BRITISH STANDARD

BS 6878:1988
EN 50052:1986
+A2:1993
Incorporating corrigendum August 2007

Specification for

High-voltage switchgear and controlgear for industrial use — Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear

ICS: 29.130.10

BSI British Standards

National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee and is the English language version of EN 50052:1986+A2:1993, incorporating corrigendum August 2007, published by the European Committee for Electrotechnical Standardization (CENELEC). It supersedes EN 50052:1986+A1:1990 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to CENELEC text carry the number of the CENELEC amendment. For example, text altered by CENELEC amendment A1 is indicated by ⟦A1⟩ ⟨A1⟧.

NOTE With reference to note 3 or **4.2**, it should be noted that the use of asbestos gaskets is being phased out as soon as possible.

Cross-references. Details of International Standards quoted in this standard for which there is an identical or technically equivalent British Standard are given in National appendix X.

Copies of ASTM documents may be purchased through BSI Sales Department, Linford Wood, Milton Keynes, MK14 6LE.

Copies of CIATF documents may be purchased from: CIATF, Walchestrasse 27, Post Fach 7190, CH 8023, Zurich, Switzerland.

The Technical Committee has reviewed the provisions of ISO 3134:1985, ISO 6520:1982 (Parts 401, 506 and 5011) and ISO Guide 2:1976, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

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

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

This British Standard was published under the authority of the Board of BSI and comes into effect on
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8052	December 1993	Implementation of CENELEC amendment A2:1993
	30 June 2008	Implementation of CENELEC corrigendum August 2007. Deletion of the A-deviations for Sweden in Annex B

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50052:1986+A2

August 1993

UDC: 621.316.3.027.3 – 213.34:621.315.618:669.71:001.4:620.1

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English version

Cast aluminium alloy enclosures for gas-filled high-voltage switchgear and controlgear

Enveloppes en alliage d'aluminium coulé pour l'appareillage à haute tension sous pression de gaz

Kapselungen aus Leichtmetallguss für gasgefüllte Hochspannungs-Schaltgeräte und-Schaltanlagen

This European Standard was ratified by CENELEC on 7 March 1985. CENELEC members are bound to comply with the requirements of the 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 CENELEC General Secretariat or to any CENELEC 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 CENELEC member into its own language and notified to the CENELEC General Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Foreword

This European Standard has been prepared by CENELEC Technical Committee 17C: High voltage enclosed switchgear and controlgear. It is based on Amendment No. 2 to IEC Publication 517 (1975) which gives, however, only general guidance not sufficient for the service allowance of pressurized high-voltage switchgear and controlgear.

The present EN has been written to get an international specification for the design, construction, testing, inspection and certification of pressurized enclosures used in high-voltage switchgear and controlgear.

This standard follows to that extent also, Article 2 of the Directive 76/767/EEC.

This standard deals only with cast aluminium alloy enclosures. Other standards for metallic enclosures are under consideration and will be issued progressively.

Reference is made to IEC Publication 517 (1975):

> High-voltage metal-enclosed switchgear for rated voltages of 72,5 kV and above (HD 358)

with its Amendments No. 1 (1977), No. 2 (1982) and No. 3 (1983).

This European Standard contains a normative technical Annex A: Welder performance test.

Brief history

The Amendment 1 to the European Standard EN 50052 has been prepared by CLC/TC 17C; it has been submitted to the CENELEC members for formal vote and acceptance by CENELEC.

Technical text

The text of the Amendment 1 to the European Standard EN 50052 was approved by the members of CENELEC on 11 September 1989.

The following dates are applicable:

- latest date of announcement of the EN at national level (doa): 1 March 1990
- date of latest publication of a new harmonized standard (dop): 1 September 1990
- date of withdrawal of conflicting national standards (dow): 1 September 1990

Foreword to amendment A1

At the 11th CLC/TC 17C meeting held in Brussels on 15 and 16 June 1988, the following decision was taken:

The scope of EN 50052 will be restricted to the range of rated voltages of "72,5 kV and above". (This also applies for EN 50064, and for prEN 50068 and prEN 50069 which are in preparation.)

These requirements are more appropriate for pressurized enclosures of gas-insulated metal-enclosed switchgear in accordance with HD 358 (IEC 517).

Foreword to amendment A2

This amendment was prepared by CENELEC Technical Committee TC17C, High-voltage enclosed switchgear and controlgear.

The text of the draft was submitted to the voting procedure in March 1993 and was approved by CENELEC as amendment A2 to EN 50052:1986 on July 6, 1993.

The present amendment A2 supersedes amendment A1:1990.

The following dates were accepted:

- latest date of publication of an identical national standard (dop) 1994-10-01
- latest date of withdrawal of conflicting national standards (dow) 1994-10-01

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0 Introduction

This standard covers the requirements for the design, construction, testing, inspection and certification of gas-filled enclosures for use specifically in high-voltage switch-gear and controlgear, or for associated gas-filled equipment. Special consideration is given to these enclosures for the following reasons.

a) The enclosures usually form the containment of electrical equipment, thus their shape is determined by electrical rather than mechanical considerations.

b) The enclosures are installed in restricted access areas and the equipment is operated by experts and instructed persons only.

c) As the thorough drying of the inert, non-corrosive gas-filling medium is fundamental to the satisfactory operation of the electrical equipment, it is periodically checked. For this reason, no internal corrosion allowance is required on the wall thickness of these enclosures.

d) The enclosures are subjected to only small fluctuations of pressure as the gas-filling density shall be maintained within close limits to ensure satisfactory insulating and arc-quenching properties. Therefore the enclosures are not liable to fatigue due to pressure cycling.

e) The operating pressure is relatively low.

