

# Specification and approval of welding procedures for metallic materials

## Part 1. General rules for fusion welding

金属材料焊接工艺的规范和认可

第 1 部分：熔焊的一般规则

The European Standard EN 288-1 : 1992, with the incorporation of its amendment A1, has the status of a British Standard

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## Committees responsible for this British Standard

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AEA Technology  
 Association of Consulting Scientists  
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 British Iron and Steel Producers' Association  
 British Nuclear Fuels plc  
 British Railways Board  
 British Stainless Steel Association  
 Castings Technology International  
 Electricity Association  
 General Municipal Boilermaker and Allied Trades Union  
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 Power Generation Contractors' Association (PGCA (BEAMA Ltd.))  
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## National foreword

This Part of BS EN 288 has been prepared by Technical Committee WEE/36, and is the English language version of EN 288-1 : 1992 *Specification and approval of welding procedures for metallic materials — Part 1 : General rules for fusion welding*, incorporating amendment A1, published by the European Committee for Standardization (CEN). It supersedes BS 4870 : Part 1 : 1981 on 28 August 1992.

EN 288-1 and amendment A1 were produced as a result of international discussions in which the UK took an active part.

### Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or using the 'find' facility of the BSI Standards Electronic Catalogue.

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### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 8, an inside back cover and a back cover. All pages are issue 2.



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English version

## Specification and approval of welding procedures for metallic materials — Part 1: General rules for fusion welding (includes amendment A1 : 1997)

Descriptif et qualification d'un mode opératoire de soudage sur les matériaux métalliques —  
Partie 1: Règles générales; soudage par fusion  
(inclut l'amendement A1 : 1997)

Anforderung und Anerkennung von  
Schweißverfahren für metallische Werkstoffe —  
Teil 1: Allgemeine Regeln für das  
Schmelzschweißen  
(enthält Änderung A1 : 1997)

This European Standard was approved by CEN on 1992-02-21. Amendment A1 was approved on 1996-12-11. 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 Central Secretariat or to any CEN member.

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Comité Européen de Normalisation  
Europäisches Komitee für Normung

**Central Secretariat: rue de Stassart 36, B-1050 Brussels**

## Foreword

This standard has been prepared by Working Group 1 Specification and approval of welding procedures for metallic materials of CEN/TC 121 Welding.

For this standard, ISO/TC 44/SC10 N 175 was considered and used as a basis. However, alterations were necessary due to the consideration of experience and updated knowledge.

This standard consists of various parts. The already finalized parts of this standard are listed in clause 2.

More parts are being prepared by CEN/TC 121 and the contents of these are described briefly in annex A of this part.

In accordance with the common CEN/CENELEC Rules, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

## Foreword to amendment A1

This Amendment EN 288-1 : 1992/A1 : 1997 to EN 288-1 : 1992 has been prepared by Technical Committee CEN/TC 121, Welding, the secretariat of which is held by DS.

This Amendment to the European Standard EN 288-1 : 1992 shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 1997, and conflicting national standards shall be withdrawn at the latest by December 1997.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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## 0 Introduction

Welding procedure specifications are needed in order to provide a well defined basis for planning of the welding operations and for quality control during welding. Welding is considered a special process in the terminology of standards for quality systems. Standards for quality systems usually require that special processes shall be carried out in accordance with written procedure specifications.

Part 2 of this standard defines a format for the welding procedure specifications for arc welding of metallic materials, which is considered to fulfil the requirements in current standards for quality systems as regards procedure specifications.

Preparation of a welding procedure specification provides the necessary basis for, but does not in itself ensure that the welds fulfill the requirements. Some deviations, notably imperfections and distortions, can be evaluated by non-destructive methods on the finished product.

Metallurgical deviations constitute a special problem, however, because non-destructive evaluation of the mechanical properties is impossible at the present level on non-destructive technology. This has resulted in the establishment of a set of rules for approval of the welding procedure prior to the release of the specification to actual production. Part 1 of this standard defines these rules.

## 1 Scope

This standard defines general rules for the specification and approval of welding procedures for metallic materials. This standard also refers to several other standards as regards detailed rules for specific applications.

It is assumed that the welding procedure specifications are used in production by competent welders, approved in accordance with the relevant Part of EN 287.

This standard applies when approval of the welding procedure is required e.g. by either contract, standards, rules or legal requirements.

The use of a particular method of approval of a welding procedure is often a mandatory requirement of an application standard. In the absence of such a requirement the method of approval shall be agreed between the contracting parties at the enquiry or at the order stage.

