BRITISH STANDARD

BS EN
12953-5:2002

Shell boilers —

Part 5: Inspection during construction, documentation and marking of pressure parts of the boiler

The European Standard EN 12953-5:2002 has the status of a British Standard

ICS 27.060.30; 27.100

National foreword

This British Standard is the official English language version of EN 12953-5:2002. It partially supersedes BS 2790:1992 which will be withdrawn on publication of BS EN 12953 Parts 1, 2, 3, 4, 5, 6, 8 and 9.

When the reference to this European Standard has been published in the Official Journal of the European Communities (OJ), compliance with it will confer a presumption of conformity with the essential requirements covered by the standard in respect of the Pressure Equipment Directive.

The UK participation in its preparation was entrusted to Technical Committee PVE/16, Shell boilers, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

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

Cross-references

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

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 14 June 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 20, an inside back cover and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 39849 8

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12953-5

May 2002

ICS 27.060.30; 27.100

English version

Shell boilers - Part 5: Inspection during construction, documentation and marking of pressure parts of the boiler

Chaudières à tubes de fumée - Partie 5: Contrôles en cours de construction, documentation et marquage des parties sous pression des chaudières

Großwasserraumkessel - Teil 5: Prüfung während der Herstellung, Dokumentation und Kennzeichnung für drucktragende Kesselteile

This European Standard was approved by CEN on 15 May 2002.

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 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 Management Centre has the same status as the official versions.

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

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Ref. No. EN 12953-5:2002 E

Contents

Foreword

This document (EN 12953-5:2002) has been prepared by Technical Committee CEN/TC 269 "Shell and water-tube boilers", the secretariat of which is held by DIN.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this standard.

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 November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

The European Standard EN 12953 concerning shell boilers consists of the following Parts:

— *Part 1: General.*

— *Part 2: Materials for pressure parts of boilers and accessories.*

— *Part 3: Design and calculation for pressure parts.*

— *Part 4: Workmanship and construction of pressure parts of the boiler.*

— *Part 5: Inspection during construction, documentation and marking of pressure parts of the boiler.*

— *Part 6: Requirements for equipment for the boiler.*

— *Part 7: Requirements for firing systems for liquid and gaseous fuels for the boiler.*

— *Part 8: Requirements for safeguards against excessive pressure.*

— *Part 9: Requirements for limiting devices of the boiler and accessories.*

— *Part 10: Requirements for boiler feedwater and boiler water quality.*

— *Part 11: Acceptance tests.*

— *Part 12: Requirements for firing systems for solid fuels for the boiler.*

— *Part 13: Operational instructions.*

CR 12953-14: *Guidelines for the involvement of an inspection body independent of the manufacturer.*

Although, these Parts can be obtained separately, it should be recognized that the Parts are inter-dependent. As such, the design and manufacture of shell boilers requires the application of more than one Part in order for the requirements of the standard to be satisfactorily fulfilled.

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, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This Part of the European Standard specifies requirements for the inspection during construction, documentation and marking of shell boilers as defined in EN 12953-1.

2 Normative references

This European 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 European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 288-3:1992, *Specification and approval of welding procedures for metallic materials — Part 3: Welding procedure tests for the arc welding of steels.*

EN 473, *Non destructive testing — Qualification and certification of NDT personnel — General principles.*

EN 571-1, *Non-destructive testing — Penetrate testing — Part 1: General principles.*

EN 764, *Pressure equipment — Terminology and symbols — Pressure, temperature, volume.*

EN 875, *Destructive tests on welds in metallic materials — Impact tests — Test specimen location, notch orientation and examination.*

EN 876, *Destructive tests on welds in metallic materials — Longitudinal tensile test on weld metal in fusion welded joints.*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile test.*

EN 910, *Destructive tests on welds in metallic materials — Bend tests.*

EN 970, *Non-destructive examination of fusion welds — Visual examination.*

EN 1290, *Non-destructive examination of welds — Magnetic particle examination of welds.*

EN 1321, *Destructive tests on welds in metallic materials — Macroscopic and microscopic examination of welds.*

EN 1435, *Non-destructive examination of welds — Radiographic examination of welded joints.*

EN 1712, *Non-destructive examination of welds — Ultrasonic examination of welded joints — Acceptance levels.*

EN 1713, *Non-destructive examination of welds — Ultrasonic examination — Characterization of indications in welds.*

EN 1714, *Non-destructive examination of welds — Ultrasonic examination of welded joints.*

EN 12953-1:2002, *Shell boilers — Part 1: General.*EN 12953-3:2002, *Shell boilers — Part 3: Design and calculation for pressure parts.*

EN 12953-4:2002, *Shell boilers — Part 4: Workmanship under construction of pressure parts of the boiler.*

EN 25817, *Arc-welded joints in steel — Guidance on quality levels for imperfections (ISO 5817:1992).*

EN ISO 6520-1*, Welding and allied processes - Classification of geometric imperfections in metallic materials - Part 1: Fusion welding (ISO 6520-1:1998).*

3 Terms and definitions

For the purposes of this Part of this European Standard, the terms and definitions given in EN 12953-1 and EN 764 apply.

