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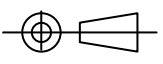
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THIRD ANGLE PROJECTION		CUSTODIAN NATIONAL AEROSPACE STANDARDS COMMITTEE	REVISION 1
PROCUREMENT SPECIFICATION NONE	TITLE BEARING INSTALLATION AND RETENTION BY SWAGING OR STAKING	CLASSIFICATION STANDARD PRACTICE NAS0331	SHEET 1 OF 43



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1. SCOPE

1.1 Scope

This standard defines the general requirements for bearing installation and includes recommended housing dimensions and usage criteria for individual design standards on bearing installation methods. This standard does not include retention by press fit, adhesives or mechanical means.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards and handbooks

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

Military

MIL-HDBK-1599

Bearings, Control System Components, and Associated Hardware Used in the Design and Construction of Aerospace Mechanical Systems and Subsystems

Copies can be obtained from the Department of Defense Single Stock Point (DODSSP). <http://dodssp.daps.dla.mil>

2.2 Order of precedence

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

3. DEFINITIONS

3.1 Terms and definitions

Though used interchangeably by some entities and individuals, the terms "swage" and "stake" as used throughout these bearing installation standards have been defined as follows:

- a. Stake: The indentation of an otherwise smooth annular surface of a bearing housing material made by a force applied with a suitable tool, for the purpose of displacing housing metal into an area which will obstruct relative axial motion between the bearing and housing, thus retaining the bearing. The metal deformation may result in cracks or splitting in the area of indentation.
- b. Swage: The cold deformation of the bearing groove lip by applied force to the manufactured surface of the bearing groove to conform to, or approach conformity to, a prepared housing face of a specified shape and thus retain the bearing in the housing.

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4. GENERAL REQUIREMENTS

4.1 General design feature

Housing bore diameters and tolerances shall conform to Requirement 202 of MIL-HDBK-1599.

5. DETAILED REQUIREMENTS

5.1 Swaging and staking methods: Usage criteria

5.1.1 Anvil swaging bearings over housing – Method 100

This is a common method of installing bearings having ductile grooved rings and is frequently used during field installations because tooling cost is low. Bearings swaged by this method are positively retained in the housing, can withstand limited axial loads applied to the bearing, and permit bearing replacement without damage to the housing.

5.1.2 Roller swaging bearings over housing – Method 200

This is a common method of installing bearings with grooved, ductile outer races. Bearings swaged by this method are positively retained in the housing, can withstand moderate axial loads applied to the bearing, and permit bearing replacement without damage to the housing.

5.1.3 Ball impression staking the housing over the bearing – Method 300

This method is used where ease of installation is required with chamfered race bearings. Bearings staked by this method can withstand only negligible axial loads applied to the bearing and permit limited bearing replacements by restaking in the field.

5.1.4 Segmented impression staking housings over bearings – Method 400

This is a common method of installing bearings with hardened races in ductile housings. Bearings staked by this method can withstand limited axial loads and permit limited bearing replacements by restaking in the field. The housing width is designed slightly thicker than the width of the bearing outer race to provide sufficient material for the impression stake.

5.1.5 Retention of bearings by swaged sleeves – Method 500

This method is useful for retaining bearings in magnesium housings or when both the race and housing are hardened materials. Sleeves which are displaced over a chamfered housing and the chamfer of the bearing will provide positive retention of the bearing under limited axial loads and permit bearing replacement without damage to the housing.

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METHOD 100: BEARINGS, GROOVED OUTER EDGE, SWAGING OF (DOUBLE ANVIL METHOD)

1. SCOPE

1.1 Scope

This standard defines the tools and provides installation and removal procedures and inspection criteria for retaining bearings which have a grooved outer race by using a set of anvil dies to swage a portion of the race over chamfers on the accommodating housing bore. Both sides of the bearing are swaged simultaneously.

