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Shell boilers - Part 4: Workmanship and construction of pressure parts of the boiler

Großwasserraumkessel - Teil 4: Verarbeitung und Bauausführung für drucktragende Kesselteile

Chaudières a tubes de fumée - Partie 4: Fabrication et construction des parties sous pression des chaudières

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EUROPEAN STANDARD
NORME EUROPÉENNE
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EN 12953-4

May 2002

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Shell boilers - Part 4: Workmanship and construction of pressure parts of the boiler

Chaudières à tubes de fumée - Partie 4: Fabrication et construction des parties sous pression des chaudières

Großwasserraumkessel - Teil 4: Verarbeitung und Bauausführung für drucktragende Kesselteile

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

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 12953-4:2002) 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of an identical text or by endorsement, at the latest by November 2002, and conflicting national standards shall be withdrawn at the latest by November 2002.

This 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: Special requirements for stainless steel boiler servicing sterilizer.*

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.

Annex A of this European Standard is informative.

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.

EN 12953-4:2002 (E)**1 Scope**

This Part of this European Standard specifies requirements for the workmanship and construction 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 287-1, *Approval testing of welders - Fusion welding - Part 1: Steels.*

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

EN 1011-2, *Welding - Recommendations for welding of metallic materials - Part : Arc welding of ferritic steels.*

EN 1418, *Welding personnel — Approval testing of welding operators for fusion welding and resistance weld set-
ters for fully mechanized and automatic welding of metallic materials.*

prEN 10216-2, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Non-alloy
and alloy steel tubes with specified elevated temperature properties.*

prEN 10217-2, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 2: Electric
welded non-alloy and alloy steel tubes with specified elevated temperature properties.*

prEN 10217-5, *Welded steel tubes for pressure purposes — Technical delivery conditions — Part 5: Submerged
arc welded non-alloy and alloy steel tubes with specified elevated temperature properties.*

EN 12953-1:2002, *Shell boilers - Part 1: General.*

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

EN 12953-5:2002 *Shell boilers — Part 5: Inspection during construction, documentation and marking of pressure
parts of the boiler.*

3 Terms and definitions

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

4 Symbols

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

5 General requirements

5.1 General

5.1.1 The rules in this Part are applicable to all aspects of fabrication, including welding, of boilers and boiler parts, and shall be used in conjunction with the specific requirements applicable to the grades of materials used.

5.1.2 All welding shall be in accordance with the requirements of this standard.

5.1.3 For category II, III and IV boilers, all welders or welding operators and welding procedures shall be approved (see 5.15.3). For category I boilers, approval shall not be mandatory.

5.1.4 The manufacturer of a boiler, or boiler part, built in accordance with the requirements of this European Standard, shall be responsible for the welding done by his workmen. The manufacturer shall designate a competent welding supervisor and also conduct the tests for the approval of the welding procedures used. No production work shall be undertaken on category II, III and IV boilers until both the welding procedures and the welders or welding operators have been approved (see 5.15.3).

5.1.5 The manufacturer shall maintain a record of the results of welding procedure and welding approval tests.

5.1.6 The welds made by each welder shall be marked with a stamp showing the welder's identity or some other appropriate record shall be made. If hand stamping is employed, only low-stress stamps shall be used.

NOTE Low-stress stamps are those with radiused edges or those making a series of dots.

5.1.7 If, during the construction of a boiler or pressure part, the work is not satisfactory or is not in accordance with the requirements of this European Standard, the causes shall be investigated by the manufacturer and rectified. If necessary, requalification tests shall be undertaken and this shall be recorded.

5.2 Material identification

In laying out and cutting the material, the material identification shall be so located as to be clearly visible when the pressure part is completed. Alternatively, for materials that cannot be stamped, or for small multiple parts, or non-pressure parts, the manufacturer shall operate a documented system that ensures material traceability for all materials in the completed boiler. If the material's identification is unavoidably cut out during manufacture, it shall be transferred by the pressure part manufacturer to another part of the component. The transfer of the identification shall be carried out by a person designated by the manufacturer. The method of transferring the original identification shall not contravene the requirements of the material specification.

5.3 Cylindrical shells

5.3.1 Each ring shall be formed from not more than two plates, bent to cylindrical form to the extreme ends of the plate. The bending shall be performed entirely by machine, and local heating or hammering shall not be used.