For the foregoing reasons and to ensure the minimum disturbance, hence reducing the risk of moisture and dust entering the enclosures which would prevent correct electrical operation of the switchgear, no pressure tests shall be carried out after installation and before placing in service and no periodic inspection of the enclosure interiors or pressure tests shall be carried out after the equipment is placed in service.

1 Scope

This standard applies to cast aluminium alloy enclosures pressurized with dry air, inert gases, for example sulphur hexafluoride or nitrogen or a mixture of such gases, used in indoor or outdoor ⟨A2⟩ installations of high-voltage switchgear and controlgear, where the gas is used principally for its dielectric and/or arc-quenching properties, with rated voltages.

— 1 kV and up to and including 52 kV and with gas-filled compartments with design pressure greater than 3 bar (gauge);

— and with rated voltage 72,5 kV and above. ⟨A2⟩

The enclosures comprise parts of electrical equipment not necessarily limited to the following examples:

Circuit-breakers

Switch-disconnectors

Disconnectors

Earthing switches

Current transformers

Voltage transformers

Surge arrestors

Busbars and connections

The scope also covers pressurized components such as the centre chamber of live tank switchgear, gas-insulated current transformers, etc.

2 Quality assurance

It is the intention of this standard that the switchgear manufacturer shall be responsible for achieving and maintaining a consistent and adequate quality of product.

Sufficient examinations shall be made by the founder to ensure that the materials, production and testing comply in all respects with the requirements of this standard. Inspection by user inspectors shall not absolve the manufacturer or the founder from their responsibility to exercise such quality assurance procedures as to ensure that the requirements and intent of this standard are satisfied.

3 Definitions

For the purposes of this standard the following definitions apply.

3.1
national standard

a technical specification available to the public drawn up with the cooperation and in general agreement with all interests affected by it, and approved by a standards organization recognized on the national level
(CLC-Memorandum No. 1 (1974),
ISO Guide 2-1976)

3.2
enclosure

a part of gas-insulated metal-enclosed switchgear retaining the insulating gas under the prescribed conditions necessary to maintain safely the rated insulation level, protecting the equipment against external influences and providing a high degree of protection to personnel
(IEC Publication 517)

3.3
manufacturer

individual or body responsible for designing and producing the enclosure. In this standard this is the switchgear manufacturer

3.4
designer

individual or body who determines the shape, dimensions and thickness of the enclosure and selects the materials and method of construction and testing

3.5
founder

individual or body who produces the raw casting

3.6
design pressure (of an enclosure)

pressure used to determine the thickness of the enclosure. It is at least the upper limit of pressure reached within the enclosure at the design temperature
(IEC Publication 517)

3.7
design temperature (of an enclosure)

highest temperature reached by the enclosure which can occur under service conditions. This is generally the upper limit of ambient air temperature increased by the temperature rise due to the flow of rated normal current
(IEC Publication 517)

NOTE Solar radiation should be taken into account when it has a significant effect on the temperature of the gas and on the mechanical properties of some materials. Similarly, the effects of low temperatures on the properties of some materials should be considered.

3.8
casting

a general term for products at or near finished shape, formed by solidification of a molten metal or alloy in a mould
(ISO 3134-4)

3.9
melt

a furnace load of homogeneous molten metal resulting from a single melting operation
(Ideological foundry dictionary (1979), CTIAF[1])

3.10
alloy

a metallic substance consisting of a mixture of the basic metallic element (the element predominating by mass) and other elements such as alloying elements and impurities
(ISO 3134-1)

3.11 casting defect

Imperfections in castings after solidification.

3.11.1
cold shut

a discontinuity with rounded edges extending either partially or entirely through the section of the casting
(Ideological foundry dictionary (1979), CTIAF[1])

3.11.2
cold crack

a crack often scarcely visible due to carelessness or excessive stresses during shake out, cleaning, machining or handling
(Ideological foundry dictionary (1979), CTIAF[1])

3.11.3
hot crack (hot tear)

a more or less deep inter-crystalline fissure of irregular outline appearing mostly in the last sections of the casting to solidify in which constraints are present
(Ideological foundry dictionary (1979), CTIAF[1])

3.11.4
inclusion

particle of a chemical composition, different from that of the casting, embedded in the casting or at its surface which may be formed of slag, sand, blacking, oxides, silicates or sulphides
(Ideological foundry dictionary (1979), CTIAF[1])

3.11.5
blowholes (pinholes)

smooth-walled cavities, essentially spherical, often not contacting the casting surface, the largest (blowholes) are mostly isolated, the smallest (pinholes) generally appear in groups
(Ideological foundry dictionary (1979), CTIAF[1])

3.12 weld defect

Imperfections in metallic fusion welds.

3.12.1
lack of fusion

lack of union between weld metal and parent metal or weld metal and weld metal
(ISO 6520:1982: 401)

3.12.2
overlap

excess of weld metal at the toe of a weld covering the parent metal surface but not fused to it
(ISO 6520:1982: 506)

[1] CTIAF = Comité International des Associations Techniques de Fonderie (International Committee of Foundry Technique Associations).

3.12.3
undercut

a groove at the toe(s) (or at the root) of a weld run due to welding
(ISO 6520:1982: 5011)

3.13
heat treatment

process in which the metal in the solid state is subjected to one or more temperature cycles, to confer certain desired properties

3.14
ductility

the property of a material to undergo permanent deformation without rupture under tensile stresses (Ideological foundry dictionary (1979), CTIAF[2])

3.15
fatigue

change of the properties of a material due to repeated application of stresses or strains which leads, in particular, to cracks or rupture
(ISO R 373)

3.16
tensile strength

the maximum unit stress related to the initial cross-section of the test specimen at which the material ruptures

3.17
test piece

two or more parts of material welded together in accordance with a specified weld procedure, or a portion of a casting taken in order to make one or more test specimens

3.18
test specimen

portion detached from a test piece, in specified dimensions, finally prepared as required for testing

4 Materials

4.1 Selection of material

Any suitable cast aluminium alloy is permissible; a list of recommended materials is given in Table 1.

