



BSI Standards Publication

Aerospace series — Bearing, spherical plain, in corrosion resisting steel with self-lubricating liner, low starting torque and low friction coefficient, elevated duty cycles under low oscillations at different operating conditions

Part 3: Technical specification

National foreword

This British Standard is the UK implementation of EN 4854-3:2019.

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English Version

**Aerospace series - Bearing, spherical plain, in corrosion
resisting steel with self-lubricating liner, low starting
torque and low friction coefficient, elevated duty cycles
under low oscillations at different operating conditions -
Part 3: Technical specification**

Série aérospatiale - Rotules en acier résistant à la
corrosion à garniture autolubrifiante, faible couple de
démarrage et faible coefficient de frottement, cycles
d'endurances élevés sous faibles oscillations à
différentes conditions de fonctionnement, série large -
Partie 3 : Spécification Technique

Luft- und Raumfahrt - Gelenklager aus
korrosionsbeständigem Stahl mit selbstschmierender
Beschichtung, geringem Losbrechmoment und
niedrigem Reibungskoeffizienten, hohe Anzahl an
gering oszillierenden Belastungszyklen bei
unterschiedlichen Einsatzbedingungen - Teil 3:
Technische Lieferbedingungen

This European Standard was approved by CEN on 12 November 2018.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 4854-3:2019) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2020, and conflicting national standards shall be withdrawn at the latest by April 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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1 Scope

This European Standard specifies the required characteristics, inspection and test methods, qualification and acceptance conditions for spherical plain bearings in corrosion resisting steel with self-lubricating liner, low starting torque and low friction coefficient, elevated duty cycles under low oscillations at different operating conditions.

This standard applies whenever referenced.

These self-lubricating spherical plain bearings are intended for use in fixed or moving parts of the aircraft structure especially for control mechanism and operating systems. The bearings are designed subjected under low dynamic radial loads and slow rotations in the temperature range of $-55\text{ }^{\circ}\text{C}$ to $120\text{ }^{\circ}\text{C}$ ($-67\text{ }^{\circ}\text{F}$ to $248\text{ }^{\circ}\text{F}$).

The liner may be of a fabric or composite material bonded to the inside diameter of the outer ring or in a composite material moulded into a pre-formed cavity between the inner and outer rings.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 4854-1, *Aerospace series — Bearing, spherical plain, in corrosion resisting steel with self-lubricating liner, low starting torque and low friction coefficient, elevated duty cycles under low oscillations at different operating conditions, narrow series — Part 1: Dimensions and loads*

EN 4854-2, *Aerospace series — Bearing, spherical plain, in corrosion resisting steel with self-lubricating liner, low starting torque and low friction coefficient, elevated duty cycles under low oscillations at different operating conditions, wide series — Part 2: Dimensions and loads*

EN 10204, *Metallic products — Types of inspection documents*

MIL-PRF-87257B, *Hydraulic Fluid, Fire Resistant; Low Temperature, Synthetic Hydrocarbon Base, Aircraft and Missile*

NSA307110, *Fluid — Hydraulic Phosphate Ester — Base Fire Resistant*

TR 4475, *Bearings and mechanical transmissions for airframe applications — Vocabulary*¹

ASTM D 1655, *Specification for Aviation Turbine Fuels*

¹ Published as ASD-STAN Technical Report at the date of publication of this standard by AeroSpace and Defence Industries Association of Europe – Standardization (ASD-STAN) (www.asd-stan.org).

3 Terms and definitions

For the purposes of this document, the terms and definitions given in TR 4475 and the following apply.

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1
self-lubricated spherical plain bearing, self-aligning in corrosion resistant steel with and without staking groove
bearing consisting of two concentric rings, between which is interposed a self-lubricating liner which is bonded or moulded on the spherical surface of the outer ring (race)

Note 1 to entry: The width of the inner ring (ball) is greater than the width of the outer ring (race), so that a tilting movement is possible in addition to the rotational movement.

Note 2 to entry: The outer ring (race) has no assembly slot but may have staking grooves for mechanical swaging.

