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Technical specification for the supply of simple pressure receptacles of steel, not fired, for air braking equipment and auxiliary pneumatic equipment for railway rolling stock

International Union of Railways

Leaflet to be classified in volumes:

V - Transport stock
VIII - Technical specifications

Amendments

Preliminary remarks:

Provisions of an obligatory nature are preceded by an asterisk: *

The double vertical line (‖) in the margin denotes amendments introduced on the date shown at the foot of the page.

Enforcement of this leaflet is governed by the provisions listed under "Application" at the end of this document.

This leaflet is:

- mandatory for all technical documents drafted within UIC or ERRI,
- mandatory for simple pressure receptacles to be fitted to rolling stock yet to be designed,
- recommendatory for simple pressure receptacles fitted to existing rolling stock.

Note

This leaflet forms part of a series which also include:

Leaflet 541-07	Brakes - Regulations governing the construction of different types of braking gear - Simple pressure receptacles, of steel, not fired, for air braking equipment and auxiliary pneumatic equipment for railway rolling stock.
Leaflet 800-30	Selection of ISO threads.
Leaflet 897-11	Technical specification for the acceptance of welders for fusion welding of steel.
Leaflet 897-12	Technical specification for the acceptance of welding procedures for arc welding in steels.
ISO standard 228-1	Pipe threads where pressure-tight joints are not made on the thread - Part 1 - Designation, dimensions and tolerances.
ISO standard 261	ISO general purpose metric screw threads - General plan.
ISO standard 1101	Technical drawings - Geometrical tolerancing - Tolerances of form, orientation, location and run-out - Generalities, definitions, symbols, indications on drawings.

ISO standard 1106 Part 1	Recommended practice for radiographic examination of fusion welded joints. Fusion welded butt joints in steel plates up to 50 mm thick.
ISO standard 1106 Part 3	Recommended practice for radiographic examination of fusion welded joints. Fusion welded circumferential joints in steel pipes of up to 50 mm wall thickness.
ISO standard 9001	Quality systems. Model for quality assurance in design/development, production, installation and servicing.

Contents

1 - Purpose

This leaflet shall govern the manufacture and supply of simple pressure receptacles in steel, not fired, for air braking equipment and auxiliary pneumatic equipment in tractive and trailing stock.

2 - Scope of application

This leaflet contains a manufacturing alternative as shown in European Norm EN 286-3.

2.1 - The reservoirs covered by this leaflet shall:

- consist of a single chamber;
- be made from a non-alloy grade of steel;
- be of welded manufacture;
- be used at a maximum in-service pressure of 10 bars;
- be such that the product of the maximum in-service pressure (in bars) and the volume (in litres) falls within the following limits: 50 bars x L < PV ≤ 10,000 bars x L ;
- consist either of a cylindrical part with the straight tubular section, called the "shell", closed at either end by two torispheric bases with their convex side, facing outwards, or of two convex bases with the same rotational axis;
- be designed with a calculation pressure P = PS x a (see paragraph 5.1.3.1) ;

- be designed for use at temperatures between -40°C and + 100°C;
- be secured to vehicles by means of straps.

2.2 - In normal service, a momentary internal pressure of 11 bars shall be authorised.

2.3 - This leaflet shall apply to the reservoir itself, between its intake and outlet pipes, and to any other isolated or auxiliary pipe belonging to the reservoir.

3 - Abbreviations

a	Coefficient of increase of PS to obtain the value of P for calculating thicknesses	——
A	Elongation at rupture	in %
A_{fb}	Area of connection piece cross-section	in mm^2
A_{fm}	Area of main body cross-section	in mm^2
A_{fp}	Area of supporting plate	in mm^2
A_p	Area of pressurized zone	in mm^2
c	Absolute value of the negative tolerance for rolling of sheets plus the value of the reduced thickness of the base wall, due to the forming process	in mm

D_o	External diameter of reservoir shell	in mm
d	External diameter of inspection and pipe connection pieces	in mm
e	Nominal thickness	in mm
e_b	Height of connecting piece	in mm
e_{bi}	Height of connecting piece within the reservoir	in mm
e_c	Calculated thickness	in mm
e_{ch}	Calculated thickness of base	in mm
e_{cs}	Calculated thickness of shell	in mm
e_h	Nominal thickness of base	in mm
e_p	Thickness of supporting plate	in mm
e_s	Nominal thickness of shell	in mm
f	Nominal stress for calculation at the calculation temperature	in N/mm^2
f_b	Permissible stress of connecting piece	in N/mm^2
h	External height of convex part of one base	in mm
h_1	Height of cylindrical part of base	in mm
h_2	Internal height of convex part of base	in mm
K_c	Coefficient of calculation which is dependent on the welding and inspection procedure adopted	———

KV	Energy at break by impact (testpiece with V notch)	in J
l_b	Thickness of connecting piece	in mm
l_m	Width of stressed cross-section of the main body	in mm
l_p	Width of supporting plate	in mm
L	Total length of reservoir	in mm
L_f	Length of reservoir without connecting pieces	in mm
L_v	Length of shell	in mm
P	Calculation pressure as a function of the maximum in-service pressure, the welding and inspection procedure adopted (P = PS x a)	in bars
PS	Maximum in-service pressure	in bars
R	Internal radius of spherical part of base	in mm
R_i	Local inner radius at a given connecting piece	in mm
r	Internal radius of toric part of base	in mm
R_{eT}	Yield strength at maximum in-service temperature	in N/mm^2
R_m	Minimum tensile strength guaranteed by manufacturer or by defining standard of the steel	in N/mm^2
S	Corrosion allowance	in mm

T_{min}	Minimum in-service temperature	in °C
T_{max}	Maximum in-service temperature	in °C
T°	Temperature at which the mean value for energy absorbed at break (V notch), KV ≥ 28 J, is guaranteed along the length	in °C
V	Volume of reservoir	in litres

4 - Materials

4.1 - Parts under pressure

4.1.1 - Shell and bases

The shell and bases shall:

- be made from steel sheet, non-effervescent and normalised, or in an equivalent state;
- have production content of carbon < 0.25 %, sulphur and phosphorus < 0.05 % for each of its elements;
- comply with the following mechanical production characteristics:
  - the maximum value of the tensile strength R_m must be less than 580 N/mm^2,
  - the elongation at rupture must be:
    - A % ≥ 22, if the testpiece is taken parallel to the direction of rolling for thicknesses ≥ 3 mm;

    - A % ≥ 20, if the testpiece is taken perpendicular to the direction of rolling for thicknesses ≥ 3 mm;
  - the mean value of energy absorbed at rupture KV determined from three testpieces lengthways must be at least 28 J. Any one of the three values may be less than 28 J, but none must be less than 20 J under any circumstances.

    This essential safety requirement may be met:

    - either by carrying out impact bending tests (V notch) at the minimum in-service temperature (Tmin) under the responsibility of the manufacturer of the material;
    - or at a temperature T* less than or equal to that obtained by extrapolation using the nomograph below.
  - if value R_{eT} is not guaranteed at 100 °C, the formula 0.6 R_{eT} x 0.9 should be used to determine the stress f.

