BS EN 4050-3:2012

BSI Standards Publication

Aerospace series — Test method for metallic materials — Ultrasonic inspection of bars, plates, forging stock and forgings

Part 3: Reference blocks

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 4050-3:2012.

The UK participation in its preparation was entrusted to Technical Committee ACE/61, Metallic materials for aerospace purposes.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2012.

ISBN 978 0 580 75195 0

ICS 49.025.05; 49.025.15

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 October 2012.

Amendments issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 4050-3

September 2012

ICS 49.025.05; 49.025.15

English Version

Aerospace series - Test method for metallic materials - Ultrasonic inspection of bars, plates, forging stock and forgings - Part 3: Reference blocks

Série aérospatiale - Méthode d'essai applicable aux matériaux métalliques - L'inspection par ultrasons des barres, des assiettes, des stocks de forgeage et de pièces forgées - Partie 3: Blocs de référence

Luft- und Raumfahrt - Prüfverfahren für metallische Werkstoffe - Ultraschallprüfung von Stangen, Platten, Schmiedevormaterial und Schmiedestücken - Teil 3: Referenzblöcke

This European Standard was approved by CEN on 15 July 2011.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 4050-3:2012: E

Contents

Page

Foreword **3**

1 Scope **4**

2 Generality **4**

3 Normative references **4**

4 Terms and definitions **4**

5 Master test blocks **5**
5.1 Materials **5**
5.2 Flat bottom holes standards **5**
5.3 Manufacture **5**
5.4 Checking **7**

6 Standard test blocks **7**
6.1 Material recommended **7**
6.2 FBH standard **7**
6.3 Manufacture **7**
6.4 Checking **9**

7 Special test blocks for round bars and forging stock **9**

Annex A (normative) **Standard test blocks** **10**
A.1 Specification **10**
A.2 Examples of standard test blocks **10**

Foreword

This document (EN 4050-3:2012) 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 March 2013, and conflicting national standards shall be withdrawn at the latest by March 2013.

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

According to the CEN/CENELEC Internal Regulations, the national standards organisations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

1 Scope

This European Standard specifies the requirements for the manufacture, checking and marking of the series of ultrasonic testing reference blocks containing flat bottom holes (FBH) which define the indicated defect size to which reference is made in EN standards.

2 Generality

The application of ultrasonic testing reference blocks containing side-drilled holes (SDH) which define an indicated defect size shall be agreed between manufacturer and purchaser.

This standard is applicable to the production of master and standard test blocks to be used when carrying out ultrasonic inspection to the requirements of EN 4050-1 (FBH method).

It is recognised that particular difficulties are encountered with round forging stock and bars due to the wide range of curvatures. For this application, only one block shall be produced to act as both master and standard test block.

3 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 2278, *Steel FE-PM 37 — 900 MPa ≤ R_m ≤ 1100 MPa — Bars D_e ≤ 150 mm — Aerospace series*[1)]

EN 2321, *Aluminium alloy 2024-T3 — Bars and section a ≤ 150 mm — Aerospace series*[1)]

EN 3311, *Aerospace series — Titanium alloy TI-64001 — Annealed — 900 MPa ≤ R_m ≤* 1 160 *MPa — Bar for machining — D_e ≤ 150 mm*[2)]

EN 4050-1, *Aerospace series — Test method for metallic materials — Ultrasonic inspection of bars, plates, forging stock and forgings — Part 1: General requirements*

EN 4050-2, *Aerospace series — Test method for metallic materials — Ultrasonic inspection of bars, plates, forging stock and forgings — Part 2: Performance of test*

EN 4050-4, *Aerospace series — Test method for metallic materials — Ultrasonic inspection of bars, plates, forgings stock and forgings — Part 4: Acceptance criteria*

ASTM E 127, *Standard practice for fabricating and checking aluminium alloy ultrasonic standard reference blocks*[3)]

4 Terms and definitions

See EN 4050-1.

---

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

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

3) Published by: American Society for Testing and Materials (ASTM) 1916 Race Street, Philadelphia, PA.

5 Master test blocks

5.1 Materials

The materials for master test blocks are given in Table 1.