3.2
surface discontinuities
see TR 4475 (surface imperfections)

3.3
starting torque without load
torque required to start the rotation of the inner ring (ball) with the outer ring (race) held stationary

3.4
friction coefficient
coefficient of the torque moment and the product of the load on the bearing and the inner spherical ring (ball) radius

Note 1 to entry: The friction coefficient of the bearing under load is given by the following formula:

$$\mu = \frac{C}{FR} \quad (1)$$

where

- μ is the friction coefficient;
- C is the torque moment in Nm;
- F is the load on the bearing in N;
- R is the inner spherical ring (ball) radius in m.

3.5**permissible [limit] static radial load** **C_s**

load corresponding to a permissible unit pressure multiplied by the effective projected area in the radial direction, the inner ring (ball) being able to take any position within the limits of the tilting angle indicated in the product standard

Note 1 to entry: The direction of the load remains in the centre plane of the outer ring (race).

Note 2 to entry: The definition for the effective projected area in radial direction is given by following simplified calculation:

$$A_r = K(C_{\min.} - 2T_{\max.}) \quad (2)$$

where

A_r is the effective radial projected area in mm²;

K spherical diameter in mm [in];

$C_{\min}$ minimum width of the outer ring (race) in mm [in];

$T_{\max}$ maximum liner set back in mm [in].

Dimensions are given in the appropriate product standards.

3.6**permissible [limit] static axial load** **C_a**

load corresponding to a permissible unit pressure multiplied by the effective projected area in the axial direction

Note 1 to entry: The effective projected area in axial direction is given by following calculation:

$$A_a = A_{\phi K} - A_{\phi K-h} \quad (3)$$

$$A_a = \pi \left(\frac{\phi K}{2} \right)^2 - \pi \left[\left(\frac{\phi K}{2} \right) - h \right]^2 \quad (4)$$

$$h = \frac{\phi K}{2} - \frac{1}{2} \sqrt{4 \left(\frac{\phi K}{2} \right)^2 - (C_{\min.} - 2T_{\max.})^2} \quad (5)$$

$$A_a = \frac{\pi}{4} (C_{\min.} - 2T_{\max.})^2 \quad (6)$$

where

A_a is the effective axial projected area in mm²;

K spherical diameter in mm [in];

h is the theoretical dimension, can be subjected to the liner thickness (difference between the spherical diameter and minimum diameter of the inner ring after swaging), in mm [in];

$C_{\min}$ minimum width of the outer ring (race) in mm [in];

$T_{\max}$ maximum liner set back in mm [in].

Dimensions are given in the appropriate product standards. See also Figure 1.