Examples of use:

- example no. 1: if e = 10 mm and T* = - 10 °C, T_{min} = - 35 °C.
- example no. 2: if T* = - 20 °C and T_{min} = - 40 °C, e_{max} = 12.7 mm

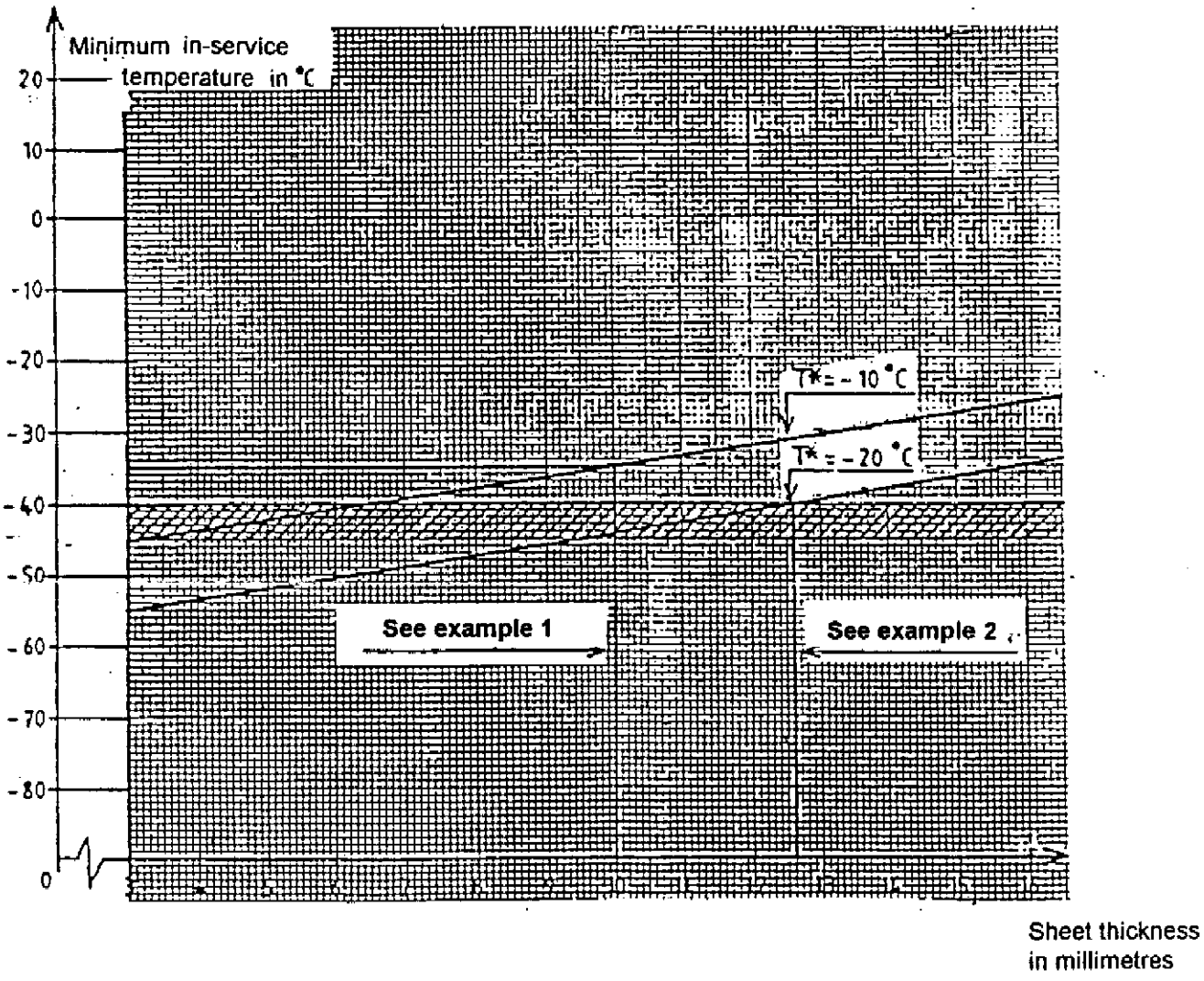

Minimum in-service
temperature in °C
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
T* = - 10 °C
T* = - 20 °C
See example 1
See example 2
Sheet thickness
in millimetres

Figure 1

4.1.2 - Connection pieces for inspection, hose connections and purging

The connection pieces shall be produced using round steel or steel pipe with a grade compatible with that of the steel sheets used to make the reservoir and shall be of weldable quality. The steel shall comply with the following conditions on the products themselves:

- $R_m < 580$ N/mm^2
- C ≤ 0.25 %, S ≤ 0.05 % et P ≤ 0.05 %

4.2 - Parts not under pressure

Any fittings that need to be welded to the reservoir but which do not contribute to its strength shall be produced in steel of compatible grade with that of the sheet steel making up the reservoir and be of weldable quality.

This steel, when cast, shall comply with the following conditions:

- $R_m \leq 580$ N/mm^2
- C ≤ 0.25 %, S ≤ 0.05 % et P ≤ 0.05 %.

4.3 - Weld products

The filler product used for welding the parts making up the reservoir shall comply with national standards and be compatible with the standards of the parts to be joined.

The gaseous and powdered flux shall be suitable for the parent metal and filler product used.

Conformity of the welding products used shall be checked during the acceptance of the welding procedure under section 7.

5 - Design

The design of the reservoirs shall enable them to be installed in complete safety under the conditions of installation and maintenance indicated in Leaflet 541-07.

5.1 - Shell and bases

5.1.1 - Design of the shell

Shells shall generally be produced from a single sheet.

When the shell is made from several welded parts:

- the number of circular welds shall be kept to a minimum;
- the longitudinal weld beads of the parts of the shell:
  - must not be situated in the lower part of the reservoir as defined by an angle of 30° to either side of the vertical axis (see figure 2);
  - must be sufficiently distant one from the other as to form an angle greater than 40° (see example in figure 3).

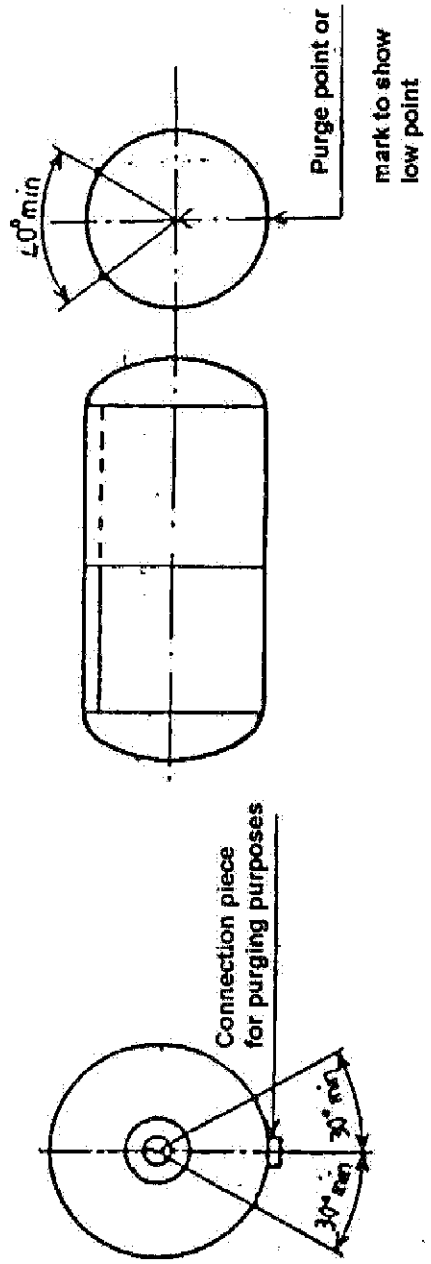


Figure 2

Figure 3

Any tack weld or any weld, even temporary, executed outside the permitted zone shall be prohibited.

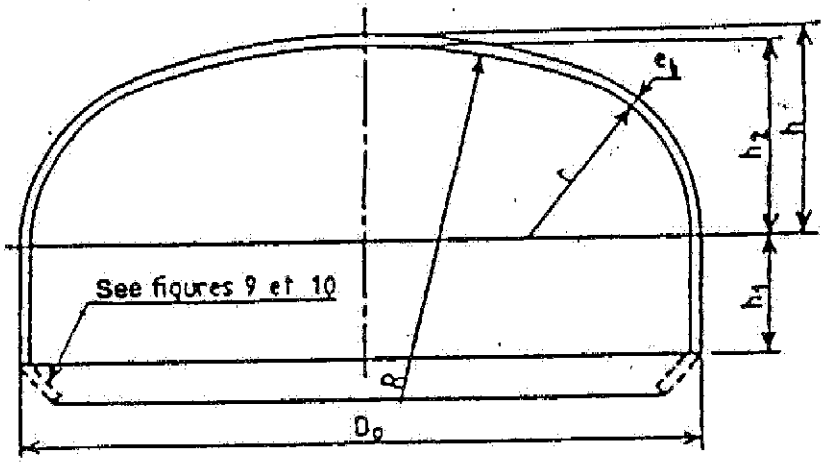
5.1.2 - Design of bases

5.1.2.1 - Form and dimensions of the bases

The torispherical bases shall be formed from one single sheet.

