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American National Standard

for Rolling Element Bearings – Aircraft Engine, Engine Gearbox, and Accessory Applications – Surface Visual Inspection

ANSI B3.2-1992

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American National Standard for Rolling Element Bearings – Aircraft Engine, Engine Gearbox, and Accessory Applications – Surface Visual Inspection

Secretariat

Anti-Friction Bearing Manufacturers Association, Inc.

Approved February 21, 1992

American National Standards Institute, Inc.

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Foreword (This foreword is not part of American National Standard B3.2-1992.)

This American National Standard was prepared by a task force consisting of representatives of companies which manufacture rolling element bearings and aircraft, or aircraft engines, or both, in the United States. This standard is issued by the Accredited Standards Committee B3 of the American National Standards Institute as an industrial standard that is intended to be used by aircraft manufacturers, or aircraft engine manufacturers, or both, for the procurement of rolling element bearings for aircraft engine and accessory applications.

Suggestions for improvement of this standard will be welcome. They should be sent to the Anti-Friction Bearing Manufacturers Association, Inc., 1101 Connecticut Avenue, NW, Suite 700, Washington, DC 20036.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Ball and Roller Bearings, B3. Committee approval of this standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the B3 Committee had the following members:

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AMERICAN NATIONAL STANDARD ANSI B3.2-1992

American National Standard for Rolling Element Bearings – Aircraft Engine, Engine Gearbox, and Accessory Applications – Surface Visual Inspection

1 Scope

This standard establishes a system for uniform visual acceptance criteria for aircraft engine, gearbox and accessory anti-friction bearings in continuous rotation applications made of the material listed in table 1. The standard requirements are in a flow chart format; the written text is supplementary and is used as support for the flow charts.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

MIL-STD-130 G-1988, *Identification marking of US military property*[1)]

3 Definitions

3.1 Surfaces

3.1.1 functional surface: All active surfaces of a bearing, specifically the following:

– *rolling elements:* All surfaces (except roller corners for class *C*);

– *rings:* Raceway surfaces; guide rib adjacent to raceway (roller bearings);

– *cage (retainer):* Entire pocket (except retention features); piloting (land riding) surface.

3.1.2 nonfunctional surface: All surfaces other than those defined as functional including, but not limited to, faces, outside diameters, inside diameters, slots, corners, flanges, etc.

3.2 Limits on spacing and number of imperfections

3.2.1 individual limits: Individual limits on the size of imperfections of the same type, without regard to their number or spacing. (A lower size limit may apply if there is a cluster of imperfections of the same type.)

3.2.2 cluster limits: Cluster limits on size and number applying to two or more imperfections of the same type, clearly separated, which can be contained within a circle of the maximum diameter allowed by the assigned standard. (Imperfections lying outside the circle are treated as individual when they lie at least the distance of the circle apart from each other.)

3.3 Imperfections

3.3.1 bulge: A swelling or protuberance caused by deformation of the part. This does not include intentional deformation required for rolling element retention.

3.3.2 burrs: Flakes of metal or roughness (feather-edge) found attached at intersecting surfaces such as corners, drilled holes, milled slots, grooves, and identification stamps.

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Table 1 – Bearing materials

Material	Melting practice	Controlling specifications	Hardening
52100	Air melt – vacuum degassed	ANSI/SAE AMS 6440	Through
52100	CEVM (consumable electrode vacuum melt)	ANSI/SAE AMS 6444	Through
440C MOD	Air melt – vacuum degassed	ANSI/SAE AMS 5630	Through
440C	VAR	ANSI/SAE AMS 5618	Through
M-50	VIM (vacuum induction melt) VAR	ANSI/SAE AMS 6491	Through
TIMKEN T-1	Air melt – vacuum degassed	ASTM A485-Grade 3	Through
BG-42	VIM – VAR	ANSI/SAE AMS 5749	Through
4340	Vacuum melt	ANSI/SAE AMS 6415	Through
4340	Air melt	ANSI/SAE AMS 6414	Through
8620	Air melt – vacuum degassed	ANSI/SAE AMS 6274	Case
8620	CEVM	ANSI/SAE AMS 6276	Case
P.Q. 8620	CEVM – double vacuum melt	ANSI/SAE AMS 6277	Case
9310	Air melt – vacuum degassed	ANSI/SAE AMS 6260	Case
9310	CEVM	ANSI/SAE AMS 6267	Case
P.Q. 9310	CEVM – double vacuum melt	ANSI/SAE AMS 6265	Case
PRYOWEAR 53	VIM – VAR	ANSI/SAE AMS 6308	Case
CBS 600	VIM – VAR	ANSI/SAE AMS 6255	Case
M-50 NIL	VIM – VAR	ANSI/SAE AMS 6278	Case

