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Seamless circular tubes made from steels for quenching and tempering
Technical delivery conditions

DIN 17 204

Nahtlose kreisförmige Rohre aus Vergütungsstählen; technische Lieferbedingungen

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

The symbol • denotes items which shall, the symbol •• denoting items which may, be agreed upon at the time of ordering.

Contents

1 Scope and field of application

This standard specifies technical delivery conditions for seamless circular tubes made from the steels for quenching and tempering specified in table 1. Such tubes are intended primarily to be used in mechanical engineering, the automotive industry, and in the construction of pressure vessels and pipelines.

2 Concepts

2.1 Steel for quenching and tempering

For the purposes of this standard, steel for quenching and tempering is structural steel which, on the basis of its chemical composition, is suitable for hardening and which, in the quenched and tempered condition, exhibits good toughness for a given level of tensile strength.

2.2 Heat treatment

The terminology used in DIN 17 014 Part 1 shall apply for the heat treatment conditions referred to in this standard.

3 Steel grades

This standard deals with tubes made from the steel grades specified in table 1, a distinction being made between unalloyed quality steel and unalloyed and high-grade alloy steel (cf. DIN EN 10 020).

High-grade steel is distinguished from quality steel by the following:

a) the minimum impact strength in the quenched and tempered condition (in the case of unalloyed steel, only grades with an average carbon content of less than 0,50 % by mass are included, but not Ck 55, Cm 55, Ck 60 or Cm 60 steels);

b) the limiting values of hardenability in the end quench test (in the case of unalloyed steels, only grades with an average carbon content exceeding 0,30 % by mass are included, but not Ck 22 or Cm 22 steels);

c) a more uniform response to heat treatment;

d) a limited content of oxidic inclusions;

e) lower permitted contents of phosphorus and sulfur.

High-grade steel includes two series of steel grades, one for which only a maximum sulfur content of 0,035 % by mass is specified, and the other specifying a controlled sulfur content of 0,020 to 0,035 % by mass (cf. table 1).

The steel grade is to be selected by the purchaser.

4 Designation and ordering

4.1 Standard designation

4.1.1 The standard designation shall give, in the following order:

a) name of product (tube);

b) DIN number (DIN 17 204);

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c) characteristic dimensions (outside diameter × wall thickness);
d) material designation or number (cf. table 1);
e) symbol denoting heat treatment condition (cf. subclause 5.2);
f) where applicable, the symbol indicating compliance with the hardenability requirements specified in table 4 (cf. subclause 5.5.1);
g) where applicable, the symbol indicating compliance with the more stringent hardenability requirements (cf. figures 2 e to 2 m).

Example:

A seamless circular tube complying with this standard, with an outside diameter of 273 mm and a wall thickness of 6,3 mm, made of 34 CrMo 4 steel (material number 1.7220), supplied in the tempered condition (V):

Tube DIN 17 204 – 273 × 6,3 – 34 CrMo 4 V

or

Tube DIN 17 204 – 273 × 6,3 – 1.7220 V

4.2 • Essential order details

The following order details are essential.

4.2.1 Quantity (e.g. desired total length of tube in a consignment).

4.2.2 Name of product (tube).

4.2.3 DIN number (DIN 17 204).

4.2.4 Characteristic dimensions (outside diameter × wall thickness).

4.2.5 Material designation or number (cf. table 1).

4.2.6 Symbol denoting heat treatment condition (cf. subclause 5.2).

4.2.7 Type of length (cf. table 10) and, in the case of specified and exact lengths, the length of the individual tube.

Example of order:

1000 m tube DIN 17 204 – 273 × 6,3 – 34 CrMo 4 V, supplied in specified lengths of 8 m

4.3 •• Optional order details

The essential order details may, if so agreed, be supplemented by one or more of the following items.

4.3.1 Type of DIN 50 049 inspection document (cf. subclause 6.1) and, in the case of third party inspection, the testing agency and any specifications to be complied with.

4.3.2 The steelmaking process used (cf. subclause 5.1.1.1).

4.3.3 Chemical composition as determined by product analysis (cf. subclause 5.3.2).

4.3.4 Determination of mechanical properties on reference test pieces.

4.3.5 End quench testing (cf. subclause 5.5.1).

4.3.6 More stringent hardenability requirements (cf. subclause 5.5.2).

4.3.7 Grain size (cf. subclause 5.8).

4.3.8 Non-metallic inclusions content permitted (cf. subclause 5.9).

4.3.9 Non-destructive testing for determining the surface appearance (cf. subclause 5.10.5).

4.3.10 Depth of skin decarburization (cf. subclause 5.10.6).

4.3.11 Tightness test (cf. subclause 5.11).

4.3.12 Dimensional tolerances other than those specified in subclauses 5.12.1.2, 5.12.2.2 to 5.12.2.5 and 5.12.3.2.

4.3.13 Deburring of tubes (cf. subclause 5.12.4.2).

4.3.14 Materials identity test (cf. subclause 6.3.1.5).

4.3.15 Brinell hardness testing (cf. subclause 6.3.7, item 2).

Example of order:

1000 m tube DIN 17 204 – 50 × 3 – 42 CrMo 4 GBK, in manufactured lengths of 2 to 7 m

and, in addition:

DIN 50 049 – 3.1 B inspection document
End quench test
Non-metallic inclusions content
Non-destructive testing

5 Requirements

5.1 Manufacturing process

5.1.1 The steelmaking process shall be at the manufacturer's discretion.

5.1.1.1 •• If so agreed, the purchaser shall be informed of the manufacturing process used.

5.1.2 The steel shall be killed (not semi-killed).

5.1.3 The manufacturing process shall be at the manufacturer's discretion. Tubes shall be produced by hot or cold rolling, hot pressing, or hot or cold drawing.

5.2 • Heat treatment condition

As a function of whether tubes are hot or cold formed, they shall be supplied in one of the heat treatment conditions described in subclause 5.2.1 or 5.2.2 (cf. table 3).

5.2.1 Hot formed tubes

a) Not heat treated (symbol U).
b) Annealed to achieve maximum hardness (symbol G; cf. table 6).
c) Normalized (symbol N; cf. table 7). Normalizing may be dispensed with where normalizing forming is the final step taken during production and where such forming provides an equivalent condition (cf. *Stahl-Eisen-Werkstoffblatt* (Iron and steel materials sheet) 082).
d) Quenched and tempered (symbol V; cf. table 8).

5.2.2 Cold formed tubes

a) Bright drawn (symbol BK).
b) Annealed to achieve maximum hardness (symbol GBK; cf. table 6).
c) Normalized (symbol NBK; cf. table 7).
d) Quenched and tempered (symbol V; cf. table 8 and subclause 5.10.4).

5.3 Chemical composition

5.3.1 Ladle analysis

Table 1 shall apply for the chemical composition.

5.3.2 Product analysis

•• A product analysis may be agreed at the time of ordering (see table 11 for scope of testing). Where a product analysis is carried out, the results may deviate from the values given in table 1 by the amounts listed in table 2.

5.4 Mechanical properties

5.4.1 As a function of the heat treatment condition, and under the conditions of test specified in clause 6, the yield strength, tensile strength, elongation at fracture, reduction in area after fracture, impact energy and Brinell hardness shall be as specified in table 6, 7 or 8.

5.4.2 In the case of conditions U, BK, G and GBK, the mechanical properties specified in tables 7 and 8 shall be obtainable for the ruling section after heat treatment.

5.4.3 •• Normalized or quenched and tempered reference test pieces may be used to verify the compliance of tubes supplied in condition U, BK, G or GBK with the requirements specified in tables 7 and 8.

5.5 Hardenability

The hardenability requirements in accordance with table 4 (and table 3) have been given for guidance and may be assumed to apply to the high-grade steels covered in this standard, under the conditions of test specified in subclauses 6.4.4 and 6.5.4.

Hardenability requirements do not apply to steel supplied in the quenched and tempered condition.

5.5.1 •• Where tubes are expected to comply with the requirements specified for end quench testing in table 4, the symbol H shall be added to the material designation or number on the order.

5.5.2 •• Narrower hardenability scatterbands, as specified in table 5, figures 2 e to 2 m, and footnotes 1 and 2 to table 4, may be agreed at the time of ordering. Where a narrower scatterband with respect to the upper or lower limiting curve is required, the symbol HH or HL shall be added to the material designation or number on the order.

5.6 Weldability

The steels specified here may not be suitable for all welding operations, as the behaviour of steel during and after welding changes as a function of the material, form and size of the component, and of the manufacturing and service conditions (cf. DIN 8528 Part 1).

