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# International Standard



# 3183

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Oil and natural gas industries — Steel line pipe

*Industrie du pétrole et du gaz naturel — Tubes en acier pour conduites*

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## FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

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It has been approved by the member bodies of the following countries :

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|                     |                |                |
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| Belgium             | Italy          | Romania        |
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The member bodies of the following countries expressed disapproval of the document on technical grounds :

Australia  
Canada  
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# Oil and natural gas industries — Steel line pipe

## 1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies the characteristics of plain-end steel line pipe used in the oil and natural gas industries.

1.2 This pipe shall be manufactured in the sizes, thicknesses and grades given in table 14.

1.3 High-strength steel line pipe is covered in ISO 3845.

1.4 Spiral-welded steel line pipe will be covered in a future International Standard.

1.5 Threaded-end steel line pipe is not covered in this International Standard.

## 2 REFERENCES

ISO/R 202, *Flattening test on steel tubes*.

ISO 375, *Steel — Tensile testing of tubes*.

ISO 404, *Steel and steel products — General technical delivery requirements*.<sup>1)</sup>

ISO/R 1027, *Radiographic image quality indicators — Principles and identification*.

ISO 2566/1, *Steel — Conversion of elongation values — Part 1 : Carbon and low alloy steels*.

ISO 3845, *Oil and natural gas industries — High-test steel line pipe*.<sup>2)</sup>

## 3 DEFINITION AND SYMBOLS

### 3.1 Definition

For the purpose of this International Standard, the following definition applies.

**line pipe** : Pipe used as an element of a pipe-line by the oil

and natural gas industries principally for the transport of liquid or gaseous products.

### 3.2 Symbols

$D$  : Nominal outside diameter of pipe, in millimetres.

$a$  : Nominal wall thickness of pipe, in millimetres.

$R_{t0,5}$  : Yield strength corresponding to a total elongation of 0,5 %, in newtons per square millimetre.

$R_m$  : Tensile strength, in newtons per square millimetre.

$A$  : Elongation after fracture on proportional test specimen,  $L_o = 5,65 \sqrt{S_o}$ , in per cent.

$p$  : Hydrostatic test pressure, in bars.

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## 4 INFORMATION TO BE SPECIFIED BY THE PURCHASER

4.1 In placing the order, the purchaser must specify the following :

- a reference to ISO 3183;
- quantity (number of metres or number of lengths);
- steel grade and class (see tables 1 and 2);
- pipe type : Plain-end line pipe (see 7.4);
- process of manufacture of the pipe (see clause 5) : seamless, electric-welded, submerged-arc or butt-welded;
- size (outside diameter), in millimetres (see table 13);
- mass per unit length, in kilograms per metre, or thickness in millimetres (see table 14);
- range lengths (see table 6);
- delivery date and shipping instructions;
- mill inspection (when required).

1) At present at the stage of draft. (Revision of ISO/R 404.)

2) At present at the stage of draft.

4.2 In placing the order, the purchaser must also specify his requirements concerning the following stipulations which are optional :

- k) chemical ladle analyses (see 9.1);
- l) chemical check analyses on product (see 9.2);
- m) method of processing steel (see 6.1);
- n) acceptance of jointers (see 8.5.3);
- o) welding method for jointers (see C.1);
- p) possible cancelling of end bevel (see 7.4.1);
- q) repairing of defects (see 11.2.2);
- r) special coatings (see clause 16).

4.3 Attention is also called to the following stipulations which are subject to agreement when placing the order :

- s) average lengths (see 8.5);
- t) special marking instructions (see 15.4).

## 5 MANUFACTURING PROCESSES

This International Standard is applicable to seamless or welded pipe manufactured according to the following process.

### 5.1 Seamless

Seamless pipe is defined as a steel tubular product manufactured without a welded seam by hot working a solid billet of steel, if necessary followed by cold finishing to produce the desired shape, dimensions and properties.

### 5.2 Welded

#### 5.2.1 Electric welding

Electric-welded pipe is pipe having one longitudinal seam formed by electric-flash welding, electric-resistance welding or electric-induction welding, without the addition of extraneous metal.