## 2 Normative references

This standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

- |                |   |
|----------------|---|
| EN 287-1       | <i>Approval testing of welders — Fusion welding — Part 1: Steels</i>  |
| EN 287-2       | <i>Approval testing of welders — Fusion welding — Part 2: Aluminium and aluminium alloys</i>  |
| EN 288-2       | <i>Specification and approval of welding procedures for metallic materials — Part 2: Welding procedure specification for arc welding</i>                                  |
| EN 288-3       | <i>Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels</i>                            |
| EN 288-4       | <i>Specification and approval of welding procedures for metallic materials — Part 4: Welding procedure tests for the arc welding of aluminium and its alloys</i>          |
| EN 288-5       | <i>Specification and approval of welding procedures for metallic materials — Part 5: Approval by using approved welding consumables for arc welding</i>                   |
| EN 288-6       | <i>Specification and approval of welding procedures for metallic materials — Part 6: Approval related to previous experience</i>  |
| EN 288-7       | <i>Specification and approval of welding procedures for metallic materials — Part 7: Approval by a standard welding procedure for arc welding</i>                         |
| EN 288-8       | <i>Specification and approval of welding procedures for metallic materials — Part 8: Approval by a pre-production welding test</i>  |
| prEN 1011      | <i>Recommendations for arc welding of ferritic steels</i>   |
| prEN 12345     | <i>Welding — Pictorial representation of terms for welded joints</i>  |
| EN 24063       | <i>Welding brazing, soldering and braze welding of metals — Nomenclature of processes and reference numbers for symbolic representation on drawings (ISO 4063 : 1990)</i> |
| EN 26520       | <i>Classification of imperfections in metallic fusion welds, with explanations (ISO 6520 : 1982)</i>  |
| ISO 857 : 1990 | <i>Welding brazing and soldering processes — Vocabulary</i>   |

### 3 Definitions

#### 3.1 welding procedure

A specified course of action to be followed in making a weld, including reference to materials, preparation, preheating (if necessary), method and control of welding and post-weld heat treatment (if relevant), and necessary equipment to be used.

#### 3.2 welding processes

For the welding processes the nomenclature and definitions given in ISO 857 are followed in this standard. The numbering system for welding processes in ISO 4063 is adhered to.

#### 3.3 preliminary welding procedure specification (pWPS)

A tentative welding procedure specification, which is assumed to be adequate by the manufacturer, but which has not been approved. Welding of test pieces needed for approval of a welding procedure specification has to be carried out on the basis of a preliminary welding procedure specification (pWPS).

#### 3.4 welding procedure specification (WPS)

A document providing in detail the required variables for a specific application to ensure repeatability.

#### 3.5 work instruction

Simplified specification (written or verbal) of the welding procedure, suitable for direct application in the workshop.

#### 3.6 approved welding procedure specification

A specification for which the welding procedure has been approved in accordance with the rules of this standard.

#### 3.7 welding procedure approval record (WPAR)

A record comprising all relevant data from the welding of a test piece needed for approval of a welding procedure specification as well as all results from the testing of the test weld.

NOTE 1. One or more welding procedure approval records may be needed in order to approve one welding procedure specification, and one welding procedure approval record may, in certain cases, provide approval for more than one welding procedure specification.

NOTE 2. WPAR was formerly designated as WPQR.

#### 3.8 previous welding experience

When it can be shown by authenticated test data that the manufacturer's established production welding procedures have been capable of consistently producing welds of acceptable quality over a period of time.

#### 3.9 approved welding consumable

A welding consumable or consumable combination tested and certified by an independent examiner or test body.

#### 3.10 welding procedure test

The making and testing of a welded joint, representative of the one to be used in production, in order to prove the feasibility of a welding procedure.

#### 3.11 standard welding procedure

A welding procedure tested and certified by an examiner or examining body which may then be made available to any manufacturer.

#### 3.12 pre-production welding test

A welding test having the same function as a welding procedure test, but based on a non-standard test piece, simulating the production conditions.

#### 3.13 welding consumables

Materials consumed in the making of a weld, including filler metals, fluxes and gases.

#### 3.14 Welding variable

##### 3.14.1 essential variable

A variable which influences the mechanical and/or metallurgical properties of the welded joint.

##### 3.14.2 additional variable

A variable which does not influence the mechanical and/or metallurgical properties of the welded joint.

#### 3.15 range of approval

The extent of approval for an essential variable.

#### 3.16 Parent metal

##### 3.16.1 standard material

Parent metal of a defined chemical composition, mechanical properties, heat treatment etc., produced and delivered according to a standard or similar comprehensive specification.

##### 3.16.2 group of standard materials

A defined number of similar standard materials.