5.7 Heat treatment and machinability

5.7.1 Table 9 gives guideline values for heat treatment temperatures.

5.7.2 Where improved machinability is required, consideration should be given to those steel grades for which a range is specified for the sulfur and lead content (cf. table 1).

5.8 •• Grain size

Where 'fine grain steel' is ordered, the austenitic grain size index, determined in accordance with DIN 50 601, shall be not less than 5.

5.9 •• Non-metallic inclusions

In the case of high-grade steel tubes, a particular degree of cleanness (regarding oxidic non-metallic inclusions), as determined microscopically as described in DIN 50 602 (method K), may be agreed at the time of ordering.

5.10 Surface appearance

5.10.1 Tubes shall have a smooth inner and outer surface, consistent with the manufacturing process used.

5.10.2 Slight irregularities in the surface resulting from the manufacturing process (e.g. excess weld metal, raised spots, pit marks, scores) are permitted, provided the thickness tolerance is not exceeded (cf. subclause 5.12.2.4) and the performance of the tubes is not adversely affected (cf. subclause 8.1).

5.10.3 Dressing of imperfections (e.g. by grinding) is permitted, provided the thickness after dressing continues to meet the requirements specified in subclause 5.12.2.4. Repair of surface defects by hammering is not permitted.

5.10.4 The surface appearance of cold formed tubes shall be as specified in clause 9 of the July 1981 edition of DIN 2391 Part 2.

In the case of quenched and tempered steel, the surface shall, though oxidized, be free from scale.

5.10.5 •• A suitable non-destructive test and the relevant requirement may be agreed at the time of ordering, to establish the surface appearance.

5.10.6 •• It may be agreed at the time of ordering that a specified depth of decarburization is not to be exceeded.

5.11 •• Tightness

It may be agreed at the time of ordering to subject tubes to tightness testing under the conditions specified in subclause 6.5.5.

5.12 Dimensions, tolerances and mass

5.12.1 • Dimensions

5.12.1.1 The outside diameter and wall thickness of tubes shall be the subject of agreement, these dimensions preferably being as specified in DIN 2448 in the case of hot formed tubes, or in DIN 2391 Part 1 in the case of cold formed tubes.

5.12.1.2 Table 10 shall be observed when specifying the tube length.

5.12.2 Dimensional tolerances

5.12.2.1 The outside diameter, d_a, of hot formed tubes shall be subject to limit deviations of $\pm 1\%$, $\pm 0{,}5\%$ also being permitted.

At points where the surface of the tube has been dressed by mechanical means (e.g. grinding), the actual outside diameter may be less than its lower limit of size, provided the wall thickness still lies within the tolerances specified.

The lower limit deviation for the wall thickness, s, of hot formed tubes shall be $-12{,}5\%$, the upper limit deviation being a function of that specified for the tolerance on mass (cf. subclause 5.12.5).

5.12.2.2 •• It may be agreed at the time of ordering that the inside diameter of tubes where d_a is greater than 200 mm is to be subject to the same tolerance as the outside diameter.

5.12.2.3 • In the case of quenched and tempered steel, the tolerance on outside diameter shall be agreed at the time of ordering.

5.12.2.4 In the case of cold formed tubes, the tolerances specified in DIN 2391 Part 1 for inside and outside diameter and wall thickness shall be complied with.

5.12.2.5 •• It may be agreed at the time of ordering to subject hot or cold formed tubes to closer tolerances on outside diameter or wall thickness.

5.12.3 Geometrical tolerances

5.12.3.1 Circularity

Tubes shall be as circular as possible, the circularity tolerance being within the limit deviations specified for outside diameter.

5.12.3.2 Straightness

5.12.3.2.1 Tubes shall be straight to the eye.

5.12.3.2.2 In the case of cold formed tubes, DIN 2391 Part 1 shall apply for straightness requirements.

5.12.3.2.3 •• Particular requirements regarding straightness may be agreed upon.

5.12.4 Finish of tube ends

5.12.4.1 Tubes shall be cut square with the tube axis and be free from burrs.

5.12.4.2 •• Deburring of tubes may be agreed at the time of ordering.

5.12.5 Mass per unit length

5.12.5.1 The mass of steels covered in this standard has been calculated, taking the density as 7,85 kg/dm^3.

5.12.5.2 The mass per unit length of hot formed tubes shall be as specified in DIN 2448.

5.12.5.3 The actual mass may deviate from the value specified by +12/−8 % for single tubes, and +10/−5 % for a consignment of not less than 10 t.

6 Testing

6.1 •• Inspection documents

Tubes complying with this standard may be supplied with a DIN 50 049 inspection document (cf. table 3).

Where an inspection certificate is to be issued, the specifications given in table 11 shall be complied with.

6.1.1 Where it has been agreed to issue a DIN 50 049 – 2.2 document, this shall include the following particulars:

a) a declaration that the tubes satisfy the specifications given in the order, based on regular internal control, where not all tubes in the consignment need undergo such control;

b) the results of ladle analysis for all elements specified in table 1 for the relevant steel grade.

6.1.2 Where any of the optional tests listed in subclause 4.3 have been agreed, the test results shall be given in a DIN 50 049 – 3.1 B inspection cerificate.

6.1.3 Where it has been agreed to issue a DIN 50 049 – 3.1 A, DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C inspection certificate, this shall include the following particulars:

a) the results of ladle analysis for all elements specified in table 1 for the relevant steel grade;

b) the results of testing as described in subclause 6.3 and carried out in accordance with subclause 6.5;

c) information regarding the heat treatment of normalized or quenched and tempered reference test pieces that were used for testing purposes;

d) tube marking in accordance with clause 7;

e) the titles of any technical specifications on which compliance with requirements is based.

6.2 Test site

Tubes shall be tested at the manufacturer's works. Where an inspector (of a testing agency) is responsible for testing, production shall not be unduly disturbed.

6.3 Scope of testing

6.3.1 All tubes shall be subjected to the following.

6.3.1.1 A visual check of the appearance of the outside and, as far as possible, the inside of tubes.

6.3.1.2 Check of dimensional accuracy (for compliance with the requirements given in subclause 5.12).

6.3.1.3 •• If agreed, tightness testing, to be carried out by the manufacturer, by subjecting tubes to internal hydrostatic pressure (cf. subclause 6.5.5).

6.3.1.4 •• If agreed, non-destructive testing as described in subclause 6.5.11.

6.3.1.5 •• If agreed, materials identity test, to be carried out by the manufacturer.

6.3.2 •• Where it has been agreed to verify the austenitic grain size, this shall be determined on one tube per cast.

6.3.3 •• Where it has been agreed to verify the nonmetallic inclusions content of high-grade steel tubes (cf. subclause 5.9), the scope of testing shall be specified at the time of ordering.

6.3.4 •• Unless otherwise agreed, the depth of decarburization shall be checked on at least two test pieces per consignment.

6.3.5 •• Where it has been agreed to conduct testing of mechanical properties on reference test pieces, testing shall be carried out on one test piece per cast (cf. subclause 5.4.3).

6.3.6 •• Where it has been agreed to conduct end quench testing as described in DIN 50 191, this shall be carried out on one sample per cast (or on the raw material, if necessary).

6.3.7 Where it has been agreed to issue an inspection certificate, tubes shall also be tested by batches.

Tubes shall be separated into batches according to material, size (wall thickness), cast, and if necessary, heat treatment, each batch consisting of 100 tubes. Tubes may also be separated according to as manufactured length.

Remainders of up to 50 units may be distributed uniformly among the other batches, remainders of over 50 units and consignments of less than 50 units being considered a whole batch.

One test tube shall be taken from each batch, at the inspector's discretion. As a function of the heat treatment condition, the following tests shall be carried out, unless otherwise agreed.

1. For conditions U and BK, where agreed:
   a) •• tensile test on reference test pieces;
   b) •• product analysis;
   c) •• hardenability in the end quench test (in the case of high-grade steels only, with symbol H, HH or HL).
2. For conditions G and GKB, where agreed, item a) above and •• a hardenability test.
3. For conditions N and NBK:
   a) tensile test;
   b) •• product analysis;
   c) •• hardenability in the end quench test (in the case of high-grade steels only, with symbol H, HH or HL).
4. For condition V:
   a) tensile test;
   b) impact test, where the wall thickness is at least 10 mm, and provided values are specified in table 8;
   c) •• product analysis, where agreed.

6.4 Sampling and sample preparation

See figure 1 for location and orientation of test pieces.

6.4.1 Tensile test

6.4.1.1 As a function of the size of the test tube, a tube section, a flattened strip as specified in DIN 50140, or a round bar test piece as specified in DIN 50125 shall be taken parallel to the tube axis. The test piece shall not be heat treated nor straightened along its length.

