

**BS EN 2311:2017**



**BSI Standards Publication**

# **Aerospace series — Bushes with self-lubricating liner — Technical specification**



**National foreword**

This British Standard is the UK implementation of EN 2311:2017. It supersedes BS EN 2311:2012 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/12, Aerospace fasteners and fastening systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

**Aerospace series - Bushes with self-lubricating liner -  
Technical specification**

Série aérospatiale - Bagues avec garniture  
autolubrifiante - Spécification technique

Luft- und Raumfahrt - Buchsen mit selbstschmierender  
Beschichtung - Technische Lieferbedingungen

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## European foreword

This document (EN 2311:2017) 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of an identical text or by endorsement, at the latest by September 2017, and conflicting national standards shall be withdrawn at the latest by September 2017.

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.

This document supersedes EN 2311:2012.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## 1 Scope

This document specifies the required characteristics, inspections and tests, quality assurance and qualification, acceptance and delivery conditions for bushes, designed to be subjected under load, to slow sliding movements, rotations and small oscillations only for aerospace applications.

This standard applies to all bushes when referred to in the respective product standards or in a design documentation.

The liner is designed to be used in the temperature range of  $-50\text{ }^{\circ}\text{C}$  to  $163\text{ }^{\circ}\text{C}$ . Aluminium bushes are limited to  $-55\text{ }^{\circ}\text{C}$  to  $121\text{ }^{\circ}\text{C}$ .

## 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 2285, *Aerospace series — Bushes, plain, aluminium alloy, with self-lubricating liner — Dimensions and loads*

EN 2286, *Aerospace series — Bushes, flanged aluminium alloy, with self-lubricating liner — Dimensions and loads*

EN 2287, *Aerospace series — Bushes, plain corrosion resisting steel, with self-lubricating liner — Dimensions and loads*

EN 2288, *Aerospace series — Bushes, flanged, corrosion resisting steel, with self-lubricating liner — Dimensions and loads*

EN 2755, *Aerospace series — Bearings, spherical plain, in corrosion resisting steel with self-lubricating liner — Elevated loads at ambient temperature — Technical specification*

EN 4534-2, *Aerospace series — Bushes, plain in aluminium alloy with self-lubricating liner, elevated load — Part 2: Dimensions and loads — Inch series*

EN 4535-2, *Aerospace series — Bushes, flanged in aluminium alloy with self-lubricating liner, elevated load — Part 2: Dimensions and loads — Inch series*

EN 4536-2, *Aerospace series — Bushes, plain in corrosion resisting steel with self-lubricating liner, elevated load — Part 2: Dimensions and loads — Inch series*

EN 4537-2, *Aerospace series — Bushes, flanged in corrosion-resisting steel with self-lubricating liner, elevated load — Part 2: Dimensions and loads — Inch series*

EN 9100, *Quality Management Systems — Requirements for Aviation, Space and Defense Organizations*

EN 9133, *Aerospace series — Quality management systems — Qualification procedure for aerospace standard parts*

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

EN ISO 8785, *Geometrical Product Specification (GPS) — Surface imperfections — Terms, definitions and parameters*

ISO 11078, *Aircraft — De-icing/anti-icing fluids — ISO type II, III and IV*

TR 4475, *Aerospace series — Bearings and mechanical transmissions for airframe applications — Vocabulary*<sup>1)</sup>

### 3 Terms and definitions

For the purpose of this standard the terms and definitions given in TR 4475 and the following definitions apply.

#### 3.1

##### **bush with self-lubricating liner**

ring in corrosion resisting steel or aluminium alloy with a self-lubricating liner bonded to the bore

Note 1 to entry: With regards to flanged bushes the self-lubricating material is bonded to the outer face of the flange as well as the bore.

#### 3.2

##### **loads**

##### 3.2.1

##### **permissible static load $C_s$ or permissible static axial load $C_a$ (flanged bushes only)**

maximum permissible load (without safety factor), which can be applied statically

Note 1 to entry: It is defined as a unit pressure multiplied by the effective projected area (radial or axial) for deformations that are compatible with correct operational behaviour.

##### 3.2.2

##### **ultimate static load (radial or axial)**

1,5 times the value of the permissible static load

Note 1 to entry: It is defined as being the highest load the bush will support without failure occurring.

##### 3.2.3

##### **permissible dynamic radial load $C_{25}$**

load that a bush can withstand, when subjected to an oscillating motion for 25 000 cycles at the rate of  $(12 \pm 2)$  cycles/min

##### 3.2.4

##### **cycle**

angular displacement of the shaft in relation to the lined bush of  $0^\circ$  to  $-25^\circ$ , then of  $-25^\circ$  to  $+25^\circ$  and finally  $+25^\circ$  to  $0^\circ$ , see Figure 1

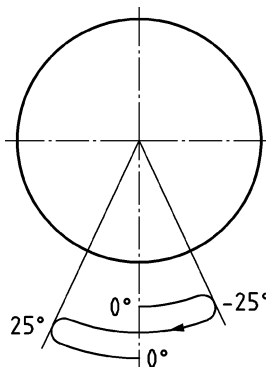


**Figure 1 — Cycle**

<sup>1)</sup> Published as ASD-STAN Technical Report at the date of publication of this standard. <http://www.asd-stan.org/>

### 3.3

#### **friction torque under load at ambient temperature**

coefficient of friction calculated as follows:

$$\mu = \frac{T}{C_{25} \cdot R}$$

where

$\mu$  is the coefficient of friction;

$T$  is the dynamic rotational torque under load, expressed in Newton meters (Nm);

$R$  is the radius of shaft, expressed in metres (m);

$C_{25}$  is the dynamic radial load, expressed in Newton (N).