1.2 Intended use

It is intended for use with any structural housing material and is applicable only to bearings containing a grooved outer race. This standard has been written around currently existing MS CRES race bearings but is intended to be adaptable to other race materials as the need arises. It will be revised as the appropriate bearing standards are released.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards and handbooks

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

Military

MIL-L-6082 Lubricating Oil, Aircraft Piston Engine (Non-Dispersant Mineral Oil)

MIL-HDBK-1599 Bearings, Control System Components, and Associated Hardware Used in the Design and Construction of Aerospace Mechanical Systems and Subsystems

Copies can be obtained from the Department of Defense Single Stock Point (DODSSP). <http://dodssp.daps.dla.mil>

SAE International

J1966 Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil)

Copies can be obtained from SAE International, 400 Commonwealth Dr., Warrendale, PA 15096-0001. www.sae.org

American Society for Quality

ANSI/ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

Copies can be obtained from the American Society for Quality, 600 North Plankinton Ave., Milwaukee, WI 53203. www.asq.org

3. EQUIPMENT

3.1 Typical swaging tools are shown in Figure 1. A swaging tool set consists of two anvils and a pilot.

3.2 A typical proof test tool is shown in Figure 2. This tool may utilize the same pilot pin as Figure 1.

3.3 Arbor press or equivalent for installing bearings.

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3.4 Hydraulic ram with pressure gauge for anvil swaging and/or applying proof loads.

3.5 Feeder gage, Ø.005 inch wire.

4. REQUIREMENTS

4.1 The housing bore, width and chamfer shall be as specified on the engineering drawing or Requirement 202 of MIL-HDBK-1599. There shall be no burrs at the I.D. edge of the chamfer.

4.2 The bearing shall, prior to and during installation, and during subsequent processing, be handled and protected from dirt and corrosion.

4.3 The bearing housing assembly shall be protected from corrosion in accordance with the applicable finish specification and MIL-HDBK-1599, Requirement 105.

4.4 Reswaging of a bearing after the initial swaging operation for the purpose of meeting acceptance limits is permissible. Bearings which have been swaged and subsequently pushed out shall be scrapped.

4.5 Bearings supplied with internal clearances shall rotate freely without binding or catching after installation. If bearings supplied with internal clearance are installed with an interference fit and preload is allowed after installation, the maximum rotational breakaway torque after installation shall not exceed the values specified on the installation drawing, handbook or installation process specification. Maximum rotational torque after installation of bearings supplied with preload shall not exceed the values specified on the applicable drawing, handbook or installation process specification. When torque values after installation are not specified, the maximum torque value after installation shall not be more than two times the maximum allowable breakaway rotational torque for the uninstalled bearings.

4.6 Tools with apparent damage or improper dimensions shall not be used.

4.7 There shall be no cracks or excessive galling on the swaged portion of the bearing.

4.8 Unless otherwise specified on the engineering drawings, all bearings shall be capable of withstanding the proof loads in Table I after installation without movement. Proof load shall be applied to both sides of the bearing as shown in Figure 2. Proof load shall be applied before breakaway torque load or radial and axial clearances are verified.

5. PROCEDURES

5.1 Prior to installation

5.1.1 Clean housing bore as necessary to remove all foreign particles and contamination prior to installing the bearing.

5.1.2 Check the bearings to assure that they are clean and free from contamination. If bearings require cleaning, clean as necessary following bearing manufacturer's recommendations. Relubricate metal-to-metal bearings with appropriate grease as required by the bearing drawing. Do not lubricate self-lubricated bearings.

5.1.3 Apply proper corrosion protection coating to the housing bore and/or bearing outside diameter surface prior to installing the bearing, as required by 4.3. Do not install bearings wet with corrosion protection where corrosion protection could interfere with relubrication provisions. After installing and swaging such bearings, the bearing to housing interface shall be coated with corrosion protection as required by the applicable finish specification.

