended to provide borescope users guidance on methods of the maximum value out of their purchase of a borescope. By following these recommendations the quality of the inspections will be maintained and the service life of the borescope will be extended. A cardinal rule to be conveyed is that borescopes are delicate optical instruments and must be shipped, stored, used, and cared for accordingly by trained personnel.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

- 2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

ARP4022 Borescope Inspection System Definitions

- 2.1.2 U.S. Government Publications: Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-C-4150H
MIL-N-18307F

MIL-STD-130C

- 2.1.3 ATA Publications:

ATA 300

3. TRAINING:

- 3.1 In order to establish an effective borescope inspection program, it is absolutely necessary to have trained personnel do the inspection. The personnel selected for training in the use and care of the borescopes should be intimately familiar with the equipment being inspected. With today's technology, the value of borescope inspections is limited more by personnel capabilities than by equipment performance.
- 3.2 The training should be a formal course and tied to some form of qualification. The training should include, but not be limited to, the following:
 - 3.2.1 Classroom instruction to provide some history/background about the evolution of borescope inspections of aircraft engines.
 - 3.2.2 Classroom demonstrations of the storage, use, and care of rigid and flexible borescopes, adapters, binocular training equipment, photographic and video equipment used with some sort of training aids; i.e., Leiby Test Box, engine combustor, and available borescope trainers containing actual engine components, etc.
 - 3.2.3 Familiarity with all operating and service manuals and instructions.
 - 3.2.4 Classroom audiovisual presentation of an actual borescope inspection of an aircraft engine including photographic/video capabilities.
 - 3.2.5 Shop or flight-line instruction with students performing many actual engine inspections to gain the required experience and familiarization. It is strongly recommended that a dual viewing device and/or video/borescope system be employed during this training so that the student and instructor can simultaneously view the item/area being inspected and the instructor can provide real-time commentary.
 - 3.2.6 If possible, mock-ups of parts or a surplus engine should be designated as a training aid and known discrepant parts installed for the students to find and determine if they are in or out of limits.
 - 3.2.7 On-the-job training under supervision of a qualified borescope operator.

4. STORAGE AND SHIPPING:

4.1 Storage/Shipping Case:

The borescopes should be shipped and stored in either Military Specification (MIL-C-4150H) or commercially acceptable (ATA 300) cases that are designed to hold the borescopes and accessories securely in place in some type of shock absorbent material or device within the case.

- 4.2 The case should be clearly marked (as specified in MIL-STD-130C for military applications) to show that it contains a delicate optical instrument.

4.3 The case should be serialized for military applications as specified in MIL-N-18307F.

4.4 Storage Area:

The borescopes should always be stored in a controlled access area (tool room, supply room) in their specified shipping/storage cases. If at all possible, the storage area should have a reasonable amount of climate control to eliminate temperature extremes and excessive humidity and saltair environments. Access to the borescopes should be controlled to preclude their use by unqualified or unauthorized personnel.

4.5 Shipping:

The borescopes and accessories should always be shipped/transported in their specified cases. The shipper should ensure that each item in the case is firmly secured in position within the case. The case should be marked with words that make it very clear that it is a delicate instrument. The mode of transportation selected should preclude severe jostling or bouncing of the borescopes.

5. PREOPERATIONAL INVENTORY, INSPECTIONS, AND FUNCTIONAL CHECKS:

5.1 Physical Inventory to Determine the Following:

- 5.1.1 Borescope is complete with specified ocular and distal end adapters, control handles, eye cups, etc.
- 5.1.2 Correct light source is included with spare bulbs and fuse.
- 5.1.3 Correct light guide cable and adapters included.
- 5.1.4 Correct guide tube/tubes, straighteners, and/or engine adapters in place.
- 5.1.5 Camera, batteries, film, and related adapters included if provided as part of borescope kit, or if photography is anticipated.
- 5.1.6 Operating and service instructions included.

5.2 Visual Inspection and Functional Checks:

- 5.2.1 Visual inspection of borescopes and accessories for obvious physical damage.
- 5.2.2 Visual inspection of ocular, distal end lenses, adapter lenses, mirrors, and prisms for dirt, grease, fingerprints, etc. Clean accessible lens surfaces as prescribed by the manufacturer.

5.2.3 Functional checks of the following:

- 5.2.3.1 Manipulate the flexible borescope distal end through its full range of articulation specified by the manufacturer. Do not bend distal end of flexible borescope with hands. Use controls at ocular end of borescope.
- 5.2.3.2 Focus adjustment if so equipped.
- 5.2.3.3 Diopter correction if so equipped.
- 5.2.3.4 Rigid borescope probe rotation if so equipped.
- 5.2.3.5 Ocular and distal end adapters for attachment and positive locking characteristics.
- 5.2.3.6 Scanning mechanism if so equipped.