#### 5.2.2 Submerged-arc welding

This process is applicable to grades E 21 and E 24 only.

Submerged-arc welded pipe is pipe having one longitudinal seam formed by automatic submerged-arc welding. At least one pass is made on the inside and at least one pass on the outside of the pipe.

If so agreed by the interested parties, submerged-arc welded pipe may have two longitudinal seams positioned approximately 180° apart. For this pipe, all weld tests provided for shall be performed after forming and welding. For each seam, at least one pass shall be made on the inside and at least one pass on the outside.

The end welding of longitudinal seams, if not carried out by an automatic process, is to be effected by a process and a welder qualified in accordance with annex B.

#### 5.2.3 Butt welding

This process is applicable to grade E 17 only.

Butt-welded pipe is pipe having one longitudinal seam formed by mechanical pressure to make the welded junction, the edges being furnace-heated to the welding temperature prior to application of the pressure.

## 5.3 Heat treatment

5.3.1 Pipe is delivered as-rolled or heat-treated.

In the second case, it shall receive one of the following treatments :

- a) normalizing;
- b) normalizing and tempering;
- c) sub-critical stress relief;
- d) sub-critical age hardening.

5.3.2 After welding, the seam in electric-resistance or electric-induction welded grade E 24 pipe shall be treated at a minimum temperature of 538 °C or in such a way that no untempered martensite remains.

5.4 Pipe furnished to this International Standard, except butt-welded, is delivered with expansion or without expansion at the option of the manufacturer, unless otherwise stipulated when placing the order.

## 6 MATERIAL

### 6.1 Processing

The only processes approved by this International Standard are the following :

- Open hearth, electric furnace or converter using blown, industrially pure oxygen, or a combination of these processes.

### 6.2 Ladle analysis

The ladle analysis requirements for the various grades of steel are shown in table 1.

### 6.3 Mechanical characteristics

The specimen mechanical characteristics for the various grades of steel are shown in table 2.

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TABLE 1 – Ladle analysis

| Grade and class | Carbon % | Manganese % |      | Phosphorus % | Sulphur % |
|-----------------|----------|-------------|------|--------------|-----------|
|                 | max.     | min.        | max. | max.         | max.      |
| E 17            | 0,21     | 0,30        | 0,60 | 0,045        | 0,06      |
| E 21            | 0,22     |             | 0,90 | 0,04         | 0,05      |
| E 24 – 1        | 0,22     |             | 1,15 | 0,04         | 0,05      |
| E 24 – 2        | 0,27     |             | 1,15 | 0,04         | 0,05      |

TABLE 2 – Mechanical characteristics

| Grade | Yield strength<br>$R_{t0,5}$<br>min. | Tensile strength<br>$R_m$<br>min. | Elongation <sup>1)</sup><br>$L_o = 5,65 \sqrt{S_o}$<br>min. |
|-------|--------------------------------------|-----------------------------------|-------------------------------------------------------------|
|       | N/mm <sup>2</sup>                    | N/mm <sup>2</sup>                 | %                                                           |
| E 17  | 172                                  | 310                               | 27                                                          |
| E 21  | 207                                  | 331                               | 25                                                          |
| E 24  | 241                                  | 413                               | 21                                                          |

1) If other gauge lengths are used, the corresponding elongation shall be determined in accordance with ISO 2566. In cases of dispute, the gauge length of  $5,65 \sqrt{S_o}$  shall be used.

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## 7 DIMENSIONS, WORKMANSHIP

### 7.1 Diameters, thicknesses and masses

Pipe supplied to the diameters, thicknesses and masses specified when placing the order shall be chosen from tables 13 and 14.

### 7.2 Workmanship

Pipe shall be rejected if it shows signs of poor quality as defined in the following paragraphs. The manufacturer must take reasonable precautions to minimize the recurrence of such imperfections.

The following imperfections are considered defects if they exceed the given limits :

#### 7.2.1 Dents

- more than 6,3 mm deep as measured between the lowest point and the prolongation of the original contour of the pipe, or
- length exceeding one-half the pipe's outside diameter.

However, cold-formed dents deeper than 3,2 mm with a sharp bottom gouge are considered injurious. The gouge may be removed by grinding.