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5.2 Bearing installation

- 5.2.1 Using the prescribed installation tool, press the bearing into the housing taking care to assure that the bearing is straight and not canted to the housing bore during insertion. Check to assure that the bearing will rotate within the torque limits specified.
 - 5.2.1.1 If an interference fit exists between the bearing and the housing bore, take extreme care in aligning the bearing with the housing bore prior to pressing it into the housing. Bearings that are canted while being pressed into the housing are easily deformed.
 - 5.2.1.2 If the bearing is mechanically pressed into the housing, with the tool face parallel with the face of the bearing race, apply the installation load using proof test tool while supporting the housing around the periphery of the bore. See Figure 3 for typical installation setup.
- 5.2.2 Obtain proper anvil swaging tool per Figure 1.
- 5.2.3 Check tool condition per 4.6.
- 5.2.4 Check the assembly to assure the bearing is properly centered in the housing. If passages are provided to relubricate metal-to-metal bearings, verify they are open.
- 5.2.5 Support the assembly in a press as shown in Figure 4.
- 5.2.6 Apply a light film of ~~MIL-L-6082~~ J1966 (or equivalent) oil to the bearing groove or to the tool each time a bearing is swaged. Do not use an excessive amount of lubricant as contamination of bearing may result.
- 5.2.7 Determine the bearing groove type, outer race diameter and material from the bearing drawing. If swaging load is not otherwise specified, use Table I as a guide to determine minimum swaging load as a starting point. Use minimum swaging force necessary to meet requirements and to avoid lip or housing damage. Variations in groove dimensions and bearing race material hardness can cause required swaging loads to vary. Apply swaging load as shown in Figure 4 and simultaneously swage both side of the bearing.
- 5.2.8 Visually determine that the lips have been swaged over the housing and check edge gap as shown in Figure 5. Reswage, if necessary, at higher swaging loads until the edge gap condition is met, as well as proof load per 5.2.9. Inspect lip for damage such as cracks, chips, etc.
- 5.2.9 Determine proof load for completed swage from engineering drawing, or if none is specified, use Table I. Apply proof load to each side of bearing. Proof load a sufficient number of bearings, which have been swaged at the same swaging load, to assure capability of meeting the proof load and edge gap.
- 5.2.10 Swage all bearings of a given lot using the same swaging load to provide uniformity of parts to resist proof load.
- 5.2.11 Proof load parts in accordance with contract requirements. In the absence of a specified sampling plan, 100% of the parts shall be proof loaded. All parts must meet the requirements shown in Table I.
- 5.2.12 Confirm that torque values are correct per 4.5.

5.3 Bearing removal procedure

- 5.3.1 Where the housing material is 150 KSI UTS or more, the swaged bearing may be pressed out without machining of the swaged-over lip.
- 5.3.2 Where the housing material is less than 150 KSI UTS, the following procedure shall be used to prevent damage to the housing.

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- 5.3.2.1 Using a suitable cutting tool, cut a groove around the portion of the bearing swaged over the housing. The diameter of the groove shall be approximately equal to but not greater than the diameter of the housing bore. Cut the groove approximately 80 percent through the swaged lip of the bearing. Exercise care not to cut completely through the bearing to prevent damaging the housing.
- 5.3.2.2 Press the bearing out of the housing.
- 5.3.3 All bearings removed from housings shall be scrapped. Under no circumstances shall these bearings be reused.
- 5.3.4 Prior to installing a new bearing, verify that the housing meets drawing requirements and that the chamfers and bores are not damaged.

6. QUALITY ASSURANCE PROVISIONS

- 6.1 Prior to installation, verify that only the appropriate tools are used to swage bearings with grooved outer races.
- 6.2 Perform a visual inspection of the tool before a production run is started. Any irregularity is cause for the tool to be subjected to a thorough dimensional inspection. Tools with improper dimensions shall not be used.
 - 6.2.1 Verify proper part numbers and dimensions of bearings and housings per engineering drawing.
- 6.3 Prior to bearing installation, verify that the housing assembly has been properly protected against corrosion as specified by the engineering drawing and 4.3.
- 6.4 After bearing installation, verify that there is no excessive galling of the swaged portion of bearings.
- 6.5 Verify that bearings were proof tested to the proper values and meet specification requirements.
- 6.6 Verify that bearings with internal clearance rotate freely without binding or catching and meet the radial and axial clearances if specified on the installation drawing.
- 6.7 Verify that bearings with preload torque do not exceed the maximum torque requirements of 4.5.
- 6.8 Verify that there is no evidence of the swaging tool having made contact with the inner face of the groove on the bearing. See Figure 5.
- 6.9 Visually inspect the swaged portion of the bearing for cracks or separations. If the visual inspection is inconclusive, inspect the bearing by penetrant inspection. No cracks or separations are permitted. Self-lubricated bearings must be masked to prevent penetrant solutions from entering bearing. Metal-to-metal bearings that have been penetrant inspected shall be cleaned and relubricated. See Figure 5.
- 6.10 Visually inspect all swaged bearings for flushness with housing sides. Asymmetry is allowed provided the race faces are within $\pm .010$ of the housing faces or as otherwise specified on the engineering drawing. Dimensionally inspect any visual irregularities. See Figure 5.
- 6.11 Verify that lubrication passages are still open, on metal-to-metal grease groove type bearings.
- 6.12 Verify that the bearing is tight in the housing. No movement of the bearing in the housing shall be allowed.

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7. NOTES

7.1 Dimensions and tolerances

All dimensions and tolerances in tables and figures herein are in inches or degrees unless otherwise specified.