Drawing and flanging the neck shall be performed mechanically, for example using a press or a lathe. Manual forming shall not be permitted.

The torispherical base shall conform to the following dimensions:



R (nominal) = D_o
r (nominal) = 0.1 D_o

e_h	3	4	5	6	8	10	11	12
h_1 min	12	16	20	24	32	40	44	48
h_1 max	25		40		50		55	

Figure 4

5.1.2.2 - Heat treatment of the bases after forming:

The steel bases obtained by cold forming,

a) may be used without post-forming heat treatment if the thicknesses are less than or equal to 6 mm;

b) shall undergo post-forming heat treatment if their thicknesses are greater than 6 mm and less than or equal to 8 mm and if the minimum temperature required for the test of the energy absorbed at rupture (V notch) is less than -10°C;

c) shall not be used without post-forming heat treatment if the thicknesses are greater than 8 mm.

If required, heat treatment after cold forming shall take the form of normalisation (see above), in other words heating beyond the range of critical temperatures followed by air cooling.

The heating temperature shall be greater than the upper limit of the critical range (generally known as point A3) but as close to it as possible.

Note : For the steels specified in section 4, the heat treatment temperature shall be between 890°C and 950°C. If this range is not found in the material standard, the real normalisation temperature shall be shown by the steel-maker.

5.1.3 - Calculation of the thicknesses of the shells and bases

The nominal thicknesses "e" of the shells and bases shall be taken greater than or equal to:

$e \geq e_c + c + S$

Under no circumstances shall the value of "e_c" be less than 2 mm.

The extra corrosion allowance "S" is taken to be equal to 1 mm.

Note : The manufacturer shall effect corrections to take account of thinning following the production process.

5.1.3.1 - Calculation of the thickness of the shell "e_{cs}"

$$e_{cs} = \frac{PD_e}{20f + P} x\ K_c$$

The nominal stress for calculation "f" shall not be greater than the lesser of the two values: 0.6 R_{eT} and 0.3 R_m.
Values R_{eT} and R_m shall be specified in the material standard.

For steels where R_{eT} is not guaranteed at 100°C, the formula 0.6 R_{eT} x 0.9 shall be used to determine stress f.

The values of P and K_c to be considered are the following:

- case no. 1 : $P \geq PS \times a \geq PS \times 1$ ($\geq$ 10 bar) and $K_c = 1$ for automatic welding and when inspections are carried out in accordance with paragraph 9.1.2.1.

- case no. 2 : $P \geq PS \times a \geq PS \times 1.25$ (≥ 12.5 bar) and:
  - Kc = 1 for automatic welding and when inspections are carried out according to paragraph 9.1.2.2.
  - Kc = 1.15 for welding using a non-automatic process and when inspections are carried out according to paragraph 9.1.1.

5.1.3.2 - Calculation of thickness of the bases "e_{ch}"

- Enter figure 5 from value P/10f. See paragraph 5.1.3.1 for the value of stress "f".
- Calculate h_e/D_o using, for h_e, the smallest of the three following values:

$$h, \quad \frac{D_o^2}{4(R+e_{ch})} \quad \text{and} \quad \sqrt{\frac{D_o(r+e_{ch})}{2}}$$

Where:

- $e_{ch} = e_{cs}$;
- $h = h_2 + e_h = 0.1935\ D_o + 0.545\ e_h$ (take $e_h = e_{cs} + 1 + 0.3$, where 0.3 is the negative tolerance value for rolling of sheets);
- Determine e_{ch}/D_o
- Multiply the resulting value by D_o to obtain thickness e_{ch}
- Check the operation using this value in place of e_{cs}

Example of calculation of thickness e_{ch} of a steel base of $R_m = 360$ N/mm^2 and $R_{eT} = 235$ N/mm^2 for a reservoir $D_o = 400$

P = PS x a = 10 x 1.25 = 12.5 bar
K_c = 1
R = D_o = 400 mm
r = 0.1 D_o = 40 mm
f = 108 N/mm^2 : Smallest of the two values:
- 0.3 R_m = 108 N/mm^2
- 0.6 R_{eT} = 141 N/mm^2

$h_e/D_o = 0.198$

where h_e = least of the 3 values:
- h = (0.1935 x 400) + [0.545 (2.3 + 1.3)] = 79.36

e_{ch} is taken to be equal to $e_{cs} = 2.3$
(where P = 12.5 et K_c = 1)

$$\frac{D_o^2}{4(R+e_{ch})} = 99.42$$

$$\sqrt{\frac{D_o(r+e_{ch})}{2}} = 91.97$$

therefore $h_e = 79.36$

$e_{ch}/D_o = 0.00885$ according to figure 5

$e_{ch} = 0.00885 \times 400 = 3.54$.

Checking calculation with $e_{ch} = 3.54$ in place of $e_{cs} = 2.3$ gives:

$e_{ch} = 3.52$

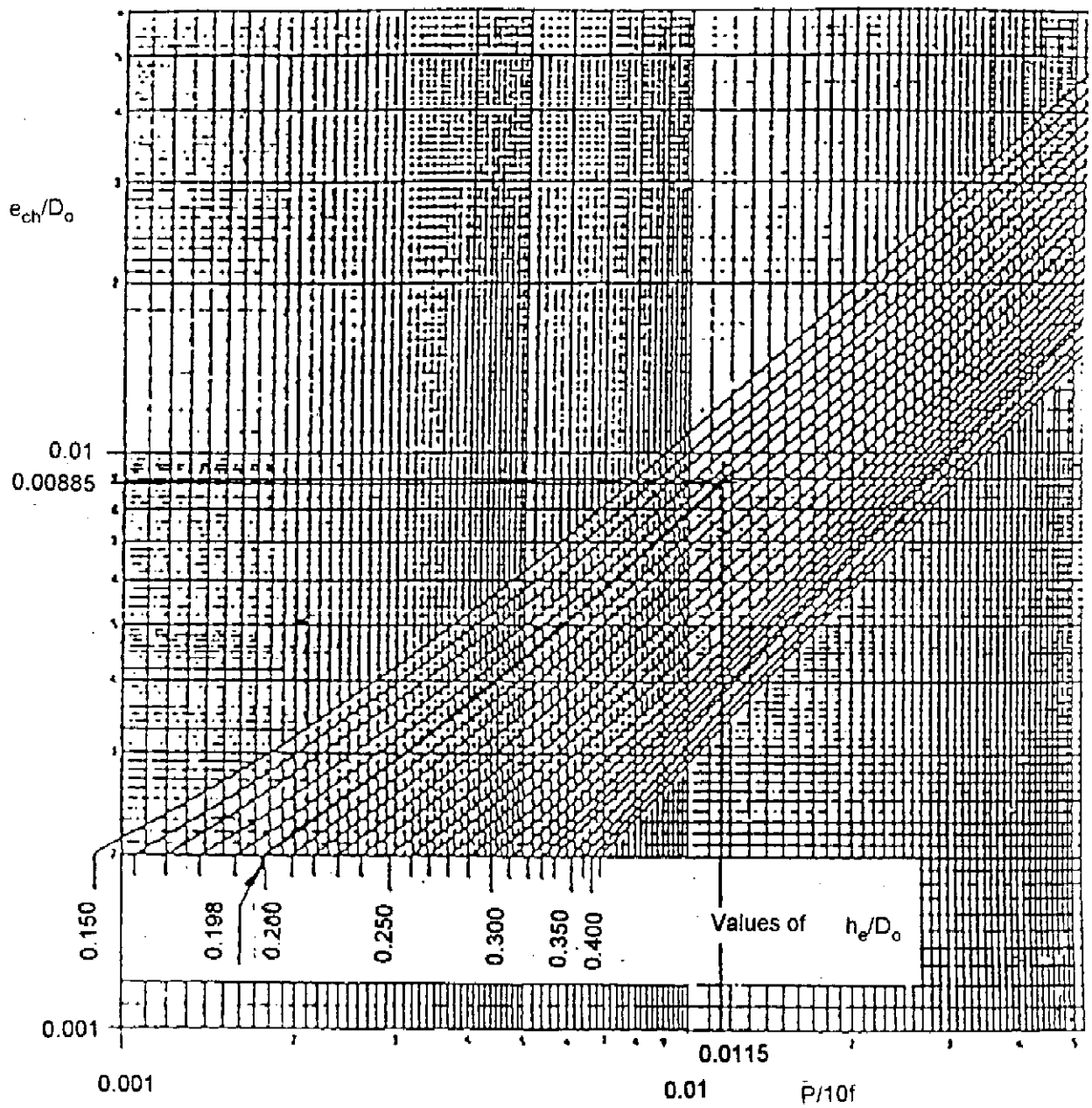


Figure 5: Theoretical curves for convex bases

5.1.4 - Welded joints on shells and bases

5.1.4.1 - Longitudinal welds

The welds shall be of the butt type and with total penetration.

No support, even temporary, shall be permitted.

5.1.4.2 - Circular welds

The circular welds necessary to the production of long shells shall be assimilated to the longitudinal welds.

The joints authorised between shell and bases shall be those defined in figures 6 to 10. The welds must penetrate totally the walls of the shells/bases for figures 6 to 8, the wall of the shell for figure 9 and the wall of the base for figure 10.

In the case of welded joints between sheets of different nominal thickness (shell-base weld), either the neutral fibres shall be aligned (figure 6), or the walls on the inner or outer face shall be aligned, with a joining slope of no more than 25% (14°) (see figures 7 and 8) and the misalignment of the neutral fibres must not exceed 1 mm. When the misalignment of the neutral fibres is greater than 1 mm, the joint shall be bevelled as shown in figures 8a and 8b.

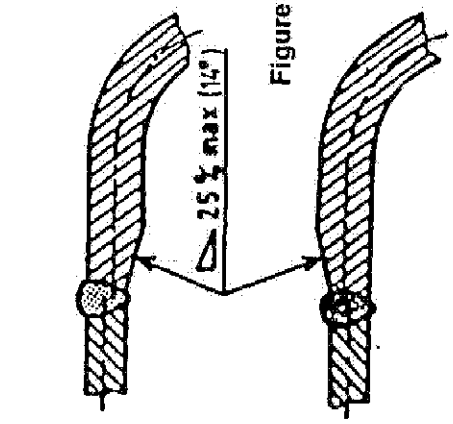


Figure 8a

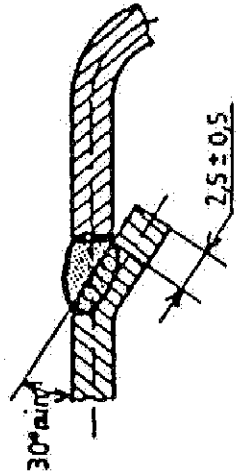


Figure 8b

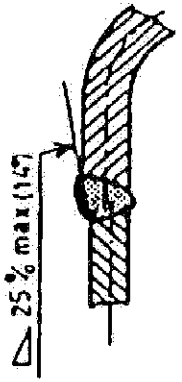


Figure 7

Figure 6

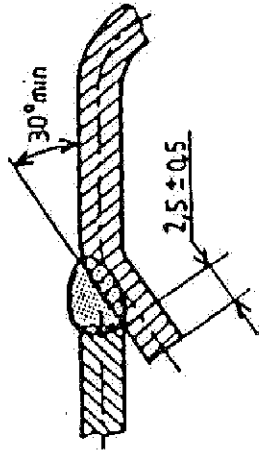


Figure 9

Figure 10

Note : The joint shown in figure 10 only applies to reservoirs with a shell having no longitudinal weld or made up of two welded bases

5.2 - Connection pieces

5.2.1 - General

Connection pieces for inspection, hose connection and purging shall be cylindrical parts with an inner hose connection thread which complies with ISO standard 228-1, or a metrical thread complying with ISO standard 261 and with diameter included in Leaflet 800-30.

Authorised shapes and welding shall be defined by paragraph 5.2.4.

The number of connection pieces, their dimensions and position on the reservoir shall be as defined by Leaflet 541-07.

The thickness of the walls of the connection pieces shall not be less than 1.5 times the thickness of the sheet to which they are welded.

5.2.2 - Apertures for connection pieces

When the diameter of the aperture in the wall is greater than 75 mm, a reinforcement calculation shall be effected as shown in paragraph 5.2.3.

The maximum distance from the pole of the convex base to the outer edge of any aperture shall not exceed 0.4 D_o (see figure 11).

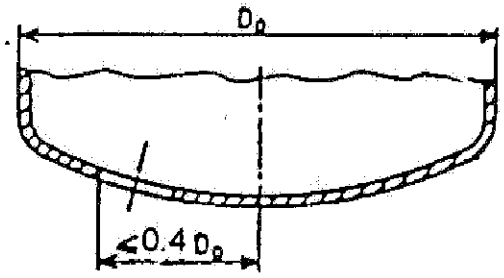


Figure 11

The apertures in the shells and in the bases shall be positioned as far as possible from the weld beads and shall under no circumstances cross one of these beads.

The distance between any two welds, measured from the end of the prepared edge, shall not be less than 4 times the real thickness of the shell or the base, to a minimum of 20 mm (see figures 12a and 12b).

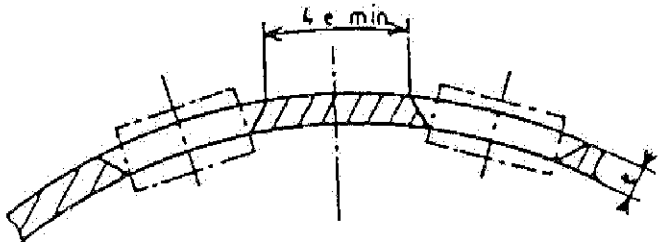


Figure 12a

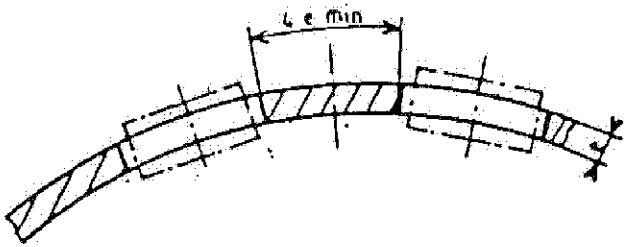


Figure 12b

When the connection pieces require reinforcement of the aperture, the distance to be kept between them shall be that defined in paragraph 5.2.3.1.

5.2.3 - Calculation of the aperture reinforcement

5.2.3.1 - General

The method of calculation specified in paragraphs 5.2.3.2 and 5.2.3.3 shall apply to shells and convex bases pierced by circular apertures, in compliance with the conditions and hypotheses given hereafter.

The supporting plates, when used, shall be made from materials of the same kind as those of the reservoir to which they are welded.