3.3.3 crack: A separation, fissure, or rupture of material surface characterized by sharp edges, or sharp changes in direction, or both, usually narrow and linear.

3.3.4 comet head, comet tail: See *tears*

3.3.5 corrosion and rust: Surface broken or pitted with discoloration around perimeter of pits. Also, surface discoloration without breaks or pits which appears to be an iron oxide (excluding heat treat discoloration). The condition of a cluster of pits alone, without discoloration, may or may not be indicative of an earlier condition of rust or corrosion. In either case, in the absence of the discoloration, a cluster of pits shall be considered under the definition of *pits*.

3.3.6 dents, nicks, indentations: Depressions or hollows on a surface made by mechanical injuries to the surface, such as from pressure or blows by hard objects against the finished surface. These generally appear the same as the unmarred surface around, and are visible only by virtue of light reflection caused by the change in uniformity of the surface. Typically these defects are bright-bottomed.

3.3.7 heat treat scale: Loosely adherent surface oxides formed during heat treatment which can be removed with a hand probe.

3.3.8 inclusion: An entrapped foreign material particle retained in the metal during solidification, irregular in shape and dark colored in contrast to the normal metallic shiny surface.

3.3.9 pits: Small cavities in the surface, free of discoloration around the perimeter, usually dark at the bottom and generally circular in shape.

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3.3.10 process marks: Marks due to processing and inspection operations, such as grinding, honing, polishing, gaging, turning, milling, broaching, etc, on finished surfaces. These are residual surface abrasions or imperfections resulting from these operations but which are not a part of the characteristic matte of these operations. Includes *grinding tears* and *scratches*. See also *tears*.

3.3.11 raised material/raised edges: Material that has been disrupted so as to be higher than the surrounding surface.

3.3.12 rust: See *corrosion and rust.*

3.3.13 scratch: A linear depression with a sharp bottom caused by movement of a sharp object or particle across the surface.

3.3.14 scuffs: A series of small superficial abrasions caused by the rubbing together of hard surfaces.

3.3.15 stains: Surface discolorations, with no broken surface, including tarnishes other than those associated with corrosion, rust, or heat treat scale. These must be removable by light polishing that will not adversely affect the surface; however, heat treatment discoloration (without scale, pitting, or corrosion) remaining on unground surfaces, and plating discoloration, although not easily removable, shall be treated as stains.

3.3.16 tears, grinding tears: A deep narrow scratch, parallel to the lay of the surface, sometimes with a hole at one end, resulting from material being pulled during a grinding or honing operation. The scratch and the hole are commonly known as a comet tail and comet head, respectively (see figure 1).

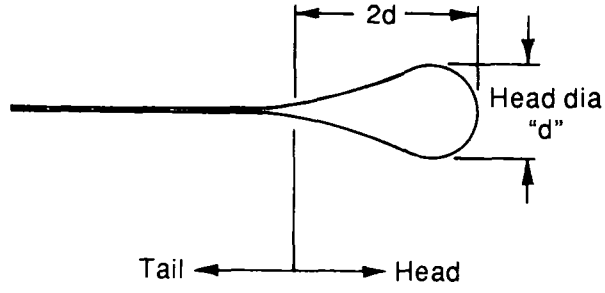


Figure 1 – Tears

4 Inspection requirements and instructions

4.1 Visual inspection

Visual inspection shall be performed in accordance with table 2 and figures 2 to 4.