### 3.4

#### **surface discontinuities**

##### 3.4.1

##### **crack**

linear recession with a sharp bottom resulting from a disturbance of the integrity of the surface and of the parent material of the workpiece

[SOURCE: EN ISO 8785, modified: figure not included]

##### 3.4.2

##### **scratch score**

surface imperfection which is a recession of irregular shape and unspecified direction

[SOURCE: EN ISO 8785, modified: synonym "score" added, figure not included]

##### 3.4.3

##### **lap**

tongue-like raising of small thickness, often in the form of a seam, caused by folding over of material and forcing it into the surface when rolling, forging etc.

[SOURCE: EN ISO 8785, figure not included]

##### 3.4.4

##### **seam**

non-welded fold which appears as an open defect in the material

### 3.5

#### **void**

area where the adhesive bond is broken or non-existent leaving a smooth and clean area on the metallic surface

Note 1 to entry: Used in context of adhesion of the liner.

### 3.6

#### **delivery batch**

consists of bushes bearing the same identity block although they may originate from different manufacturing batches

## 4 Required characteristics, inspection and test methods

According to Table 1.

**Table 1 — Required characteristics, inspection and test methods (1 of 4)**

| Clause | Characteristics           | Requirements                                                                                                                                                                                                                                                                                                                 | Inspection and test method                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Q <sup>a</sup> | A <sup>a</sup> |
|--------|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|
| 4.1    | Materials                 | In accordance with the product standards or design documentation                                                                                                                                                                                                                                                             | Chemical analysis and physical properties or a certificate of compliance according to EN 10204, 3.1B issued by the semi-finished product manufacturer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | X              | X              |
| 4.2    | Dimensions and tolerances | In accordance with the product standards or design documentation                                                                                                                                                                                                                                                             | Suitable measuring instruments<br><b>Measurement of the bore<sup>b</sup> and of the outer diameter</b> <ul style="list-style-type: none"> <li>— Rings having a width of &lt; 10 mm:               <ul style="list-style-type: none"> <li>— in the median plane.</li> </ul> </li> <li>— Rings having a width of &gt; 10 mm:               <ul style="list-style-type: none"> <li>— in two planes parallel to the outer faces and placed at a distance from these faces twice the maximum chamfer value of these rings.</li> </ul> </li> </ul> <b>Measurement of widths of rings:</b> <ul style="list-style-type: none"> <li>— A minimum four point check on the width of each ring (distance between the two faces).</li> </ul> | X              | X              |
| 4.3    | Masses                    | In accordance with the product standards or design documentation                                                                                                                                                                                                                                                             | Suitable methods                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | X              |                |
| 4.4    | Marking                   | In accordance with the product standards or design documentation                                                                                                                                                                                                                                                             | Visual examination                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | X              | X              |
| 4.5    | Surface appearance        | <ul style="list-style-type: none"> <li>— The bushes shall be free of surface discontinuities liable to have a detrimental effect on the characteristics and durability.</li> <li>— The liner shall not contain contaminant products and shall not show broken or voided areas.</li> <li>— No lubrication allowed.</li> </ul> | Visual monitoring using appropriate procedures.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | X              | X              |

**Table 1 — Required characteristics, inspection and test methods (2 of 4)**

| Clause | Characteristics                       | Requirements                                                                                                                                                                                          | Inspection and test method                                | Q <sup>a</sup> | A <sup>a</sup> |
|--------|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|----------------|----------------|
| 4.6    | Surface roughness                     | Shall conform to product standards                                                                                                                                                                    | Suitable measuring instruments or visual tactile samples. | X              | X              |
| 4.7    | Static loads:                         | Shall conform to product standards                                                                                                                                                                    | According to Annex A.                                     | X              |                |
|        | — radial: $C_s$                       | With permissible static loads no maximum total deformations greater than those indicated in Table A.1.                                                                                                |                                                           |                |                |
|        | — axial: $C_a$                        | After removal of the loads, no permanent deformations greater than those indicated in Table A.1.                                                                                                      |                                                           |                |                |
| 4.8    | Ultimate loads<br>— radial<br>— axial | After removal of the loads, no rupture, or crack.                                                                                                                                                     | According to Annex A.                                     | X              |                |
| 4.9    | Dynamic load and friction coefficient |                                                                                                                                                                                                       |                                                           | X              |                |
| 4.9.1  | Dynamic radial load $C_{25}$          | Shall conform to product standards.<br><b>After removal of the loads:</b> These shall be:                                                                                                             | According to Annex B.                                     |                |                |
|        | — at ambient temperature              | — no metal to metal contact between the shaft and bush.                                                                                                                                               |                                                           |                |                |
|        | — at low temperature                  | — wear of the liner shall not exceed the values indicated in Table B.1.                                                                                                                               |                                                           |                |                |
|        | — at high temperature                 | — liners resistance to peeling and adhesion shall meet the requirements of 4.11 and 4.12.                                                                                                             |                                                           |                |                |
| 4.9.2  | Friction coefficient <sup>c</sup>     | After dynamic test and before removal of load, torque to rotate shaft shown in Figure B.1 shall be measured and the value of $\mu$ calculated. The value shall not exceed 0,05 at ambient temperature | According to Annex E.                                     |                |                |