4 Symbols

For the purposes of this Part of this European Standard, the symbols given in EN 12953-1:2002, Table 4-1 shall apply.

5 Inspection and testing

5.1 General

The manufacturer shall be responsible for ensuring the boiler conforms to the requirements of this European Standard. Conformity shall be confirmed by the completion of a series of inspection activities as given in Table 5.4-1.

Depending upon the conformity assessment module chosen by the manufacturer for the design and manufacture of each boiler (see EN 12953-1:2002, Annex B), the inspection activities shall involve, to a greater or lesser extent, organisations which are independent of the manufacturer.

NOTE For the guidance of the manufacturer, the specific involvement of such organisations, known as responsible authorities (RA), is described in CR 12953-14.

The manufacturer shall provide all the necessary access to enable the responsible authority to carry out the activities in which it is required to be involved.

5.2 Approval of personnel

5.2.1 Check of welder and welding operator approval

The manufacturer shall certify that the welding of the boiler has been done by welders and welding operators who have been approved under the requirements of EN 12953-4:2002, 5.15.3.2 and the appropriate certification shall be made available on request.

5.2.2 Approval of non-destructive examination personnel

For the purposes of this standard the term non-destructive examination (NDE) covers the conventional techniques of visual, radiographic, ultrasonic, magnetic particle examination and/or penetrant testing as specified in 5.5.2 to 5.5.4.

Personnel responsible for non-destructive examination, including interpretation, evaluation and reporting shall be certified in accordance with EN 473.

An exception to this requirement shall be made for visual examination of welds and final inspection of boilers, for which EN 473 is not applicable. Visual examination shall be in accordance with EN 970.

Visual examination shall be carried out by experienced personnel having sufficient knowledge in welding techniques, and a full comprehension of this European Standard, to identify and interpret imperfections that might occur at the surface of the weld and the heat affected zone.

Radiographs shall be viewed by personnel qualified to level 2 of EN 473 as a minimum.

Magnetic particle inspection, penetrant inspection and ultrasonic examination shall be performed under the direct supervision of personnel qualified to level 2 of EN 473 as a minimum.

5.3 Calibration of equipment

The manufacturer shall establish procedures to ensure that tools, gauges, instruments and other measuring and testing devices used in the manufacture and inspection activities affecting boiler quality, are properly controlled, calibrated and adjusted at specific intervals, to maintain accuracy within defined limits.

5.4 Inspection activities

The manufacturer shall confirm that the boiler components, as a minimum, conform to the requirements of this European Standard by performing and authenticating the inspection activities listed in Table 5.4-1.

Table 5.4-1 — List of inspection activities to be undertaken by the manufacturer

Reference no.	Area of activity	Inspection operation
1	**Design and general documentation**	
1.1	Design data/calculations	Ensure that the design data/calculations conform to: — technical specifications, if applicable — the requirements of this European Standard
1.2	Manufacturing drawings	Ensure that drawing information conforms to: — design data and calculations — technical specifications, if applicable — the requirements of this European Standard
1.3	Purchase specifications	Ensure that material and component specifications conform to: — technical specifications, if applicable — manufacturing drawings — the requirements of this European Standard
1.4	Specifications for sub-contracted parts	Ensure that the specification for sub-contracted parts conform to: — technical specifications, if applicable — manufacturing drawings — the requirements of this European Standard
2	**Material**	
2.1	Material certificates	Verify that certificate information and results conform to the design specification
2.2	Welding consumables	Verify that the consumables to be used are in accordance with the design specification
2.3	Material identification	Identify the material with the material certificates and check the markings
2.4	Transfer of identification marks	Ensure that the transfer of identification marks is in accordance with the approved procedure
2.5	Acceptance of sub-contracted parts	Verify that sub-contracted parts conform to the manufacturer's specification
3	**Fabrication and welding**	
3.1	Welding procedure specifications	Verify that appropriate welding specifications are available and that their contents are compatible with the welding procedure approvals
3.2	Welding procedure approvals	Verify that the welding procedures are appropriate for the materials and the field of welding application, and that they have been approved by a responsible authority
3.3	Welder approval	Verify that the welder approvals have been approved by a responsible authority and that they are available and valid

Table 5.4-1 (*continued*)

