

Specification for

Test pieces and test methods for metallic materials —

Part 1: Tensile tests —

Section 3: Uninterrupted creep and
rupture tests —

Metric units

UDC 629.7:669.01:[620.1 + 620.172]

Foreword

Reference is made in this section to the following British Standards:

BS 1041, *Code for temperature measurement.*

BS 1610, *Methods for the load verification of testing machines.*

BS 1826, *Reference tables for platinum/rhodium v. platinum thermocouples.*

BS 1827, *Reference tables for nickel/chromium v. nickel/aluminium thermocouples.*

BS 1828, *Reference tables for copper v. constantan thermocouples.*

BS 1829, *Reference tables for iron v. constantan thermocouples.*

BS 3846, *Methods for calibration and grading of extensometers for testing of metals.*

NOTE Information concerning SI units is given in Supplement No. 1, "Additional tables for SI conversions" to BS 350, "Conversion factors and tables", and in PD 5686, "The use of SI units".

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Amendments issued since publication

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Contents

	Page
Foreword	Inside front cover
1 Scope	1
2 Basis of test	1
3 Symbols	1
4 Definitions	1
5 Selection and preparation of test pieces	2
6 Round test pieces	2
7 Rectangular section test pieces	6
8 Testing equipment	6
9 Test procedure	7
10 Stress rupture test	8
11 Creep strain test	9
12 Presentation of results	9
13 Notes and recommendations	10
Appendix A Dimensions of rupture test pieces from turbine blades	12
Figure 1 — Proportional round test piece	3
Figure 2 — Notched test pieces of circular cross section	4
Figure 3 — Combined notched and unnotched test pieces	5
Figure 4 — Test piece of rectangular cross section	6
Figure 5 — Stress-strain diagram	10
Figure 6 — Typical creep strain curve	11
Table 1 — Dimensions of proportional round test pieces	3
Table 2 — Dimensions of notched test pieces	4
Table 3 — Dimensions of notched and unnotched test pieces	5
Table 4 — Dimensions of rectangular section test pieces	6
Table 5 — Tolerances on test temperatures	8
Table 6 — Proportional round test pieces	12
Table 7 — Notched test pieces	12
Table 8 — Notched and unnotched test pieces	12

1 Scope

This section of this British Standard, covers tensile creep strain and rupture tests of aircraft metallic materials. It defines the properties that may need to be determined and the terms used in describing tests and test pieces. It specifies the dimensions of standard test pieces, and the standard method of testing. The duration of the creep strain and creep rupture tests complying with this standard shall be within the range 20–30 000 hours.

The standard is also applicable to tests of shorter duration than 20 hours provided agreement is reached, between the interested parties, concerning the tolerances on the temperature and the soaking time.

2 Basis of test

The test consists of maintaining a test piece at a uniform temperature and subjecting it to a constant tensile load at that temperature in order to determine specified properties.

3 Symbols

For the purposes of this section of this British Standard the following symbols apply:

Symbol	Description
d	Diameter of test section (see Figure 1).
D_n	Diameter of the parallel portion of a notched test piece of circular cross section (see Figure 2).
d_n	Diameter of test piece at root of notch (see Figure 2).
a	Thickness of test section (see Figure 4).
b	Width of test section (see Figure 4).
r_n	Notch root radius (see Figure 2).
α	Notch angle (see Figure 2).
r	Transition radius (see Figure 1).
L_o	Original gauge length (see Figure 1).
L_e	Extensometer gauge length.
L_c	Parallel length (see Figure 1).
L_n	Parallel length including the notch (see Figure 2).
L_t	Total length.
L_u	Gauge length after test.
S_o	Original cross-sectional area of test section.
S_u	Minimum cross-sectional area of test section after rupture.
A	Percentage elongation after rupture.
A_p	Percentage total plastic strain.
k	Ratio of L_o to $\sqrt{S_o}$.
z	Percentage reduction of area after rupture.

4 Definitions

For the purposes of this section of this British Standard the following definitions apply:

test piece

the portion of the test sample on which the creep strain or rupture test is carried out

proportional test piece

a test piece of circular cross section with a gauge length having a specified relation to the square root of the cross sectional area e.g. an original gauge length equal to $5.65\sqrt{S_o}$

non-proportional test piece

a test piece having a gauge length not specifically related to the cross-sectional area

original gauge length, (L_o)

the portion of the test piece on which elongation measurements are made at room temperature (see 9.2.2). This may also be used for the measurement of creep strain (see Clause 11)

extensometer gauge length, (L_o)

the length of the parallel portion of the test piece used for the measurement of the extension by means of an extensometer. This length may be different from the original gauge length L_o

extension

the increase of the extensometer gauge length from the original at any moment during the test

percentage elongation after rupture, (A)

the permanent increase in length ($L_u - L_o$) of the gauge length expressed as a percentage of the original gauge length (L_o) i.e. $100 (L_u - L_o)/L_o$, all measurements being made at room temperature

percentage reduction in area after rupture, (Z)

the maximum decrease of the cross sectional area ($S_o - S_u$) expressed as a percentage of the original cross sectional area (S_o), i.e. $100 (S_o - S_u)/S_o$

stress

the load on the test piece divided by the original cross sectional area of the parallel portion. In the case of the notched test pieces this is the load divided by the initial cross-sectional area at the root of the notch

strain

the extension per unit length

percentage total plastic strain, (A_p)

the total plastic extension of the gauge length, inclusive of any plastic extension during loading (i.e. the total extension excluding elastic extension), expressed as a percentage of the original gauge length (see Figure 5 and Figure 6)

young's modulus of elasticity

the value of the increment in stress divided by the corresponding increment in strain for the straight portion of the stress-strain (or load extension) diagram (see Figure 5)

NOTE Some materials do not give a single, straight, clearly defined stress-strain line, and for such materials the limits between which the apparent modulus of elasticity is determined shall be stated by the Inspecting Authority.

rupture

complete fracture of the test piece within the original gauge length or at the root of the notch under constant load and at constant temperature

time to rupture

the total time, at the test temperature and the test load, between the commencement of the test and the rupture of the test piece

5 Selection and preparation of test pieces

The selection and preparation of test samples and the location of test pieces shall be governed by the Inspection and Testing procedure or by the material specification.

6 Round test pieces

6.1 The proportional test pieces have an original gauge length which bears a specified relationship to the cross-sectional area. This ensures that comparable values for percentage elongation are obtained from test pieces of different sizes but having the same relationship. The relationship $L_o = 5.65 \sqrt{S_o}$ shall be used. This gives a value of $L_o = 5d$.

6.2 The cross section of the test piece shall be circular. There shall be a transition radius between the gripped ends and the parallel length (see Figure 1).

6.3 Sizes of machined proportional round test pieces are given in Table 1.

6.4 Sizes of machined notched round test pieces are given in Table 2 and Table 3.

6.5 Unnotched test pieces shall be chosen from Table 1 and notched test pieces from Table 2 or Table 3. If the size of the material available is too small the dimensions of the test piece used shall be as agreed with the Inspecting Authority. See also Appendix A for rupture test pieces manufactured from turbine blades.

6.6 The gripped ends of the test piece shall be co-axial with the parallel portion within a concentricity tolerance of 0.03 mm and may be of any shape to suit the holders of the testing machine.