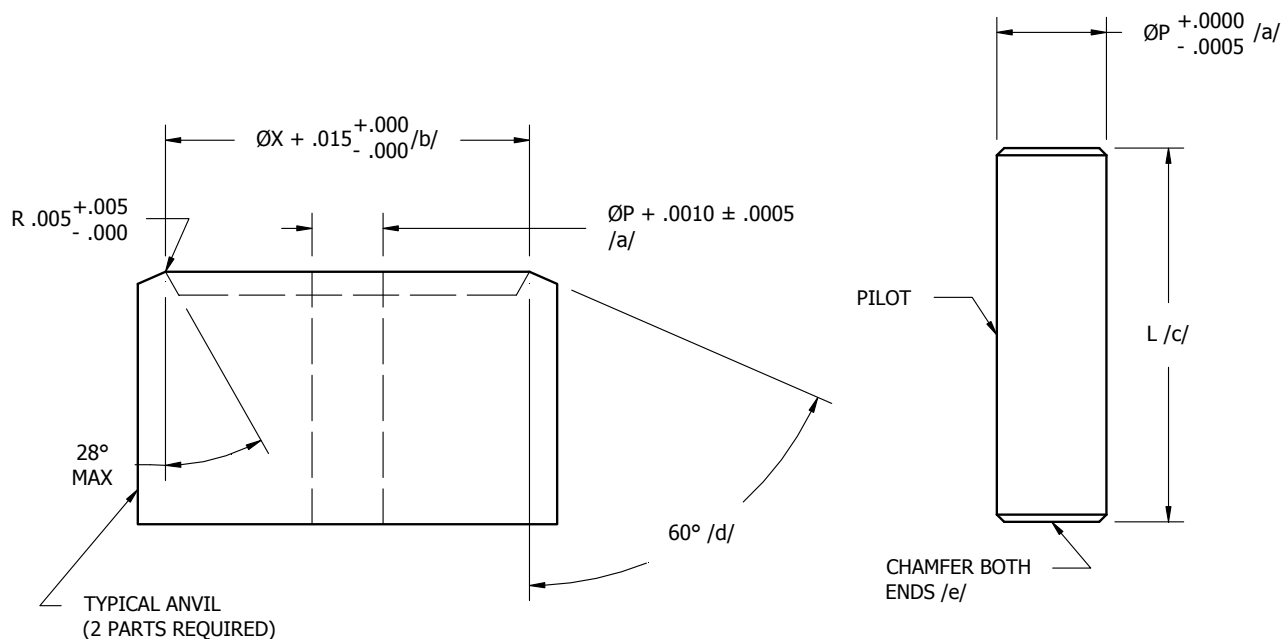


FIGURE 1 – TYPICAL ANVIL SWAGING TOOL

TABLE I – ANVIL SWAGING AND PROOF LOADS

Groove Type	a +.000 -.015	b +.000 -.015	Swaging Loads (LBF) /f/ /g/	Proof Load (LBF) /f/ /g/
A	.030	.045	(15,000 X ØD) ± 3,000	900 X ØD
B	.040	.055	(18,000 X ØD) ± 3,000	1,000 X ØD
C	.060	.080	(25,000 X ØD) ± 5,000	1,600 X ØD

- /a/ "ØP" shall equal the minimum bore diameter of the bearing minus .001 inch.
- /b/ "ØX" is the nominal pitch diameter measured at the bottom of the groove in the bearing outer race.
- /c/ "L" is two times the nominal anvil height plus the nominal bearing outer race width minus .250.
- /d/ 60° is the preferred angle, although 45° angles are quite common. Angles as low as 40° can be used, however, a secondary operation with a high angle (usually 80°) flattening anvil is usually required.
- /e/ Chamfer of definition. Smoothly blended.
- /f/ ØD = Outside diameter of bearing.
- /g/ Use 50% of calculated values for bearings with aluminum outer races and 62.5% of the calculated values for bearings with aluminum bronze outer races. Tabulated values are for CRES.