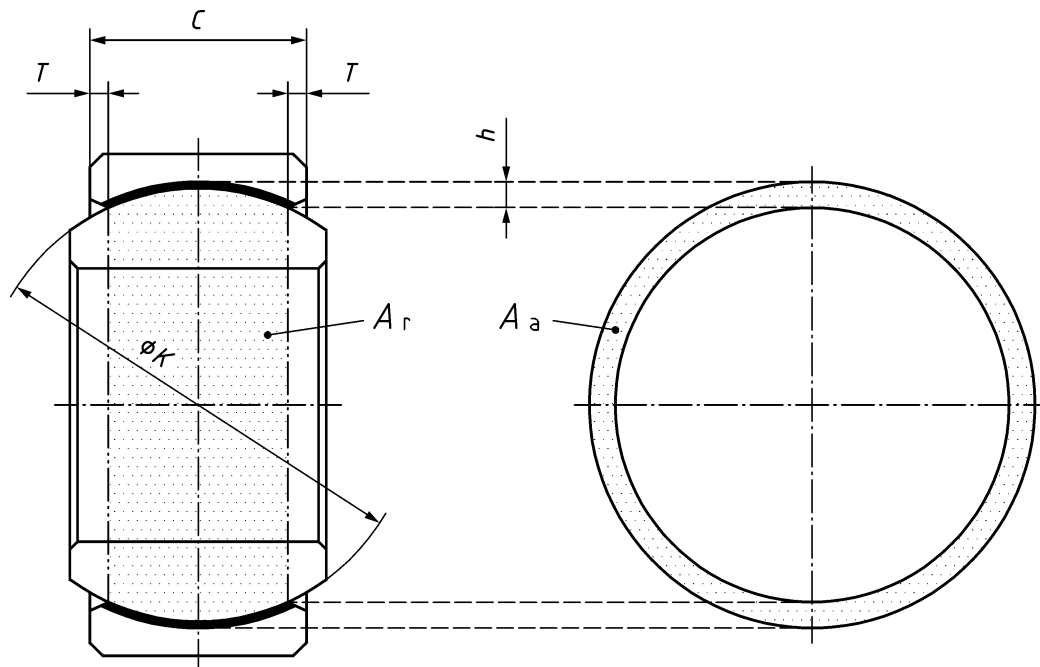


Figure 1 — Effective projected areas (radial and axial)

3.7

dynamic radial load

oscillatory duty cycles

load which may be withstood by a bearing submitted to an oscillatory movement for a defined number and rate of oscillation cycles without the dimensional or other characteristics deviating from the values permitted by this technical specification

Note 1 to entry: The number and rate of oscillation cycles to be considered for this technical specification are defined in Annex B.

3.8

ultimate static load

load defined as being the highest load that a product can accept without fractures and cracks; the ultimate static load is equivalent to the permissible (limit) static load (radial or axial) multiplied by 1,5

3.9

duty cycle

series of oscillating cycles under constant or varying load applied to a bearing

3.10 oscillating cycle

sequence of alternate angular displacements (φ°) of one ring in relation to the other

Note 1 to entry: The oscillating cycle has the following composition:

- from 0° to $+\varphi^\circ$;
- then from $+\varphi^\circ$ to $-\varphi^\circ$;
- and finally from $-\varphi^\circ$ to 0° .

The angular displacement (see Figure 2) to be considered for this technical specification is defined in Annex B.

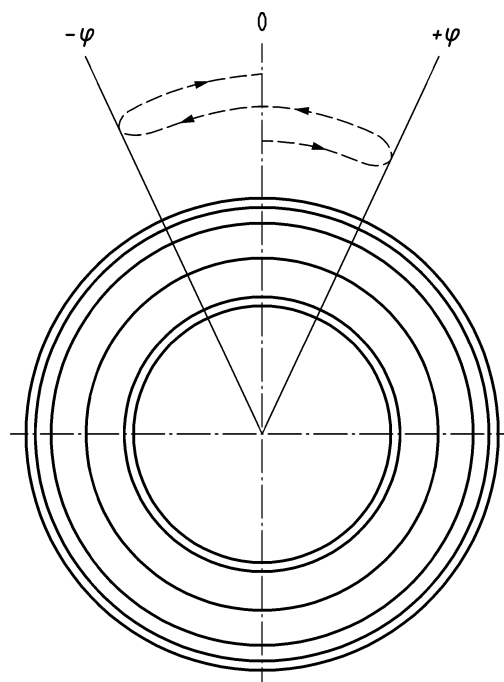


Figure 2 — Angular displacement (oscillating cycles)

3.11 delivery batch

batch consisting of bearings with the same identity block, which may come from different production batches

4 Requirements, inspection and test methods

For required characteristics, inspection and test methods see Table 1.

For starting torques at zero load see Table 2.

For maximum permanent deflection and deformation see Table 3.

For maximum starting torques at different surface pressure levels see Table 4.

Table 1 — Characteristics, inspections and test methods

Clause	Characteristics	Requirements	Inspection and test methods	Q ^a	A ^b
4.1	Materials	Shall conform to the product standards or design documentation.	Chemical analysis or certificate issued by semi-finished product manufacturer	X	X
4.2	Dimensions and tolerances	Shall conform to the product standards or design documentation. Dimensions not shown shall be at manufacturer's option.	Suitable calibrated measuring instruments Measurement of bore and outer diameter: — rings with a width of ≤ 10 mm: in the centre plane; — rings with a width of > 10 mm: in two planes parallel to the outer faces and at a distance from these faces of twice the maximum value of the ring chamfer. The minimum and maximum diameters shall be determined in each measuring plane. Measurement of ring width: — the width of each ring (distance between the two faces) shall be verified at a minimum of four points.	X	X
4.3	Masses	Shall conform to the product standards or design documentation.	Suitable methods	X	
4.4	Marking	Shall conform to the product standards or design documentation. It shall be legible and shall not adversely affect the material or the functioning of the bearing.	Visual examination	X	X
4.5	Surface appearance	- the bearings shall be free of surface discontinuities liable to have an adverse effect on their characteristics and endurance; - the liner shall not contain contaminant products and shall not show broken or voided areas; - lubrication shall not be permitted.			
4.5.1	Assembled bearings		Visual inspection using suitable methods	X	X
4.5.2	Unassembled rings		Magnetic or dye penetrant inspection	X	X

