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Part 001: Tensile testing at ambient temperature

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Introduction

This draft standard is based on European discussions in which the UK has taken an active part. Your comments on this draft are welcome and will assist in the preparation of the consequent British Standard. Comment is particularly welcome on national, legislative or similar deviations that may be necessary.

Even if this draft standard is not approved by the UK, if it receives the necessary support in Europe, the UK will be obliged to publish the official English Language text unchanged as a British Standard and to withdraw any conflicting standard.

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	(7)
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/ Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

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Introduction

This standard is part of the series of EN metallic material standards for aerospace applications. The general organization of this series is described in EN 4258.

1 Scope

This standard specifies the requirements for the tensile testing of metallic materials at ambient temperature for aerospace applications.

It shall be applied when referred to in the EN technical specification or material standard unless otherwise specified on the drawing, order or inspection schedule.

2 Normative references

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

EN ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines – Calibration and verification of the force-measuring system*

EN ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

EN 4258, *Aerospace series — Metallic materials — General organization of standardization — Links between types of EN standards and their use*

EN 4259, *Aerospace series — Metallic materials — Definition of general terms*¹⁾

ASTM E-1012, *Standard practice for verification of testing frame and specimen alignment under tensile and compressive axial force application*²⁾

3 Terms, definitions and symbols

For the purposes of this standard, the terms, definitions and symbols given in EN 4259 and the following given in Table 1 apply.

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

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

¹⁾ Published as ASD-STAN Prestandard at the date of publication of this standard.

²⁾ This standard is published by: American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

Table 1 — Terms, definitions and symbols

Symbol	Unit	Term	Definition
–	–	Test piece	The portion of the test sample on which the tensile test is carried out
–	–	Proportional test pieces	A test piece with an original gauge length (L_0) having a specified relationship to the square root of the cross-sectional area (S_0). The proportionality coefficient, K , has the internationally recognized value of 5,65 for test pieces of circular cross-section. The gauge length of a proportional test piece is therefore equal to $5,65 \sqrt{S_0}$. Certain material standards use proportional test pieces with other than the 5,65 proportionality coefficient. In this case, see A_x for the percentage elongation symbol used.
–	–	Non-proportional test piece	A test piece where the original gauge length is independent of the cross-sectional area
–	mm	Extension	The increase of the extensometer gauge length (L_e) at any moment during the test
–	MPa	Limit of proportionality	The stress at which the stress-strain (or force-extension) relationship deviates from a straight line
A	%	Percentage elongation (proportional test piece) NOTE For non-standard proportional test piece, see A_x .	Elongation after fracture expressed as a percentage of the original gauge length (L_0) for a proportional test piece with an original gauge length of $L_0 = 5,65 \sqrt{S_0}$. $A = \frac{L_u - L_0}{L_0} \times 100$
A_{L0}	%	Percentage elongation (non-proportional test piece)	Elongation after fracture expressed as a percentage of the original gauge length (L_0) for a non-proportional test piece with an original gauge length of L_0 . For a non-proportional test piece, the original gauge length is given in millimetres, e.g. $A_{50\text{mm}}$. $A_{L0} = \frac{L_u - L_0}{L_0} \times 100$
A_x	%	Percentage elongation (non standard proportional test piece)	Elongation after fracture expressed as a percentage of original gauge length (L_0) for a non-standard proportional test piece with an original gauge length of $L_0 = x$ (e.g.: A_{40}) A non-standard proportional test piece is one in which the proportionality coefficient has a value other than 5,65. In the example above the gauge length is four times the diameter, equivalent to a proportionality coefficient of 4,51.
a	mm	Test piece thickness	Thickness of a test piece of rectangular cross-section or wall thickness of a tube
b	mm	Test piece width	Width of test pieces of rectangular cross-section, average width of the longitudinal strip taken from a tube or width of a flat wire
D	mm	Tube external diameter	External diameter of a tube
d	mm	Test piece diameter	Diameter of the parallel length of a circular test piece or diameter of round wire or internal diameter of a tube