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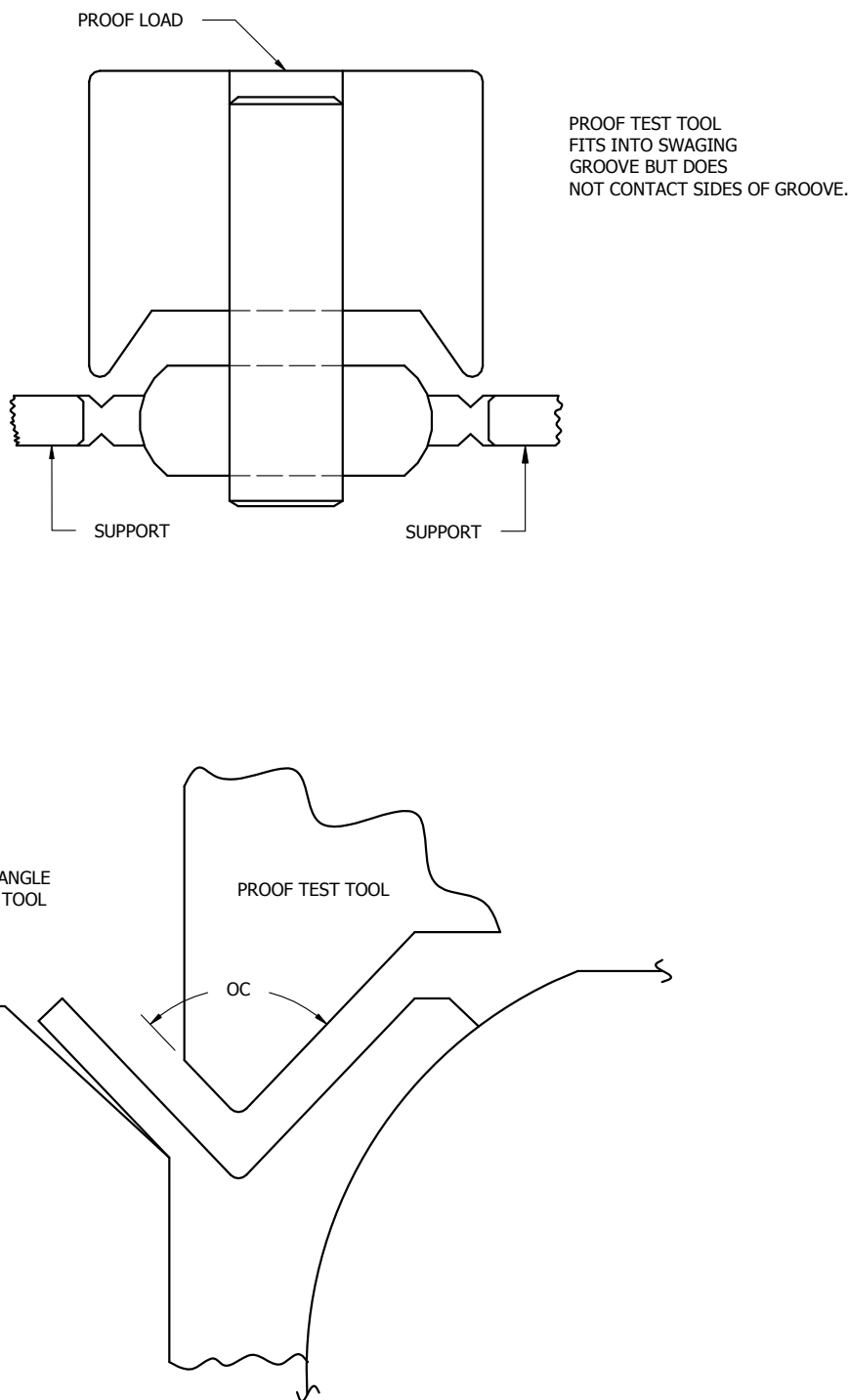