Where tubes have a wall thickness greater than 30 mm, the axis of round bar test pieces shall be located at a point which corresponds to a distance from the outer surface equal to one-fourth of the wall thickness, or as near as possible to this point.

6.4.1.2 In the case of tubes with an outside diameter of 200 mm or more, and where straightening is not required, the manufacturer shall be permitted to take test pieces transverse to the tube axis and machine them on all sides to produce flat or round bar test pieces.

6.4.2 Impact test

For the impact test, a set of three ISO-V notch test pieces shall be taken transverse to the tube axis. For tubes with a wall thickness exceeding 30 mm, the axis of the test pieces shall be located at a point which corresponds to a distance from the outer surface equal to one-fourth of the wall thickness, or as near as possible to this point.

The test pieces shall be taken and prepared so that the notch axis runs at right angles to the tube surface.

6.4.3 Chemical composition

For determination of the chemical composition based on a product analysis of the manufactured tube, sample chips shall be taken at points uniformly distributed over the wall thickness, this also applying where spectral analysis is to be carried out. Unless otherwise specified, sampling shall be in accordance with *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805.

6.4.4 End quench test

Samples for end quench testing shall be taken in accordance with DIN 50191.

6.4.5 Austenitic grain size

Samples for determination of austenitic grain size shall be taken and prepared in accordance with DIN 50601.

6.4.6 Non-metallic inclusions

Sampling for determination of the non-metallic inclusions content shall be carried out on the lines of DIN 50602.

6.4.7 Depth of decarburization

Determination on the depth of skin decarburization shall normally be carried out on the lines of DIN 50192, on transverse microsections taken from the tube in its as delivered condition, having sufficiently sharp edges.

6.4.8 Hardness test

Sample preparation shall be carried out as specified in DIN 50351.

6.5 Test procedures

6.5.1 Tensile testing shall be carried out as described in DIN 50140 or DIN 50145.

6.5.2 Impact testing shall be carried out at ambient temperature, in accordance with DIN 50115. The minimum values specified in table 8 shall apply for the mean from three test pieces, but only one single value may be lower, by not more than 30%, than the specified minimum value.

6.5.3 The chemical composition shall be tested using a method specified in the *Handbuch für das Eisenhüttenlaboratorium* (Handbook for the ferrous metallurgy laboratory) and developed by the Chemists' Committee of the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgy Engineers).

6.5.4 End quench testing shall be carried out as described in DIN 50191, the test temperature being in compliance with the values specified in table 9. The hardness shall be determined as described in DIN 50103 Part 1, method C.

6.5.5 Tightness testing shall be carried out by applying an internal hydrostatic pressure as described in DIN 50104. Unless otherwise agreed, the test pressure shall be 80 bar, to be maintained for at least five seconds.

Instead of hydrostatic testing, the manufacturer shall be permitted to subject the tubes to non-destructive testing (e.g. by the eddy current method described in *Stahl-Eisen-Prüfblatt* 1925).

6.5.6 Tubes shall be visually checked under sufficient light, by a person with normal vision.

Note. Instead of the visual check, the manufacturer and purchaser may agree on a suitable alternative method.

6.5.7 The wall thickness at both tube ends shall be measured for dimensional accuracy using suitable instruments.

6.5.8 The tube diameter shall be established by way of two-point measurement using suitable instruments.

6.5.9 Determination of austenitic grain size shall be carried out as described in DIN 50601 and, unless otherwise agreed, by means of the quench test specified therein.

6.5.10 Determination of the oxidic non-metallic inclusions content shall be carried out using method K as described in subclause 8.2.2 of DIN 50602.

6.5.11 Non-destructive ultrasonic testing shall be carried out as described in *Stahl-Eisen-Prüfblatt* 1915 or by means of an equivalent method.

6.5.12 Determination of the depth of skin decarburization shall be carried out as described in DIN 50192.

6.5.13 Hardness testing shall be carried out as described in DIN 50351.

6.5.14 Determination of materials identity shall be carried out by suitable means.

6.6 Retests

6.6.1 Tubes which do not satisfy the requirements specified in subclauses 6.5.5 to 6.5.8 shall be sorted out. The manufacturer shall be entitled to correct any defects or deficiencies determined upon testing and to submit the tubes for renewed inspection.

6.6.2 If one test tube fails the tensile test or, if applicable, the impact test, the manufacturer shall be permitted to retest twice the number of test pieces taken from the same tube, in which case all test pieces shall satisfy the requirements. If this is not the case, the tube shall be sorted out.

Instead of retesting the failed tubes as described above, two other tubes may be taken from the same batch and subjected to renewed tensile and, if applicable, impact testing. Should these tubes also fail, the batch shall be deemed not to be in conformance with this standard. However, the manufacturer and purchaser may agree that all units belonging to the same batch be tested individually.

The manufacturer shall be permitted to correct defects or deficiencies by means of heat treatment or in another suitable manner, and resubmission of a failed batch shall be at his discretion. If the batch fails testing after resubmission, it shall be deemed not to be in conformance with this standard.

6.6.3 Test results that may be deemed to have been falsified by incorrect sampling, sample preparation or testing shall not be counted.

7 Marking

7.1 Hot formed tubes in compliance with this standard shall be clearly and durably marked with the following information:

a) manufacturer's mark;
b) material designation or number;
c) the symbol N or V, where one of these conditions has been agreed;
d) the inspector's mark (where acceptance inspection has been agreed);
e) symbol indicating that the products have been subjected to non-destructive testing.

7.2 Tubes shall be marked by means of stamping, engraving or imprinting. Thin-walled tubes or those with small outside diameters may be marked by other suitable means (e.g. by labelling the bundle).

7.3 Cold formed tubes shall normally be marked by means of a label on the bundle containing the information given in subclause 7.1.

8 Complaints

8.1 Under current law, warranty claims may only be raised against defective products if the defects impair their processing and use to a more than negligible degree. This shall apply unless otherwise agreed at the time of ordering.

8.2 It is normal and practical for the purchaser to give the supplier the opportunity to judge whether the complaints are justified, if possible by submitting the products objected to or samples of the products supplied.

Footnotes to table 1:

1) Elements that are not given in the table shall not be added intentionally to the material without the purchaser's consent, except to finally treat the cast. In cases of doubt, the limit values specified in DIN EN 10020 shall apply.
2) With the exception of sulfur and phosphorus, slight deviations in the ladle analysis from the limit values specified shall be permitted, provided that either narrower hardenability scatterbands in the end quench test (cf. footnotes 1 and 2 to table 4), or that quenched and tempered or normalized products complying with the requirements specified in table 7 or 8 are ordered. The deviations specified in table 2 shall also be complied with.
3) Single values given (i.e. not ranges) represent the maximum permissible content.
4) The steel is intended for special applications.
5) •• This steel may also be ordered with a lead content of 0,15 to 0,30 %, identified by material designation (or material number) C 22 Pb (1.0404), C 35 Pb (1.0502), C 45 Pb (1.0504), C 55 Pb (1.0537) and C 60 Pb (1.0602).

Table 1. **Steel grades and their chemical composition as determined by ladle analysis**