5.3.2 The shell of completed boilers shall be in accordance with the following requirements.

a) Straightness

Unless otherwise shown on the drawing, the maximum deviation of the shell from a straight line shall not exceed 0,3 % both of the total cylindrical length and of any 5 m length. Measurements shall be made to the surface of the parent plate and not to a weld, fitting, or other raised part;

b) Irregularities in profile

1) Gradual local departures from circularity

Irregularities in profile (checked by a 20° gauge) shall not exceed 2 % of the gauge length.

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NOTE This maximum value can be increased by 25 % if the length of the irregularities does not exceed one quarter of the length of the shell part between two circumferential seams, with a maximum of 1 m. Greater irregularities require proof by calculation or strain gauge measurement that the stresses are permissible.

2) Peaking at welded seams

If an irregularity in profile occurs at the welded seam and is associated with "flats" adjacent to the weld, the irregularity in profile or "peaking" shall not exceed the values given in Table 5.3-1.

Table 5.3-1 — Maximum permitted peaking for dynamic and cyclic loads

Dimensions in millimetres

Wall thickness e	Maximum permitted peaking
$e < 3$	1,5
$3 \leq e < 6$	2,5
$6 \leq e < 9$	3,0
$9 \leq e$	$e/3$

A conservative method of measurement (covering peaking and ovality) shall be by means of a 20° profile gauge or template.

The use of such a profile gauge shall be in accordance with Figure 5.3-1. Two readings shall be taken, P_1 and P_2 , on each side of the seam at any particular location, the peaking is taken as being equivalent to 0,25 (P_1+P_2), or P_3 . [SIST EN 12953-4:2002](https://standards.iteh.ai/catalog/standards/sist/b27c9645-ee67-49b2-957d-d57740cbff2e/sist-en-12953-4-2002)

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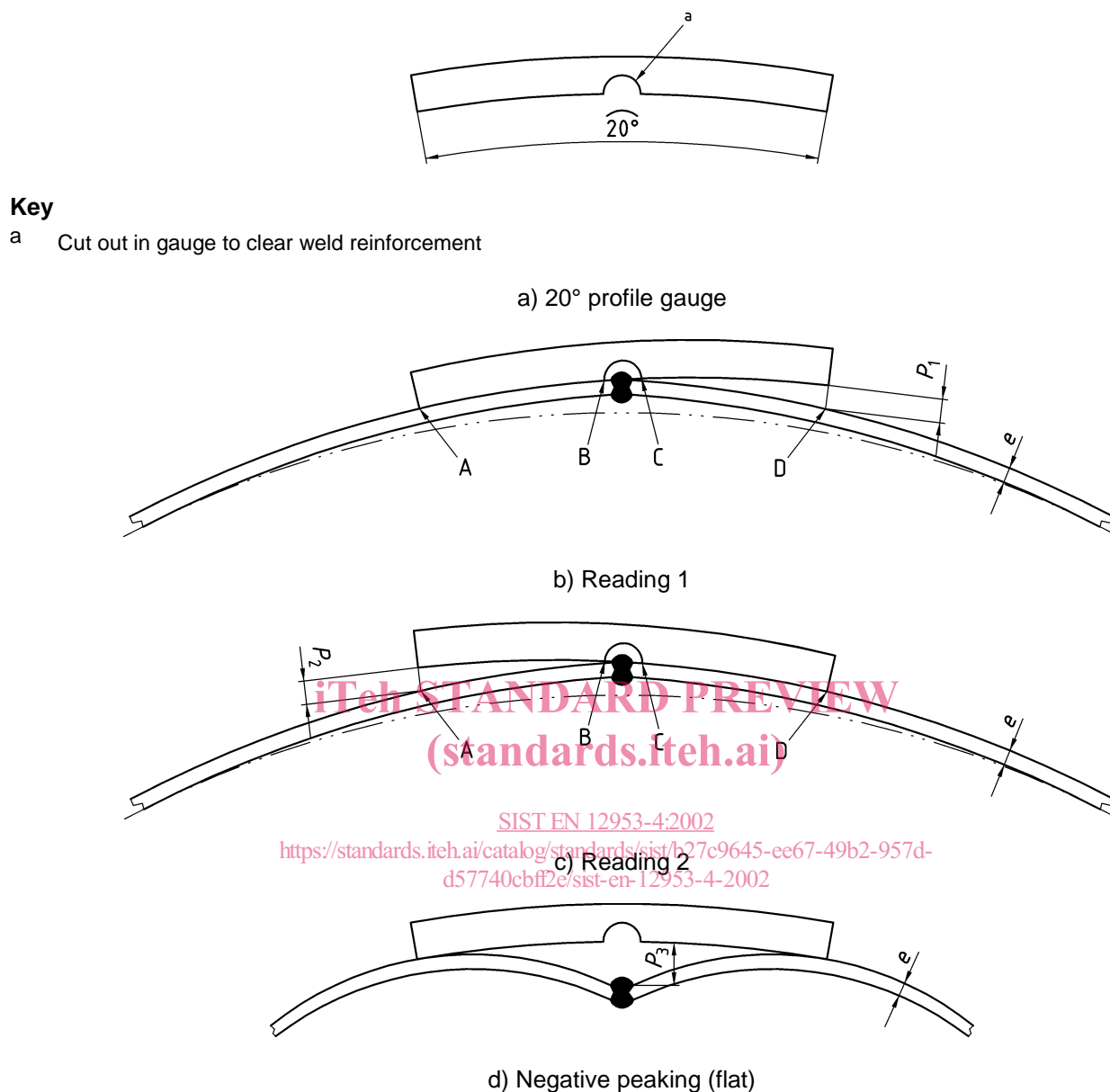