Reference	Area of activity	Inspection operation
3.4	Forming procedures	Verify that forming procedures are available, where applicable, and their contents are appropriate to the product to be formed
3.5	Formed parts	Examine formed parts in accordance with the requirements of EN 12953-4:2002, clause 5
3.6	Weld preparations	Examine material cut edges where thermal cutting has been used and confirm machined preparations are to the correct profile
3.7	Weld seam set-up	Examine set-up of seams for welding, including dimensional check
3.8	Welding	Verify that the welding is conducted in accordance with the requirements of the welding procedure specification
3.9	Production test plates, if any	Witness removal and marking of production test plates
		Verify that any PWHT on production test plates independent of the boiler complies with the specific heat treatment applied to the boiler
		Examine NDE reports on production test plates
		Identify and mark the test specimens taken from production test plates for mechanical tests
		Verify that the test information and results from the mechanical tests contained in the manufacturer's report conform to the requirements of this European Standard
4	**Non-destructive examination of welds**	
4.1	Non-destructive examination procedures	Verify that appropriate non-destructive examination procedures are available and ensure the qualification of the originator is appropriate
4.2	Non-destructive examination operator qualifications	Ensure the non-destructive examination operator's qualifications are appropriate
4.3	Non-destructive examination operation	Scrutinise any radiographs and check conformance to the acceptance criteria
		Verify that the results of any ultrasonic examination conforms to the acceptance criteria
4.4	Non-destructive examination reports	Verify that the information and results conform to the acceptance criteria
5	**Post-weld heat treatment (PWHT)**	
5.1	PWHT procedures	Verify that the post-weld heat treatment procedures conform to this European Standard
5.2	PWHT records	Verify that temperature/time recordings conform to the requirements of this European Standard
6	**Final inspection and marking**	
6.1	Pre-hydrostatic pressure test inspection	Carry out dimensional checking, visual examination and identification of accessible parts after component completion, prior to hydrostatic pressure test
6.2	Hydrostatic pressure test	Ensure the final hydrostatic pressure test is carried out in accordance with the requirements of this European Standard
6.3	Post-hydrostatic pressure test inspection	Perform visual examination on completion of the hydrostatic pressure test
		Check marking on nameplate
6.4	Safety devices	Ensure the provision of safety equipment
6.5	Manufacturer's data dossier	Ensure completeness of the data dossier (see 6.2)

5.5 Non-destructive examinations

5.5.1 General

The NDE shall be performed after any PWHT.

5.5.2 Extent of non-destructive examination

All welded seams shall be subjected to visual examination and, in addition, to NDE in accordance with Table 5.5-1.

Table 5.5-1 — Extent of NDE for welds

Component	Type of weld	Weld location	Figure No. EN 12953-4:2002	Testing technique	Footnotes	Percentage of total length of weld to be tested	
						Weld factor	
						1	0,85
All welds	—	—	—	Visual		100	100
Branch welds and pads		In shell section	A.5 to A.7	MP & DP	[a]	25	10
Shell	Longitudinal	In shell section	A.1	Radiographic or ultrasonic	[b] and [c]	100	10
	Circumferential	Between shell sections	A.1	Radiographic or ultrasonic	[b], [c] and [d]	25	10
	Circumferential	Between shell sections and flanged end plates	A.1	Radiographic or ultrasonic	[b], [c], [d] and [e]	25	10
	Circumferential	Between shell sections and set-on end plates	A.13c) and A.13d)	Radiographic or ultrasonic	[f]	100	100
	T-butt	At junction of shell with set-in end plates	A.13a) and A.13b)	Radiographic or ultrasonic	[c] and [g]	10	10
Flat end plates	Butt	Between the two sections in large diameter end plates	A.1	Radiographic or ultrasonic	[c]	100	10
Furnaces	Longitudinal	In furnace sections	A.1	Radiographic or ultrasonic	[c]	10	10
	Circumferential	Between furnace sections and between furnace and bowling hoops	A.1	Radiographic or ultrasonic	[b] and [c]	10	10
	Circumferential	Between furnace sections and flanged end plates	A.17c)	Radiographic or ultrasonic	[b] and [c]	10	10
	T-butt	Between furnace sections and set-in end plates	A.15	Radiographic or ultrasonic	[c], [f] and [g]	25	25
	T-butt	Furnace to reversal chamber end plates	A.15	Radiographic or ultrasonic	[c]	10	10
Reversal chambers	Longitudinal	In wrapper plate	A.1	Radiographic or ultrasonic	[c], [f] and [g]	25	25
	Circumferential	Between wrapper plate and flanged end plate	A.13d)	Radiographic or ultrasonic	[b] and [c]	10	10
	T-butt	Between wrapper plate and flanged end plate	A.14a) to A.14c)	Radiographic or ultrasonic	[c], [f] and [g]	10	10
Reversal chamber access tube	Longitudinal	In access tube	A.1	Radiographic or ultrasonic	[c]	10	10
	T-butt	Access tube to boiler and reversal end plate chamber end plates	A.16a) A.16b)	Radiographic or ultrasonic	[c], [f] and [g]	10	10
Gusset and girder stays	T-butt	Between stay and plate	EN 12953-3:2002, Figures 10.2-11 and 10.2-14	Radiographic or ultrasonic	[f]	10	10

[a] Type P355GH steel only.