### 7.2.2 Offset of plate edges

Submerged-arc welded pipe :

- For thicknesses  $\leq 12,5$  mm : offset greater than 1,6 mm.
- For thicknesses  $> 12,5$  mm and  $\leq 25$  mm : offset greater than 3,2 mm.
- For thicknesses  $> 25$  mm : offset greater than 1/8 of the wall thickness.

Electric-resistance welded pipe :

- Offset of edges plus flash trim : 1,5 mm.

### 7.2.3 Misalignment of seam in submerged-arc welded pipe

Incomplete penetration or fusion shown by non-destructive examination.

Evidence of tack weld made by electric-resistance welding remaining after submerged-arc welding.

### 7.2.4 Height of outside seam

Seam extending above prolongation of original surface of the pipe :

- 3,2 mm for thicknesses  $\leq 12,5$  mm;
- 4,8 mm for thicknesses  $> 12,5$  mm.

However, seams may be ground to acceptable limits.

### 7.2.5 Height of inside seam in electric-welded pipe

Flash (inside seam) extending 1,5 mm above the prolongation of the original inside surface.

### 7.2.6 Trim of inside seam in electric-welded pipe

Groove resulting from the flash trim exceeding 10 % of the thickness for thicknesses  $\leq 3,6$  mm, 0,4 mm for thicknesses between 3,6 mm and 8 mm, 5 % of the thickness for thicknesses  $\geq 8$  mm.

### 7.2.7 Surface conditioning by grinding carried out in an incorrect (unworkmanlike) manner

## 7.3 Hard spots

The surface of welded pipe in sizes over 508 mm outside diameter shall be examined visually to detect irregularities in the curvature of the pipe. When this examination fails to disclose mechanical damage as the cause of an irregular surface, but instead indicates that the irregular surface may be attributed to a hard spot, the hardness of the area in question shall be determined. If the hardness is 35 Rockwell C (327 Brinell) or harder, and the dimension of the hardened area is greater than 50 mm in any direction, the section of the pipe containing the hard spot shall be cut off.

7.4 Pipe ends

7.4.1 Unless otherwise ordered, the pipes are to be delivered with ends bevelled to an angle of  $30^{\circ} + \frac{5^{\circ}}{0}$ , as measured from a line drawn perpendicular to the axis of the pipe and with a root face of  $1,6 \pm 0,8$  mm.

For pipe of outside diameter  $D$  273 mm or larger, the ends shall be square machined within 1,6 mm (measured no less than three times per 8-hour working shift).

7.4.2 When internal machining is required to maintain the root face tolerance or to remove an internal burr on seamless pipe, the angle made by the machined surface with a line perpendicular to the axis of the tube shall not be less than the values given below :

| Specified thickness, mm | Angle, degrees |
|-------------------------|----------------|
| < 10                    | 83             |
| 10 to 14                | 80             |
| 14 to 17                | 79             |
| > 17                    | 76             |

For the removal of an internal burr on welded pipe larger than 114,3 mm outside diameter, the angle value shall be  $83^{\circ}$  or larger.

7.4.3 Both ends of submerged-arc welded pipe shall have the inside seam reinforcement removed for a distance of approximately 100 mm.

If so agreed when placing the order, approximately 150 mm of this excess inside weld thickness shall be removed for pipe of diameter  $D$  greater than or equal to 1 016 mm.

7.4.4 If so specified on the order, pipes shall be furnished with ends suitable for use with certain special couplings. Such pipe shall be sufficiently free from indentations, projections or roll marks for a distance of 200 mm from the end of the pipe, to permit proper make-up of coupling.

8 DIMENSIONAL TOLERANCES

8.1 Outside diameter

8.1.1 Pipe body

The tolerances on the outside diameter  $D$  are given in table 3.

TABLE 3

| Outside diameter<br>mm   | Tolerance<br>% |
|--------------------------|----------------|
| $60,3 \leq D \leq 101,6$ | $\pm 1$        |
| $114,3 \leq D \leq 457$  | $\pm 0,75$     |
| $D \geq 508$             | $\pm 1$        |

For pipe of outside diameter  $D$  greater than or equal to 114,3 mm, measurements are to be made with a diameter tape no less than three times per 8-hour working shift.