The properties of the materials should be taken from the applicable standards.

4.2 Chemical analysis

Ingots used shall comply with the requirements of the appropriate material specification and any special requirement called for on the order; they shall be clean and free from harmful defects.

Providing the chemical analysis of the melt meets the requirements of the appropriate specification, the founder may use scrap which arises from his own production from approved ingots, which is segregated and identifiable. It can include heavy fettling scrap, but shall exclude all drosses and small particles such as sawings and chippings.

NOTE 1 Attention is drawn to a limitation in the otherwise very useful range of aluminium-magnesium alloys. The high strength, relatively high magnesium content alloys can become susceptible to stress-corrosion cracking after use for long periods at temperatures above 66 °C.

NOTE 2 Contact with more noble metals, particularly copper and its alloys, can lead to heavy galvanic corrosion. Austenitic stainless steel is an exception to this rule because of its protective oxide film, and can often be used in contact with aluminium. Aluminium enclosures should be protected externally where, for example, they come into contact with mild steel supports. Zinc chromate paint, bitumen, thin zinc sheet (which gives sacrificial protection) or a combination of these are useful in this respect. Alternatively, the mild steel supports can be galvanized or zinc or aluminium sprayed.

A2 NOTE 3 It should be noted that contact with certain gasket materials can cause corrosion of aluminium; the gasket manufacturer should be consulted. A2

5 Design

5.1 General

The rules for the design of enclosures of gas-insulated switchgear and controlgear prescribed in this clause take into account that these enclosures are subjected to particular operating conditions (see Introduction) which distinguish them from compressed air receivers and similar storage vessels. Examples of such enclosures are listed in clause **1**.

The geometry of an enclosure can be determined by electrical rather than mechanical considerations; moreover, further constraints in shape can be enforced by the casting process used. These constraints can result in an enclosure geometry which requires an unacceptable degree of calculation or which cannot be calculated at all. In the case of such an enclosure or an enclosure for which calculations are not made a proof test is necessary.

When designing an enclosure, account shall be taken of the following, if applicable:

a) the possible evacuation of the enclosure as part of the filling process;

b) the full differential pressure possible across the enclosure wall or partition;

c) superimposed loads and vibrations by external effects.

[2] CTIAF = Comité International des Associations Techniques de Fonderie (International Committee of Foundry Technique Associations).

5.2 Corrosion allowance

The enclosures are filled in service with a non-corrosive thoroughly dried gas, therefore no internal corrosion allowance is necessary.

5.3 Design stresses

Design stresses can be established either by calculation or proof tests, see **9.1**.

The permissible design stress (f_a) at the design pressure including the safety factor of the appropriate equations is given by:

$$f_a = \frac{R_m}{3,5} \times CF$$

where

R_m : minimum tensile strength of the material at the design temperature taken from the material standard for the chosen alloy.

3,5 : safety factor.

CF : casting factor which makes allowance for the reduction in properties achieved in the casting. The casting factor has a value of 0,8.

The calculation may be based on higher values of tensile strength and casting factor, if the values are guaranteed by a material certification (see **6.5**).

When the strength of the enclosure or part thereof has not been determined by calculation, proof tests shall be made in order to demonstrate that the permissible design stress is not exceeded at the design pressure (see **9.1**).

5.4 Calculation methods

5.4.1 *General*. When the wall and flange thicknesses of the enclosure are calculated the permissible design stress shall be taken from **5.3** and the equations from established specifications such as:

AD — Merkblätter
ANCC VSR
ASME Section VIII
BS
CODAP
ISO
Netherlands Rules for P.V.
SVDB
Swedish P.V. Code

using the design pressure and the design temperature as defined in **3.6** and **3.7**.

The equations in the specifications are equivalent to each other, the choice is left to the manufacturer.

NOTE Pressure stresses due to an internal electrical fault are not considered in the design of an enclosure since after such an occurrence, the enclosure would be carefully checked and, if necessary, replaced.
For the case of arcing due to an internal fault, reference is made to IEC Publication 517.

5.4.2 *Flanges*. The design of flange connections (see Figure 1, flange A or B) shall be based on the following:

the number of bolts shall be chosen to ensure a plane support surface,

the distance a between bolt and gasket should be as small as possible.

the radius R between the flange and the cylindrical neck shall be as large as possible.

If flange connections have been proven sound in the bursting test of the enclosure no calculation of the flanges is necessary.

5.4.3 *Bolts*. Bolted connections can be designed in accordance with ISO 898 or established specifications (see **5.4.1**) taking into consideration the design pressure and the sealing forces of gaskets, if necessary. O-ring sealing forces may be neglected in relation to the flange forces.

The mechanical properties of the bolted connections are in accordance with ISO 898. The material of bolts should not exceed a ratio of

$R_e/R_m = 0,8$

where

R_m : minimum tensile strength

R_e : minimum yield strength

Where the design requires the use of high strength bolts, they shall be appropriately marked.

If bolted connections have been proven sound in the bursting test of the enclosure no calculation of the bolts is necessary.

5.5 Manholes and inspection openings

No manholes or inspection openings are necessary for inspection of the enclosure.

6 Manufacture and workmanship

6.1 Manufacture

Castings can be made by introducing molten metal by gravity or low pressure into:

sand moulds,

semi-permanent metallic moulds with sand cores,

permanent metallic moulds

and allowing it to solidify.

In order to obtain specific mechanical properties, the castings can then be heat treated following which they can be machined, if required.

The castings can receive, in part or in their entirety, special surface treatments such as anodizing, chemical oxidization, electroplating or hot blast metal plating.