Clause	Characteristics	Requirements	Inspection and test methods	Q ^a	A ^b
4.6	Hardness	Shall conform to the product standards or design documentation.	Suitable processes and measuring instruments	X	X
4.7	Surface roughness	Shall conform to the product standards or design documentation.	Suitable measuring instruments or visual-tactile samples	X	X
4.8	Surface treatment	Shall conform to the product standards or design documentation.	— Visual inspection; — as per surface treatment standard.	X	X
4.9	Movability and clearances	—	—	—	—
4.9.1	Behaviour in rotation and tilt	Bearings shall be able to move freely within the angular limits specified in the product standards or design documentation.	Manual inspection	X	X
4.9.2	Internal clearances (radial and axial)	The internal radial and axial clearances shall conform to the product standards.	— Suitable measuring instruments; — test load: $\pm 13,3$ N (± 3 lbs)	X	X
4.10	Starting torque without load	—			
4.10.1	— at ambient temperature 23^{+2}_{-10} °C	Shall conform to Table 2 and product standards.	Suitable processes and measuring instruments: — measurement of the starting torque shall be preceded by some rotations and a few turning movements by hand; — measure the torque, applied gradually to the inner ring, in both directions, with the outer ring held stationary. Read off the maximal value required to start up the inner ring.	X	X
4.10.2	— at low temperature -55^{+5}_{-10} °C	Starting torque must be ≤ 2 times that listed in Table 2 and product standards.	— Subject the bearing, during 4 h at the low temperature; — immediately after, measure the torque following 4.10.1.	X	
4.10.3	— after limit temperatures. -55^{+5}_{-10} °C 85^{+10}_{-5} °C	Shall conform to Table 2 and product standards.	— Subject the bearing during 1 h at the low temperature °C, then 1 h at the high temperature; — repeat successively $\times 10$ this test; — 4 h after these tests, measure the torque, at ambient temperature, following 4.10.1.	X	

Clause	Characteristics	Requirements	Inspection and test methods	Q ^a	A ^b
4.11	Conformity of ball and race	—	For bearings with bonded liner types, the conformity of the ball and the race shall be measured normally. For bearings with injected/moulded liner types, the conformity of the ball and the race shall be measured both normally and circumferentially.		
4.11.1	— normal conformity	Difference between the values measured radially from the center of the bore shall not exceed 0,08 mm.	Encapsulate the bearing in plastic material as used in metallurgical mounts, to prevent motion of the ball with respect to the race. Section the bearing following a diameter plane normal to the race side and polish the surfaces (see Figure 3a). By use of an optical comparator or another accurate technique, measure dimension “ <i>t</i> ” radially from the ball to the race on both opposite surfaces at a minimum of five uniformly spaced positions across the bearing (see Figure 3a). The selected points shall include the center position of the race as well as both the <i>C</i> /10 positions.	X	
4.11.2	— circumferential conformity	Difference between the values measured radially from the center of the bore shall not exceed 0,08 mm.	Bearings with injected/moulded liners shall be encapsulated in plastic material as used in metallurgical mounts, to prevent motion of the ball with respect to the race. Section the bearing along the diameter described by the centerline of the race width and polish the surfaces (Figure 3b). By use of an optical comparator or another accurate technique, measure dimension “ <i>δ</i> ” radially from the center of the bore at a minimum of eight uniformly spaced positions.	X	
4.12	Permissible static loads: — radial: C_S ; — axial: C_A .	Shall conform to the product standards or design documentation. No maximum total deflection greater than those listed in Table 3 under permissible static loads (C_S). After removing the loads, no permanent deformations greater than those listed in Table 3.	See Annex A.	X	