##### 3.16.3 batch of standard materials

Parent metals of the same chemical composition, mechanical properties, heat treatment etc., delivered as a unit from a single manufacturer (e.g. steel mill). The batch is limited to a single charge.

#### 3.17 test piece

The welded assembly which is used in the approval test.

#### 3.18 test specimen

The part or portion cut from the test piece in order to perform a specified destructive test.

#### 3.19 test

A series of operations which will include the making of a welded test piece and subsequent non-destructive and/or destructive testing and reporting of results.

### 3.20 homogeneous assembly

An assembly in which the weld metal and parent metal have no significant differences in mechanical properties and/or chemical composition.

NOTE. An assembly made of similar parent metals without filler metal is considered homogeneous.

### 3.21 heterogeneous assembly

An assembly in which the weld metal and parent metal have significant differences in mechanical properties and/or chemical composition.

### 3.22 dissimilar metal joint

An assembly in which the parent metals have significant differences in mechanical properties and/or chemical composition.

### 3.23 imperfection

A discontinuity in the weld or a deviation from the intended geometry. Imperfections include e.g.: cracks, lack of penetration, porosity, slag inclusions.

NOTE. EN 26520 contains a comprehensive list of imperfections.

### 3.24 metallurgical deviation

Changes in the mechanical properties and/or metallurgical structure of the weld metal or heat affected zones compared to the properties of the parent metal.

NOTE. Metallurgical changes include: reduced strength, reduced ductility, reduced fracture toughness etc.. in the weld metal and heat affected zones. The metallurgical changes are caused by the temperature variations during welding combined with the resulting chemical composition and structure of the weld metal.

### 3.25 manufacturer

The person or organisation which is responsible for the welding production (welding workshop).

### 3.26 welder

A welder who holds and manipulates the electrode holder, welding gun, torch or blowpipe by hand.

### 3.27 welding operator

A person who performs fully mechanized or automatic welding.

### 3.28 examiner or examining body

A person or organization who verifies compliance with the applicable standard. The examiner/examining body shall be acceptable to any contracting parties.

### 3.29 supplier of consumables

The company which manufactures or supplies the consumables.

### 3.30 welding coordination personnel

Personnel who, within a manufacturer, have responsibilities in the manufacturing operation for welding and welding related activities whose competence and knowledge has been demonstrated by e.g. training, education and/or relevant manufacturing experience.

### 3.31 heat input

The energy introduced into the weld region during welding a run per unit length of the run length.

NOTE. See EN 1011 for calculation of heat input.

### 3.32 run out length

The length of a run produced by melting a covered electrode.

NOTE. See EN 1011 for calculation of run out length.

### 3.33 parent metal thickness

The nominal thickness of the materials to be welded.

### 3.34 weld metal thickness

See prEN 12345.

### 3.35 fillet weld throat thickness

See prEN 12345.

### 3.36 partial penetration weld

See prEN 12345.

## 4 Specification of welding procedures

Welding operations shall be adequately planned prior to production; the planning shall provide WPS's for all welded joints. The WPS shall comply with Part 2 of this standard. The specification level shall be compatible with the chosen method of approval.

WPS shall be classified as pWPS until approved in accordance with the rules of this standard.

The manufacturer may, in addition to the WPS, prepare detailed work instructions etc., to be used during the actual production. Work instructions are not mandatory, unless required by the manufacturer. If prepared, the work instructions shall:

- be prepared on the basis of an approved WPS;
- define values for the welding process to be used by the welder for all essential variables under direct control by the welder. The values may be given as machine settings, provided there is a well defined correspondence between machine settings and the values of the essential and additional variables defined in the WPS.

## 5 Approval of welding procedures

### 5.1 General

#### 5.1.1 *Methods for approval*

This standard defines a number of methods for approval of welding procedures. Each method of approval has certain limits of application as regards welding process, parent metal and consumables (if used). Limitations for the application of the various methods of approval are stated in this standard and in subsequent parts of this standard.

Each pWPS shall be approved by only one method. The use of a particular method of approval of a welding procedure is often a mandatory requirement of an application standard. In the absence of such a requirement the method of approval shall be agreed between the contracting parties at the enquiry or at the order stage.

Approval shall be obtained by one of the following methods:

- welding procedure tests to EN 288-3 or -4, see **5.2**;
- approved welding consumables to EN 288-5, see **5.3**;
- previous welding experience to EN 288-6, see **5.4**;
- standard welding procedure to EN 288-7, see **5.5**;
- pre-production welding test to EN 288-8, see **5.6**.

Annex A provides some guidelines for the application of each method of approval.