Table 1

Alloy class	Representative (alloy AECMA designation)		Typical application for	Standard FBH ∅ (mm)[1)]	Correction for attenuation
	Old	New			
A	2024 (EN 2321)	AL-P2024-	Aluminium alloys	0,8	no
B1	FE-PM37 (EN 2278)	FE-PM1502	Nickel-cobalt alloys (grain size ASTM 5 or finer) Martensitic stainless steels P.M. super alloys	0,4	no
B2	FE-PM37 (EN 2278)	FE-PM1502	Nickel-cobalt alloys (grain size ASTM 4 or coarser) Austenitic steels	1,2	yes
C	TI-P63	TI-P64001 (EN 3311)	Titanium or Titanium alloys	0,8	yes

[1)] Where long metal paths make the standard FBH quoted above impractical then larger sized FBH's shall be used with agreement between manufacturer and purchaser and shall be referenced on the order or in an inspection schedule.

5.2 Flat bottom holes standards

Flat bottom holes in the master test blocks shall be used to calibrate standard test blocks. The master test blocks shall have FBH at different metal paths to suit the product range to be inspected. It shall be ensured however that there is sufficient number with a minimum of three different metal paths to accurately produce the required distance/amplitude curve (see 5.4.2.2).

5.3 Manufacture

5.3.1 Material procurement

Material for each set of master test blocks shall be obtained from the same cast, forging and heat treatment batch.

For longitudinal waves when checking anisotropic materials, the FBH shall be drilled perpendicular to the grain flow, if possible, but always perpendicular to the surface.

Ultrasonic tests shall be carried out on each test block to ensure:

— freedom from defects greater than or equal to – 12 dB below the DAC (see EN 4050-1);

— consistent grass level across each test block and between master test blocks in the vicinity of the FBH. Maximum variation ± 3 dB;

— consistent attenuation across each test block and between master test blocks not to exceed 0,1 dB/cm variation.

5.3.2 Machining

5.3.2.1 Procedures

The machining route shall be initially qualified as meeting the geometric tolerance requirements of ASTM E 127. Changes in the machining route shall not be made without reference to the responsible Level 3 NDT person.

Upon completion of the drilling operations, clean the hole bottom with a suitable cleaning fluid and dry with a fine stream of dried, filtered, compressed air blown through a capillary tube inserted in the hole. Apply injection for small diameters (∅ ≤ 1,2 mm).

After drilling the holes, these shall be plugged. Care shall be taken that a sufficient air gap subsists between plug and the bottom of the hole.

If the hole has to be counterbored to permit this sealing (small standards), a minimum distance of 5 mm is required between the bottom of the counterbore and that of the actual hole. This hole of bigger diameter can also be drilled before to make it easier for the drilling of the smallest standard and/or plugged with a T-thread nylon screw with its countersunk head slightly underflush.

The FBH geometry of the master test block shall be such as to ensure that the amplitude values during the machine qualification will be achieved within an accuracy of ± 3 dB.

5.3.2.2 Tolerances

FBH shall normally be drilled to a minimum remaining metal path of 3 mm and to a tolerance of ± 3 % of diameter. Where low frequencies are used (e.g. 2 MHz), the minimum metal path shall be increased up to 7 mm. Other depths shall be agreed upon by the purchaser and manufacturer.

The FBH interface shall be parallel to the ultrasonic entry face within 1 % of hole diameter and shall be perpendicular to its longitudinal axis, within 0,05 mm per 10 mm depth.

The radius between the FBH interface and the hole cylinder shall be ≤ 5 % of hole diameter.

If more than one hole is to be drilled in a test block, then adjacent holes shall be separated by a distance of not less than 40 mm.

No hole shall be closer than 20 mm to an edge.

Both end faces of the blocks shall be parallel to each other within 0,05 mm and the external surface shall be free from damage and have a surface roughness R_a < 0,8 μm.

Not all tolerances can be measured in the master test blocks. Statistical or destructive method shall be applied to verify the accuracy.

5.3.3 Identification

Each master test block shall be identified and have a serial number followed by the alloy class number or alloy designation.

The permanent marking shall be on the side wall of the test block. The marking shall stipulate the hole diameter(s) in millimetres followed by an oblique and the metal path(s) in millimetres.

5.4 Checking

5.4.1 Electronic equipment

Basic requirements for testing the equipment shall be in accordance with EN 4050-2.