8.1.2 Pipe ends

For a distance of 100 mm from each end, the outside diameter  $D$  of the pipe shall comply with the tolerances given in table 4.

TABLE 4

| Diameter<br>mm | Tolerances<br>mm   |
|----------------|--------------------|
| $D \leq 273,1$ | $+ 1,6$<br>$- 0,4$ |
| $D \geq 323,9$ | $+ 2,4$<br>$- 0,8$ |

For pipes of outside diameter  $D$  less than or equal to 508 mm, the plus tolerance shall be verified by the passage over the ends for a distance of 100 mm of a ring-gauge which has a bore equal to the outside diameter of the pipe plus the corresponding tolerance. The minus tolerance may be measured with a diameter tape. If so agreed when the order is placed, the tolerance on outside diameter  $D$  at the ends may be applied instead to the inside diameter at the ends.

For pipe of outside diameter  $D$  greater than 508 mm, the plus and minus tolerances shall be verified with a diameter tape. On expanded pipe of outside diameter  $D$  greater than 508 mm, the diameter, measured with a diameter tape at one end of the pipe, shall not differ by more than 2,4 mm from that at the other end. These measurements may be made on the internal diameter, at the manufacturer's option.

8.2 Inside diameter

If so agreed when placing the order, the tolerance at the ends may be applied to the inside diameter instead of the outside diameter.

8.3 Out-of-roundness

For pipe of outside diameter  $D$  greater than or equal to 559 mm, and for a distance of 100 mm from each end, the maximum outside diameter shall not be more than 1 % larger than the nominal outside diameter, and the minimum outside diameter shall not be more than 1 % smaller than this nominal outside diameter.

8.4 Thickness

8.4.1 At any given point, the thickness of each pipe length shall comply with the tolerances given in table 5.



TABLE 5

| Process of manufacture | Outside diameter<br>mm | Tolerances<br>% |
|------------------------|------------------------|-----------------|
| Seamless and welded    | $D \leq 73$            | + 20<br>- 12,5  |
| Seamless and welded    | $73 < D \leq 88,9$     | + 18<br>- 12,5  |
| Seamless               | $D \geq 101,6$         | + 15<br>- 12,5  |
| Welded                 | $101,6 < D \leq 457$   | + 15<br>- 12,5  |
| Welded                 | $D \geq 508$           | + 17,5<br>- 10  |

For welded pipe, the weld area is not limited by the plus tolerance.

8.4.2 Thickness measurements shall be made with a mechanical caliper or with a properly calibrated non-destructive testing device of appropriate accuracy. In case of dispute, the measurement determined by use of the micrometer governs.

The mechanical caliper shall be fitted with contact pins having circular cross-sections of 6,3 mm. The pin contacting the inside surface shall be rounded to a radius of 38,1 mm; the end of the pin contacting the outside surface shall be rounded to a radius of not less than 38,1 mm.

### 8.5 Mass

8.5.1 Each pipe shall be weighed separately. However, pipe of outside diameter less than or equal to 114,3 mm may be weighed in lots whose size shall be determined by the manufacturer.

8.5.2 The masses determined shall be in accordance with the masses given in table 14, within the limit of the tolerances indicated in 8.5.3.

The mass  $m$ , expressed in kilograms per metre, is given by the following formula :

$$m = 0,024\ 66 (D - a) a$$

where

$D$  is the outside diameter, in millimetres, rounded to the nearest 0,1 mm;

$a$  is the specified thickness, in millimetres, rounded to the nearest 0,1 mm.

The result shall be recorded to the nearest 0,01 kg/m.

8.5.3 Per pipe and per lot, the tolerance shall be  $\begin{matrix} + 10 \\ - 3,5 \end{matrix}$  %.

However, this tolerance in the case of "special" tubes (marked with an asterisk in table 14) shall be  $\begin{matrix} + 10 \\ - 5 \end{matrix}$  %.