#### 5.1.2 *Application*

The manufacturer shall prepare a pWPS in accordance with the rules in clause 4. The workshop shall ensure that the pWPS is applicable for the actual production, using experience from previous productions and the general fund of knowledge of welding technology. Subsequently, the pWPS shall be approved by one of the methods stated in **5.1.1**.

If the approval involves welding of test pieces, then the test pieces shall be welded in accordance with the pWPS.

Welding procedures shall be approved prior to actual welding in production.

### 5.2 Approval by welding procedure tests

This method specifies how a pWPS can be approved by the welding and testing of a standardized test piece.

### 5.3 Approval by use of approved welding consumables

Some materials do not deteriorate significantly in the heat affected zones, provided heat inputs are kept within specified limits. For such materials, a pWPS shall be considered approved on the condition that the welding consumables are approved and that all essential variables are within the range for which the approval is valid.

All activities related to welding, testing and examination of test pieces shall be the responsibility of an examiner or examining body. The examiner or examining body shall state the permitted range of approval with regards to essential variables for the approved welding consumables.

### 5.4 Approval by previous welding experience

A manufacturer may have a pWPS approved by referring to previous experience on condition that he can prove by appropriate authentic documentation of an independent nature that he has previously satisfactorily welded the type of joint and materials in question.

The permissible range for a WPS, approved by reference to previous experience, shall be limited to the standard material(s), welding process(es), consumable(s) and ranges of essential variables, for which adequate previous experience can be documented.

### 5.5 Approval by use of a standard welding procedure

A pWPS prepared by a manufacturer is approved, if the ranges for all variables are within the range permitted by a standard welding procedure.

A standard welding procedure shall be issued as a specification in the format of a WPS or WPAR based on an approval to the relevant Part of EN 288 for welding procedure testing. Issue and amendment of standard welding procedures shall be via the examiner or examining body taking responsibility for the initial approval.

Application of a standard welding procedure is also subject to conditions to be satisfied by the user.

### 5.6 Approval by a pre-production welding test

Approval by a pre-production welding test may be used where the shape and dimensions of standardized test pieces (e.g. those in **6.2** of Part 3) do not adequately represent the joint to be welded, e.g. attachment weld to thin pipe.

In such cases, one or more special test pieces shall be made to simulate the production joint in all essential features e.g. dimensions, restraint, heat sink effects. The test shall be carried out prior and under the conditions to be used in production.

Examination and testing of the test piece shall be carried out as far as possible within the requirements of this standard e.g. Parts 3 and 4, but this testing may need to be supplemented or replaced by special tests according to the nature of the joint in question and shall be agreed by the examiner or examining body.

## Annex A (informative)

### Guidelines for the application and the subsequent choice of method of approval

A large number of national standards for specification and approval of welding procedures are in existence. Although of a similar nature, the requirements differ in many details. The present set of standards (Part 1 and subsequent Parts) provides an European, standardized system for specification and approval of welding procedures. The European system should comply with the principles of most of the national standards and should permit a gradual transfer to a truly European system.

Approval by reference to previous welding experience (see 5.2) has a number of applications. Only welding procedures known from experience to be reliable should be used in such cases.

Approval by use of an approved welding consumable (see 5.3) has been used for many years by some branches of industry. Approval of the welding consumables is carried out according to national schemes pending the establishment of European certification schemes.

Approval by welding procedure tests (see 5.4) is standardized in a large number of national standards and widely used in many countries. A procedure test is needed whenever the properties of the material in the weld metal and heat affected zones are critical for the application.

Approval by reference to a standard welding procedure (see 5.5) presently is used to a rather limited extent; it is covered only by few national rules.

National schemes for standard welding procedures are presently being developed in several countries. The present set of European standards should be compatible with such national schemes.

Approval by pre-production welding test (see 5.6) is rarely mentioned in national standards. It is, however, needed for special welding procedures.

Approval by a pre-production test is the only reliable method of approval for some welding procedures, of which the resulting properties of the weld strongly depend on certain conditions such as; component, special restraint conditions, heat sinks etc., which cannot be reproduced by standardized test pieces.

NOTE 1. Testing of test pieces or complete products may be carried out during actual production as part of a statistical quality control programme, based on destructive testing. Such production testing should not be used as a substitute for pre-production testing and a requirement for pre-production testing should not be taken to entail production testing.

NOTE 2. In many cases feasibility tests are performed prior to production even though the welding procedure is approved. Examples are run-in tests of new welding machines and tests of an established (and approved) welding procedure in an unusual joint or position. Test pieces welded during feasibility tests usually are examined and tested for imperfections only. Reference to this standard should not be interpreted as a requirement for any feasibility testing and a requirement for approval of the welding procedure by pre-production test.



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