Material		Percentage by mass [1], [2]								
designation	number	C	Si max.	Mn	P max.	S [3]	Cr	Mo	Ni	V
C 22 [4], [5]	1.0402 [4], [5]	0,17 to 0,24	0,40	0,30 to 0,60	0,045	0,045	–	–	–	–
Ck 22 [4]	1.1151 [4]				0,035	0,035				
Cm 22 [4]	1.1149 [4]				0,035	0,020 to 0,035				
C 35 [5]	1.0501 [5]	0,32 to 0,39	0,40	0,50 to 0,80	0,045	0,045	–	–	–	–
Ck 35	1.1181				0,035	0,035				
Cm 35	1.1180				0,035	0,020 to 0,035				
C 45 [5]	1.0503 [5]	0,42 to 0,50	0,40	0,50 to 0,80	0,045	0,045	–	–	–	–
Ck 45	1.1191				0,035	0,035				
Cm 45	1.1201				0,035	0,020 to 0,035				
C 55 [4], [5]	1.0535 [4], [5]	0,52 to 0,60	0,40	0,60 to 0,90	0,045	0,045	–	–	–	–
Ck 55 [4]	1.1203 [4]				0,035	0,035				
Cm 55 [4]	1.1209 [4]				0,035	0,020 to 0,035				
C 60 [5]	1.0601 [5]	0,57 to 0,65	0,40	0,60 to 0,90	0,045	0,045	–	–	–	–
Ck 60	1.1221				0,035	0,035				
Cm 60	1.1223				0,035	0,020 to 0,035				
28 Mn 6	1.1170	0,25 to 0,32	0,40	1,30 to 1,65	0,035	0,035	–	–	–	–
36 Mn 4	1.0561	0,32 to 0,40		0,90 to 1,20	0,040	0,040				
36 Mn 5	1.1167			1,20 to 1,50	0,035	0,035				
41 Cr 4	1.7035	0,38 to 0,45	0,40	0,60 to 0,90	0,035	0,035	0,90 to 1,20	–	–	–
25 CrMo 4	1.7218	0,22 to 0,29	0,40	0,60 to 0,90	0,035	0,035	0,90 to 1,20	0,15 to 0,30	–	–
34 CrMo 4	1.7220	0,30 to 0,37	0,40	0,60 to 0,90	0,035	0,035	0,90 to 1,20	0,15 to 0,30	–	–
42 CrMo 4	1.7225	0,38 to 0,45	0,40	0,60 to 0,90	0,035	0,035	0,90 to 1,20	0,15 to 0,30	–	–
36 CrNiMo 4	1.6511	0,32 to 0,40	0,40	0,50 to 0,80	0,035	0,035	0,90 to 1,20	0,15 to 0,30	0,90 to 1,20	–
34 CrNiMo 6	1.6582	0,30 to 0,38	0,40	0,40 to 0,70	0,035	0,035	1,40 to 1,70	0,15 to 0,30	1,40 to 1,70	–
30 CrNiMo 8	1.6580	0,26 to 0,34	0,40	0,30 to 0,60	0,035	0,035	1,80 to 2,20	0,30 to 0,50	1,80 to 2,20	–
30 CrMoV 9	1.7707	0,26 to 0,34	0,40	0,40 to 0,70	0,035	0,035	2,30 to 2,70	0,15 to 0,25	–	0,10 to 0,20

For [1] to [5], see page 6.

Table 2. **Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for ladle analysis**

Element	Maximum content as determined by ladle analysis, as a percentage by mass		Limit deviations in the product analysis from the limiting values specified for the ladle analysis, as a percentage by mass [1]
C		≤ 0,55	0,02
	> 0,55	≤ 0,65	0,03
Si		≤ 0,40	0,03
Mn		≤ 1,00	0,04
	> 1,00	≤ 1,65	0,05
P		≤ 0,045	0,005
S		≤ 0,045	0,005
Cr		≤ 2,00	0,05
	> 2,00	≤ 2,70	0,10
Mo		≤ 0,30	0,03
	> 0,30	≤ 0,50	0,04
Ni		≤ 2,00	0,05
	> 2,00	≤ 2,20	0,07
V		≤ 0,20	0,02

[1] If a number of product analyses are to be carried out, the deviations within one cast that an element shows shall either be above the upper limit or below the lower limit of the range specified for the ladle analysis, but not both at the same time for one cast.

Table 3. **Requirements and inspection documents as a function of heat treatment condition**

Heat treatment condition	Symbol for		Relevant requirements (unless otherwise agreed) for			Hardenability as in table 4 [1]	Type of DIN 50049 inspection document			
	hot formed tubes	cold formed tubes	chemical composition	hardness as in table 6	mechanical properties		2.2	3.1B	3.1C	3.1A
Not heat treated	U	BK	X	–	Cf. subclauses 5.4.2 and 5.4.3.	X	X	X	–	–
Annealed	G	GBK	X	X [2]		X	X	X [2]	–	–
Normalized	N [3]	NBK	X	–	X	X	X	X	X	X
Quenched + tempered	V	V	X	–	X	–	–	X	X	X

[1] Only applies to high-grade steel (cf. subclauses 5.5 and 5.5.1).
[2] •• Subject to agreement at the time of ordering.
[3] Cf. subclause 5.2.1.

Table 4. **Limiting values of Rockwell C hardness determined in the end quench test** [1], [2], [3]
(Hardness values not specified in this table may be taken from figures 2a to 2m.)

Material designation	Material number	Limits of hardenability scatterband	Hardness, in HRC, at a distance from quenched end face, in mm, of																				
			1	1,5	2	3	4	5	6	7	8	9	10	11	13	15	20	25	30	35	40	45	50
Ck 35 [4], [5]	1.1181 [4], [5]	Maximum	58	–	57	55	53	49	41	34	31	28	27	26	25	24	23	20	–	–	–	–	–
Cm 35 [4], [5]	1.1180 [4], [5]	Minimum	48	–	40	33	24	22	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Ck 45 [4], [5]	1.1191 [4], [5]	Maximum	62	–	61	61	60	57	51	44	37	34	33	32	31	30	29	28	27	–	–	–	–
Cm 45 [4], [5]	1.1201 [4], [5]	Minimum	55	–	51	37	30	28	27	26	25	24	23	22	21	20	–	–	–	–	–	–	–
Ck 55 [4], [5]	1.1203 [4], [5]	Maximum	65	–	64	63	62	60	57	52	45	37	36	35	34	33	32	30	29	–	–	–	–
Cm 55 [4], [5]	1.1209 [4], [5]	Minimum	58	–	55	47	37	33	32	31	30	29	28	27	26	25	24	22	20	–	–	–	–
Ck 60 [4], [5]	1.1221 [4], [5]	Maximum	67	–	66	65	63	62	59	54	47	39	37	36	35	34	33	31	30	–	–	–	–
Cm 60 [4], [5]	1.1223 [4], [5]	Minimum	60	–	57	50	39	35	33	32	31	30	29	28	27	26	25	23	21	–	–	–	–
28 Mn 6 [4], [5]	1.1170 [4], [5]	Maximum	55	–	–	54	–	51	–	48	–	44	–	41	38	35	31	29	27	26	25	25	24
		Minimum	46	–	–	43	–	37	–	27	–	21	–	–	–	–	–	–	–	–	–	–	–
36 Mn 5 [6]	1.1167 [6]	Maximum																					
		Minimum																					
41 Cr 4 [4]	1.7035 [4]	Maximum	–	61	–	61	–	60	–	59	–	58	–	56	54	52	46	42	40	38	37	36	35
		Minimum	–	53	–	52	–	50	–	47	–	41	–	37	34	33	29	26	23	21	–	–	–
25 CrMo 4 [4]	1.7218 [4]	Maximum	–	52	–	52	–	51	–	50	–	48	–	46	43	41	37	35	33	32	31	31	31
		Minimum	–	44	–	43	–	40	–	37	–	34	–	32	29	27	23	21	20	–	–	–	–
34 CrMo 4 [4]	1.7220 [4]	Maximum	–	57	–	57	–	57	–	56	–	55	–	54	53	52	48	45	43	41	40	40	39
		Minimum	–	49	–	49	–	48	–	45	–	42	–	39	36	34	30	28	27	26	25	24	24
42 CrMo 4 [4]	1.7225 [4]	Maximum	–	61	–	61	–	61	–	60	–	60	–	59	59	58	56	53	51	48	47	46	45
		Minimum	–	53	–	53	–	52	–	51	–	49	–	43	40	37	34	32	31	30	30	29	29
36 CrNiMo 4 [4]	1.6511 [4]	Maximum	–	59	–	59	–	58	–	58	–	57	–	57	57	56	55	54	53	52	51	50	49
		Minimum	–	51	–	50	–	49	–	49	–	48	–	47	46	45	43	41	39	38	36	34	33
34 CrNiMo 6 [4]	1.6582 [4]	Maximum	–	58	–	58	–	58	–	58	–	57	–	57	57	57	57	57	57	57	57	57	57
		Minimum	–	50	–	50	–	50	–	50	–	49	–	48	48	48	48	47	47	47	46	45	44
30 CrNiMo 8 [4]	1.6580 [4]	Maximum	–	56	–	56	–	56	–	56	–	55	–	55	55	55	55	54	54	54	54	54	54
		Minimum	–	48	–	48	–	48	–	48	–	47	–	47	47	46	46	45	45	44	44	43	43
30 CrMoV 9 [4]	1.7707 [4]	Maximum	–	56	–	56	–	56	–	56	–	56	–	56	55	55	54	53	52	51	50	49	48
		Minimum	–	48	–	48	–	47	–	47	–	46	–	46	45	44	41	39	38	37	36	35	34

[1] ●● For unalloyed steels (except 28 Mn 6 steel), at the following distances from the quenched end face, a restriction of the hardenability scatterband to two-thirds width, either from the upper or the lower limiting curve (cf. table 5) may be agreed:

Ck 35, Cm 35, Ck 45 and Cm 45, at 4 mm;
Ck 55, Cm 55, Ck 60 and Cm 60, at 5 mm.