Distance/amplitude curves shall be plotted using the immersion technique preferably with a non focused probe in a range of 5 MHz to 10 MHz, whose diameter shall not be less than 12,5 mm and using a water gap $\geq 1\ N$. N is the near field.

5.4.2 Checking procedures

5.4.2.1 Checking geometric characteristics

At the initial drilling qualification and on the finished master test blocks, geometric characteristics shall be verified and acceptable to the requirements of ASTM E 127.

5.4.2.2 Checking ultrasonic response characteristics

The ultrasonic response from the flat bottom holes of a given set of master test blocks shall be verified by:

— comparison with the amplitude obtained from a set of master test blocks in the same material applying suitable compensations;

— evaluation using the DGS system;

— destructive measurements and statistical techniques.

The method to be used shall be agreed between the manufacturer and the purchaser and shall be recorded on the order or inspection schedule.

6 Standard test blocks

6.1 Material recommended

The materials, mentioned in Table 1, are recommended for standard test blocks. Other materials shall be agreed between manufacturer and purchaser.

6.2 FBH standard

FBH sizes shall be used in accordance with the applicable class of EN 4050-4. Metal paths shall suit the product range to be inspected.

6.3 Manufacture

6.3.1 Material procurement

Material for each set of standard test blocks shall be obtained from the same cast, forging and heat treatment batch.

For longitudinal waves, checking anisotropic materials, the FBH shall be drilled perpendicular to the grain flow, if possible, but always perpendicular to the surface.

Ultrasonic test shall be carried out on each test block to ensure:

— freedom from defects greater than or equal to −12 db below the DAC (see EN 4050-1);

— consistent grass level across each test block and between master test blocks in the same area. Maximum variation ± 3 dB;

— consistent attenuation across each test block and between master test blocks not to exceed 0,1 dB/cm variation.

6.3.2 Machining

6.3.2.1 Procedures

The machining route shall be initially qualified as meeting the geometric requirements of ASTM E 127. Changes in the machining route shall not be made without reference to the responsible Level 3 NDT person.

Upon completion of the drilling operations, clean the hole bottom with a suitable cleaning fluid and dry with a fine stream of dried, filtered, compressed air blown through a capillary tube inserted in the hole. Apply injection for small diameters (∅ ≤ 1,2 mm).

After drilling the holes, these shall be plugged. Care shall be taken that a sufficient air gap subsists between plug and the bottom of the hole.

If the hole has to be counterbored to permit this sealing (small standards), a minimum distance of 5 mm is required between the bottom of the counterbore and that of the FBH interface. This hole of bigger diameter may also be drilled before to make it easier for the drilling of the smallest standard and/or plugged with a T-thread nylon screw with its countersunk head slightly underflush.

6.3.2.2 Tolerances

FBH shall normally be drilled to a minimum remaining metal path of 3 mm and to a tolerance of ± 3 % of diameter. Where low frequencies are used (e.g. 2 MHz), the minimum metal path may be increased up to 7 mm. Other depths shall be agreed upon by the purchaser and manufacturer.

The FBH interface shall be parallel to the ultrasonic entry face within 1 % of hole diameter and shall be perpendicular to its longitudinal axis within 0,05 mm per 10 mm depth.

The radius between the FBH interface and the hole cylinder shall be ≤ 5 % of hole diameter.

If more than one hole is to be drilled in a test block, then adjacent holes shall be separated by a distance ≥ 40 mm.

No hole shall be closer than 20 mm to an edge.

Both end faces of the blocks shall be parallel to each other within 0,05 mm and the external surface shall be free from damage and have a surface roughness R_a < 0,8 μm.

Not all tolerances shall be measured in the standard test blocks. Statistical or destructive methods shall be applied to verify the accuracy.

6.3.3 Identification

Each standard test block shall be identified and have a serial number followed by the alloy class number, or alloy designation.

The permanent marking shall be on the side wall of the test block. The marking shall stipulate the hole diameter(s) in millimetres followed by an oblique and the metal path(s) in millimetres.

In addition, the marking shall stipulate the correction factor, where applicable.

NOTE When a standard test block is ascribed a positive correction factor, the effective size of the FBH it contains is less than that in the corresponding master test block.