6.2 Consultation between manufacturer and founder

It is strongly advised that the manufacturer, having defined the necessary geometry and thickness of the casting, shall obtain the founder's and pattern maker's agreement to the design prior to casting to enable sound castings to be produced consistently, having the required mechanical properties.

6.3 Foundry technique

For each enclosure design the founder shall record the essential particularities of the foundry technique such as the position of runners, risers, dead heads, chills, mould lines, the mould material and mould temperature, and the attitude of the mould when pouring the metal. This record shall also include the metal pouring temperature and subsequent heat treatment process.

All subsequent production castings shall be made by the same foundry technique and under the same conditions, without significant deviation.

If, for any reason, the foundry technique needs to be altered, production shall not proceed without the permission of the manufacturer.

6.4 Geometry and dimensions

The geometry and dimensions of the casting shall be defined by:

the manufacturer's drawings, when the founder is required to make the pattern or permanent mould, or

the pattern or the permanent mould when these are provided by the manufacturer, or

the accepted sample casting when mass production methods are employed.

Tolerances on dimensions shall be agreed between manufacturer and founder and recorded on the approved drawings.

The castings shall be capable of being machined, when provided in the drawing, to the finished dimensions without leaving evidence of the cast surface. Drawings shall indicate the datum points to be used for machining or jigging.

6.5 Chemical composition and mechanical properties

6.5.1 *Sampling*. In order to provide a control on the quality of normal production, samples shall be taken from each melt and production batch of castings.

6.5.2 *Chemical composition*. To permit determination of the chemical composition of each casting, a sample or samples shall be taken from each melt which, without any further additions, is used to make castings. The sample shall be suitably marked to ensure identification with the castings it represents.

The chemical composition of the sample or samples shall meet the material specification.

6.5.3 *Mechanical properties.* As a control check on the mechanical properties and heat treatment operations, separately cast test bars in accordance with the dimensions given in the material specification shall be made for each melt. Where a number of castings are made from one melt and undergo separate heat treatment, test bars shall be made for each heat treatment batch. The test bars shall be suitably marked to ensure identification with the batch of castings they represent.

The separately cast test bars shall be heat treated with the casting or batch of castings they represent.

The mechanical properties of the test bars representing each casting or batch of castings shall meet the requirements of the material specification.

6.6 Workmanship

6.6.1 *Surface finish*. The castings shall be suitably cleaned. Runners, risers, dead heads and chills shall be removed without reducing the strength of the casting.

The surfaces of the castings which are not to be machined shall be equal to a surface finish which is agreed on the sample casting.

6.6.2 *Soundness*. The castings shall be uniform in composition and shall be free from injurious defects.

The acceptable limits for the extent and frequency of defects shall be as defined in clause **7**.

Defects may be repaired only by processes in accordance with clause **7**, which have been agreed between manufacturer and founder.

7 Repair of casting defects

7.1 General

Castings may be repaired only by processes approved and agreed upon by founder and manufacturer.

Limitations on the location, extent and frequency of such repairs and methods of inspection of repaired areas shall also be agreed upon.

Surface irregularities caused by locally broken down moulding sand or fettling damage which does not affect the strength of the casting may be repaired after agreement has been obtained between the manufacturer and the founder. After such repairs, visual examination is sufficient and the requirements of **7.2.6** can be disregarded.

This clause shall also apply to the filling of core support apertures.

7.2 Repair by welding

7.2.1 *Welding performance test*. All welders engaged in the repair of cast enclosures in accordance with this standard shall pass welder performance tests which are designed to demonstrate their competence to make sound welds on the same material composition as the casting to be repaired (see Annex A).

If there is any reason to doubt the welder's ability to make satisfactory weld repairs, the manufacturer can, at his discretion, require the welder to retake the whole or part of the approval test.

7.2.2 *Weld procedure*. A written weld instruction shall be produced for each specified method of weld repair which shall state:

a) parent metal specification

b) welding process

c) method of excavation of defective material

NOTE Excavation by the use of flame is not permitted.

d) electrode size and type

e) shielding gas and flow rate

f) filler material and diameter

g) power source (a.c./d.c.), its frequency/polarity and current

h) welding position

i) pre-heating, temperature and method

j) post-weld heat treatment

7.2.3 *Weld procedure test*. The test piece representing the weld procedure to be approved shall satisfy the assessment requirements in Annex A.

If the test piece fails to satisfy the visual inspection and dye penetrant examination requirements given in Annex A, one further test piece shall be welded and subjected to the same test.

If any specimen fails to satisfy the macro examination and strength requirements given in Annex A, two further test specimens for each one that failed shall be prepared and subjected to the same test. These new test specimens are obtained either from the same test piece, if there is sufficient material available, or from a new test piece.

If either of these additional test specimens or the new test piece do not meet the required quality, the weld procedure shall be regarded as incapable of meeting the requirements of this standard without modification.

7.2.4 *Application to castings*. The decision to repair by welding shall be taken on the basis of visual inspection and/or radiographic examination of the casting.

The limits given below are for guidance only, the ultimate responsibility rests with the manufacturer.

These limits apply to defects in the shell. Repairs should not be permitted in the highly stressed zones in the flange inside the pitch circle of the bolts.

NOTE 1 Definitions of the defects comply with "Gussfehler Atlas" (Atlas of casting defects) Giesserei-Verlag GmbH, Düsseldorf 1971.

NOTE 2 Reference Standard ASTM E 155 "Standard reference radiographs for inspection of aluminium and magnesium castings" is used to grade defects.

a) *Blow holes* — Gussfehler Atlas No. B121 and No. B111. Weld repairs are permitted if the extent of the blow holes on the surface is smaller than 20 mm × 10 mm.

b) *Cold shut* — Gussfehler Atlas No. C311. When cold shut is observed, radiographs shall be taken.