4.2 The use of the stylus

A stylus of the designated tip radius shall be used for determining the acceptability of certain observed surface imperfections (where *Can you feel it?* appears in figure 2). The use of the stylus shall be in accordance with the following:

– With the stylus approximately 30° off perpendicular to the surface in question, guide with the fingers and thumb. Do not firmly grasp the stylus or push it towards the surface; rather, allow it to float between fingers and thumb, applying only its own weight against the surface;

– Guide the stylus in a direction approximately perpendicular to the general lay of the imperfection. If the point hesitates (catches) at any one spot, the surface imperfection being judged shall be evaluated in accordance with figures 2 to 4.

4.3 Perpendicularity

Perpendicularity and *30° off perpendicular* are as determined by eye and should be adjusted by the inspector to accommodate the size or configuration of the part.

4.4 Imperfections

Imperfections which cannot be felt shall not count towards any spacing or quantity limits on those which can be felt.

4.5 Application

This standard provides three grades of visual criteria, based on rolling element size. The grade of visual inspection required shall be specified by the design activity (as defined by MIL-STD-130) on each specific part number drawing, or bearing specification, or both. If

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Table 2 – Visual magnification for inspecting functional surfaces of rings and rolling elements

Grade Rolling element diameter	Visual magnification[1)]		
	A	B	C
Up to 0.5 in (12.7 mm)	7x	3x	1x
Over 0.5 through 1.0 in (25.4 mm)	3x	1x	1x
Over 1.0 in (25.4 mm)	1x	1x	1x

[1)] Higher magnification can be used to determine the type and size of imperfection at the suppliers' option; however, imperfections shall be subject to rejection only if visible at the stated magnification. 1x is defined as 16 – 18 in (406 – 457 mm) distant. Illumination shall be 100 ft candles (1000 lux) minimum.

no grade is specified by the design activity, grade C shall apply. Table 2 indicates the required visual magnification for each grade.

5 Inspection criteria

5.1 Maximum limits are specified in figures 2 to 4: functional ring and rolling element surfaces; nonfunctional ring surfaces and control lands; and cage (retainer) surfaces.

5.2 Defects not meeting these chart requirements shall be cause for rejection.

5.3 Stains, in accordance with the definition of 3.3.15, which are acceptable need not be removed.

5.4 Coated or plated surfaces shall be inspected additionally after coating or plating using the appropriate coating or plating specification acceptance criteria.

5.5 The following nonconformances shall be observed:

– For functional surfaces, no localized powered hand rework shall be allowed;

– For nonfunctional surfaces, corrective work may consist of machine rework, or hand rework, or both;

– Parts that do not meet the requirements of the standard after authorized rework shall be rejected.

6 Certification

6.1 Inspectors shall have been trained and certified. Minimum requirements are as follows:

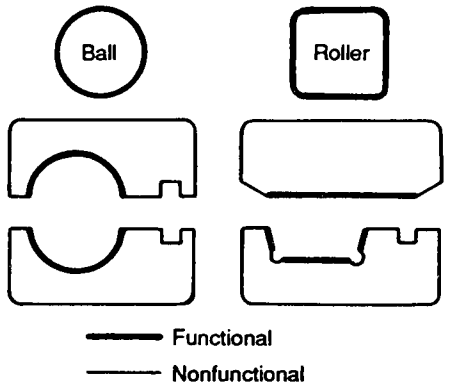
– Vision test, administered by qualified personnel with a requirement of reading Ortho-Rater 8 or Jaeger #2 letters, at 12 in (300 mm) in at least one eye with normal or corrected vision;

– Physical demonstration of skills, including an understanding of the intent and use of this standard, in accordance with written procedures and approvals.