If necessary, a similar agreement may also be made in each case for a distance of 1 mm from the end face.

If a restriction in the hardenability scatterband with respect to the upper limiting curve is required, the symbol HH and the associated distance from the end face, x, i.e. HH 4 or HH 5, shall be specified in the order; if a restriction in the hardenability scatterband with respect to the lower limiting curve is required, the symbol HL and the associated distance from the end face, i.e. HL 4 or HL 5, shall be specified in the order. If at the same time the restriction is also to apply at a distance of 1 mm from the end face, the digit 1 shall precede digit 4 or 5, i.e. HL 1 4 or HL 1 5.

[2] ●● For alloy steel and 28 Mn 6 steel, restricted hardenability scatterbands in comparison with the original scatterband determined in the end quench test, i.e. restricted with respect to the upper limiting curve or the lower limiting curve (cf. figures 2e to 2m), may be agreed at the time of ordering. If a restriction in the hardenability scatterband with respect to the upper or lower limiting curve is required, the symbol HH or HL, respectively, shall be specified in the order.

[3] ●● Within the context of the conditions specified, particular values for hardenability in the end quench test may be agreed at the time of ordering.

[4] The limiting values of Rockwell C hardness have been taken from DIN 17 200 (superseded by DIN EN 10 083 Parts 1 and 2).

[5] The Rockwell C hardness values are to be regarded as provisional for this steel.

[6] Specifications have not yet been made with regard to the limits of hardenability scatterband for this steel.

Table 5. **Possible restriction of the hardenability scatterbands at one or two distances from the quenched end faces in the case of unalloyed steel** [1]

Material		Hardness, in HRC, at a distance from the quenched end face, in mm, of			Restriction of hardenability scatterband [2]
designation	number	1	4	5	
Ck 35	1.1181	51 to 58	34 to 53	–	HH
Cm 35	1.1180	48 to 55	24 to 43	–	HL
Ck 45	1.1191	57 to 62	41 to 60	–	HH
Cm 45	1.1201	55 to 60	30 to 50	–	HL
Ck 55	1.1203	60 to 65	–	42 to 60	HH
Cm 55	1.1209	58 to 63	–	33 to 51	HL
Ck 60	1.1221	62 to 67	–	44 to 62	HH
Cm 60	1.1223	60 to 65	–	35 to 53	HL

[1] Cf. table 4 and figures 2a to 2d.
[2] Cf. footnote 1 to table 4.

Table 6. **Maximum hardness for tubes supplied in the annealed condition (G and GBK)**

Material		Maximum Brinell hardness, in HB 30
designation	number	
C 22	1.0402	156
Ck 22	1.1151	
Cm 22	1.1149	
C 35	1.0501	183
Ck 35	1.1181	
Cm 35	1.1180	
C 45	1.0503	207
Ck 45	1.1191	
Cm 45	1.1201	
C 55	1.0535	229
Ck 55	1.1203	
Cm 55	1.1209	
C 60	1.0601	241
Ck 60	1.1221	
Cm 60	1.1223	
28 Mn 6	1.1170	223
36 Mn 4	1.0561	217
36 Mn 5	1.1167	
41 Cr 4	1.7035	241
25 CrMo 4	1.7218	212
34 CrMo 4	1.7220	223
42 CrMo 4	1.7225	241
36 CrNiMo 4	1.6511	248
34 CrNiMo 6	1.6582	248
30 CrNiMo 8	1.6580	248
30 CrMoV 9	1.7707	248

Table 7. **Mechanical properties of tubes with wall thicknesses up to 80 mm supplied in the normalized condition (N)** [1]

Material		Minimum upper yield stress [2], R_{eH}, or 0,2 % proof stress, in N/mm², for the following wall thicknesses, in mm			Tensile strength, R_m, in N/mm², for the following wall thicknesses, in mm			Minimum elongation at fracture, A_5, as a percentage, for the following wall thicknesses, in mm					
								≤ 16		> 16 ≤ 40		> 40 ≤ 80	
desig-nation	number	≤ 16	> 16 ≤ 40	> 40 ≤ 80	≤ 16	> 16 ≤ 40	> 40 ≤ 80	Longitudinal	Transverse	Longitudinal	Transverse	Longitudinal	Transverse
C 22 Ck 22 Cm 22	1.0402 1.1115 1.1149	260	240	220	420 to 550	400 to 530	380 to 510	21	19	24	22	24	22
C 35 Ck 35 Cm 35	1.0501 1.1181 1.1180	300	280	270	520 to 670	500 to 650	480 to 630	17	15	19	17	21	19
C 45 Ck 45 Cm 45	1.0503 1.1191 1.1601	350	330	320	610 to 760	590 to 740	570 to 720	16	14	17	15	17	15
C 55 Ck 55 Cm 55	1.0535 1.1203 1.1209	370	350	340	670 to 820	650 to 800	620 to 770	14	12	15	13	15	13
C 60 Ck 60 Cm 60	1.0601 1.1221 1.1223	390	370	360	720 to 900	700 to 880	670 to 850	13	11	14	12	14	12
28 Mn 6	1.1170	380	360	340	580 to 730	520 to 670	470 to 620	16	14	17	15	18	16
36 Mn 4	1.0561	360	340	320	600 to 750	550 to 700	500 to 650	16	14	17	15	18	16
36 Mn 5	1.1167	380	360	340	650 to 820	600 to 770	550 to 720	15	13	16	14	17	15

[1] • Where the wall thickness exceeds 80 mm, values of mechanical properties shall be the subject of agreement

[2] If there is no pronounced yield point, the values shall apply for the 0,2 % proof stress.

Table 8. **Mechanical properties of tubes with wall thicknesses up to 80 mm supplied in the quenched and tempered condition (V) [1]**

Material		Minimum upper yield stress [2], R_{eH}, or 0,2 % proof stress, in N/mm², for the following wall thicknesses, in mm				Tensile strength, R_m, in N/mm², for the following wall thicknesses, in mm				Minimum elongation at fracture, A_5, as a percentage, for the following wall thicknesses, in mm								Minimum reduction in area at fracture, Z, as a percentage, for the following wall thicknesses, in mm				Minimum impact energy (ISO-V), A_V, in J, for the following wall thicknesses, in mm		
		≤ 8	> 8 ≤ 20	> 20 ≤ 50	> 50 ≤ 80	≤ 8	> 8 ≤ 20	> 20 ≤ 50	> 50 ≤ 80	≤ 8		> 8 ≤ 20		> 20 ≤ 50		> 50 ≤ 80		≤ 8	> 8 ≤ 20	> 20 ≤ 50	> 50 ≤ 80	> 18 ≤ 20	> 20 ≤ 50	> 50 ≤ 80
designation	number									Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse	Longi-tudinal	Trans-verse							
C 22	1.0402	340	290	270	260	500 to 700	470 to 670	440 to 640	420 to 620	20	18	22	20	22	20	22	20	50	50	50	50	–	–	–
Ck 22	1.1151																					50	40	40
Cm 22	1.1149																							
C 35	1.0501	430	380	320	290	630 to 830	600 to 800	550 to 750	500 to 700	17	15	19	17	20	18	20	18	40	45	50	50	–	–	–
Ck 35	1.1181																					35	35	35
Cm 35	1.1180																							
C 45	1.0503	490	430	370	340	700 to 900	650 to 850	630 to 830	600 to 800	14	12	16	14	17	15	17	15	35	40	45	45	–	–	–
Ck 45	1.1191																					25	25	25
Cm 45	1.1201																							
C 55	1.0535	550	490	420	390	800 to 1000	750 to 950	700 to 900	660 to 860	12	10	14	12	15	13	15	13	30	35	40	40	–	–	–
Ck 55	1.1203																							
Cm 55	1.1209																							
C 60	1.0601	580	520	450	420	850 to 1050	800 to 1000	750 to 950	710 to 910	11	9	13	11	14	12	14	12	25	30	35	35	–	–	–
Ck 60	1.1221																							
Cm 60	1.1223																							
28 Mn 6	1.1170	590	490	440	–	800 to 1000	700 to 900	650 to 850	–	13	11	15	13	16	14	–	–	40	45	50	–	40	40	–
36 Mn 4	1.0561	550	450	400	–	800 to 1000	700 to 900	600 to 800	–	13	11	15	13	15	13	–	–	40	45	50	–	–	–	–
36 Mn 5	1.1167	600	500	400	–	830 to 1030	730 to 930	630 to 830	–	12	10	13	11	14	12	–	–	35	40	45	–	40	40	–
41 Cr 4	1.7035	800	660	560	–	1000 to 1200	900 to 1100	800 to 1000	–	11	9	12	10	14	12	–	–	30	35	40	–	35	35	–
25 CrMo 4	1.7218	700	600	450	400	900 to 1100	800 to 1000	700 to 900	650 to 850	12	10	14	12	15	13	16	14	50	55	60	60	50	50	45
34 CrMo 4	1.7220	800	650	550	500	1100 to 1200	900 to 1100	800 to 1000	750 to 950	11	9	12	10	14	12	15	13	45	50	55	55	40	45	45
42 CrMo 4	1.7225	900	750	650	550	1100 to 1300	1000 to 1200	900 to 1100	800 to 1000	10	8	11	9	12	10	13	11	40	45	50	50	35	35	35
35 CrNiMo 4	1.6511	900	800	700	600	1100 to 1300	1000 to 1200	900 to 1100	800 to 1000	10	8	11	9	12	10	13	11	45	50	55	60	40	45	45
34 CrNiMo 6	1.6582	1000	900	800	700	1200 to 1400	1100 to 1300	1000 to 1200	900 to 1100	9	7	10	8	11	9	12	10	40	45	50	55	45	45	45
30 CrNiMo 8	1.6580	1050		900	800	1250 to 1450		1100 to 1300	1000 to 1200	9	7	9	7	10	8	11	9	40		45	50	30	35	45
30 CrMoV 9	1.7707	1050		900	800	1250 to 1450		1100 to 1300	1000 to 1200	9	7	9	7	10	8	11	9	35		40	45	25	30	35