In the case of welded pipe of outside diameter greater than or equal to 508 mm, this tolerance shall be  $\begin{matrix} + 12,5 \\ - 3,5 \end{matrix}$  %.

For a full carload (a minimum of 18 t) the tolerance shall be - 1,75 %.

NOTE - Specifications for separate pipe, pipe in lots and pipe in carloads apply simultaneously, except for orders of less than 18 t, where only the tolerance per pipe or pipe in lots applies.

### 8.6 Length

8.6.1 Pipe shall be furnished as stipulated in the order, namely in single random lengths, in double random lengths, or as agreed.

8.6.2 The limits on pipe lengths are given in table 6.

TABLE 6

|                                   | Shortest length<br>in 100 %<br>of shipment | Shortest length<br>in 90 %<br>of shipment | Minimum<br>average length<br>in 100 %<br>of shipment |
|-----------------------------------|--------------------------------------------|-------------------------------------------|------------------------------------------------------|
| Single random<br>lengths          | 2,7 m                                      |                                           | 5,3 m                                                |
| Double random<br>lengths          | 4,3 m                                      | 8,0 m                                     | 10,7 m                                               |
| Lengths as<br>agreed<br>(> 6,1 m) | 40 % of agreed<br>average length           | 75 % of agreed<br>average length          |                                                      |

8.6.3 Unless otherwise indicated when the order is placed, jointers may be furnished to a maximum of 5 % of the delivered length.

However, no short lengths used in making these jointers shall measure less than 1,5 m.

The jointers shall comply with the requirements of annex C.

### 8.7 Straightness

8.7.1 Pipe of outside diameter less than 114,3 mm shall be reasonably straight.

Pipe of outside diameter greater than or equal to 114,3 mm shall be random checked; any deviation shall not exceed 0,2 % of the length.

8.7.2 Checking shall be carried out using a taut string or wire from end to end along the side of the pipe to measure the greatest deviation.

## 9 CHEMICAL ANALYSES

### 9.1 Ladle analysis

On request, for grades E 21 and E 24 pipe, the manufacturer shall supply the purchaser with a ladle analysis of each heat of steel used.

The analyses so obtained shall comply with the requirements of 6.2 and table 1.

For grade E 17 pipe, the manufacturer shall certify that the material has been analysed and meets the requirements of 6.2 and table 1.

### 9.2 Check analysis

**9.2.1** If so agreed when the order is placed, the manufacturer shall perform analyses on two lengths of finished pipe from each lot of 400 ( $60,3 \leq D \leq 141,3$  mm), 200 ( $168,3 \leq D \leq 323,9$  mm) or 100 ( $D \geq 355,6$  mm) of the same diameter.

For multiple-length seamless pipe, a length shall be considered as all of the sections cut from a particular multiple length.

**9.2.2** The samples for check analysis shall be taken as follows :

#### a) Seamless pipe

At the manufacturer's option, cuttings or drillings for check analyses shall be taken either from the pipe at several points around the finished pipe or from the tensile test specimen.

If drillings are used, the minimum drill size shall be 12,5 mm. The drillings shall be taken by drilling all the way through the pipe wall.

#### b) Welded pipe

At the manufacturer's option, cuttings or drillings shall be taken from the finished pipe, plate, skelp, tensile test specimens or flattening test specimens.

Samples shall be taken at a minimum of 90° from the weld in such manner as to represent the total thickness.

For pipe having two longitudinal seams, samples shall be taken on the two plates.

If drillings are used, the minimum drill size shall be 12,5 mm.

**9.2.3** The chemical composition of the product shall conform to the requirements specified in table 1, with the following permissible variations :

- Carbon :  $\pm 0,03$  %
- Manganese :  $\pm 0,10$  %
- Phosphorus :  $\pm 0,005$  %
- Sulphur :  $\pm 0,005$  %

When table 1 only specifies a maximum content, only the plus variation shall apply.

These tolerances are not applicable to rimmed steels.

**9.2.4** If one of the lengths representing a lot fails to conform to the requirements of 9.2.3, at the manufacturer's option either the entire lot shall stand rejected or two additional lengths shall be tested for conformance to the specified requirements.

If both recheck analyses meet the specified requirements, the lot shall be accepted except for the initial defective length.