The distance between the connection pieces, measured from the outer face of the supporting plates or the connection pieces, shall not be less than 2 x l_m when two apertures are reinforced, and not less than l_m when only one of the two apertures requires reinforcing.

where $l_m = \sqrt{(2Ri + e)e}$ (1)

$R_i = D_o/2 - e_s$ for the shells,

$R_i = R$ for the bases

The bases are reinforced using:

- connection pieces welded in recess (see figures 13a and 13b);
- welded supporting plates and connection pieces welded in recess (see figure 13c)

A sufficient reinforcement shall be ensured in all planes crossing the axis of the connection piece.

5.2.3.2 - Reinforcement by connection piece

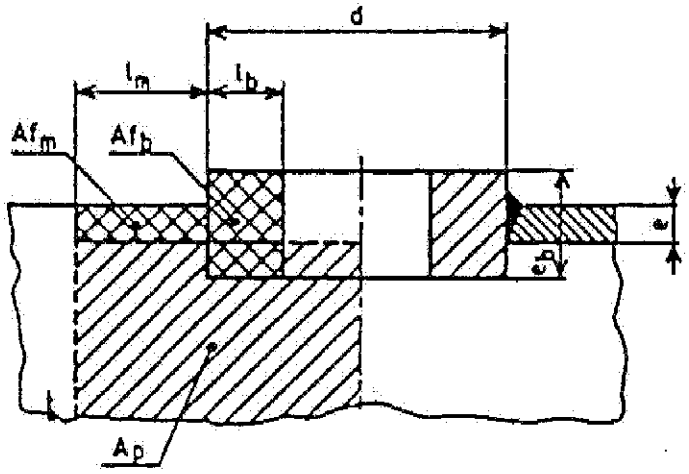


Figure 13a

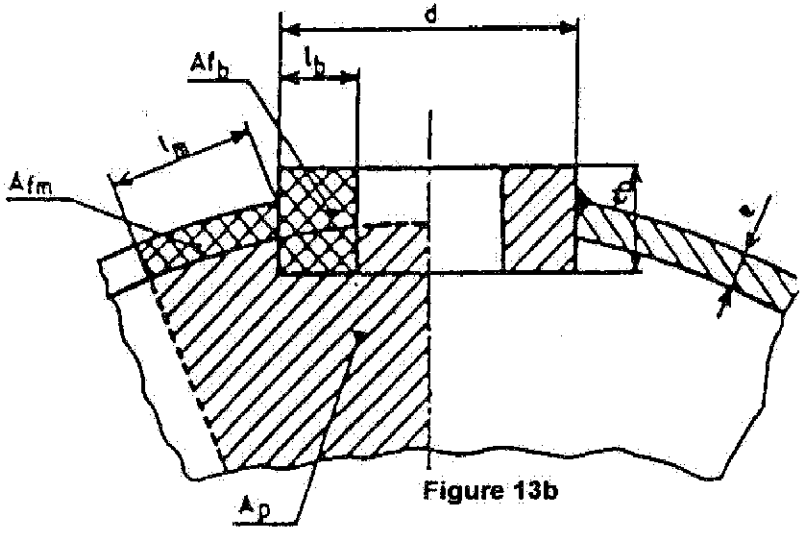


Figure 13b

Only those connection pieces of the "recess welded" type in accordance with figures 13a and 13b may be used.

The thickness of the connection piece l_b which contributes to the reinforcement and used in equation (2) to determine A_{fb} must not be greater than l_m (equation (1)):

$l_b \leq l_m$

The value of e_b used to determine A_{fb} in equation (2) must not be greater than twice e.

Furthermore, the following condition must be met:

$$\frac{P}{10}\left(\frac{A_p}{A_{fm}+A_{fb}}+0.5\right) \leq f \qquad (2)$$

5.2.3.3 - Reinforcement by supporting plate and connection piece

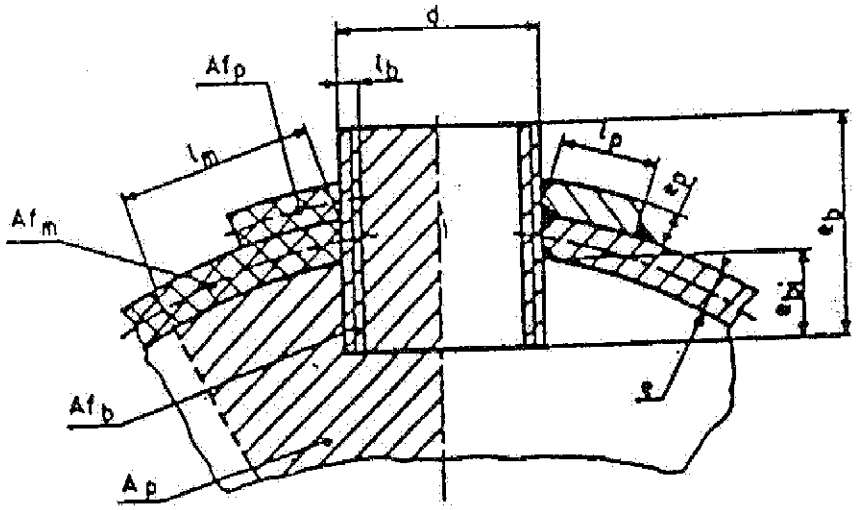


Figure 13c

One of the two following conditions must be met (see Notes below):

- when the permissible stress f_b is less than stress f:

$P/10\ (A_p + 0.5\ (A_{fm} + A_{fb} + 0.7\ A_{fp})) \leq f\ (A_{fm} + 0.7\ A_{fp}) + f_b\ .\ A_{fb}$

- when the permissible stress f_b is greater than stress f:

$$\frac{P}{10}\left(\frac{A_p}{A_{fm}+A_{fb}+0.7A_{fp}}+0.5\right) \leq f$$

Notes:

1. The areas A_p, A_{fb}, A_{fm} and A_{fp} shall be determined as shown in figures 13a, 13b and 13c.

2. The maximum height of the connection piece (e_b) to be used in calculation shall be:

$$e_b = \sqrt{0.8(d - l_b)}\, l_b$$

3. The maximum height of the part of the connection piece (e_{bi}), inside the reservoir to be used in calculation shall be:
   $e_{bi} = 0.5\ e_b$

4. The dimensions of the supporting plate to be used in the calculation shall be:
   $e_p \leq e$ and $l_p \leq l_m$

5.2.4 - Welding of purge connection pieces

5.2.4.1 - Connection pieces for inspection and hose connection

The welds may be of total or partial penetration.

A single weld with partial penetration shall be permitted for connection pieces with external diameter of 65 mm at most; this being the case, the weld throat thickness g_1 must be equal to at least 1.5 times the thickness e of the wall to which the connection piece is welded (see figure 14).

The weld throat thickness (g_2) should be at least 0.7 times the thickness e of the wall to which the connection piece is welded (see figure 15).

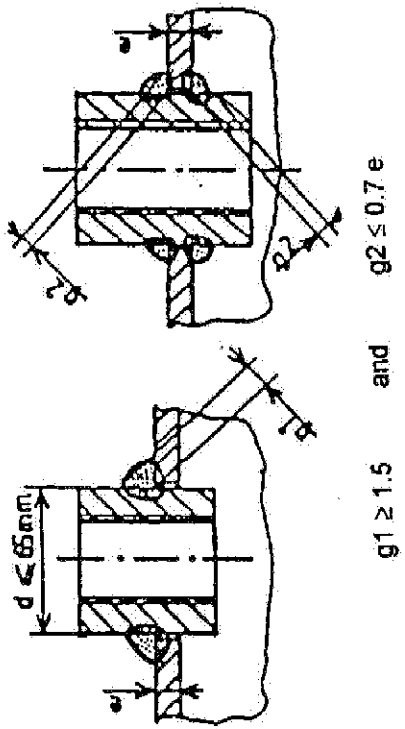


Figure 15

Figure 14

5.2.4.2 - Drainage connection pieces

The welds must fully penetrate the wall of the reservoir. If necessary, the aperture in the wall may be prepared.

Examples of authorised joints are given in figures 16, 17 and 18 below.
The weld bead must not project more than 1 mm into the inside of the reservoir.