[b] The percentage of welds to be examined shall include each intersection of longitudinal and circumferential seams. For each longitudinal and circumferential seam there shall be at least one radiograph, or where ultrasonic testing is specified, at least a 200 mm length shall be examined.

[c] In each case the section of weld to be tested shall be selected at random.

[d] If the end plates are fully stayed to each other by bar stays, stay tubes, or a combination of bar stays and reversal chamber stays, 10 % of the length of the circumferential seams shall be non-destructively examined. All seam intersections shall be NDE.

[e] If the flange is thicker than the end plate, the flange shall be machined to a taper and welded in a manner to that shown in EN 12953-4:2002, Figure A.1a).

[f] If T-butt welds cannot be radiographically or ultrasonically examined due to physical limitations, they shall be visually examined at the following stages — weld preparation, tack welding, initial root run, finished weld, and shall be subjects to MP or DP on completion.

[g] The position of the tested section of weld shall be marked on the boiler and recorded.

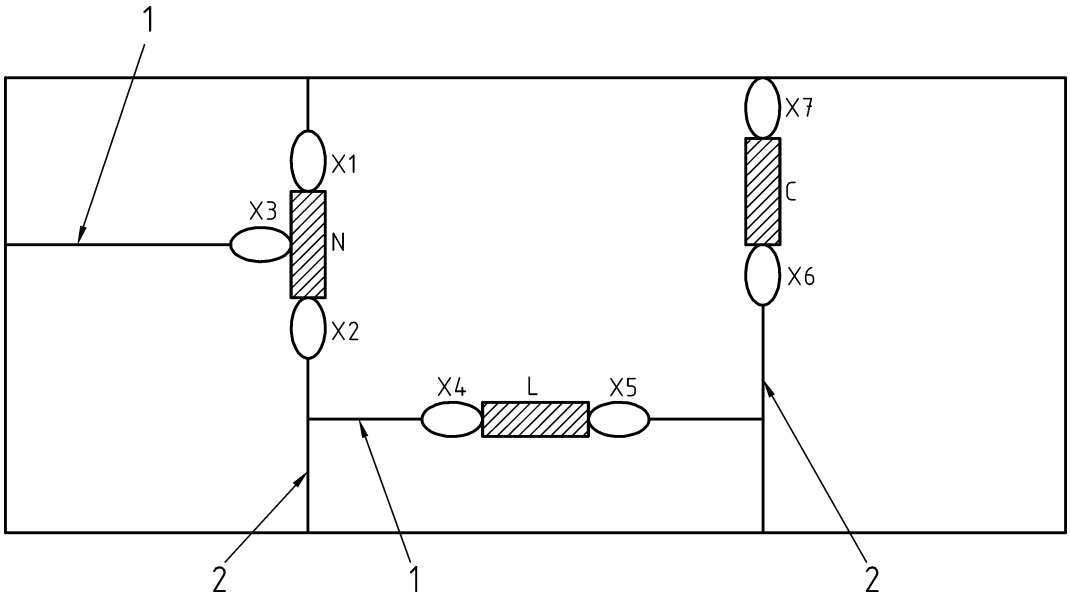
If, during inspection, a defect is detected in the weld under examination, the following additional inspections shall be carried out prior to any repair, (see Figure 5.5-1).

a) Cross welds

If the defect occurs in the region of a weld intersection, a check shall be made in the longitudinal and circumferential weld at each side of the intersection.

b) Circumferential and longitudinal welds

For defects in the circumferential and longitudinal seam welds, a check shall be made at each side of the defect.



Key

Weld under examination
Additional examinations ≥ 200 mm
1 Longitudinal weld
2 Circumferential weld
X1 ... X7 checks points
N Cross weld defect
L Longitudinal weld defect
C Circumferential weld defect

Figure 5.5-1 — Additional inspection of defective welds

If the results of a) and b) are satisfactory, no further action is required and the weld shall be repaired.

If additional defects are detected, the particular seam shall be subjected to 100 % examination together with all other welds produced by the recorded welder to the same procedure.

Any repair to a weld shall be documented. If the repair is made as a consequence of a radiographic examination, the films of the original defects shall be made available.

5.5.3 Non-destructive examination of repairs

On completion of repairs, the re-welded portions shall be examined by all the techniques specified for the original weld.