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Bearing Grade	A	B	C	Reference Table 2
Rolling Element Diameter	Visual Magnification to Be Used			
1/2 in. (12.7mm) or Smaller	7x	3x	1x	
33/64 in. (12.8 mm) to 1 in. (25.4 mm)	3x	1x	1x	
Larger than 1 in. (25.4 mm)	1x	1x	1x	



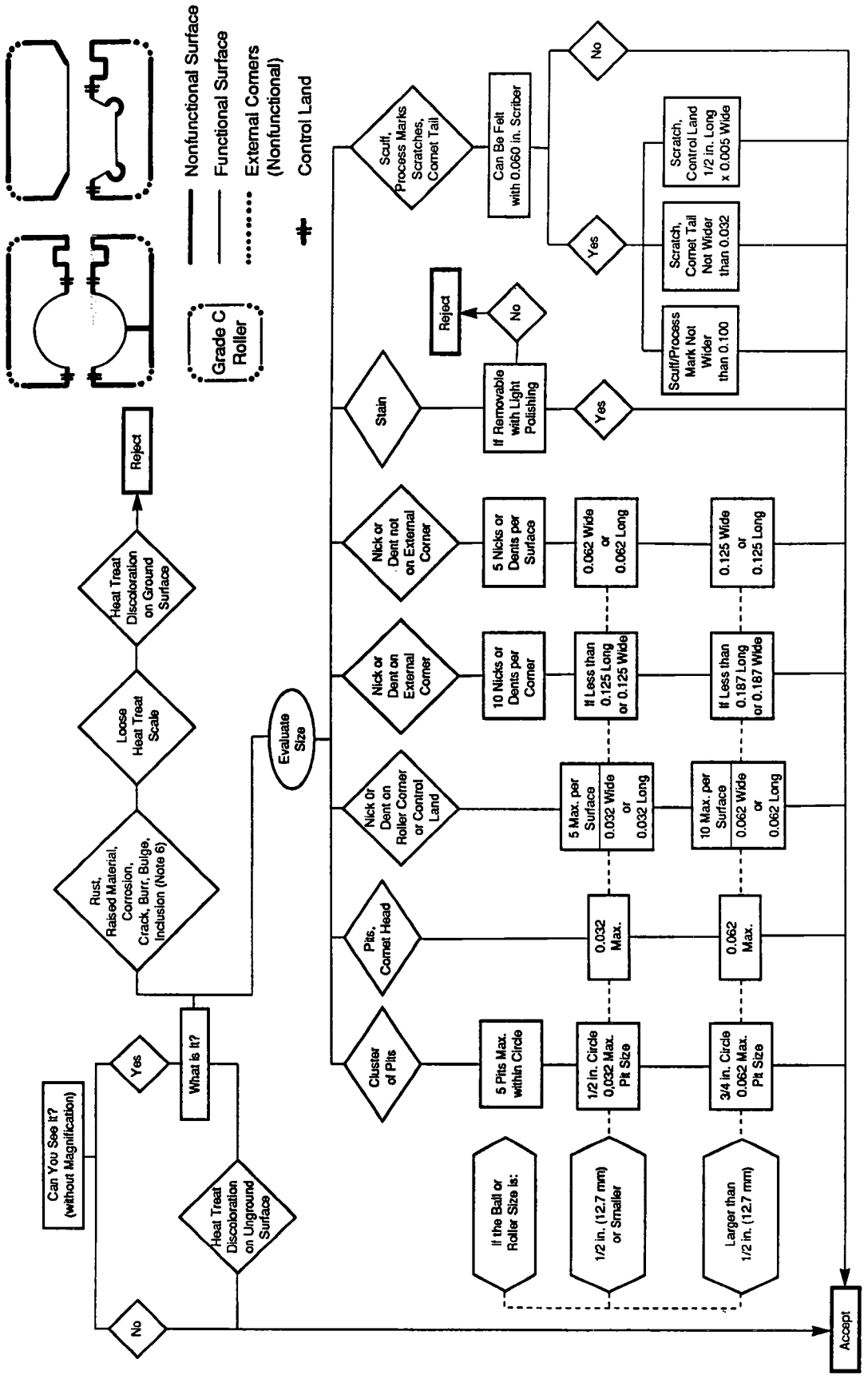
If the Ball or Roller Size is:			
Grades A & B	1/2 in. (12.7 mm) or Smaller	33/64 in. (12.8 mm) to 1 in. (25.4 mm)	Larger than 1 in. (25.4 mm)
Grade C		1/2 in. (12.7 mm) or Smaller	Larger than 1/2 in. (12.7 mm)
Scriber Radius	0.030	0.030	0.060