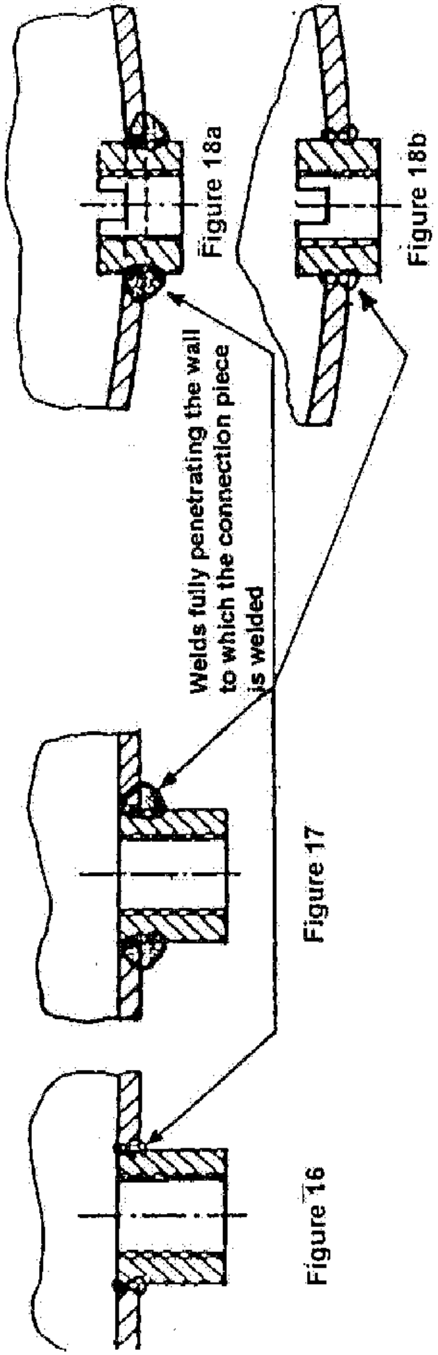


Figure 16

Figure 17

Figure 18a

Figure 18b

5.3 - Marking

Reservoirs which comply with this leaflet shall bear the identification and service markings shown in paragraph 5.3.3.

These markings shall be engraved either in the metal of the reservoir itself or on a plate welded to the reservoir wall. They shall have a minimum height of 5 mm.

The markings shall be situated on the reservoir at one of the points specified in Leaflet 541-07.

5.3.1 - Markings engraved in the reservoir metal

The imprints must not have any sharp edges and their depth must not exceed one tenth of the wall thickness.

Where a marking is made on a base, the markings shall be made as far as possible from the imaginary line of intersection of the radius of the toric part with the radius of the spherical end dome and shall come close to the base pole, though without interfering with the weld of the hose connection piece.

5.3.2 - Marking made on a plate

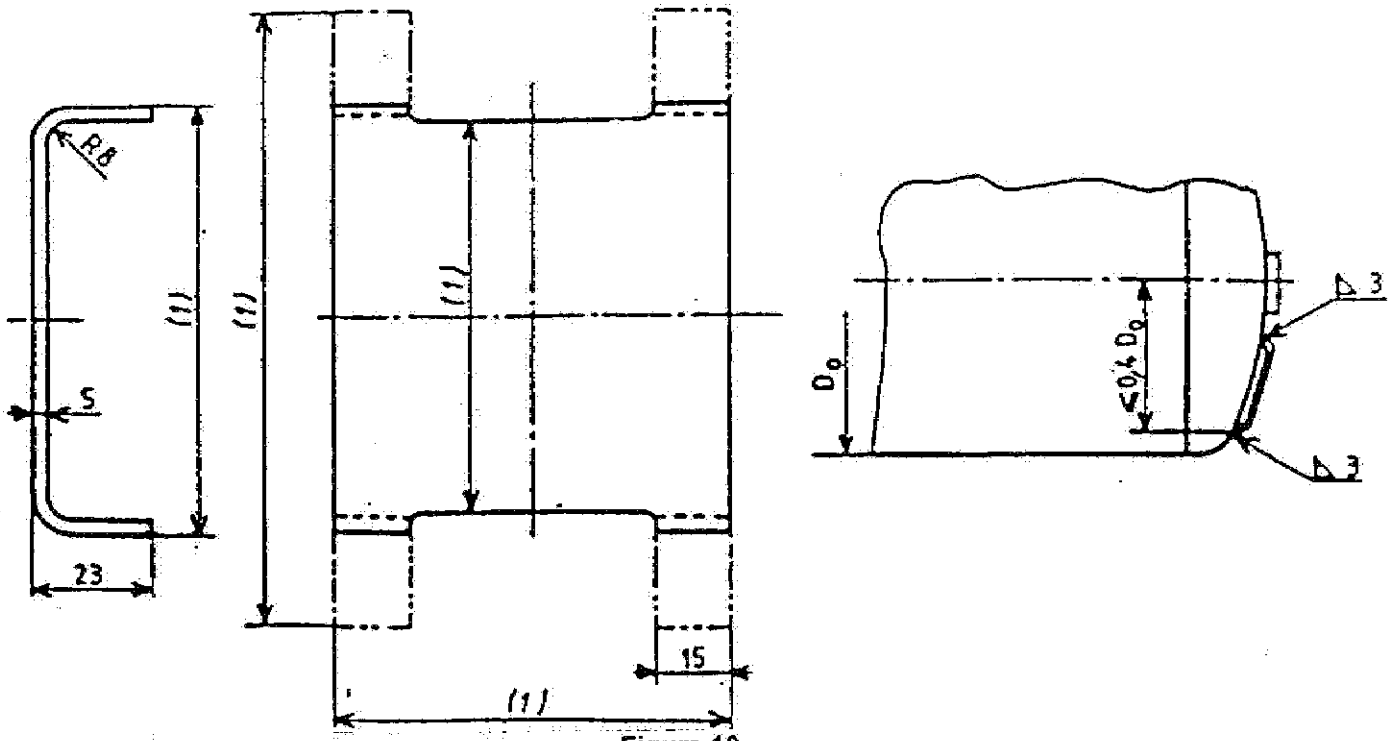


Figure 19

(1) The dimensions must be adapted to those of the marking defined in paragraph 5.3.3.

5.3.3 - Identification and service markings

This marking shall be made in accordance with the general arrangement shown in figure 20.