Weld repairs are permitted if the extent of the defect on the surface is not longer than 300 mm or not deeper than 300 mm. Internal cold shut is not acceptable. In this case weld repairs are not permitted.

c) *Oxide inclusions* — Gussfehler Atlas No. G142. When oxide inclusions are observed, radiographs shall be taken. These defects may be repaired according to the following criteria[3)]:

Wall thickness	Defect area size	Type of inclusions ASTM standard	Maximum number of inclusions per defect area	Maximum number of defect areas
mm	mm			
⩽ 12	100 × 100	Less dense	6	4
> 12	150 × 150	Less dense	8	2

d) *Cracks* — Gussfehler Atlas No. C221 and No. C222. Cracks are not acceptable. Weld repairs are not permitted.

e) *Tungsten Inclusions after Welding* — Gussfehler Atlas No. G111. When tungsten inclusions are observed on radiographs of welded areas, these may be repaired according to the following criteria[3)]:

Wall thickness	Type of inclusions ASTM standard	Maximum number of inclusions
mm		
⩽ 12	More dense	4
> 12	More dense	4

f) *Blackening defects, treatment defects*. These defects are limited in their extent and do not affect the adjacent material. Weld repairs are permitted in all cases.

[3)] The tables are for guidance only. The maximum size of the defects which can be repaired is to be determined by the founder and the manufacturer and depends upon the repair technique available.

7.2.5 *Preparation of castings for weld repairs*. Fusion faces prepared for weld repairs are visually examined; if in addition non-destructive testing is specified these faces shall be examined by a dye or fluorescent penetrant check.

Particular care shall be taken to ensure that residues from testing materials do not have a deleterious effect on the quality of any subsequent welding.

7.2.6 *Inspection of weld repair areas*. After completion of the weld repair, the repaired areas shall be radiographed to ensure no evidence of the original defect is present and that the weld repair has been executed in such a manner as to give satisfactory bonding and freedom from harmful defects. A dye penetrant check shall be performed on the surface of the repaired areas to ensure freedom from cracks.

All castings subjected to weld repairs shall be heat treated in accordance with the material specification after weld repair.

Enclosures which have been repaired subsequent to the routine pressure test shall be retested after completion of the weld repairs and after any heat treatment.

Relevant certificates for repaired castings shall record the position and extent of the repaired areas and the procedure used.

7.3 Impregnation of castings

Castings which show slight leakage on pressure or gas leakage tests may be rectified by impregnation after agreement has been obtained from the manufacturer.

The process shall only be applied after the casting has been inspected for freedom from other defects, in particular cracks.

The process used shall be agreed between the manufacturer and the founder regarding its suitability for the application.

A gas leakage test shall be carried out after impregnation.

8 Heat treatment

8.1 Heat treatment procedure

The heat treatment shall be carried out in accordance with a documented procedure.

8.2 Methods of heating

Cast aluminium alloys are usually heated in air chamber furnaces. Other methods can be used, however, in specific applications.

Whichever heating means are employed, careful evaluation is required to ensure that the alloy responds properly to the heat treatment and is not damaged by overheating or contamination from the environment.

Heat treatment furnaces can be oil or gas-fired or electrically heated. The temperature of the furnace atmosphere shall be controlled to prevent high temperature oxidization during heat treatment.

The furnaces shall be fitted with automatic temperature recording and control equipment capable of maintaining the specified temperature in the working zone within a tolerance of $\pm$ 5 °C.

8.3 Quenching

Quenching of cast aluminium alloys is normally performed by immersion in water. The baths shall be located close enough to the heat treatment furnace to minimize the delay in quenching. The quench delay time shall not exceed 40 s.

8.4 Calibration of furnace temperature

A temperature survey to ensure compliance with the requirements of this standard shall be performed for each furnace.

A new temperature survey shall be carried out after any change in the furnace which can affect the operational characteristics.

8.5 Heat treatment charts

For castings to be subjected to heat treatment, charts shall be provided to record the temperature for the full duration of the heat treatment cycle. The serial numbers of the enclosures treated shall be included on the charts.

9 Inspection, testing and certification

9.1 Proof tests

9.1.1 *General*. For all designs of castings which are not calculated, or where doubt exists regarding the accuracy of the calculations and where having been calculated the predicted stress at the routine pressure test will exceed 90 % of the 0,2 % proof stress of the material in the enclosure, a proof test shall be carried out on one casting.

One of the following proof tests is applicable:

a) Burst test

b) Strain measurement test

When proof tests are carried out on enclosures which will be subjected to significant static superimposed loads in service, the effect of these loads shall be simulated during the test.

The proof test may be used for the purpose of establishing the design pressure of enclosures or enclosure parts only then when the thickness is not determined by means of the design rules given in this standard. The design pressure of all other parts shall be determined by means of the applicable design rules.

9.1.2 *Burst test procedure*. This procedure can be used for enclosures or enclosure parts under internal pressure. The design pressure of any part of the enclosure tested by this method shall be established by a pressure test so that the specified safety factor is demonstrated. Any casting surviving this test shall be scrapped.

The design pressure (p) for which an enclosure meets the requirements of this standard shall be calculated by the following formula:

$$p = \frac{B}{3,5} \times 0,7$$

where

B : Burst pressure

3,5 : Safety factor

The value 0,7 has been included to cover the possible variability of production castings. It is permitted to increase this factor to 1,0 if it can be justified.

9.1.3 *Strain measurement test procedure*. Before the test commences or any pressure has been applied to the enclosure, strain gauges of electrical resistance or other types shall be affixed to both the inside and outside surfaces of the enclosure. The type and number of gauges, their positions and their directions shall be chosen so that principal strains and stresses can be determined at all points of importance to the integrity of the enclosure. The type of gauge and the cementing technique shall be chosen so that strains up to 1 % can be determined.

Pressure shall be applied gradually in steps of approximately 20 % of the expected design pressure and shall be unloaded after each step. Strain readings shall be taken during the loading and unloading cycle.