FIGURE 2 – ALTERNATE PROOF TEST SET-UP AND TOOL CONFIGURATION

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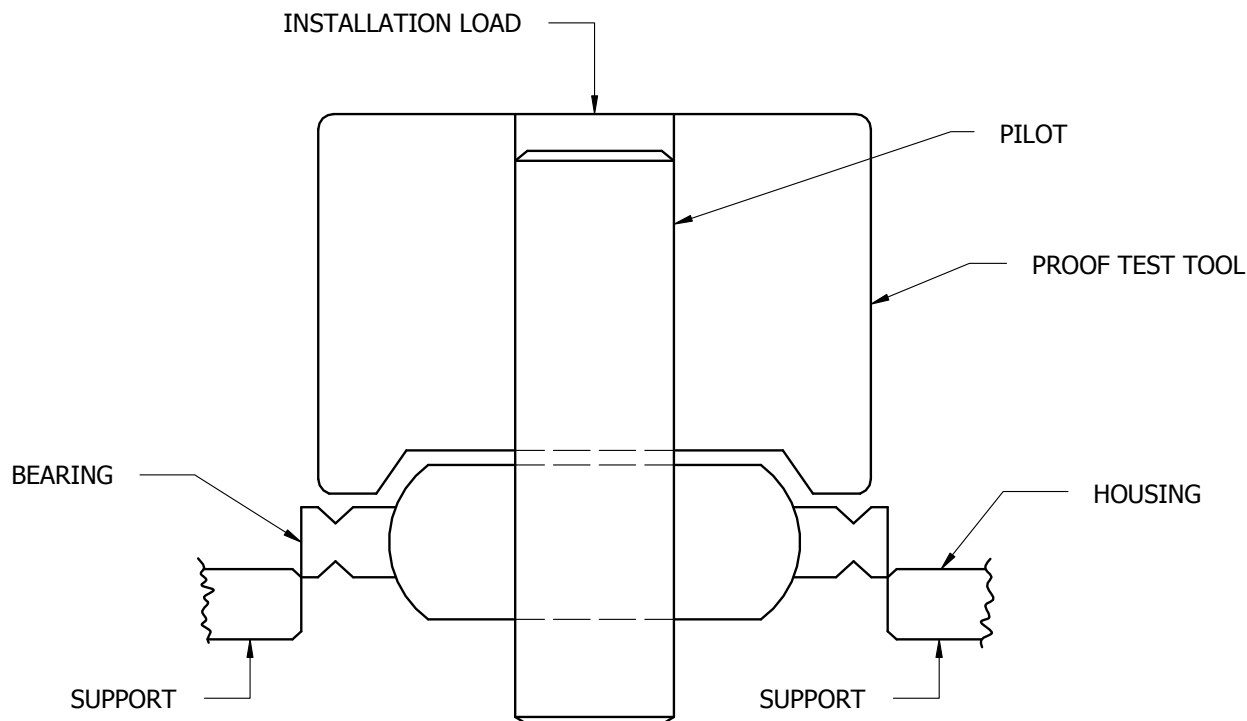