5.5.4 Non-destructive examination of welded joints – techniques and acceptability of imperfections

5.5.4.1 General

All welded joints which are to be subjected to non-destructive examination shall be prepared so as to be suitable for the method to be used.

NOTE Acceptance limits for imperfections occurring at the surface of welded components have been modified to reflect current European boiler manufacturing practice. When this has been done, an identifying letter "S" has been utilised in the tables in the columns "EN 25817 level".

5.5.4.2 Visual examination

5.5.4.2.1 Examination

All welded joints shall be visually examined for profile imperfections in accordance with EN 970. This shall be additional to other NDE of welds.

5.5.4.2.2 Acceptance level of imperfections in welds

The acceptance level of imperfections shall be in accordance with Table 5.5-2.

5.5.4.3 Radiography

5.5.4.3.1 Examination

Radiographic examination of welds shall be carried out in accordance with class A of EN 1435.

5.5.4.3.2 Acceptance level of imperfections in welds

The acceptance level of imperfections in welds shall be in accordance with Table 5.5-3.

5.5.4.3.3 Radiographs

A complete set of radiographs for each job shall be retained by the manufacturer and kept on file for a period of at least 10 years.

Table 5.5-2 — Acceptance levels of imperfections found by visual examination

Identification of imperfection			EN 25817 level	Limit of imperfection
EN ISO 6520-1 Group No.	EN ISO 6520-1 Ref. No.	Type of imperfection		
1	100X	Cracks (all)	B	Not permitted
2	201X 202X	Gas cavity (all) Shrinkage cavity (all)	"S"	When occurring at the surface — diameter ≤ 2 mm, or — depth ≤ 1 mm With additional conditions that: — it does not occur at a stop or restart, — it is not systematic on the same weld for pressure welds or load carrying attachment welds
3	301X 302X 303X 304X	Slag inclusions (all) Flux inclusions (all) Oxide inclusions Metallic inclusions (all)	"S"	Not permitted when occurring at the surface (shall be removed e.g. by grinding).
4	401X	Lack of fusion (all)	B	Not permitted
	402	Lack of penetration	B	Not permitted if a full penetration weld is required.
5	5011 5012	Undercut	B	Depth ≤ 0,5 mm Smooth transition is required.
	502	Excess weld metal	C	$h \leq 1$ mm + 0,15 b, maximum 7 mm h = excess weld metal, in mm b = width of weld, in mm. Smooth transition is required.
	504	Excessive penetration	C	$h \leq 1$ mm + 0,6 b, maximum 4 mm h = excess penetration, in mm b = width of the penetration, in mm.
	506	Overlap	B	Not permitted
	507	Linear misalignment	"S"	See EN 12953-4:2002, 5.3 and 5.15
	508	Angular misalignment	"S"	See EN 12953-4:2002, 5.3 and 5.15
	511	Incompletely filled groove	C	Long imperfections (> 25 mm) not permitted. Short imperfections (≤ 25 mm) $h \geq 0,1\ e$, maximum 1,0 mm h = depth of sagging, in mm e = thickness of base material, in mm Smooth transition is required
	515	Root concavity	C	$h \leq 1,0$ mm h = root concavity, in mm Smooth transition is required
	516	Root porosity	"S"	Not permitted
6	600	Miscellaneous imperfections	"S"	Surface imperfections due to stray flash or arc strike, spatter, torn surfaces, grinding and chipping marks shall be removed usually by grinding to produce a smooth transition.
	606	Underflushing	"S"	Not permitted. Any local underflushing shall be related to the design characteristics (calculated thickness + corrosion allowance = minimum thickness for base material). Thickness shall be measured by ultrasonic method in case of doubt.