6.4 Checking

6.4.1 General

Whilst close tolerances are imposed on all dimensions quoted in this standard it shall be remembered that it is the resultant ultrasonic reflection characteristic that is important. Therefore, all standard test blocks manufactured shall be calibrated to the master test blocks for acceptance purposes even though they may conform to the dimensional requirements.

6.4.2 Electronic equipment

Basic requirements for testing the equipment shall be in accordance with EN 4050-2.

Distance/amplitude curves shall be plotted using the immersion technique preferably with a non focused probe in a range of 5 MHz to 10 MHz, whose diameter shall be ≥ 12,5 mm and using a water gap ≥ 1 N. N is the near field.

6.4.3 Checking procedures

6.4.3.1 Checking geometric characteristics

At the initial drilling qualification and on the finished standard test blocks, geometric characteristics shall be verified in accordance with ASTM E 127.

6.4.3.2 Checking ultrasonic response characteristics

The ultrasonic response shall be verified by comparison to the master test blocks using a best fit distance amplitude curve derived from the master test blocks.

7 Special test blocks for round bars and forging stock

It is recognised that particular difficulties are encountered with round forging stock and bars due to the wide range of curvatures. For this application, only one block shall be produced to act as both master and standard test block (see Annex A).

Special test blocks for the inspection of round bars and forging stock shall be machined to take into account the influence of surface curvature.

In addition to all the requirements of Clause 5, the following specific requirements shall apply.

A deviation of ± 15 % of diameter is permitted up to max. of 25 mm.

The test blocks shall contain a plain full diameter section for attenuation correction, where applicable.

Where difficult to machine, it is permitted to drill the FBH in plugs manufactured from the same material, taken from the radial direction. These plugs shall then be fitted in the actual bar or forging stock, before its final surface machining. Their diameter shall be ≥ (28 + 0,5 P) mm, where P is the distance from FBH interface to the bar or forging stock surface.

Annex A
(normative)

Standard test blocks

A.1 Specification

See Table A.1.

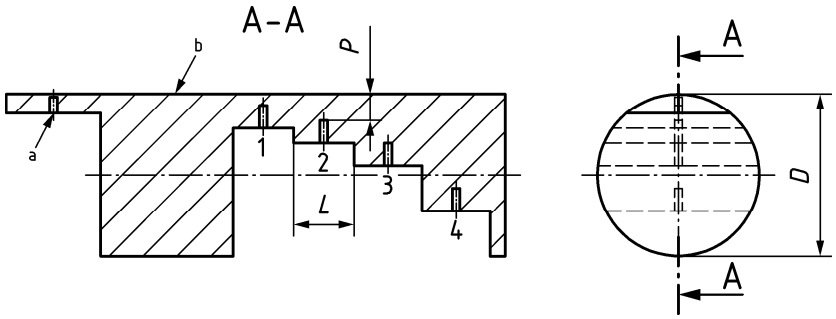
Table A.1

Hole index	1	2	3	4	
				$D \leq 50$	$D > 50$
P, distance to FBH (± 0,5 mm)	0,1 D	0,167 D	0,25 D	0,5 D + 5 mm	0,5 D + 12,7 mm

L (mm) shall be $\geq (28 + 0{,}5\ P)$ mm for the evaluation of hole echo amplitudes only. The exact specification shall be agreed between manufacturer and purchaser.

A.2 Examples of standard test blocks

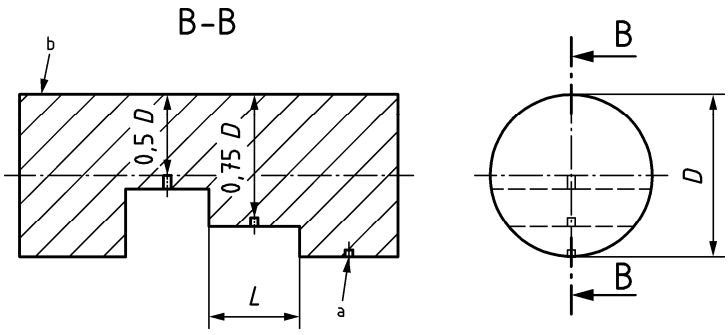
See Figures A.1 and A.2.



Key

a near surface resolution hole
b attenuation

Figure A.1 — Recommended standard test block for front to middle inspection



Key

a far surface hole (as rear as possible)
b attenuation

Figure A.2 — Recommended standard test block for middle to back inspection

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™