Figure 5.3-1 — Profile gauge and its method of use

c) Departure from circularity

The difference between the maximum and minimum internal diameter of any section of a shell welded longitudinally shall not exceed $(D+1250)/200$, where D is the nominal internal diameter expressed in millimetres.

Measurements shall be made to the surface of the parent plate and not to the weld, fitting or other raised part.

Shell sections shall be measured for departure from circularity either when laid flat on their sides or when set up on end. If the shell sections are checked when laid flat, each measurement for diameter shall be repeated after turning the shell through 90° about its longitudinal axis. The two measurements for each diameter shall be averaged to give the out-of-roundness.

Any local departure from circularity shall be gradual.

EN 12953-4:2002 (E)**d) Cold rolling**

Cold rolling of a welded shell to rectify a small departure from circularity shall be permitted, provided that non-destructive testing conforming to EN 12953-5:2002, 5.3 is carried out after the departure from circularity has been remedied.

5.4 Tell-tale holes

Reinforcing plates and saddles of nozzles attached to the outside of a boiler shall be provided with at least one tell-tale hole that may be tapped (maximum size G ¼) for a preliminary leakage test for tightness of welds that seal off the inside of the boiler. These tell-tale holes may be left open or may be plugged when the boiler is in service. If the holes are plugged, the plugging material used shall not be capable of sustaining pressure between the reinforcing plate and the boiler wall.

5.5 End plates and tube plates

If practicable, flat or dished ends shall be made in one piece except that, where the diameter is so large as to make this impracticable, flat ends may be made from two plates butt welded together (see Figure A.1). The weld shall be located preferably between two rows of bar stays or, if there is only one row of bar stays, between this row and the top row of stay tubes.

Dished end plates and flanging of flat end plates shall be produced either by pressing or spinning. The cylindrical skirt shall have a good surface condition and shall be free from local irregularities.

Cold forming of flat flanged end plates, tube plates and dished ends shall be permitted in accordance with an agreed approved procedure, including normalising, if required.

Hot forming of plates that have been dished or flanged at non-uniform temperatures, or that have been locally heated, shall be normalized after forming unless the manufacturer can demonstrate that the safety of the component is not affected.

Where hemispherical shell end plates are pressed from one plate, they shall be pressed to form by machine in progressive stages, and shall be normalised on completion.

NOTE Normalising can be omitted for hot formed ends, when the forming process is completed at temperatures within the normalising range.

5.6 Plain tubes and stay tubes

5.6.1 Tubes shall be expanded or welded into the tube plate, or secured by a combination of both methods.

5.6.2 If the tubes are fully expanded only, the process shall be carried out with roller expanders, and the expanded portion of the tube shall be parallel throughout the full thickness of the plate.