FIGURE 3 – INSTALLATION OF BEARING IN HOUSING

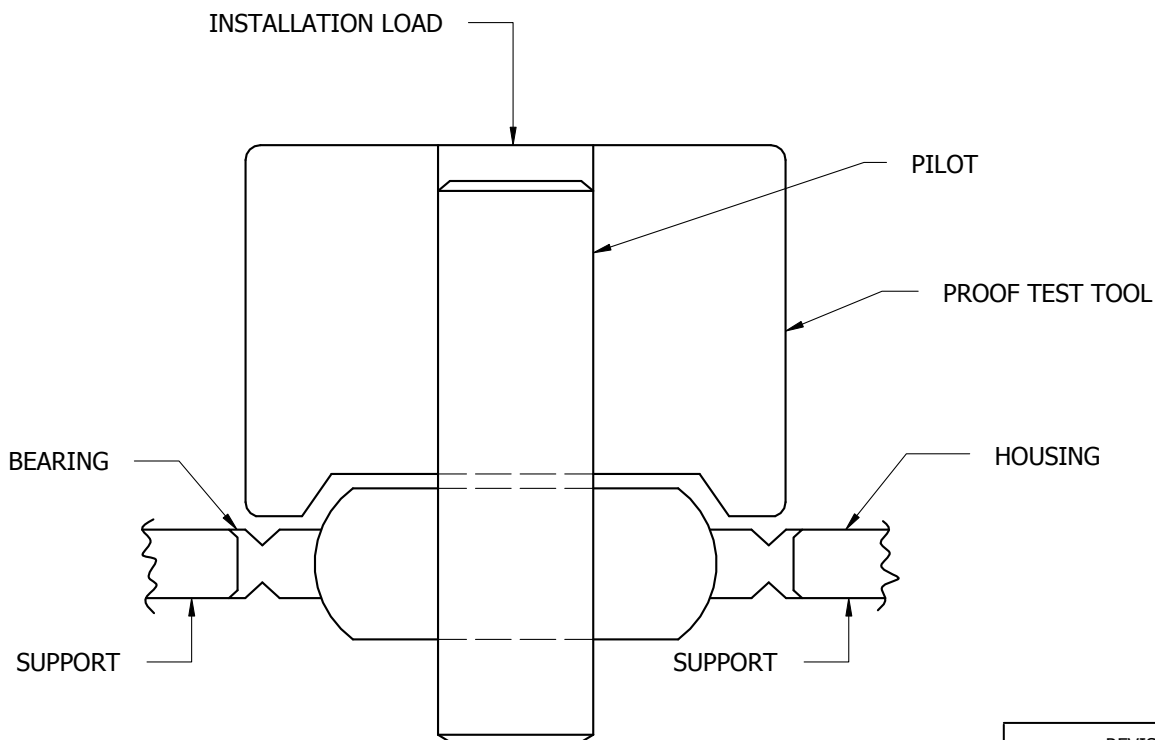


FIGURE 3A – PROOF TEST SET-UP AND TOOL CONFIGURATION

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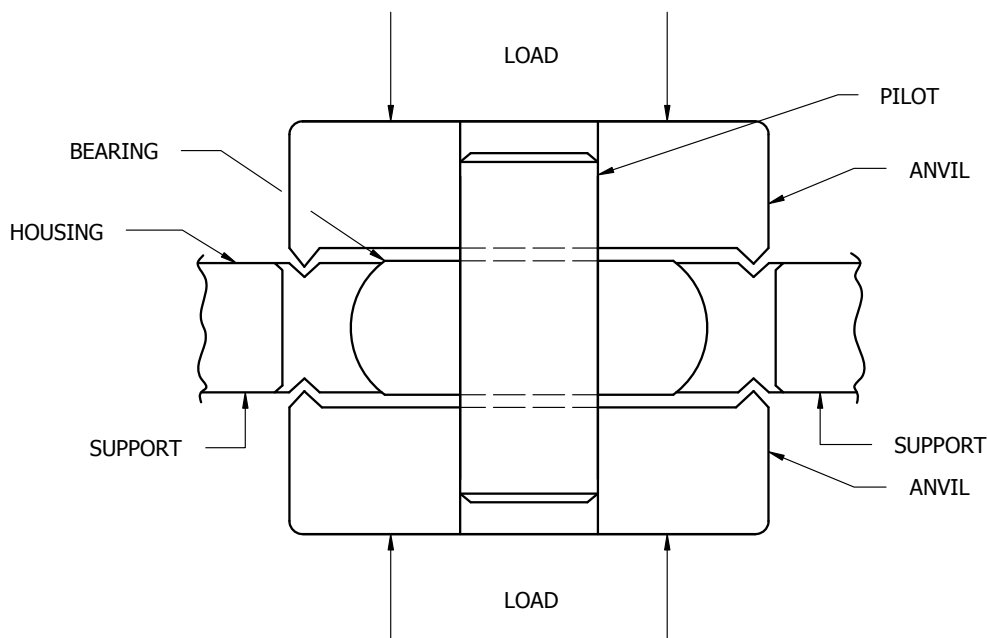
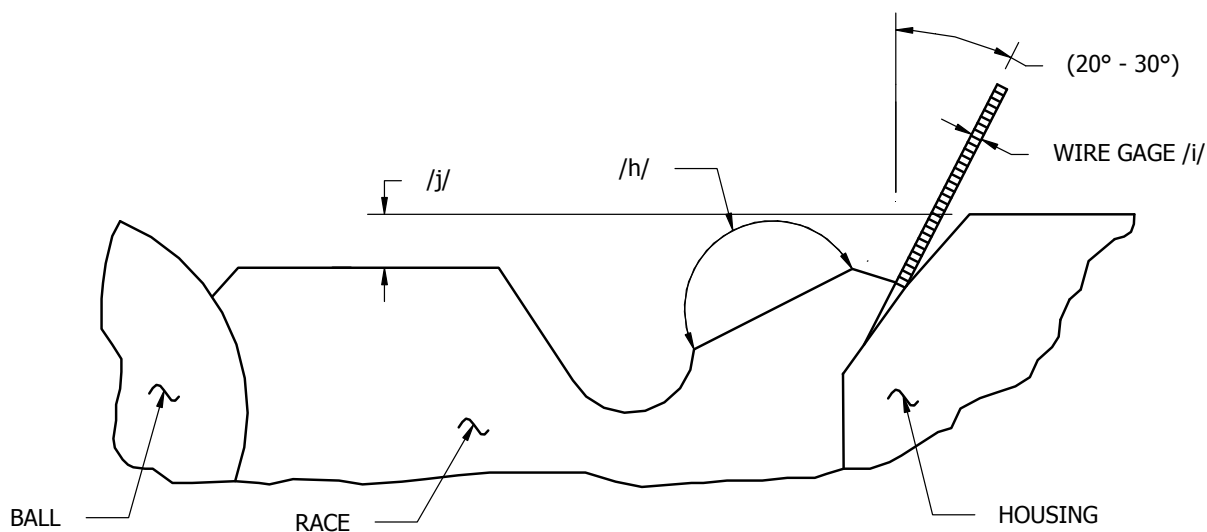