Indication of localized permanent set can be disregarded provided there is no evidence of general distortion of the enclosure.

As long as the permanent strain does not exceed 0,2 %, the pressure shall be increased up to 2,2 times the expected design pressure, which shall then be considered as being confirmed.

If the permanent strain exceeds 0,2 % during an earlier step, the pressure may be re-applied at a lower value not more than five times to determine the pressure (p_y) related to a permanent strain of less than 0,2 %. In this case the design pressure (p) shall be calculated by the following equation:

$$p = \frac{p_y}{2,2} \times \frac{f_a}{f_t}$$

where

f_a : permissible design stress at design temperature (see **5.3**)

f_t : permissible design stress at the test temperature (based on the same conditions)

Where a strain measurement proof test is carried out the high stressed areas of the first five castings shall be subjected to radiographic and dye penetrant examinations to demonstrate that a sound quality has been achieved.

Test specimens shall be taken from the high stressed areas of one enclosure for mechanical tests to determine that the properties of the material on which the design is based have been achieved.

9.2 Inspection and routine tests

9.2.1 *General*. Any defective casting can be rejected for faults, whether discovered during inspection or subsequently during machining, notwithstanding that the casting has been passed previously as conforming to the chemical composition and mechanical test requirements of the material specification.

9.2.2 *Visual inspection*. A visual inspection shall be made of all internal and external surfaces. Where any doubt exists, dye penetrant or radiographic examination of the suspect area shall be made.

Reports of visual inspection shall be provided.

9.2.3 *Dye penetrant examination*. Dye penetrant examination is required in cases of doubt arising from visual inspection.

9.2.4 *Radiographic examination*. Radiographic examination is required:

a) in case of doubt arising from visual inspection of production castings,

b) to establish the type and extent of defects as to the possibility of a weld repair,

c) to determine the quality of weld repairs.

9.2.5 *Ultrasonic examination*. Ultrasonic examination can be used as an alternative to radiography.

9.2.6 *Reporting of non-destructive test examinations.* The following information shall be given on reports:

a) the date of the examination and report,

b) identification of the enclosure,

c) description and location of all defects, together with records,

d) test method applied.

9.2.7 *Routine pressure test.* Every enclosure shall be subjected to a routine pressure test at 2 times design pressure for not less than 1 minute.

Each chamber of an enclosure consisting of two or more separate chambers shall be subjected to the test pressure specified without support from pressure in any adjoining chamber.

9.3 Certification

9.3.1 *Design specification, drawings and data sheets.* The founder or manufacturer shall maintain a technical file of all data and foundry techniques supporting the proof test (see **9.1**). This file shall be kept available for a period of not less than 10 years from the date of completion of the enclosure.

9.3.2 *Certificate.* The manufacturer shall issue a certificate stating that all castings have been designed, cast and tested in accordance with this standard.

9.3.3 *Stamping.* Each enclosure shall be stamped by visible marking in an area where operating stresses are low, e.g. on the outside edge of a flange, or on a permanently attached nameplate to indicate that it has passed the routine pressure test.

9.3.4 *Final inspection of castings.* An internal and external inspection of the completed enclosures shall be carried out prior to despatch, and the certificates and stamping on the enclosure shall be checked.

10 Pressure relief devices

10.1 General

If necessary, enclosures within the scope of this standard shall be provided with protective devices which can be one of the following:

a) burstings discs

b) self-closing valves

c) non-self-closing devices

The protective devices shall be constructed, located and installed so that they are accessible for inspection and repair. They shall be protected against accidental damage.

The devices need not be installed directly on the enclosure, but the discharge areas and any connecting ports to or within the enclosure shall be of adequate size to permit effective relief in the event of overpressure.

Pressure relief devices shall be arranged so as to minimize the danger to an operator during the time he is performing his normal operating duties, if gases or vapours are escaping under pressure.

Pressure relief devices may be connected to the enclosure or in the gas supply lines of gas-filling plant.

In the case of devices fitted to enclosures connected to an external source of pressure and devices fitted in gas supply lines of gas-filling plant, they shall be designed to limit over-pressure to 1,1 times the design pressure.

Each device shall be marked with its nominal opening pressure.

It might be considered necessary to design the pressure relief device in order to limit the pressure rise in the event of an internal fault.

10.2 Bursting discs

Bursting discs can be manufactured from brittle or ductile materials.

The rupture pressure of the bursting disc should be chosen to ensure long service without premature bursting. The disc manufacturer should be consulted.

10.3 Self-closing pressure relief valves

Self-closing pressure relief valves shall be of the direct spring loaded type.

10.4 Non-self-closing pressure relief devices

Non-self-closing pressure relief devices which operate by the “breaking bolt” system may be used.

NOTE The breaking bolt system pressure relief device is one whereby a diaphragm being secured by a bolt or bolts relieves pressure by fracture or bending of the bolt or bolts, the diaphragm being restrained after venting by other bolts or a cover.

Table 1 — List of recommended cast aluminium alloys

A Ö-NORM M 3429	CH VSM 10895	D DIN 1725 Teil 2	F NF A 57 – 702	I UNI 3059	S SS	UK BS 1490	USA AA	ASTM	E UNE 38.201
G–Al Si 7 Mg (wa) (ta)	G–Al Si 7 Mg (wa) (ta)	G–Al Si 7 Mg (wa)	A-S7 G03-Y.. A-S7 G06-Y..	3599 7257-73	14 4244-04 14 4245-04	LM 25 (M) (TE) (TB7) (TF)	A 356	SG70B	38.267 L-2651
G–Al Si 9 Mg (wa)	G–Al Si 9 Mg (wa)	G–Al Si 9 Mg (wa)							
G–Al Si 10 Mg (wa) (ta)	G–Al Si 10 Mg (wa)	G–Al Si 10 Mg (wa)	A-S10-Y..	3599[a] 3051	14 4253-04	LM 9 (M)[a] (TE) (TF)			38.256 L-2560
G–Al Si 12							A 357		
	G–Al Si 13		A-S13-Y..	4514	14 4255-03 14 4261-03	LM 6 (M)	A 13	S 12A	38.252 L-2520
	G–Al Cu 4 Ti Mg (ka) (wa) (ta)	G–Al Cu 4 Ti Mg (ka) (wa)	A-U5GT-Y..				204		38.214 L-2140

NOTE The materials can be used in any condition; care should be taken, however, to ensure that materials in the same condition are compared.