[1] • Where the wall thickness exceeds 80 mm, values of mechanical properties shall be the subject of agreement. In the case of 28 Mn 6, 36 Mn 4, 36 Mn 5 and 41 Cr 4 steels, they shall be the subject of agreement where the wall thickness exceeds 50 mm.

[2] If there is no pronounced yield point, the values shall apply for the 0,2 % proof stress.

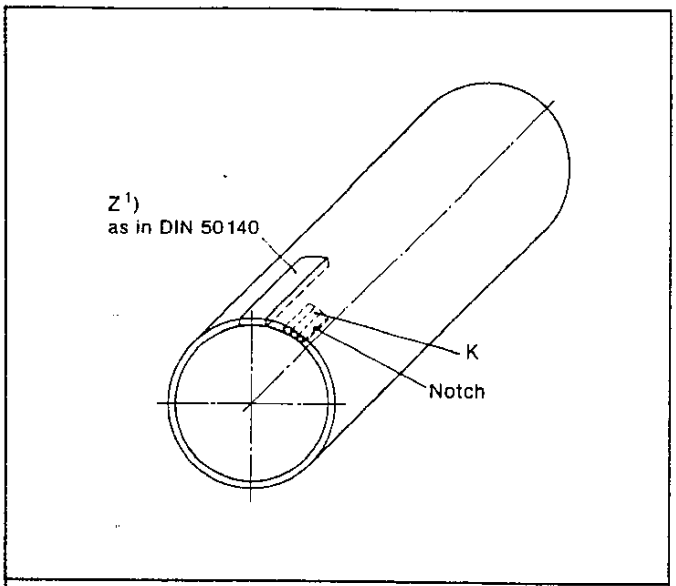
Table 10. **Types of length and limit deviations**

Type of length		Limit deviations, in mm
As manufactured length [1]		[1]
Specified length		$\pm$ 500
Exact length	$\leq$ 6 m	$^{+10}_{0}$
	> 6 m $\leq$ 12 m	$^{+15}_{0}$
	> 12 m	Subject to agreement.

[1] The as manufactured length is a function of outside diameter, wall thickness, and the manufacturer's works involved, and is to be declared by the manufacturer.

Table 11. **Summary of scope of testing and DIN 50 049 inspection documents for tubes subject to acceptance inspection** (See figure 1 for location and orientation of test pieces, and subclause 6.3.7 for batch sizes.)

No.	Test to be carried out	Subclause	Scope of testing	DIN 50 049 inspection document
1	Ladle analysis	5.3.1	1 analysis per cast (all elements given in table 1 for the relevant material).	DIN 50 049 – 2.2
2	Tensile test	6.4.1 6.5.1	1 test piece per batch.	DIN 50 049 – 3.1 A or DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C
3	Impact test	6.4.2 6.5.2	1 set of 3 test pieces from 1 test tube per batch, where s is at least 10 mm, in condition V, on one end.	DIN 50 049 – 3.1 A or DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C
4	Tightness test	6.2.1.3 6.5.5	All tubes.	DIN 50 049 – 3.1 B
5	Visual check	6.5.6	All tubes.	DIN 50 049 – 3.1 A or DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C
6	Check for dimensional accuracy	6.5.7 6.5.8	All tubes.	DIN 50 049 – 3.1 A or DIN 50 049 – 3.1 B or DIN 50 049 – 3.1 C
7	•• Materials identity test	6.3.1.5 6.5.14	All tubes.	DIN 50 049 – 3.1 B
8	•• Product analysis	6.4.3 6.5.3	1 test piece per batch.	DIN 50 049 – 3.1 B
9	•• End quench test	6.4.4 6.5.4	1 sample per cast.	DIN 50 049 – 3.1 B
10	•• Hardness test	6.4.8 6.5.13	1 test piece per batch.	DIN 50 049 – 3.1 B
11	•• Determination of grain size	6.4.5 6.5.9	1 test per cast.	DIN 50 049 – 3.1 B
12	•• Test for non-metallic inclusions	6.4.6 6.5.10	Subject to agreement.	DIN 50 049 – 3.1 B
13	•• Non-destructive testing	5.10.5 6.3.1.4	All tubes.	DIN 50 049 – 3.1 B
14	•• Check for depth of decarburization	6.3.4 6.5.12	At least 2 samples per consignment.	DIN 50 049 – 3.1 B



1) Cf. subclauses 6.4.1.1 and 6.4.1.2.

K = set of three DIN 50115 test pieces.
Z = tensile test piece (cf. subclause 6.4.1).

Figure 1. Test piece location and orientation

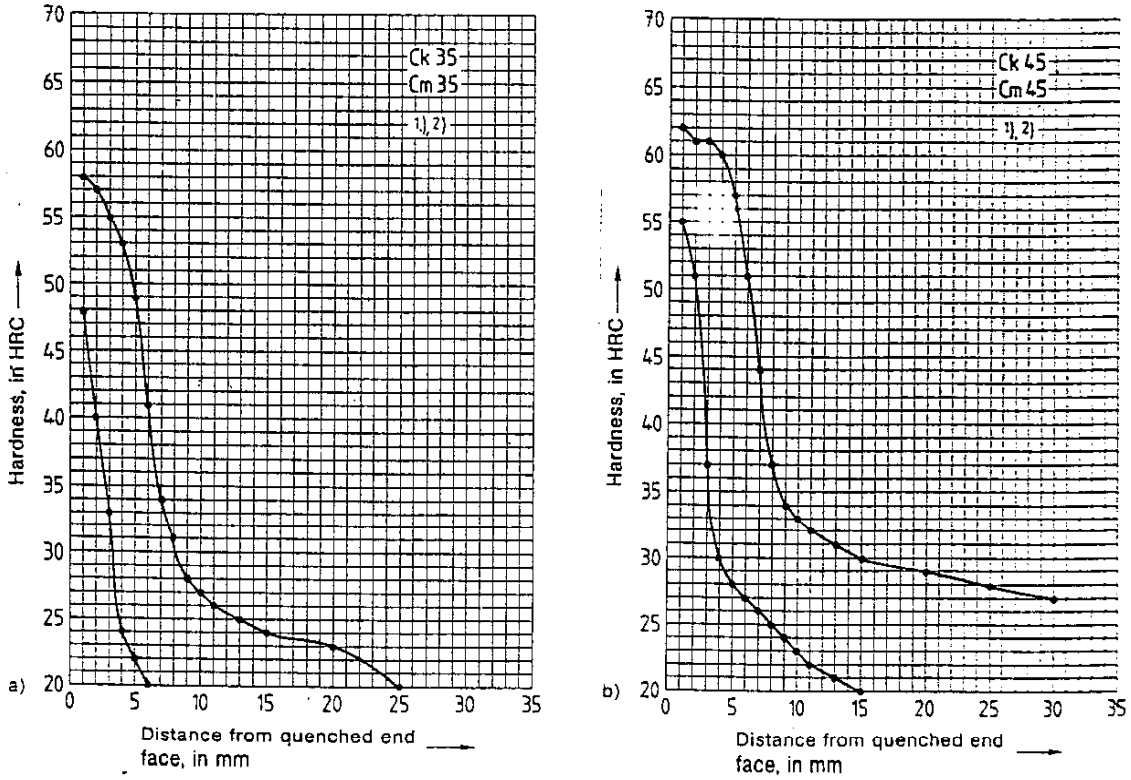
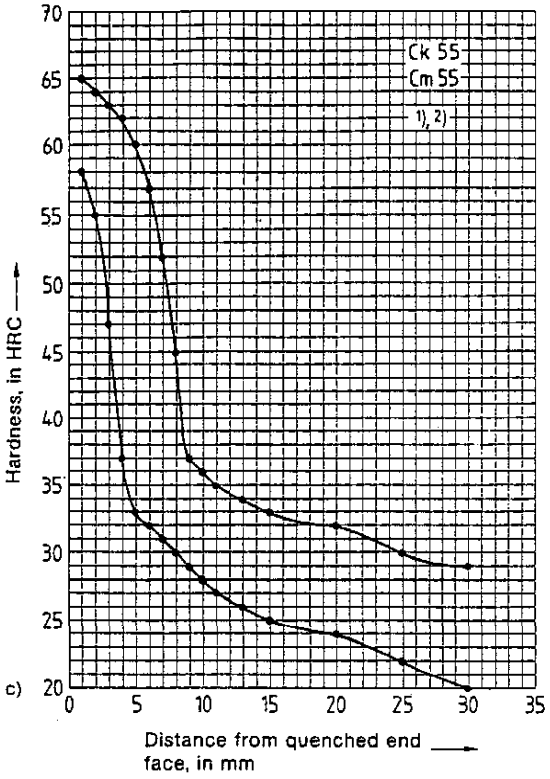