5.2.4 Optical Condition:

- 5.2.4.1 Without using the light source, position distal end of borescope so it is aimed at a plain white or light colored surface. Look through the scope, adjust the focus, and determine whether or not there are an excessive number of broken fibers or other defects affecting optical performance. Aim one end of the light guide (this would be the distal end for most flexible borescopes) towards a window or lamp and check the other end visually to see whether there is an excessive number of broken light guide fibers. If there are defects affecting optical performance, or an excessive number of broken fibers in the image guide and/or light guide, return the borescope to the appropriate organization for repair.
- 5.2.4.2 If available, a Leiby optical resolution test box incorporating a USAF 1951 resolution target should be used to check the optical condition of the borescope.
- 5.2.4.3 Alternatively, if Leiby test box is not available, select some item with distinct features and inspect it through the borescope to determine if adequate detail can be seen. If not, return the borescope to the appropriate organization for repair.
- 5.2.4.4 Attach ocular and/or distal end viewing adapters (side, oblique retroviewing) and perform checks cited in 5.2.4.2 and 5.2.4.3.

5.2.5 Light Source:

- 5.2.5.1 Ensure that bulb/bulbs work.
- 5.2.5.2 Manipulate the light intensity control, if applicable, throughout the full range and check to see that light intensity changes sufficiently.
- 5.2.5.3 Ensure cooling fan operates if so equipped.

5.2.5.4 Ensure that the light guide cable is compatible with the light source and borescope and transmits adequate light.

5.2.6 Photographic Equipment:

5.2.6.1 Ensure that the camera provided is specified for use in inspection criteria or borescope manufacturer's operating manual.

5.2.6.2 Check to ensure that the camera is compatible with the borescope adapter.

5.2.6.3 Make certain correct intensity light source is utilized.

5.2.6.4 Check rollers on pack film for instant prints.

5.2.6.5 Check lens/viewfinder/focus controls to ensure that they function satisfactorily.

5.2.6.6 Make certain that the shutter functions satisfactorily.

5.2.6.7 Inspect film compartment and actuate advancing mechanisms to ensure that they function satisfactorily.

5.2.6.8 Inspect lens, mirrors, and prisms to ensure that they are undamaged and clean. Clean as prescribed by the manufacturer.

5.2.6.9 If the camera requires batteries, be certain that spares are available.

5.2.7 Video Equipment:

5.2.7.1 Inspect camera, VCR, CRT, and accessories to ensure that they are undamaged.

5.2.7.2 Check camera and adapter to ensure that they are compatible with one another, and that the adapter is compatible with the borescope.

5.2.7.3 Make certain correct intensity light source is utilized.

5.2.7.4 Operate the camera, VCR, CRT, and accessories to ensure that they function satisfactorily.

5.2.7.5 Inspect lenses, eyepieces, screens, etc., to ensure that they are undamaged and clean. Clean as prescribed by the manufacturer.

6. OPERATIONAL USE:

6.1 Borescopes should be used only by thoroughly trained personnel. Selection of the most appropriate type of borescope (rigid or flexible) should be based on the inspector's experience and specified inspection criteria and procedures. Because they are easier to use and normally provide better optical resolution than flexible borescopes, the use of rigid borescopes is strongly recommended wherever practical.

- 6.1.1 Double check that the equipment gathered is the equipment specified for the particular inspection being done.
- 6.1.2 Carry the borescope and accessories to the inspection aircraft/engine in their carrying cases.
- 6.1.3 Ensure work area where access to the engine will be made is free of safety hazards. In the case of installed engines make certain other maintenance personnel are aware of the inspection being done.
- 6.1.4 Position borescope and accessories in or on safe, reasonable spaces/surfaces on the aircraft maintenance stand, shop table, etc. Ensure that the location/position of the equipment precludes it from falling, being stepped on, struck with other tooling, etc. Be especially particular about placement of the borescope and light guide during interruptions of the inspection.
- 6.1.5 Review borescope manufacturer's operating instructions and engine manufacturer's inspection criteria so that the inspection requirement and application of the borscope is thoroughly understood.
- 6.1.6 Interconnect the borescope system components as prescribed by the borescope manufacturer. Ensure light guide cable connectors are fully seated.
- 6.1.7 With power switch in off position, set light source light intensity to lowest setting and connect light source to correct power supply prescribed by the manufacturer. Turn on light source per manufacturer's instruction and manipulate the intensity control through its full range to determine that adequate light will be available for all inspection requirements. Ensure cooling fan ventilation screen/louvers are unobstructed.
- 6.1.8 Ensure distal end optical adapters (if used) are properly installed and secure. Make final check of ocular and distal end focus control, distal end articulation, and/or rigid borescope probe rotation features prior to inserting borescope into engine.
- 6.1.9 When specified, insert the proper guide tube into the engine as specified in the engine inspection procedure.
- 6.1.10 Insert the borescope into the guide tube or engine inspection port to the depth prescribed in the inspection criteria document if so specified. Ensure that boscopes go in straight, and no side loads are exerted. In the case of flexible borescope, ensure that the articulated distal end locking mechanism is "off", and the distal end is in the neutral or zero degree position. Avoid striking engine parts with distal end of borescope.
- 6.1.11 Peer through the borescope and set light intensity to desired level. Set focus and gently maneuver borescope to prescribed location within the engine.