If both lengths representing a lot or one (or both) of the lengths used for the recheck analyses fail to give satisfactory results, at the manufacturer's option the entire lot shall be rejected or each of the remaining lengths shall be tested individually. These recheck analyses are only to be carried out on the unsatisfactory elements. The samples shall be taken in the manner specified in 9.2.2.

### 9.3 Mill-control check analysis

The manufacturer shall make a check analysis of each heat of steel used. A record of these analyses shall be available to the purchaser.

## 10 TECHNOLOGICAL TESTS

### 10.1 Nature of the tests

Depending on the manufacturing process, the pipe shall undergo the following tests as indicated.

- pipe body tensile tests;
- weld tensile tests;
- flattening tests;
- weld ductility tests;
- guided-bend tests of the weld;
- non-destructive inspection.

Every pipe shall withstand a hydrostatic test.

For each manufacturing process, table 7 indicates which tests are to be made.

### 10.2 Number of tests

The number of tests is indicated in table 7.

### 10.3 Tensile tests

#### 10.3.1 Tests on the pipe body

**10.3.1.1** The tests shall be carried out in accordance with ISO 375. The yield strength shall be the tensile stress required to produce an elongation of 0,5 % ( $R_{t0,5}$ ).

TABLE 7 – Nature and number of tests

| Type of test                                  | Process of manufacture                                                                                                                                                                                                                 |                                                                                                                                    |                                                                                                  |                                                         |
|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------|
|                                               | Seamless                                                                                                                                                                                                                               | Electric-welded                                                                                                                    | Submerged-arc welded <sup>4)</sup>                                                               | Butt-welded                                             |
| Tensile test on specimen taken from pipe body | $D < 141,3$ : 1 for every 400 lengths<br>$141,3 < D < 323,9$ : 1 for every 200 lengths<br>$D \geq 355,6$ : 1 for every 100 lengths                                                                                                     |                                                                                                                                    |                                                                                                  | 1 for every 400 lengths <sup>1)</sup>                   |
| Tensile test on weld specimen                 |                                                                                                                                                                                                                                        | $219,1 \leq D < 323,9$ : 1 for every 200 lengths<br>$D \geq 355,6$ : 1 for every 100 lengths                                       |                                                                                                  |                                                         |
| Mill-control tensile test (on pipe body)      | 1 for each E 21 or E 24 heat of steel                                                                                                                                                                                                  |                                                                                                                                    |                                                                                                  |                                                         |
| Specimen flattening test                      | a) Grades E 21 and E 24 nonexpanded at each end of each length <sup>3)</sup><br>b) Grades E 21 and E 24 expanded<br>1 for every 100 lengths <sup>1)</sup><br>c) Grade E 17,<br>$D \geq 73$ mm<br>1 for every 400 lengths <sup>1)</sup> |                                                                                                                                    |                                                                                                  | $D \geq 73$ mm<br>1 for every 400 lengths <sup>1)</sup> |
| Special tests on the weld                     |                                                                                                                                                                                                                                        | Ductility test<br>$D < 141,3$ : 1 per 400 lengths<br>$141,3 < D < 323,9$ : 1 per 200 lengths<br>$D \geq 355,6$ : 1 per 100 lengths | Guided-bend test<br>1 face-bend test and 1 root-bend test on 1 length for every 50 <sup>1)</sup> |                                                         |
| Hydrostatic test                              | On every pipe                                                                                                                                                                                                                          |                                                                                                                                    |                                                                                                  |                                                         |
| Non-destructive inspection                    | Optional                                                                                                                                                                                                                               | Each weld of E 21 and E 24 steel pipe                                                                                              |                                                                                                  |                                                         |

1) Of the same size.

2) For seamless pipe in multiple lengths, one length is considered to be the sum of the sections obtained from this multiple length.

3) For multiple lengths cut into sections, additional tests on two intermediate rings.

4) For pipe having two longitudinal seams, samples shall be taken either on the two plates or on the two weld seams.