Can You See It?
No
Yes
What is It?
Rust, Raised Mat'l, Corrosion, Crack, Burr
Heat Treat Scale, Inclusion (Note 6)
Reject
Stain
Use Size Limit Only No Scriber Test
If Removable with Light Polishing
No
Yes
Pit, Cluster of Pits, Nick or Dent, Scuff
Scratch, Process Mark, Tear
Can You Feel It?
Accept
No
Yes
What is It?
Pit
Cluster of Pits
Nick or Dent
Scratch
Process Marks, Scuff, Comet Tail and Head
Reject
Race
1. Not Wider than 0.003
2. Not Crossed
3. Minimum 0.050 Apart
4. Circumferential: 1/2 Length of Race, Maximum
5. Cross Race: 1/2 Width of Race, Maximum
Balls or Rollers
1. Not Wider than 0.003
2. Not Crossed
3. Minimum 0.050 Apart
Single: Less than 1/2 Way Around Circumference or Length
Multiple: Less than 1/4 Way Around Circumference or Length
If the Ball or Roller Size is:
1/2 in. (12.7 mm) or Smaller Grades A & B
33/64 in. (12.8 mm) to 1 in. (25.4 mm) Grades A & B
1/2 in. (12.7 mm) or Smaller Grade C
Larger than 1 in. (25.4 mm) Grades A & B
Larger than 1/2 in. (12.7 mm) Grade C
0.010 Max.
0.015 Max.
0.020 Max.
3 Max. per Surface
0.008 Max.
5 Max. per Surface
0.010 Max.
10 Max. per Surface
0.015 Max.
3 Max. per Surface
3 Pits Max. in 1/4 in. Circle
0.005 Max.
5 Max. per Surface
5 Pits Max. in 1/2 in. Circle
0.008 Max.
10 Max. per Surface
10 Pits Max. in 3/4 in. Circle
0.012 Max.
3 Max. per Surface
0.005 Wide x 0.015 Long
5 Max. per Surface
0.005 Wide x 0.025 Long
10 Max. per Surface
0.010 Wide x 0.035 Long
3 Max. per Surface
5 Max. per Surface
10 Max. per Surface
3 Max. per Surface
5 Max. per Surface
10 Max. per Surface
Accept

Notes:

1. All Parts Having Imperfections Exceeding the Limits on this Chart are to Be Rejected.
2. All Dimensions Shown are in Inches Unless Otherwise Specified.
3. No Evidence of Nital Etch Left on Balls, Rollers or Raceways.
4. Roller Corners are Nonfunctional Surfaces for Grade C Bearings and when the Corner Runout Requirements are Greater than 0.001 or not Specified.
5. No Localized Power Hand Rework Allowed.
6. For Air-Melt Materials, Evaluate as for Pit and Refer to Metallurgy to Reevaluate per J-K Rating as Appropriate.
7. Corners at the Point of Intersection with Functional Surfaces are Functional.

Figure 2 – Visual defects acceptability test for functional surfaces on rings and rolling elements



Notes:

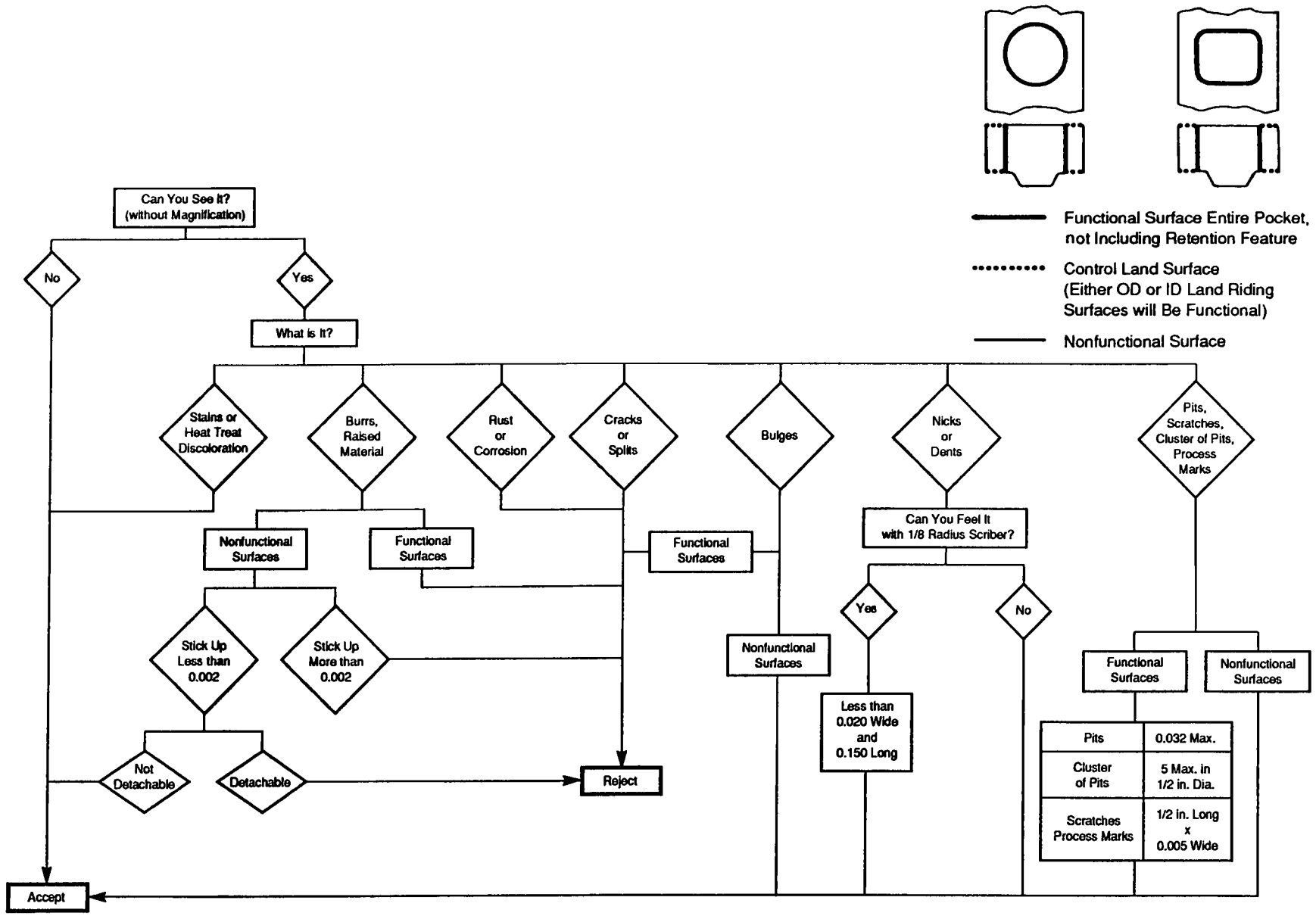
1. All Parts Having Imperfections Exceeding the Limits on this Chart are to Be Rejected.
2. All Dimensions Shown are in Inches Unless Otherwise Specified.
3. No Evidence of Nital Etch on Cage Controls Lands.
4. Roller Corners are Defined as Non-functional Surfaces for Grade C Bearings and when the Corner Runout Requirements are Greater than 0.001 or not Specified.
5. Exclude Marking and Hardness Test Marks from Evaluation.
6. For Air-Melt Materials, Evaluate as for Pit and Refer to Metallurgy to Reevaluate per J-K Rating as Appropriate.

Figure 3 – Visual defects acceptability test for nonfunctional surfaces and control lands

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Notes:

1. All Parts Having Imperfections Exceeding the Limits on this Chart are to be Rejected.
2. All Dimensions in Inches Unless Otherwise Noted.