Figure 2. Scatterbands for Rockwell C hardness determined by end quench testing
(The curves shown in figures 2a to 2e are provisional.)

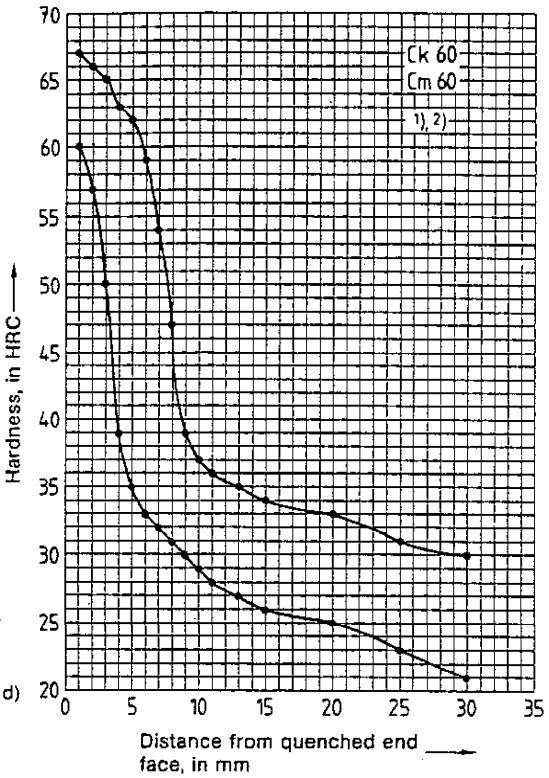
1) Cf. table 4.

2) It should be noted that when the hardness test indentations are spaced 1 mm apart, and with hardness values of less than 30 HRC, the indentations interact.

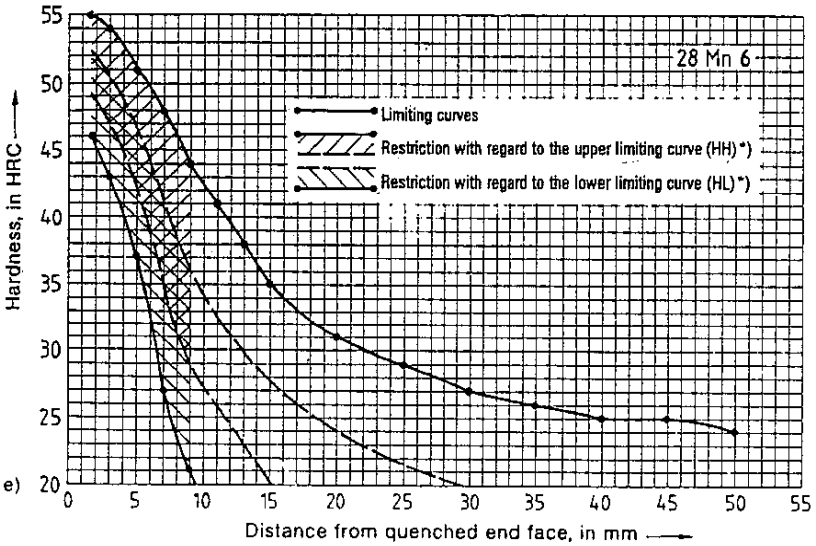
c)



d)