5.6.3 In addition to expanded tubes, flared tubes, bell-mouthed tubes or beaded tubes shall be permitted.

5.6.4 If tubes are welded to the tube plate by welds other than full penetration welds, the unwelded portion of the tube within the tube hole shall be lightly expanded to provide full contact with the tube plate, except as permitted otherwise in EN 12953-3:2002, 6.1d).

5.6.5 If stay tubes are not provided, the ends of the tubes shall be welded or expanded and beaded at the inlet end and welded or expanded only at the outlet end.

5.6.6 Welding of tubes shall be permitted after stress relief of the boiler.

5.7 Manhole frames and openings

5.7.1 Jointing flanges

The jointing flanges of openings and covers shall be machined on the face and edges and on the bearing surface of the bolt heads and nuts. Bolts and nuts shall be machined where they are in contact with the flanges.

5.7.2 Doors

Doors shall be constructed in accordance with the following requirements.

- a) Doors shall be formed to fit closely to the internal joint surface and shall be fitted with studs, nuts and cross bars;
- b) The spigot part, or recess, of manhole and sight-hole doors shall be as neat a fit as practicable. However, in no case shall the clearance all round exceed 1,5 mm;
- c) Nuts shall be compatible with the studs.

5.8 Connections for mountings

5.8.1 Mountings

Screwed mountings (valves etc) over 25 mm internal diameter and flanged mountings greater than DN 80 shall not be attached directly to any boiler plate, but shall be attached to suitably forged, cast or fabricated nozzles.

NOTE Alternatively, nozzles can be in the form of either screwed or studded pads, forged or cut from plate or round bar.

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5.8.2 Pads

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Nozzles in the form of pads in contact with the boiler shall be formed to fit closely to the plate to which they are to be attached.

If pads are used, the jointing surfaces shall be machined. The pads shall have sufficient thickness to allow the drilling of the stud holes for mountings without the inner surface being pierced and the length of the screwed portion of the stud in the pad shall be not less than the diameter of the stud.

5.8.3 Nozzles

If nozzles are used, the flanges shall be machined or thermal-cut by machine on the edges. The bolting flanges shall be machined on the jointing and bolting surfaces.

5.8.4 Screwed mountings

Screwed mountings not exceeding DN 80 bore shall be fitted to screwed nozzles welded to the boiler. Mounting shall be able to withstand the operating pressure and temperature of the boiler.

5.9 Cylindrical furnaces

5.9.1 Each section of a cylindrical or conical furnace shall be made from one plate. If this is not possible, no more than two plates shall be used. The longitudinal welds shall be at least 120° apart and shall be full penetration butt welds in accordance with 5.12. Alternatively, furnaces shall be made from tubes to prEN 10216-2, prEN 10217-2 or prEN 10217-5. The tensile strength and minus tolerances on thickness shall be taken into account.

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NOTE The welding procedure and the welder/operator for welded tubes in accordance with prEN 10217-2 or prEN 10217-5 are to be approved by the notified body.

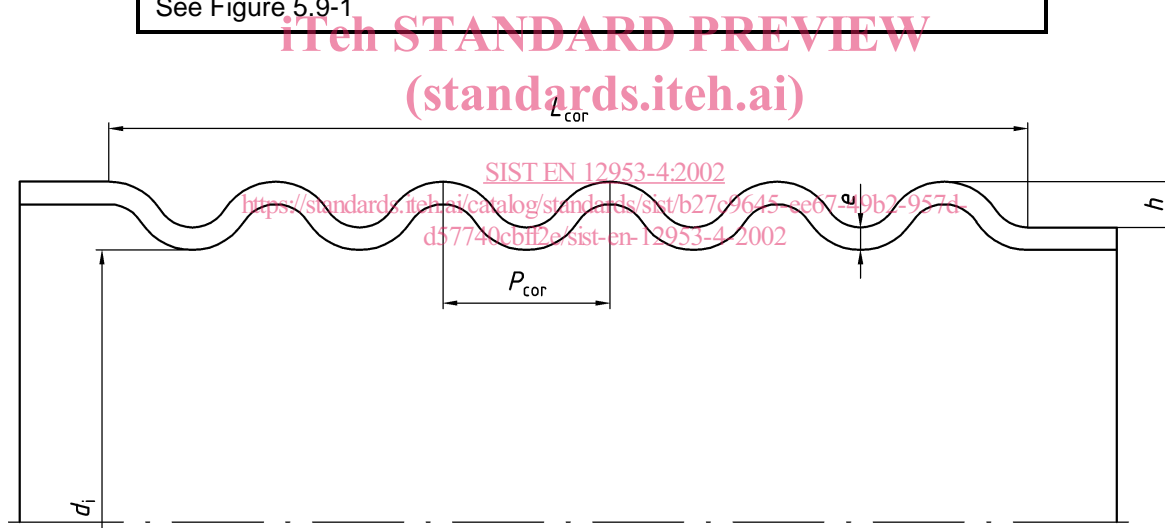
5.9.2 Finished plain or corrugated furnace tubes shall be subjected to an internal and an external inspection, especially the welds and weld-adjacent zones.

