

UDC 669.14.018.26-42

October 1989

Cold heading and cold extruding steelsTechnical delivery conditions
General**DIN**
1654
Part 1

Kaltstauch- und Kaltfließpreßstähle; technische Lieferbedingungen; Allgemeines Supersedes March 1980 edition.

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.

See Explanatory notes for connection with Euronorm 119-74 published by the European Coal and Steel Community (ECSC) and with International Standard ISO 4954 : 1979 published by the International Organization for Standardization (ISO).

The clauses and subclauses marked ● give specifications which are to be agreed upon at the time of ordering, those marked ●● give specifications which are optional and may be agreed upon at the time of ordering.

1 Field of application

1.1 This standard applies to steels intended for cold heading or cold extruding and delivered as wire or steel bars. It covers the following steel groups and diameter ranges:

- a) killed unalloyed steels not intended for heat treatment, with diameters from 2 to 100 mm (see DIN 1654 Part 2);
- b) case hardening steels with diameters from 2 to 100 mm (see DIN 1654 Part 3);
- c) steels for quenching and tempering with diameters from 2 to 100 mm (see DIN 1654 Part 4);
- d) stainless steels with diameters from 5 mm (or by particular agreement, from 1,5 mm) to 15 mm in the case of ferritic steels and to 63 mm in the case of martensitic and austenitic steels (see DIN 1654 Part 5).

●● Subject to agreement at the time of ordering, steel bars and wire may also be supplied with diameters larger than those specified under items a) to d).

1.2 This standard does not deal with the properties of cold headed or cold extruded parts that have not been subjected to a subsequent heat treatment, because the properties are largely a function of the cold forming conditions.

1.3 In addition to the requirements specified in this standard, the general technical delivery conditions for steel and steel products given in DIN 17 010 shall apply unless otherwise specified in this standard.

2 Concepts**2.1 Cold heading and cold extruding steels**

Cold heading and cold extruding steels are characterized by good cold forming properties, good surface condition and,

depending on the steel grade, an initial strength suited to the forming process used, a lower initial strength being obtained by annealing where required.

2.2 Product forms

See Euronorm 79 for definitions.

2.3 Heat treatment

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

3 ● Dimensions and limit deviations

The dimensions and limit deviations shall be agreed at the time of ordering, reference being made, if possible, to the dimensional standards listed in appendix A.

4 Mass

4.1 The nominal mass of stainless steel shall be calculated using the specifications listed in table 7 of DIN 1654 Part 5, October 1989 edition, and that of any other steel shall be calculated taking the density as 7,85 kg/dm³.

4.2 ●● Unless the dimensional standard stated in the order specifies limit deviations for the mass, these may be agreed at the time of ordering.

5 Designation and ordering

5.1 The standard designation for steel covered in this standard shall give, in the following order:

Continued on pages 2 to 13

the name of product (steel);
the number of this standard;
the material designation or material number identifying the steel grade (see table 2 of DIN 1654 Parts 2 to 5, respectively, October 1989 editions¹⁾);
the symbols identifying the treatment condition on delivery (see table 1 of DIN 1654 Parts 2 to 5, respectively).

Example:

Steel DIN 1654 – 16 MnCr 5 GKZ
or
Steel DIN 1654 – 1.7131 GKZ

5.2 The standard designation of steel products shall be formed as specified in the relevant dimensional standard.

5.3 The order shall provide any information necessary for a clear description of the required products including their condition and the test methods to be applied. If the designation given in subclause 5.1 or 5.2 does not fully describe the steel as ordered, e.g. where agreements have been made with respect to clauses or subclauses marked ● or ●●, the designation shall be supplemented accordingly.

6 Steel grades

Table 2 of DIN 1654 Parts 2 to 5, respectively, specifies the steel grades for the relevant steel groups listed under items a) to d) of subclause 1.1.

7 Requirements

7.1 ●● Manufacturing process

Unless otherwise agreed at the time of ordering, the steel-making process, the casting process and the forming process shall be at the manufacturer's discretion. On request, the customer shall, however, be informed of the steelmaking process applied and, where relevant, of the casting process.

7.2 Treatment condition of material on delivery

7.2.1 ● The treatment condition in which the steel is to be supplied shall be agreed at the time of ordering. Table 1 of DIN 1654 Parts 2 to 5, respectively, lists the usual treatment conditions.

7.2.2 ●● Any surface treatment facilitating cold forming and providing a certain degree of rust protection, such as descaling, copper plating, lime coating, phosphatizing, greasing, oiling, etc. shall be the subject of particular agreement at the time of ordering.