[a] Equivalence only approximate

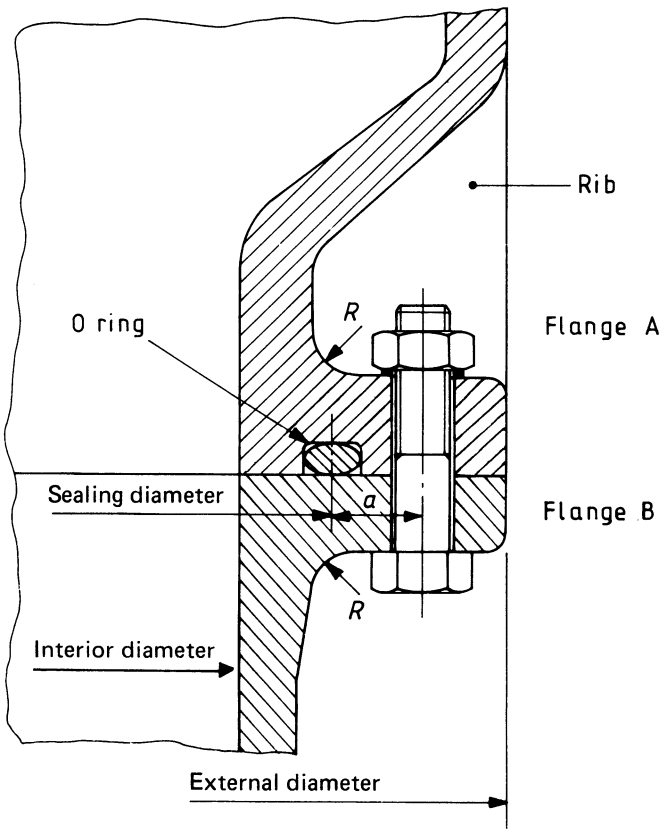

Figure 1 — Flange connections

Annex A Welder performance test

A.1 Test piece

The welder performance test shall be carried out on a cast block of material of the same composition as the defective castings and using the specified weld procedure.

The test piece shall be not less than 150 mm long, 75 mm wide and 10 mm thick, with a "V" shaped excavation parallel to the longer side, 20 mm wide and with a minimum depth of 5 mm.

The weld metal shall be deposited in order to build up the material to test piece thickness. At the point near the centre of the test piece the weld deposit shall be stopped and recommenced.

A.2 Assessment of welder performance test

A.2.1 *Visual inspection and dye penetrant examination*

The completed test piece shall be assessed visually as follows:

Factor 1: Weld thickness

The thickness of the weld deposit shall be equal to that of the test piece and shall be over rather than under the specified size.

Factor 2: Shape of profile

The profile of the weld shall be uniform and free from overlap and undercut.

Factor 3: Uniformity of surface

The weld face shall be uniform in appearance throughout its length.

Factor 4: Smoothness of join where weld is recommenced

The join in weld runs where welding has been recommenced shall be free from humps or craters in the weld surface.

Factor 5: Freedom from surface defects

The surface of the weld shall be free from porosity, cavities and solid inclusions.

Factor 6: Disposition of runs

Each run of weld shall at the surface be of approximately equal width and there shall be no notch or groove between adjacent runs; the edge of each run shall not produce a sharp ridge or recess in the surface of another run.

If the visual inspection is satisfactory, the test piece shall be checked for harmful defects by the dye penetrant method.

If the dye penetrant test is satisfactory, the test piece shall be heat treated in accordance with the material specification and cut transversely to obtain two cross tensile specimens and four macro specimens.

A.2.2 *Examination of macro specimens*

Etched specimens shall be assessed as follows:

Factor 7: Degree of fusion

Fusion shall be complete over the whole area of fusion faces and interfusion of the runs of weld metal shall be complete.

Factor 8: Degree of root penetration

There shall be fusion at the root of the deposit.

Factor 9: Non-metallic inclusions and gas cavities

The weld shall have a clean appearance and shall be free from voids, porosity, non-metallic inclusions, scale and oxide films.

A.2.3 *Examination of tensile specimens*

The tensile specimens shall have substantially the same properties as the parent metal.

A.3 Welder qualification

The welder who completes the welder performance test satisfactorily is approved without further tests for a period of 12 months.

Re-qualification shall be made on a test piece of similar dimensions to that according to clause **A.1**. The examination may be made without heat treatment after welding and limited to visual examination and examination of two macro specimens.

Retests shall be at 12-monthly intervals unless the welder has been assessed regularly by radiographic checks on his work during the preceding 12-monthly period.

Annex B (informative)
A-deviations

A-deviations: National deviation due to regulations, the alteration of which is for the time being outside the competence of the CENELEC member.