5.9.3 For plain furnaces, the manufacturing tolerance on diameter shall be ± 5 mm. For corrugated furnaces, the manufacturing tolerance shall be as given in Table 5.9-1. Out of roundness (see 5.3.2 c)), shall not exceed 1 % for corrugated furnaces or 1,5 % for plain furnaces. Any departure from circularity shall be gradual.

Table 5.9-1 — Manufacturing tolerances for corrugated furnaces

Symbol	Definition	Limit deviations mm
d_i	Internal diameter	+ 5, - 20
e	Plate thickness	± 2
L_{cor}	Total length of corrugation	± 25
P_{cor}	Pitch of corrugation	± 5
h	Height of corrugation	± 10

See Figure 5.9-1



Key

- d_i internal diameter
- e plate thickness
- h height of corrugations
- L_{cor} total length of corrugations
- P_{cor} pitch of corrugations

Figure 5.9-1 — Corrugated furnaces

5.9.4 The longitudinal welds of furnaces shall be placed in such a position that they can be examined from the water side in accordance with inspection category 2 of EN 12953-3.

5.9.5 Corrugated furnaces and bowing hoops shall be produced by machine. They shall be normalised unless the manufacturing process is carried out above the normalising temperature.

5.9.6 If stiffeners are required, they shall be attached externally by continuous full penetration welds.

5.9.7 Forms of furnace connections to end plates are shown in Figure A.15. Where the furnace is inserted into a hole in the end plate, it shall be a good fit around the whole periphery.

5.10 Water-cooled reversal chamber

The reversal chamber tube plates and end plates shall be welded to the wrapper plate, e.g. Figure A.14.

5.11 Stays

5.11.1 Bar stays

All bar stays shall be made from a solid rolled bar without a weld in its length, except those attaching the bar stays to the plates they support.

Bar stays that have been hot worked shall be subsequently normalized.

If a stay is in position in the boiler, its axis shall be normal to the plate it supports.

A tell-tale hole shall be drilled along the axis of all bar stays. The nominal diameter of the hole shall not exceed 5 mm and the drilling shall extend a minimum of 15 mm beyond the water surface of the plate.

5.11.2 Girder stays

The attachment of girder stays welded directly to the crown plates shall be by means of full penetration welds.

5.11.3 Tube stays

Tube stays shall be made from seamless or welded tube.

NOTE If appropriate, tube stays can be fitted in accordance with the requirements of bar stays as given in 5.11.1.

5.12 Design of welded joints

5.12.1 Weld deposition

The design of the welded joints shall be such as to provide adequate access to enable the deposition of weld metal to meet the requirements laid down in this European Standard.

5.12.2 Weld crosses

5.12.2.1 Pressure parts

Joints shall not be permitted where more than two welded seams meet at one point.

If a component is made of two or more shell sections, the longitudinal seams shall be completed before commencing the adjoining circumferential seam(s). The longitudinal seams of each adjacent section shall be staggered by at least 100 mm and they should, if possible, be located in the top half of the boiler (i.e. between 9 and 3 o'clock of the circumference).

5.12.2.2 Non-pressure parts

Attachment of non-pressure parts by welds that cross, or for which the minimum nominal distance between the edge of the attachment weld and the edge of the existing main welds or nozzle welds is less than twice the thickness of the pressure part, or 40 mm, whichever is the smaller, shall be avoided.