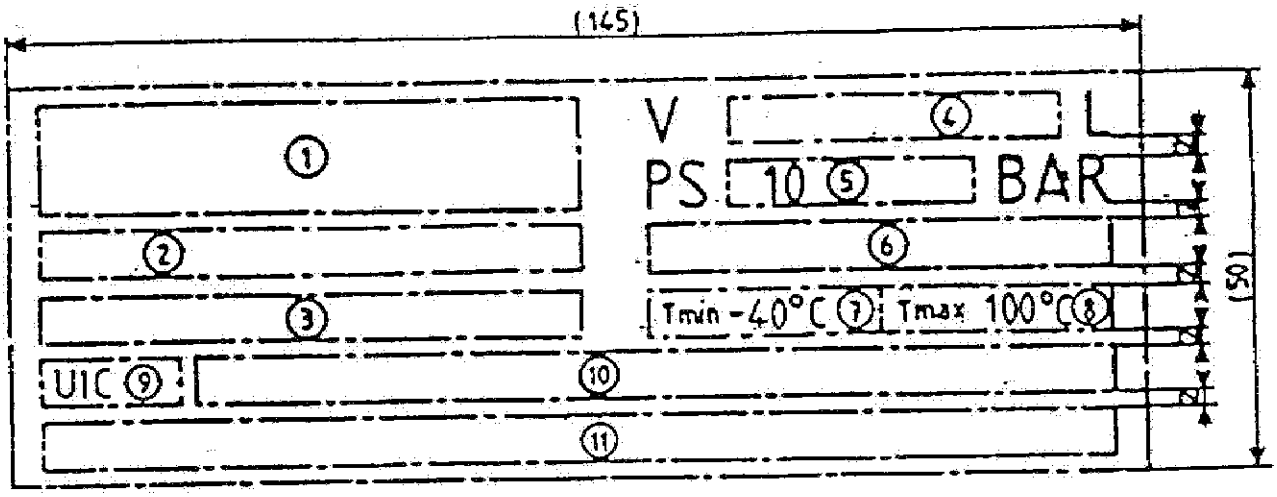


Figure 20

1. Name, company name or description of the manufacturer and production site. (The arrangement and height of the characters shall be left to the choice of the manufacturer).
2. Year of production.
3. Number of the type of reservoir and batch identification number.
4. Internal volume (expressed in litres).
5. Maximum in-service pressure (in bars).
6. Location of the marking in accordance with European Norm EN 286-3 for EEC railways plus the last two figures of the year when the marking was made and the expert's stamp.
   For non-EEC railways: the last two figures of the year the hydraulic test was performed plus the stamp of the expert present at this test.
7. Minimum in-service temperature T_{min} (- 40 °C)
8. Maximum in-service temperature T_{max} (+ 100 °C)
9. Marking showing compliance with this leaflet: "UIC"
10. Name, company name or description of the user.
    Serial number allocated by the user.
11. Markings (date: month plus last two figures of the year) corresponding to further in-depth inspections and tests

6 - Corrosion protection

The reservoirs must be protected against corrosion inside and out.

This protection shall be agreed between the customer railway and the supplier and must be sufficiently effective to comply with maintenance requirements.

Surfaces which are to receive this protection shall be free from all traces of corrosion, grease and pickling product.

7 - Approval of welding procedures

Welding procedures shall be approved in accordance with Leaflet 897-12.

8 - Approval of welders and welding operators

Welders shall be approved in accordance with Leaflet 897-11 and inspected according to the limits defined in Appendix 4 class B.

9 - Inspection of reservoirs

9.1 - Inspection of welds

Welds shall be inspected in accordance with the provisions shown in the tables below.

Acceptance criteria are specified in paragraph 9.1.5.

9.1.1 - Welds executed using a non-automatic process

In this case: $P \geq 1.25$ PS and $K_C = 1.15$ (see paragraph 5.1.3.1, example no. 2)

Manufacturer's inspection			Check by approved inspecting body when required
Inspection	Non-destructive inspection (CND)	Destructive inspection (CD)	
Each reservoir	100 % visual inspection		
Each welding machine and each welding procedure	During production **Longitudinal weld** 1 100% radiography of the weld, including nodes, for same reservoir or 1 control coupon for the first 100 metres of weld Then every 100 m of weld 1 control coupon		Visual inspection of the control coupons and the fiims kept by the manufacturer

	Circular weld If the welding process or the standardised designation of the filler product differ from those used for the longitudinal weld: 1 control coupon at start of production Then every 300 m of weld with a minimum of any single reservoir in the batch 1 100% radiography of the weld or 1 control coupon	Inspection of the results of the various tests carried out in accordance with this leaflet

9.1.2 - Welds executed using an automatic process

9.1.2.1 - Where $P \geq PS$ and $K_C = 1$ (see paragraph 5.1.3.1, example 1)

Manufacturer's inspection			**Check by approved inspecting body, when required**
Inspection	**Non-Destructive Inspection**	**Destructive Inspection**	
Each reservoir	**100 % visual inspection**		
	After tooling 1 radiography per film of length greater than 200 mm including at least one node. or 1 control coupon **Longitudinal weld** During production Every 250 metres of weld or at each tooling change outside the tolerances laid down by the welding procedure description (WPD) or at each change of the standardised designation of the filler product type.		

Each welding machine and each welding procedure	1 radiography per film of length greater than 200 mm including at least one node	or	1 control coupon
	Circular weld If the standardised designation of the filler product differs from that used for the longitudinal weld:		
	1 radiography per film of length greater than 200 mm including at least one node.	or	1 control coupon
	During production Every 750 metres of weld or at each tooling change outside the tolerances laid down by the welding procedure description (WPD) or at each change of the standardised designation of the filler product type.		

Visual inspection of the control coupons and films kept by the manufacturer.

Inspection of the results of the various tests carried out in accordance with this leaflet.

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Manufacturer's inspection			**Check by approved inspecting body, when required**
Inspection	**Non-Destructive Inspection**	**Destructive Inspection**	
Each reservoir	**100 % visual inspection**		
	1 radiography per film of length greater than 200 mm including at least one node.	or 1 control coupon	
	With a minimum per batch of reservoirs or per month 2 radiographies per film of length greater than 200 mm including at least one node.	or 2 control coupons	
	NOTE : The control coupons or radiographies must be produced using different reservoirs from the batch.		

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9.1.2.2 Where $P \geq 1.25$ PS andt $K_C = 1$ (see paragraph 5.1.3.1, example 2)

Manufacturer's inspection			Check by approved inspecting body, when required
Inspection	**Non-Destructive Inspection**	**Destructive Inspection**	
Each reservoir	**100 % visual inspection**		
	After tooling 1 radiography per film of length greater than 200 mm including at least one node. or 1 control coupon **Longitudinal weld** During production Every 500 metres of weld or at each tooling change outside the tolerances laid down by the welding procedure description (WPD) or at each change of the standardised designation of the filler product type.		

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Manufacturer's inspection			Check by approved inspecting body when required
Inspection	**Non-destructive inspection (CND)**	**Destructive inspection (CD)**	
Each reservoir	**100% visual inspection**		
Each welding machine and each welding procedure	1 radiography per film of length greater than 200 mm including at least one node. or 1 control coupon		Visual inspection of the control coupons and films kept by the manufacturer.
	Circular weld If the standardised designation of the filler product differs from that used for the longitudinal weld:		Inspection of the results of the various tests carried out in acordance with this leaflet
	1 radiography per film of length greater than 200 mm including at least one node. or 1 control coupon		

	During production	
	Every 1500 metres of weld or at each tooling change outside the tolerances laid down in the Welding Procedure Description (WPD) or at each change of the standardised designation of the filler product type. 1 radiography per film of length greater than 200 mm including at least one node — or — 1 control coupon **With a minimum per batch of reservoirs or per month** 1 radiography per film of length greater than 200 mm including at least one node. — or — 1 control coupon NOTE : The control coupon or the radiography must be produced from any given reservoir in the batch	

9.1.3 - Destructive inspection of welds on control coupons

The manufacturer shall carry out the following tests on control coupons:

- a face bend test;
- a root bend test;
- a macrographic test;
- impact bend tests (V notch) at in-service temperature, for in-service temperatures lower than 10° C and wall thicknesses greater than 5 mm only;
- three Charpy V impact bend tests (V notch) in the weld metal;
- three Charpy V impact bend tests (V notch) in the heat-affected zone (HAZ), on the first control coupon of each batch only when checking and on two control coupons per batch when making a declaration of compliance.

9.1.4 - Quality of films

The density of films must correspond to class B of ISO standard 1106 - Parts 1 and 3 with a maximum of 4.

9.1.5 - Weld acceptance criteria

The results of all tests shall be recorded. If a test gives an unsatisfactory result, the reason for this shall be sought and two further samples prepared and checked. If it can be shown that failure to pass the test is due to a local or accidental defect and that the repeat tests are satisfactory, the results of these latter tests shall be accepted. If, however, the new sample again gives poor results, the whole batch of receptacles received shall be refused.

Tables 1 and 2 give the levels of acceptance, whether or not the welds have undergone tests.

When any part of a weld is repaired, the whole repaired zone shall be checked by non-destructive inspection.

Should a weld prove defective, each weld on each receptacle produced since the start of production or since the last satisfactory non-destructive inspection shall undergo a non-destructive inspection.