Table 5.5-3 — Acceptance levels of imperfections found by radiography

Identification of imperfection			EN 25817 level	Limit of imperfection
EN ISO 6520-1 Group No	EN ISO 6520-1 Ref. No	Type of imperfection		
1	100	Cracks (all)	B	Not permitted
2	2011	Gas pore (isolated or individual in a group)	"S"	$d \leq 0{,}3\ e$, maximum 4 mm d = diameter of a single pore, in mm e = thickness of base material, in mm
	2012	Uniformly distributed porosity	"S"	For any individual pore, see gas pore No 2011
			"S"	Not permitted if the total projected surface of porosity exceeds 2 % of the considered projected surface of the weld
	2013	Clustered (localized) porosity	"S"	For any individual pore, see gas pore No 2011
			B	Not permitted if the total projected surface of porosity exceeds 4 % of the considered projected surface of the weld, which is the greatest of the 2 following areas: — area 1: an envelope surrounding all the pores — area 2: a circle with a diameter corresponding to the weld width
	2014	Linear porosity	"S"	Same as for uniformly distributed pores No 2012, but the distance between two pores shall always be greater than twice the diameter of the larger pore, and not less than 4 mm (to ensure fusion)
	2015	Elongated cavity	"S"	$l \leq 0{,}3\ e$, maximum 5 mm and w = 2 mm l = length of the projected indication, in mm e = thickness of base material, in mm w = width of the projected indications, in mm
	2016	Worm hole	"S"	Same as for elongated cavity No 2015
	202	Shrinkage cavity	"S"	$l \leq 0{,}3\ e$, maximum 5 mm and w = 2 mm l = length of the projected indication, in mm e = thickness of base material, in mm w = width of the projected indications, in mm
3	301	Slag inclusion	"S"	$w \leq 0{,}3\ e$, maximum 3 mm w = width of projected indication, in mm, l = length of projected indication, in mm, e = thickness of base material, in mm. In the case of several linear slag inclusions with a distance between any two less than twice the length of the longest, the total length shall be considered an imperfection.
	302	Flux inclusion	"S"	Same as for slag inclusion No 301
	303	Oxide inclusion	"S"	Same as for slag inclusion No 301
	304	Metallic inclusion	"S"	Copper inclusions — not permitted Tungsten inclusions — same as for gas pore No 2011, 2012, 2013.
4	400	Lack of fusion and lack of penetration	B	Not permitted
5	500	Imperfect shape	—	Defects are accepted or rejected by visual examination.

5.5.4.4 Ultrasonic examination

5.5.4.4.1 Examination

Ultrasonic examination of welds shall be carried out in accordance with level A of EN 1714.

5.5.4.4.2 Classification of imperfections

Classification of imperfections shall be in accordance with EN 1713.

5.5.4.4.3 Acceptance level of imperfections in welds

The acceptance level of imperfections in welds shall be level 2 of EN 1712 except for T-butt welds, which shall be in accordance with 5.5.4.4.4.

5.5.4.4.4 Acceptance levels of defects in T-butt welds

The acceptance levels for T-butt welds shall apply to shell to end plate welds of the types shown in EN 12953-4:2002, Figures A.13a) to A.13c), furnace to end plate and reversal chamber welds, as shown in EN 12953-4:2002, Figures A.15 and reversal chamber end plate to wrapper plate welds, as shown in EN 12953-4:2002, Figures A.14a) to A.14c), and access tube to end plate welds, as shown in EN 12953-4:2002, Figures A.16a) and A.16b).

The requirements of 5.5.4.4.3 for acceptance levels of imperfections found by ultrasonic examination shall apply, except for welds with a second side fillet weld (see EN 12953-4:2002, Figures A.13, A.14 and A.15), where full penetration is desirable, but lack of penetration at the root shall be permitted within the following limits:

l = 200 mm maximum

h = 3 mm maximum

where

h is the height of the defect;

l is the length of the defect.

This shall apply with the ratio $e_{rs}/e_{rh} < 1{,}25$

Surface defects due to incomplete penetration, which are revealed by visual inspection or surface crack detection, (preferably by the magnetic particle method) are unacceptable and shall be ground out to sound metal and repaired.

5.5.4.5 Magnetic particle examinination and penetrant testing

5.5.4.5.1 Examination

Magnetic particle examination of welds shall be carried out in accordance with EN 1290, and penetrant testing of welds shall be carried out in accordance with EN 571-1.

5.5.4.5.2 Acceptance criteria

The following imperfections shall be judged unacceptable in magnetic particle examination or the dye penetrant test:

a) discontinuities interpreted as cracks, lack of fusion or penetration, regardless of the length;

b) any defect greater than the acceptance levels in accordance with Table 5.5-2.

5.6 Weld production control test plates

5.6.1 General

In order to control the continuing quality of manufacture and the compliance of the mechanical properties of the welded joints to the specification, a test plate shall be welded to the boiler and tested in accordance with the requirements detailed below.

5.6.2 Quantity of test plates

The following test plates shall be prepared:

a) one test plate per boiler if v = 1,0;

b) one test plate per 100 m of longitudinal joints if v = 0,85;

c) if circumferential seams are welded to a different procedure to the longitudinal seams, one test plate per year. If the circumferential welds are made to the same procedure as the longitudinal welds no test plates need be provided for the circumferential seams;

NOTE After 10 test plates successfully pass the tests, testing can be reduced to the following:

1) one test plate per 100 m of longitudinal joints if v = 1,0;

2) one test plate per 1 000 m of longitudinal joints if v = 0,85;

3) if circumferential seams are welded to a different procedure to the longitudinal seams, one test plate per year. If the circumferential welds are made to the same procedure as the longitudinal welds no test plates need be provided for the circumferential seams.

If a test plate fails, testing shall revert to a), b) and c).

Production control test plates shall only apply to main shell longitudinal and circumferential welds.