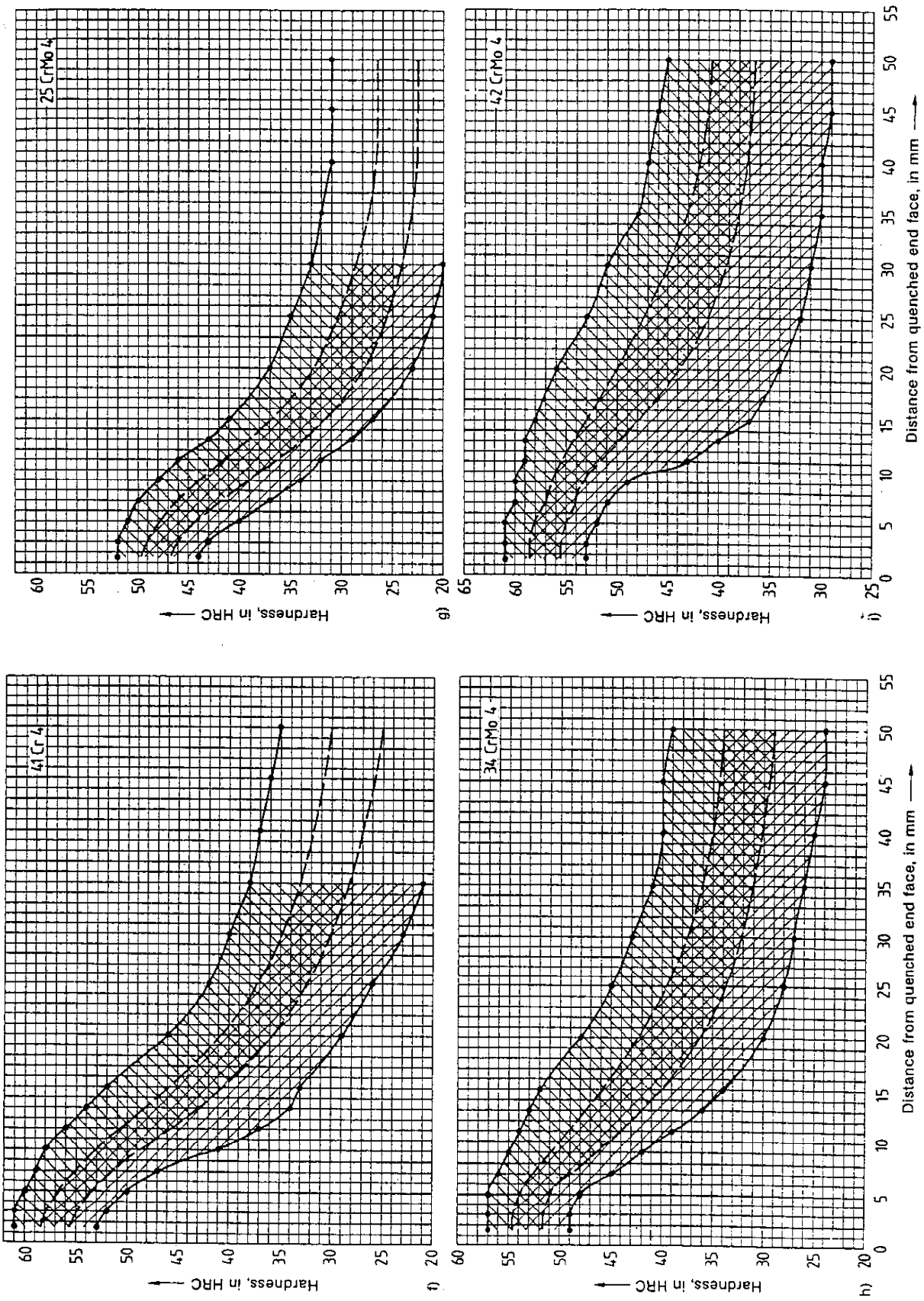


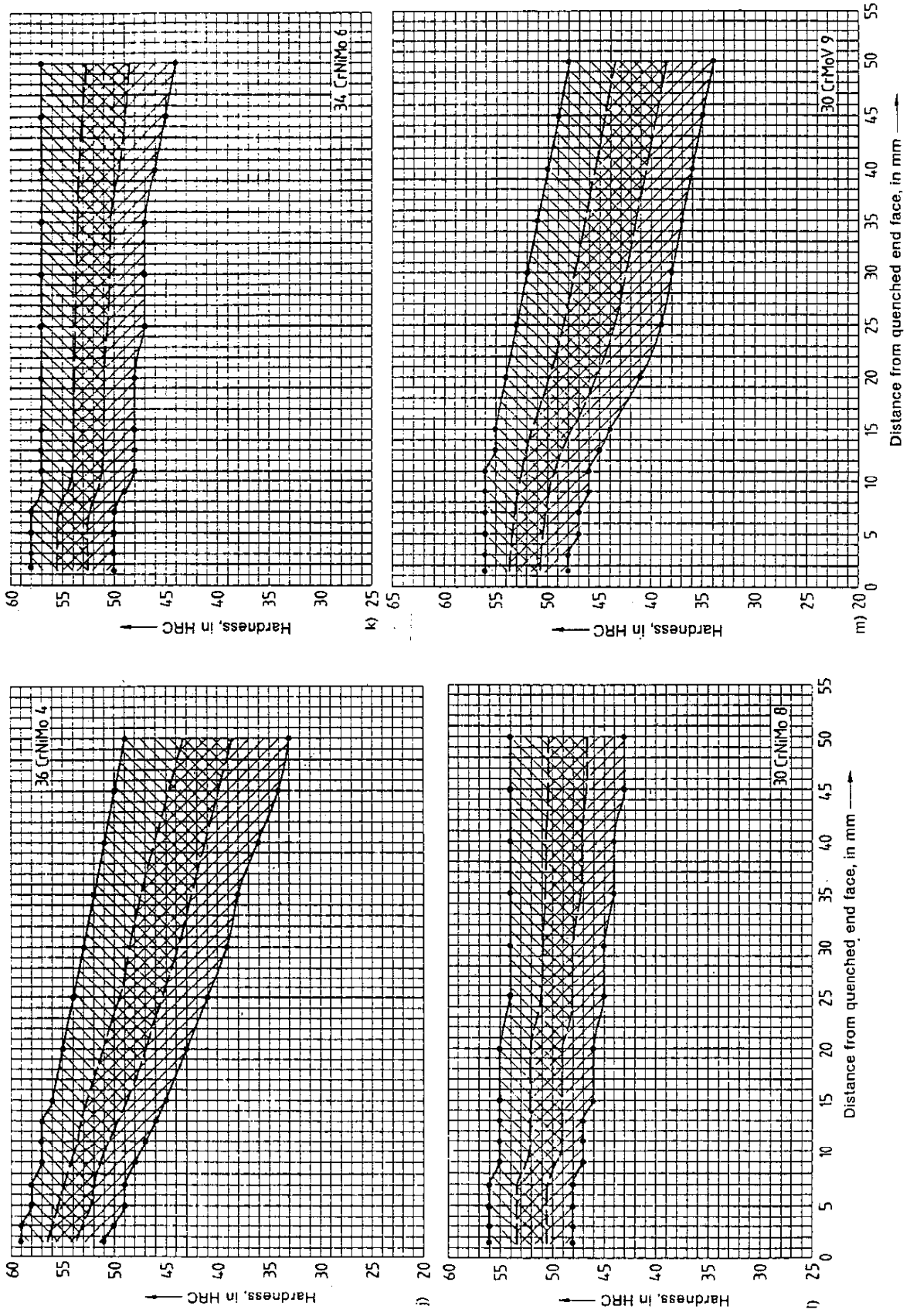
e)



*) The restricted hardenability scatterbands shall apply only up to the distance from the quenched end face for which a hardness value has been specified for the lower limiting curve; for greater distances, the restricted scatterbands are for guidance only.

For 1) and 2), see page 15.


25 CrMo 4
42 CrMo 4
41 Cr 4
34 CrMo 4
Hardness, in HRC
Distance from quenched end face, in mm
g)
i)
f)
h)


34 CrNiMo 6
30 CrMoV 9
36 CrNiMo 4
30 CrNiMo 8
Hardness, in HRC
Distance from quenched end face, in mm
k)
m)
j)
l)

Standards and other documents referred to

DIN 2391 Part 1	Seamless precision steel tubes; dimensions
DIN 2391 Part 2	Seamless precision steel tubes; technical delivery conditions
DIN 2448	Seamless steel pipes and tubes; dimensions and mass per unit length
DIN 8528 Part 1	Weldability of metallic materials; concepts
DIN 17014 Part 1	Heat treatment of ferrous materials; terminology
DIN 17200	Steels for quenching and tempering; technical delivery conditions (superseded by DIN EN 10083 Parts 1 and 2)
DIN 50049	Inspection documents for the delivery of metallic materials
DIN 50103 Part 1	Rockwell hardness testing of metallic materials; C, A, B, F scales
DIN 50104	Internal hydrostatic pressure testing of hollow bodies; general specifications
DIN 50115	Notched bar impact testing of metallic materials using test pieces other than ISO test pieces
DIN 50125	Test pieces for the tensile testing of metallic materials
DIN 50140	Testing of metallic materials; tensile testing of tubes and tube sections
DIN 50145	Tensile testing of metallic materials
DIN 50191	End quench hardenability testing of steel (Jominy test)
DIN 50192	Determination of depth of decarburization of steel
DIN 50351	Brinell hardness testing of metallic materials
DIN 50601	Determination of grain size of ferrite or austenite in ferrous materials by metallographic methods
DIN 50602	Microscopic examination of high-grade steel to determine the non-metallic inclusions content
DIN EN 10020	Definition and classification of steel grades
DIN EN 10083 Part 1	Quenched and tempered steels; technical delivery conditions for special steels
DIN EN 10083 Part 2	Quenched and tempered steels; technical delivery conditions for unalloyed quality steels

Stahl-Eisen-Werkstoffblatt 082 [3] *Begriffsbestimmungen zur thermomechanischen Behandlung von Stahl* (Concepts associated with thermomechanically formed steel)

Stahl-Eisen-Prüfblatt 1805 [3] *Probenahme und Probenvorbereitung für die Stückanalyse von Stählen* (Sampling and sample preparation for the product analysis of steel)

Stahl-Eisen-Prüfblatt 1915 [3] *Ultraschallprüfung auf Längsfehler von Rohren aus warmfesten Stählen* (Ultrasonic testing for longitudinal imperfections in steel tubes with elevated temperature properties)

Stahl-Eisen-Prüfblatt 1925 [3] *Elektromagnetische Prüfung von Rohren zum Nachweis der Dichtheit* (Electromagnetic testing of tubes for verification of leak tightness)

Handbuch für das Eisenhüttenlaboratorium [3]

Explanatory notes

At the request of tube manufacturers, it was decided to take seamless tubes out of the scope of the March 1987 edition of DIN 17200 and to cover them in a separate standard. The request and the decision were based on a number of factors:

a) on the one hand, not all DIN 17200 steels may be used for the manufacture of tubes; on the other, several suitable quenched and tempered steels are not covered in DIN 17200;

b) specifications could be made solely for tubes, which is of particular relevance in terms of testing;

c) the number of footnotes could be reduced, which facilitates data processing and printing;

d) revision of DIN 17200 would be facilitated.

Several DIN 17200 steels are not included here, since they are not suitable for the manufacture of seamless tubes. On the other hand, this standard includes Cm 22 (1.1149), 36 Mn 4 (1.0561) and 36 Mn 5 (1.1167) steels, which were not covered in the previous edition of DIN 17200.

As far as possible, the requirements regarding chemical composition, maximum hardness in the annealed condition, hardenability in the end quench test, and heat treatment have been adopted from DIN 17200. The Explanatory notes in DIN 17200 should be referred to with regard to more specific information on hardenability scatterbands.

The mechanical properties specified for the normalized and the quenched and tempered conditions are based on the specifications made in DIN EN 10083 Parts 1 and 2.

International Patent Classification

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[3] Obtainable from *Verlag Stahleisen mbH*, Postfach 82 29, D-4000 Düsseldorf 1.