Table 1: Acceptance levels for defects in butt welds detected by visual examination

Defect	ISO 6520 reference	Limit of detectable defect
Lack of penetration	402	Not permitted
Undercut/penetration notches	5011 5012	Slight and intermittent, permitted if edges are not sharp and if depth does not exceed 0.5 mm
Gas cavity	5013	as for undercut
Gas cavity at the root	515	as for undercut
Excessive penetration	504	See paragraph 9.1.6
Excessive thickness	502	See paragraph 9.1.6
Irregular surface	514 509 511 513 517	Thickness allowance smooth and regular with joint totally filled
Overspill	506	Not permitted
Alignment defect	507	See paragraph 5.1.4.2
Arc burn Splash (beads) Tungsten splash Local tear Grinding marks Chipping marks	610 602 6021 603 604 605	Light grinding permitted subject to checking the thickness and testing for cracks

Table 2 : Acceptance levels for defects in butt welds detected by radiographic examination

Defect	ISO 6520 reference	Limit of detectable defect
Cracks and lamellar tears	100	Not permitted
Gas pores (isolated or clustered)	2011 2013 2017	Not permitted. Individual diameter e/4 or 2 mm. Max. 2% of the projected surface*
Gas pores (uniformly distributed)	2012	Individual diameter e/4 or 2 mm. Max. 2% of the projected surface*
Gas pores (aligned in row)	2014	Check fusion defect before acceptance. Otherwise see 2011, 2012, 2013
Crater gas cavity	2024	Not permitted

Table 2 : Acceptance levels for defects in butt welds detected by radiographic examination

Defect	ISO 6520 reference	Limit of detectable defect
Inclusions of slag and flux and elongated gas pores (isolated and parallel to the weld axis)	3011 3021 2015	Max. individual length: e/4 Cumulative length = max e for a length of 12 e if the distance is < 6 times the longest defect
Inclusions of slag and flux and pipe gas pores (distribution not parallel to the weld axis)	3012 3013 3022 3023 2016	Max. individual length e/4
Tungsten inclusions	3041	as for gas pores
Copper inclusions	3042	Not permitted
Lack of fusion (lateral, at root, between passes)	401	Not permitted
* Area: Maximum affected length of the weld x local length of the weld		

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9.1.6 - Finishing of longitudinal and circular joints

All welds shall have a smooth, crater-free finish and shall be joined to the sheets without major undercut or sharp irregularity (see table 1).

To guarantee the total penetration of the weld and thus to ensure that no sag will occur in relation to the adjacent sheets, the built-up material may form a slight surplus thickness on each side of the sheet. This thickness allowance shall not exceed the values given in table 3.

The thickness allowance need not be removed provided it does not exceed the permissible limits.

Table 3 : Maximum permissible thickness allowances for longitudinal and circular welds

Thickness of the thickest sheet	Maximum thickness allowance r_1 or r_2 (see figure 21)
e ≤ 12 mm	2.5 mm

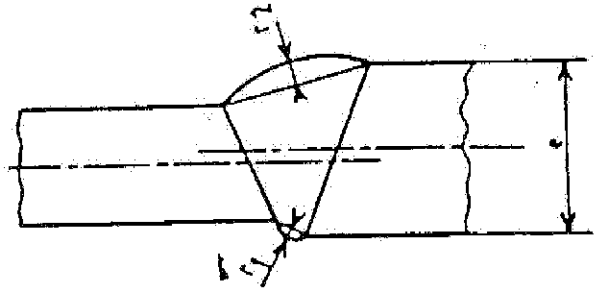

Figure 21

9.2 - Calibration

Reservoirs that have been manufactured manually shall be inspected individually to ensure they comply with the tolerances laid down below.

For reservoirs manufactured on an automatic production line, the inspector shall ensure at the start of production that the reservoirs meet the following dimensional requirements. He shall then carry out a sample test on at least one reservoir for every 50 manufactured.

The tolerances between the dimensions and the volume measured on the reservoir and those specified in the order shall not exceed the following limits:

- length L ..... ± 7 mm
- diameter D_O (≤ 500 mm ..... ± 3 mm
  (> 500 mm ..... ± 0.6 %
- circularily (1) of the cylindrical body ..... 0.01 D_O
- straightness (1) of any generating line of the cynlindrical body ..... ± 0.01 L
- volume of the reservoir as delivered ..... ± 3.5 %

In addition, the wall of the reservoirs shall be free from individual defects, such as: sudden local irregularities, bumps, flattening, hollows, creases, tool marks or visible symmetry defects. Hollows or bumps are tolerated provided they are joined to the surrounding surface by gentle slopes of 25% at most and with rounded edges of radius greater than 50 mm.

(1) Tolerances for shape and position are defined in international standard ISO 1101.

Their dimensions must not exceed:

- radially: ± 3 mm
- longitudinally: 0.25 L
- transversally: $\pi D_0/20$

9.3 - Pressure test

Each reservoir with all its fittings attached shall undergo a hydraulic test before the protective layer is applied, of sensitivity equivalent to 1.5 times the calculation pressure, that is:

- 15 bars when the calculation pressure is taken as equal to 10 bars (case no. 1 - paragraph 5.1.3.1);
- ≥ 18.75 bars when the calculation pressure is taken as equal to 12.5 bars (case no. 2 - paragraph 5.1.3.1);

with a person of recognised authority present.

This pressure shall be maintained for a sufficient length of time to enable visual examination of all surfaces and all welded joints. The reservoir must show no sign of plastic deformation or leakage.

Subject to agreement, a pneumatic test may be carried out on each reservoir, at the pressure defined above.

Warning: The pneumatic test is potentially a far more dangerous operation than the hydraulic test since, whatever the size of the receptacle, any defective element may lead to an explosion during the course of the test. It should therefore only be performed after consultation with the inspecting authority and after ensuring that the safety measures taken comply with the legislation in force in the country where the test is carried out.

Any reservoir which fails the pressure test shall be refused.

10 - Choice of manufacturer

The functional and organisational aptitudes required for the manufacture of the reservoir shall comply with the provisions of ISO standard 9001.

11 - Approval of the reservoir

Compliance with the approval procedure for the reservoirs shall be the responsibility of the manufacturer. This approval procedure shall be that in force in the country of the customer railway.

12 - Details to be given for the invitation to tender and the order

The invitation to tender and the order, to which the drawing defining reservoir design shall be attached, must give an indication of the index of this leaflet and make clear the following provisions, if they are not already specified on the drawing or its accompanying documents:

- dimensions and volume of the reservoir (see Leaflet 541-07);
- the type of joint between shell and bases (see paragraph 5.1.4.2.);
- definition of the connection pieces (shape, dimensions, threads. See paragraph 5.2.4 of this leaflet);

- the position of the connection pieces (see Leaflet 541-07);
- whether the markings are engraved in the metal or on a plate (see paragraph 5.3.3 of this leaflet and Leaflet 541-07);
- the markings of the reservoir must carry and their position on it (see paragraph 5.3.3 of this leaflet and Leaflet 541-07);
- the methods used for corrosion protection (see section 6);
- a drawing of the method of mounting the reservoir on the vehicle (see Leaflet 541-07).

13 - Delivery

On delivery, the reservoir must, following thorough drying of the inner walls, have all apertures blocked with plastic plugs or any other means which ensures the inside is free from dust or water and all other foreign particles.

Before despatch, the reservoirs must receive proper protection to avoid damage in transit (impact, deformations, etc.).

Application

With effect from 1 January 1993 for vehicles to be built and for existing vehicles.

All UIC railways.

Record references

Heading under which the question has been dealt with

- *Question 5/SA/FIC* - Approval of new Leaflet 834 - Technical specification for the supply of simple pressure receptacles of steel, not fired, for air braking equipment and auxiliary pneumatic equipment for railway rolling stock.
(Traction & Rolling Stock Committee: Paris, June 1992).