FIGURE 4 - ANVIL SWAGING BEARING



Inspection of swaged V-groove bearings shall be as follows:

- /h/ Visually inspect this circumferential area for cracks and separations.
- /i/ Inspect circumference of the gap in the swaged lip as shown with .005 inch feeler gage. A properly swaged bearing in an optimally prepared housing will not accept the feeler gage, however, no more than 40% of the circumference may accept the gage. (Inspect while installation treatment is uncured.) Check installation by applying specified proof load in accordance with 5.2.9.
- /j/ Bearing race face to be flush with housing within $\pm .010$ inch.

FIGURE 5 - COMPLETED SWAGE REQUIREMENTS

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METHOD 200: BEARINGS, GROOVED OUTER RACE, SWAGING OF (ROLLER SWAGED)

1. SCOPE

1.1 Scope

This standard defines the tools and provides installation and removal procedures and inspection criteria for retaining bearings which have a grooved outer race by using a three roller swaging tool to swage a portion of the race over chamfers on the accommodating housing bore. One side of the bearing is roller swaged at a time.

1.2 Intended use

It is intended for use with any structural housing material and is applicable only to bearings containing a grooved outer race. This standard has been written around currently existing MS CRES race bearings but is intended to be adaptable to other race materials as the need arises. It will be revised as the appropriate bearing standards are released.

2. APPLICABLE DOCUMENTS

2.1 Government documents

2.1.1 Specifications, standards and handbooks

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Copies can be obtained from the Department of Defense Single Stock Point (DODSSP). <http://dodssp.daps.dla.mil>

American Society for Quality

ANSI/ASQ Z1.4 Sampling Procedures and Tables for Inspection by Attributes

Copies can be obtained from the American Society for Quality, 600 North Plankinton Ave., Milwaukee, WI 53203. www.asq.org

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3. EQUIPMENT

- 3.1 Typical swaging tools are shown in Figure 1. A swaging tool set consists of a roller fixture and locating fixture.
- 3.2 A typical proof test tool is shown in Figure 2. This tool utilizes the same pilot from Figure 1 and may also be used for installation of the bearing in the housing (see Figure 3).
- 3.3 Hand fed drill press for installing bearings. The size of the drill press should be as small as possible consistent with the force needed to swage the bearing.
- 3.4 Hydraulic press for applying proof loads.
- 3.5 Feeler gage, Ø.005 inch wire.

4. REQUIREMENTS

- 4.1 The housing bore, width and chamfer shall be as specified on the engineering drawing or see MIL-HDBK-1599, Requirement 202. There shall be no burrs at the I.D. edge of the chamfer.
- 4.2 The bearing shall, prior to and during installation and during subsequent processing, be handled and protected from dirt and corrosion.
- 4.3 The bearing housing assembly shall be protected from corrosion in accordance with the applicable finish specification and MIL-HDBK-1599, Requirement 105.
- 4.4 Reswaging of a bearing after the initial swaging operation for the purpose of meeting acceptance limits is permissible. Bearings which have been swaged and subsequently pushed out shall be scrapped.
- 4.5 Bearings supplied with internal clearance shall rotate freely without binding or catching after installation. If bearings supplied with internal clearance are installed with interference fit and preload is allowed after installation, the maximum rotational breakaway torque after installation shall not exceed the values specified on the installation drawing, handbook or installation process specification. Maximum rotational torque after installation of bearing supplied with preload shall not exceed the values specified on the applicable drawing, handbook or installation process specification. When torque values after installation are not specified, the maximum torque value after installation shall not be more than two times the maximum allowable rotational breakaway torque for the uninstalled bearings.
- 4.6 Tools with apparent damage or improper dimensions shall not be used.
- 4.7 There shall be no cracks or excessive galling on the swaged portion of the bearing.
- 4.8 Unless otherwise specified on the engineering drawings, all bearings shall be capable of withstanding the proof loads in Table I after installation. Proof load shall be applied to both sides of the bearing as shown in Figure 2. Proof load shall be applied before breakaway torque load or radial and axial clearances are verified.

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