Figure 4 – Visual defects acceptability test for functional and nonfunctional cage surfaces prior to plating (machined metallic cages only)

Annex A
(informative)

Bibliography

ANSI/SAE AMS 5618C, *Steel bars and forgings, corrosion resistant – 12 Cr – 0.5 Mo (0.95–1.20°C), consumable electrode vacuum melted*

ANSI/SAE AMS 5630F, *Bars and forgings – 17 Cr – 0.52 Mo (0.95–1.20°C) (SAE 51440C)*

ANSI/SAE AMS 5749B, *Steel bars, forgings, and tubing, corrosion resistant – 14.5 Cr – 4.0 Mo – 1.2 V (1.10–1.20°C), premium quality bearing applications, double vacuum melted*

ANSI/SAE AMS 6255, *Steel bars, forgings, and tubing – 1.0 Cr – 3.0 Ni – 4.5 Mo – 0.08 Al – 0.38V (0.10–0.16°C) premium aircraft quality, double vacuum melted*

ANSI/SAE AMS 6260K, *Bars, forgings, and tubing – 3.25 Ni – 1.2 Cr – 0.12 Mo (0.07–0.13°C), Carburizing*

ANSI/SAE AMS 6265G, *Bars, forgings, and tubing – 1.2 Cr – 3.25 Ni – 0.12 Mo (0.07–0.13°C) premium aircraft quality, vacuum consumable electrode remelted*

ANSI/SAE AMS 6267C, *Steel bars, forgings, and tubing – 1.2 Cr – 3.25 Ni – 0.12 Mo (0.07–0.13°C) (SAE 9310)*

ANSI/SAE AMS 6274G, *Steel bars, forgings, and tubing – 0.50 Cr – 0.55 Ni – 0.20 Mo (0.18–0.23°C)*

ANSI/SAE AMS 6276F, *Steel bars, forgings, and tubing – 0.50 Cr – 0.55 Ni – 0.20 Mo (0.18–0.23°C) (SAE 8620) vacuum melted*

ANSI/SAE AMS 6277D, *Steel bars, forgings, and tubing – 0.50 Cr – 0.55 Ni – 0.20 Mo (0.18-0.23°C) (SAE 8620) vacuum arc or electroslag melted*

ANSI/SAE AMS 6278, *Steel bars, forgings, and tubing – 4.1 Cr – 3.4 Ni – 4.2 Mo – 1.2V (0.11-0.15°C) premium aircraft quality for bearing applications, double vacuum melted*

ANSI/SAE AMS 6308A, *Steel bars and forgings – 0.90 Si – 1.0 Cr – 2.0 Ni – 3.2 Mo – 2.0 Cu – 0.10 V (0.07–0.13°C), vacuum arc or electroslag remelted*

ANSI/SAE AMS 6414E, *Bars, forgings, and tubing – 1.8 Ni – 0.80 Cr – 0.25 Mo (0.38–0.43°C) (SAE 4340) vacuum consumable electrode remelted*

ANSI/SAE AMS 6415L, *Steel bars, forgings, and tubing – 0.80 Cr – 1.8 Ni – 0.25 Mo (0.38–0.43°C) (SAE 4340)*

ANSI/SAE AMS 6440J, *Steel bars, forgings, and tubing – 1.45 Cr (0.98–1.10°C) (SAE 52100), for bearing applications*

ANSI/SAE AMS 6444G, *Bars, forgings, and tubing – 1.45 Cr (0.98–1.10°C), premium bearing quality, consumable electrode vacuum melted*

ANSI/SAE AMS 6491A, *Steel bars, forgings, and tubing – 4.1 Cr – 4.2 Mo – 1.0 V (0.80–0.85°C), premium aircraft quality for bearing applications, double vacuum melted*

ASTM A485-Grade 3, *Specification for high hardenability anti-friction bearing steel*[2)]

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2) Available from ASTM,1916 Race Street, Philadelphia, PA 19103-1187.

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