Production control test plates for longitudinal seams shall be welded as a continuation of a longitudinal seam. For a weld factor of v = 1,0 the material for the production test plates shall be from the same batch as the shell and for a weld factor v = 0,85 the material for the production test plates shall be to the same specification as plates local to the seam represented.

When boilers with a weld factor of v = 0,85 are manufactured along with boilers with a weld factor of v = 1,0 and are welded to the same procedure, test plates shall not be required for the boilers with a weld factor of v = 0,85 provided that sufficient test plates are produced to cover the total length of welding involved.

5.6.3 Non-destructive examination of test plates

The welds in the test plate shall be subjected to either radiographic or ultrasonic examination.

If any defects in the weld of a test plate are revealed, their position shall be clearly marked on the plate and test specimens shall be selected from other parts of the test plate.

The cause of defects in the production test plate shall be ascertained.

5.6.4 Destructive testing of test plates

The number and type of test specimens to be taken from the test plate are dependent on the plate thickness and shall be in accordance with in Table 5.6-1 and the symbols used in the table shall be in accordance with Table 5.6-2.

Table 5.6-1 — Number and type of production test specimens

Plate size mm	Specimens
$e \leq 12$	1-FB, 1-RB, 1-MA
$12 < e \leq 35$	3-IW, 1-MA
$35 < e$	3-IW, 1-TT, 1-LT, 1-MA

Table 5.6-2 — Designation of test specimens

Test specimens	Symbol
Face bend test to EN 910	FB
Root bend test to EN 910	RB
Transverse tensile test to EN 895	TT
Longitudinal weld tensile test to EN 876	LT
Impact test — weld deposit to EN 875	IW
Macro examination to EN 1321	MA

Test plates shall be of sufficient size to allow for the required number of specimens including an allowance for retests.

If so desired, weld test plates may be provided at both ends of a longitudinal seam, in which case the dimensions of the test plates shall be sufficient to take the required test specimens out of one, and the specimens for retesting out of the other.

The test plates shall be supported or reinforced during the welding in order to prevent undue warping.

The test plates shall be subjected to the same heat treatment as required for the work piece to which they belong.

Test plates warped during welding shall be straightened at a temperature below the temperature of heat treatment of the shell to which they belong. Straightening shall be performed before final heat treatment.

5.6.5 Test specimens and testing requirements

The test pieces and methods of testing shall be in accordance with EN 288-3 for welding procedure approval.

The individual test pieces shall be manufactured and tested as specified in 5.6.2 to meet the acceptance criteria defined below:

a) Bend test

The testing and the test requirements shall comply with EN 288-3:1992, 7.4.2.

b) Transverse tensile test

The tensile strength of the test specimens shall not be less than the corresponding specified minimum value for the parent metal.

c) Longitudinal weld tensile test

$R_{p\,0,2}$, R_m and A_5 of the test specimens shall not be less than the corresponding specified minimum values for the parent metal.

d) Impact test of weld metal

This test shall be performed in accordance with EN 288-3:1992, 7.4.4. The mean toughness values of the specimens shall not be below the specified transverse value of the base metal.

e) Test record

A test record shall be prepared indicating compliance of the test results found with the specified requirements.

f) Retests

Production factors may cause a scatter of mechanical test results that may occasionally fall below the agreed specification level. If individual tests do not comply with the above requirements the reasons for this failure shall be investigated and if no unacceptable imperfections are found, the following retests shall be made:

1) tensile test — two retests;
2) bend test — two retests;
3) impact test — three additional Charpy impact test specimens.

If any of the retests fail to comply with the requirements, then the seams/vessels represented by the test plate shall be deemed not to be in compliance with this European Standard.

5.7 Final assessment

5.7.1 General

Each completed boiler designed and constructed to this European Standard shall be subject to a final assessment for conformance with the requirements of the approved construction drawings and this European Standard.

The final assessment shall consists of:

— a visual and dimensional examination of the boiler;

— an examination of the documentation;

— a proof test;

— a post proof test examination;

— inspection of provision of safety devices.

Those performing the final assessment shall have access to all of the files/records relevant to the boiler under examination.

5.7.2 Extent of final assessment

5.7.2.1 Visual and dimensional examination

The scope of the visual and dimensional examination shall include, but not be limited to, the following:

— check of conformity of construction with the approved boiler manufacturer's construction drawings including dimensional requirements to the tolerances specified on the drawings and in this European Standard. The results of the dimensional examination (as built condition) shall be documented;

— check of the condition of a completed boiler with particular attention to finished weld seams, nozzle connections and attachments in respect of weld profile and general weld geometry in compliance with the approved construction drawings and this European Standard;

— check of material markings for traceability of material against documented records;

— check of welders and NDE identification on the boiler against documentation, if applicable.