Table 1 — Terms, definitions and symbols

Symbol	Unit	Term	Definition
E	GPa	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 force-extension) diagram
F_m	N	Maximum force	The greatest force which the test piece withstands during the test
L	mm	Gauge length	The length of the cylindrical or prismatic portion of the test piece on which elongation is measured
L_c	mm	Parallel length	The length of the reduced section of the parallel portion of the test piece. The concept of parallel length is replaced by the concept of distance between grips for non-machined test pieces.
L_e	mm	Extensometer gauge length	The length of the parallel portion of the test piece used for the measurement of extension by means of an extensometer at any moment during the test. This length may differ from L_0 but can be of any value greater than b , d or D (see above) but shall be less than the parallel length (L_c). It is recommended that the extensometer gauge length is as large as possible.
L_0	mm	Original gauge length	The gauge length before the application of force
L_t	mm	Test piece length	Total length of test piece
L_u	mm	Final gauge length	The gauge length after fracture of the test piece
$L_u - L_0$	mm	Elongation	Elongation after fracture. The permanent increase in the original gauge length (L_0) after fracture.
R_m	MPa	Tensile strength	The maximum force (F_m) divided by the original cross-sectional area (S_0) of the test piece
R_p	MPa	Proof stress	The stress at which a non-proportional extension is equal to a specified percentage of the extensometer gauge length (L_e) (see Figure 1). The symbol used is followed by a suffix giving the prescribed percentage of the original gauge length for example: $R_{p0,2}$
r	mm	Test piece transition radius	Radius at ends of parallel length
S_0	mm ²	Original cross-sectional area	Original cross-sectional area of the parallel length
S_u	mm ²	Minimum cross-sectional area	Minimum cross-sectional area of test piece after fracture
Z	%	Percentage reduction of area after fracture	The maximum decrease of the cross-sectional area ($S_0 - S_u$) expressed as a percentage of the original cross-sectional area (S_0) i.e. $Z = \frac{S_0 - S_u}{S_0} \times 100$
ε	—	Strain	The extension of any moment during the test divided by the original gauge length (L_0) of the test piece
σ	MPa	Stress	The force at any moment during the test divided by the original cross-section area (S_0) of the test piece
θ	°C	Specified temperature	The temperature at which the test is to be carried out

4 Health and safety

Resources, test pieces, test samples, test materials, test equipment and test procedures shall comply with the current health and safety regulations/laws of the countries where the test is to be carried out.

Where materials and/or reagents that may be hazardous to health are specified, appropriate precautions in conformity with local regulations and/or laws shall be taken.

5 Principle

The test involves straining a test piece by a tensile force at ambient temperature to fracture for the purpose of determining one or more of, Young's modulus of elasticity, proof stress, tensile strength, elongation, reduction of area.

6 Testing requirements

6.1 Resources

6.1.1 Equipment/plant

6.1.1.1 Testing machine

Testing machine accuracy shall be verified at intervals not exceeding 12 months in accordance with EN ISO 7500-1 and shall be certified to class 1 or better.

Its design shall permit automatic loading alignment. The loading system alignment shall be checked at least annually with a strain-gauged test piece. The difference between the recorded maximum and minimum strains shall not exceed 10 % of the mean strain at an appropriate verification force relative to the forces expected during a subsequent series of tests. Reference may be made to ASTM E1012 for a verification method.

It may be computer controlled and capable of automatic calculation and recording of Young's modulus of elasticity, proof stress, tensile strength and elongation.

6.1.1.2 Extensometer

The extensometer accuracy shall be verified at intervals not exceeding 12 months in accordance with EN ISO 9513 and shall be certified for determination of:

- Young's modulus of elasticity to class 0,5 or better and a type that is capable of measuring extension on both sides of a test piece and allows readings to be averaged is preferred.
- Proof stress to class 1 or better.

6.1.1.3 Grips

Grips shall consist of screwed holders, shouldered holders, wedge pieces, pin grips or other means such that the tensile test force is applied axially.

The use of screwed holders is recommended and shall be mandatory in case of dispute.