For electric-welded pipe of diameter  $D$  less than or equal to 168,3 mm and for seamless pipe, the specimens shall be taken longitudinally. For electric-welded and submerged-arc welded pipe of diameter  $D$  greater than or equal to 219,1 mm, they shall be taken transversely.

At the manufacturer's option, longitudinal specimens shall be either pipe sections or strip sections. Strip sections from seamless pipe may be taken from any location. Strip specimens from welded pipe shall be taken at approximately  $90^\circ$  from the weld or from the skelp parallel to the direction of rolling and approximately midway between the edge and the centre. Specimens shall represent the full thickness of the pipe from which they are cut and shall be tested without flattening.

Transverse specimens shall be taken from the side opposite the weld. They shall represent the full thickness of the pipe from which they are cut.

**10.3.1.2** Strip specimens shall be approximately 38 mm wide in the gauge length if suitable curved-face testing grips are used or if the ends of the specimens are machined to reduce the curvature in the grip area; otherwise, they shall be approximately 19,0 mm wide for pipe 88,9 mm and smaller, 25,4 mm for pipe 101,6 to 193,7 mm (inclusive) and approximately 38 mm for pipe 219,1 mm and larger. In no case shall the width of the specimen in the gauge length be greater than four times the thickness of the specimen.

**10.3.2 Weld tensile tests**

Weld tensile tests shall be carried out in accordance with ISO 375. Determination of yield strength and elongation are not necessary.

The specimens shall be taken at  $90^\circ$  to the weld with the weld at the centre of the specimen.

The specimens shall represent the full thickness of the pipe from which they are cut.

The weld reinforcement shall not be removed.

**10.3.3** If a tensile test specimen shows defective machining or flaws, it shall be discarded and another specimen substituted.

When the elongation of a tensile test specimen is less than that specified, a re-test shall be allowed if any part of the fracture is outside the middle third of the gauge length and indicated by scribe scratches marked on the specimen before testing.

**10.4 Flattening test**

**10.4.1** The test shall be made in accordance with ISO/R 202. No opening in the weld shall take place as long as the distance between the plates is greater than the value of  $X$  indicated in table 8.

No cracks or breaks shall occur in the metal, elsewhere than in the weld, as long as the distance between plates is greater than the value of  $Y$  given in table 8.

For electric-welded pipe, evidence of laminations or burnt metal shall not develop during the entire test.

**10.4.2** The specimens shall be tested as follows :

Grades E 21 and E 24 non-expanded steel pipe :

- single lengths :
  - one crop end, weld at  $0^\circ$
  - one crop end, weld at  $90^\circ$  (point of maximum bending)
- multiple lengths :
  - two crop ends, weld at  $90^\circ$
  - two intermediate rings, weld at  $0^\circ$

Grades E 21 and E 24 cold-expanded steel pipe :

101,6 mm ring cut from one end, weld at  $90^\circ$

Grade E 17 steel pipe :

152,4 mm section, weld at  $90^\circ$

**10.4.3** For electric-welded pipe, the weld is considered to extend for a distance of 12,5 mm on either side of the fusion line.

**10.5 Weld ductility test**

**10.5.1** For electric-welded pipe the weld ductility shall be determined by tests on full-section specimens of 51 mm minimum length. The specimens shall be flattened cold between parallel plates. The weld shall be placed  $90^\circ$  from the direction of applied force (point of maximum bending). No cracks or breaks exceeding 3 mm in any direction in the weld or the parent metal shall occur on the outside surface until the distance between plates is less than the value  $z$  calculated by the following formula :

$$z = \frac{3,07 a}{0,07 + 3 a/D}$$

where

- $z$  is the distance between flattening plates, in millimetres;
- $a$  is the specified wall thickness of the pipe, in millimetres;
- $D$  is the specified outside diameter of the pipe, in millimetres.

Cracks which originate at the edges of the specimen and which are less than 6 mm long shall not be cause for rejection. One test shall be made on a length of pipe from each lot of 400 lengths or less of each size 141,3 mm and smaller and from each lot of 200 lengths or less of each size 159 mm through 323,9 mm and from each lot of 100 lengths or less of each size 355,6 mm and larger. For multiple-length pipe, a length shall be considered as each section cut from a particular multiple length.