Any remedial actions resulting from this examination shall be completed, re-examined and cleared prior to the proof test.

5.7.2.2 Examination of documentation

The scope of the examination of documentation shall include, but not be limited to checking the documents (e.g. tests certificates of the welding procedures approval, certificates of the welders approval, certificates for NDE personnel, production tests reports, NDE reports, post-weld heat treatment records, dimensional checking records).

The extent of the examinations and all deviations shall be reported. Any remedial actions resulting from this examination shall be completed, re-examined and cleared prior to the proof test.

5.7.2.3 Proof test

In order to demonstrate the strength and integrity of the completed boiler, and to establish that no major error or defect has occurred, the boiler shall be hydrostatically tested to the pressure specified in EN 12953-3.

When it is necessary to test boilers hydrostatically to pressures greater than that specified in EN 12953-3 due to the omission of back fillet welds (see EN 12953-4:2002, 5.12.4.2), the design shall be checked to ensure that the membrane stress in any part of the boiler under test does not exceed 90 % of the room temperature 0,2 % proof strength of the material.

In cases where 90 % of the room temperature 0,2 % proof strength would be exceeded, the design of the boiler shall be changed to ensure that this does not occur.

The acceptance test pressure shall be applied and maintained for a sufficient length of time to permit a visual examination to be made of all surfaces and joints, but in any case for not less than 30 min. The boiler shall exhibit no sign of general plastic deformation or leakage.

It is important that the boiler shall be properly vented so as to prevent the formation of air pockets before the test pressure is applied. The test temperature of the water shall be such as to prevent brittle fracture.

NOTE It is recommended that before the boiler is approached for close examination, the pressure should be reduced to not less than 1,1 times the maximum allowable pressure and not more that 0,9 times the test pressure.

5.7.2.4 Post proof pressure test examination

This is a visual examination that shall be performed following the pressure test and after the boiler has been drained and cleaned. The examination shall determine that there has been no deterioration resulting from the pressure test.

The examination shall also determine the application and accuracy of markings as required by this European Standard and the approved construction drawings.

The extent of the examinations and all deviations shall be recorded.

5.7.2.5 Inspection of provision of safety devices

The boiler shall be checked for the provision of safety devices in compliance with the requirements of this European Standard.

6 Documentation, certification and marking

6.1 General

The manufacturer shall allow the Responsible Authority full access to all drawings and calculations necessary for checking the design and dimensions of parts during manufacture, as appropriate. If erection on site is not undertaken by the manufacturer, the manufacturer shall supply full information to enable the erection of the boiler to be performed.

6.2 Documentation

The manufacturer shall produce a Design and manufacturing data dossier which shall be kept by the manufacturer for a minimum period of 10 years.

Radiographic films shall be kept by the manufacturer for a minimum period of 10 years from the date of completion of the boiler.

6.3 Declaration

The manufacturer shall sign a Declaration to certify that the boiler has been designed and manufactured to the requirements of this standard.

NOTE A typical Declaration is shown in CR 12953-14

6.4 Marking

Each shell boiler shall be permanently and legibly marked either on the boiler or on a permanently attached nameplate.

The marking shall show the following:

a) the number of this European Standard;

b) the name and address of the manufacturer;

c) the year of manufacture;

d) the manufacturer's type and serial number of the boiler;

e) the maximum allowable pressure, in bar;

f) the following information, as appropriate;

Hot water boiler - Maximum water outlet temperature

Superheater - Maximum steam temperature

g) the maximum heat output, in kW;

h) the hydrostatic test pressure, in bar;

i) the date of the hydrostatic pressure test;

j) the safety valve set pressure, in bar;

k) the identification mark(s) of the Responsible Authority, if applicable;

l) the CE mark, if applicable.

Annex ZA
(informative)

Clauses of this European Standard addressing essential requirements or other provisions of the Pressure Equipment Directive

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential safety requirements of the Pressure Equipment Directive 97/23/EC.

WARNING Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

The following clauses of this standard given in Table ZA.1 are likely to support essential safety requirements of the Pressure Equipment Directive 97/23/EC:

Table ZA.1 — Comparison between EN 12953-5and the Pressure Equipment Directive 97/23/EC with respect to inspection during construction, documentation and marking of shell boilers

EN 12953-5 harmonised clauses	Content	Pressure Equipment Directive 97/23/EC Annex I
5.2.2	Approval of NDE personnel	3.1.3
5.4	Manufacturing procedure	3.1
5.5	Permanent joining/NDE	3.1.2/3.1.3
5.6	Preparation of component parts	3.1.1/3.1.2
5.7.2	Final assessment	3.2.2
6.4	Marking and labelling	3.3

Compliance with the clauses of this European Standard provides one means of conforming with the specific essential safety requirements of the Directive concerned and associated EFTA regulations.

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