Clause	Member (regulation)
Clause **0** (last paragraph)	*Austria* (Dampfkesselverordnung (Fire Vessel Code) BGB1. Nr. 510/1986, Clause V and decree Nr. 143, GZ 43010/2-IV/81) The regulations for pressure vessels include specifications for tests which — are the responsibility of the manufacturer only; — have to be carried out in connection with a type approval (type test); — have to be carried out by independent experts. NOTE This principle is in accordance with the EC Directive 87/404/EEC and the Policy Statement of the EC Commission Doc. 74/88. *France* (Ministerial Decree of July 23rd, 1943, Clause **17**) An internal and external inspection of the enclosure is mandatory every 3 years, and the renewal of the pressure test every 5 years (in case of SF_6 gas). *Italy* (CAPITOLO VSR 8.B D.M. 1 DICEMBRE 1980) Disciplina dei contenitori a pressione di gas con membrature miste di materiale isolante e di materiale metallico, contenenti parti attive di apparecchiature elettriche. A routine test at 1.1 the design pressure is required on the complete assembly. The test can be performed in the factory or at site.
Clause **4**	*Austria* (Werkstoff- und Bauvorschriften (Material and Construction Rules) BGB1.Nr. 264/49, Clause 1-V/C) The material characteristics are defined exactly (e.g. elongation > 14 %) and the material appropriate for the construction of pressure vessels are specified mandatorily. *Italy* (ANCC RACCOLTA M EDIZIONE 1978; AGGIORNAMENTI al 31 GENNAIO 1982) Only cast aluminium alloys which are listed in the Raccolta M of ANCC edition 1978 and revision edition 31st January 1982 are permitted.
Clause **5.3**	*Italy* (ANCC RACCOLTA VSR EDIZIONE 1978; AGGIORNAMENTO 31 GENNAIO 1982). Design stress established by calculation (clauses VSR5 of the Raccolta VSR). The permissible design stress (f_a) at the design pressure and for a temperature up to 50 °C is: $f_a = \frac{R_m}{4 \times 1,2} = \frac{R_m}{4,8}$

A2

Clause	Member (regulation)
Clause **5.4**	*Italy* (ANCC RACCOLTA VSR EDIZIONE 1978; AGGIORNAMENTO 31 GENNAIO 1982) The rules of the design listed in the Raccolta VSR Edition 1978 and revision January 31st, 1982 are permitted. The design must be approved by the Authority.
Clause **6.5**	*Austria* (Werkstoff- und Bauvorschriften (Material and Construction Rules) BGB1.Nr. 264/49, enclosure 1-clause V/C) The scope of testing procedures is specified closely.
Clause **7.2**	*Austria* (Werkstoff- und Bauvorschriften (Material and Construction Rules) BGB1.Nr. 67/78, enclosure 1-clause III/1) The supplier needs the approval of an Austrian supervisor as specialized welding manufactory according to ÖNORM M7812. The regulations include also precise instructions on procedure certification, welder certification and accepted errors. *Italy* (ANCC RACCOLTA S EDIZIONE 1978; AGGIORNAMENTI al 31 GENNAIO 1982) Welding procedure and welders must be approved by the Authority according to ANCC Raccolta S Edition 1987 Revision 31st January 1982.
Clause **8**	*Italy* (ANCC RACCOLTA M EDIZIONE 1978; AGGIORNAMENTI al 31 GENNAIO 1972) Heat treatment must be carried out according to ANCC Raccolta M Edition 1978.
Clause **9.1**	*Austria* (Werkstoff- und Bauvorchriften (Material and Construction Rules) BGB1.Nr. 264/49 The regulations require the calculation generally. A burst test is specified. The safety factor is 5,0.
Clause **9.1.2**	*Italy* (ANCC CAPITOLO VSR 6.B) The bursting pressure B must be higher or equal than the value given in the following formula: $B = 4{,}25 \times \frac{k}{R_m} \times \frac{1}{s_{min}} \times p$ where: k = actual tensile strength of the sample under test s = actual thickness of the sample under test s_{min} = minimum design thickness permitted

A2

A2

Clause	Member (regulation)
Clause **9.1.3**	*Italy* (ANCC CAPITOLO VSR 6.B and VSR 7.A) The permissible design stress (f_a) computed according VSR 6.B and VSR 7.A must be equal or less than: $f_a \leq \frac{R_m}{4.8}$
Clause **9.2**	*Italy* (ANCC CAPITOLO VSR 8.B) Inspection and certification must be carried out according to ANCC Capitolo VSR 8.B.
Clause **10**	*Austria* (Dampfkesselverordnung (Fire Vessel code), BGB1.Nr. 510/1986, § 30, paragraph 2). Pressure relief devices shall be provided mandatorily.

A2

National appendix W

The United Kingdom participation in preparation of this European Standard was entrusted by the Power Electrical Engineering Standards Committee (PEL/-) to Technical Committee PEL/92 upon which the following bodies were represented:

ASTA Certification Services

Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)

British Railways Board

Copper Development Association

Department of the Environment (Property Services Agency)

Electrical Installation Equipment Manufacturers Association (BEAMA Ltd.)

Electricity Supply Industry in England and Wales

ERA Technology Ltd.

GAMBICA (BEAMA Ltd.)

Health and Safety Executive

Transmission and Distribution Association (BEAMA Limited)

National appendix X

The British Standards which are identical or technically equivalent to the International Standards referred to in EN 50052 are as follows:

International Standard	British Standard
IEC 517:1975[a]	BS 5424 *Specification for controlgear for voltages up to and including 1 000 V a.c. and 1 200 V d.c.* Part 1:1977 *Contactors* (Identical)
ISO/R 373[b]	BS 3518 *Methods of fatigue testing* Part 1:1962 *General principles* (Technically equivalent)
ISO 898[b]	BS 6104 *Mechanical properties of fasteners*

NOTE See national foreword for details of other cross-references, for which there are no British Standard equivalents.

[a] BS 5424 currently implements IEC 517:1975 and its Amendment No. 1:1977, reflecting the requirements of HD 358. IEC 517 Amendment No. 2:1982 and No. 3:1983 have not yet been implemented but are incorporated in the revision of IEC 517:1986 which is also under consideration for harmonization in a revision of HD 358.

[b] Undated in the text.

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