**10.5.2** The weld ductility test may also serve as one of the flattening tests of 10.4.1, 10.4.2 and 10.4.3 by complying with the appropriate degree of flattening.

## 10.6 Guided-bend test

**10.6.1** The test shall be performed in a jig in accordance with figure 2. A value for dimension  $A$  corresponds to any combination of diameter, thickness and grade. Table 9 gives the values of  $A$  for pipe sizes greater than or equal to 323,9 mm.

**10.6.2** Specimens shall be taken at  $90^\circ$  to the weld with the weld at the centre as shown in figure 1.

**10.6.3** For each lot, one face-bend and one root-bend specimen shall be bent approximately  $180^\circ$  in a jig.

These specimens shall not :

- a) fracture completely;
- b) reveal any cracks or ruptures in the weld metal greater than 3,2 mm in length, regardless of depth;
- c) reveal any cracks or ruptures in the parent metal, the heat-affected zone or the fusion line longer than 3,2 mm and deeper than 12,5 % of the specified thickness.

NOTE — Cracks which occur at the edges of the specimen and which are less than 6,3 mm long shall be neglected, regardless of depth.

**10.6.4** If the rupture or crack in the specimen is caused by a defect or flaw, a new specimen shall be substituted for that specimen.

## 10.7 Retests

**10.7.1** If a specimen representing a lot fails to conform to test requirements, the manufacturer may elect to make retests on specimens cut from two additional lengths from the same lot.

These specimens are to be taken in the same manner as the specimen which failed to meet the minimum requirements.

If these specimens conform to the specified requirements, all the lengths in the lot shall be accepted, except the length from which the initial defective specimen was taken.

If one of the retest specimens fails to conform to the specified requirements, the manufacturer may elect to individually test every length remaining in the lot. In this case, determinations shall be required only for the particular requirements with which the specimens failed to comply in the retests.

**10.7.2** In case of unsatisfactory flattening tests on welded pipe in multiple lengths, the manufacturer may elect to make retests on each individual length, one end being tested with the weld at  $0^\circ$  and the other with the weld at  $90^\circ$ .

**10.7.3** In case of unsatisfactory flattening tests on welded pipe in single lengths, the manufacturer may make retests on specimens cut from the same end of the length of pipe as the unsatisfactory specimen, until satisfactory results are obtained. However, the pipe shall not be shorter than 80 % of its length after the initial cropping.

Precautions shall be taken so that crop ends can be identified with respect to the length of pipe from which they were cut.

**10.7.4** In case of unsatisfactory weld ductility tests, the manufacturer may elect to retest any length which has failed to conform to the test requirements, by cropping back and cutting two additional specimens from the same end. If the weld ductility test requirements are met by both of these additional tests, that length shall be acceptable. No further cropping and retesting is permitted.

## 10.8 Hydrostatic test

**10.8.1** Each length shall withstand a hydrostatic test performed by the manufacturer.

The test pressure shall be held for not less than 5 s for seamless pipe and welded pipe in sizes 457,2 mm and smaller. It shall be held for not less than 10 s for welded pipe in sizes 508 mm and larger.

There shall be no leakage.

**10.8.2** During the test, welded pipe shall be struck, with a hammer of mass approximately 1 kg, or its equivalent, near each weld at both ends of the pipe.

**10.8.3** Except for butt-welded pipe, the testers shall be equipped with a recording gauge which records the test pressure and duration of time applied to each length of pipe or with some automatic interlocking device to prevent pipe from being classified as tested until the pressure and time requirements have been complied with. Such records or charts shall be available for examination at the mill by the purchaser's inspectors when the purchaser is so represented at the mill.

**10.8.4** The pressure for each grade shall be as listed in table 14.

For grades E 21 and E 24 pipe, the hydrostatic test pressure  $p$  is computed using the following formula :

$$p = 2 \frac{Sa}{D}$$

where

$p$  is the hydrostatic pressure, in megapascals;

$a$  is the specified thickness, in millimetres;

$D$  is the specified outside diameter, in millimetres;

$S$  = 60 % of the minimum yield strength for the standard test, or = 75 % of the minimum yield strength for the alternative test.