7.3 Chemical composition, mechanical properties and hardenability

Table 1 of DIN 1654 Parts 2 to 5, respectively, summarizes combinations of usual treatment conditions of the material on delivery, product forms and requirements regarding chemical composition and mechanical properties of steel covered in DIN 1654 Parts 2 to 5 and requirements regarding hardenability of steel covered in DIN 1654 Parts 3 and 4.

7.3.1 The chemical composition as determined by ladle analysis shall comply with the specifications of table 2 of DIN 1654 Parts 2 to 5, respectively.

7.3.2 The amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for the ladle analysis shall be as given in table 3 of DIN 1654 Parts 2 to 5, respectively.

7.3.3 The mechanical properties shall be as specified in subclause 7.3.3 of DIN 1654 Parts 2 to 5, respectively.

7.3.4 Products made from case hardening steel or steel for quenching and tempering shall comply with the requirements regarding hardenability in the end quench test specified in subclause 7.3.4 of DIN 1654 Part 3 or 4.

7.3.5 Products made from steel for quenching and tempering shall comply with the requirements regarding core hardness specified in subclause 7.3.5 of DIN 1654 Part 4.

7.4 Microstructure

7.4.1 ●● Austenitic grain size

If a 'fine grain steel' has been ordered for products made from case hardening steel or steel for quenching and tempering as specified in DIN 1654 Parts 3 and 4, the grain size index for the austenite shall be 5 or finer when tested as described in DIN 50 601.

Note. It should be taken into account that unalloyed fine grain case hardening steels tend to form soft spots.

7.4.2 ●● If requirements regarding spheroidization of carbides have been ordered for products made from case hardening steel or steel for quenching and tempering as specified in DIN 1654 Parts 3 and 4, these steels shall have a microstructure which is characterized by a high degree of spheroidization of the carbides. It should, however, be taken into account that spheroidization of the cementite is more difficult for steel with lower carbon content.

7.5 Surface condition and soundness

7.5.1 The steel shall be free from defects liable to make it split during normal cold heading or cold extruding or during normal quench hardening.

For the steel to meet quality class 4 specifications given in *Stahl-Eisen-Lieferbedingungen* (Iron and steel delivery conditions) 055 (at present at the stage of draft), the following requirements in respect of freedom from surface defects shall be satisfied.

- In tests as described in subclauses 8.4.9 and 8.5.7, the test pieces shall not exhibit any cracks.
- In tests as described in subclauses 8.4.10 and 8.5.8, the requirement specified under item a) shall be complied with.
- In tests as described in subclauses 8.4.11 and 8.5.9, the minimum number of twists in each direction shall be five and the requirement specified under item a) shall be complied with.

●● Agreements regarding the depth of cracks may be made for peeled or ground steel bars or wire taking into account the particular test method. Grooves resulting from rolling scores associated with normal machining do not count as defects.

¹⁾ *DIN-Normenheft* (DIN Standardization booklet) No. 3 provides information on how the material designations and numbers for steels are formed.

Table 1. ●● Microscopic degree of cleanness of high-grade steel¹⁾
(applies to oxidic nonmetallic inclusions)

Diameter, d , of steel bars (or cross section of equal area), in mm	Case hardening steel (DIN 1654 Part 3) Overall index, K (oxides), for the particular cast	Steel for quenching and tempering (DIN 1654 Part 4) Overall index, K (oxides), for the particular cast
Above 70 up to 100	$K 4 \leq 50$	$K 4 \leq 40$
Above 35 up to 70	$K 4 \leq 45$	$K 4 \leq 35$
Above 17 up to 35	$K 3 \leq 45$	$K 3 \leq 40$
Above 8 up to 17	$K 3 \leq 35$	$K 3 \leq 30$
Up to 8	$K 2 \leq 40$	$K 2 \leq 35$
For 1), see subclause 7.5.2.		

7.5.2 ●● If requirements regarding the degree of cleanness (applicable to oxidic nonmetallic inclusions) determined microscopically as specified in DIN 50 602 have been agreed at the time of ordering steel covered in DIN 1654 Parts 3 and 4, the values given in table 1 shall apply for the overall index, K , of the particular cast.

7.5.3 When evaluating test pieces taken from coils, it shall be taken into account that the test pieces as specified in subclause 8.4.10 have been taken from one end of the coil only.

In cases of doubt, a production test on a test batch may be agreed.

7.6 Decarburization

Hot rolled or drawn wire and hot rolled or drawn steel bars made from steel as specified in DIN 1654 Parts 3 and 4 and from martensitic stainless steel as specified in DIN 1654 Part 5, in the heat treatment conditions stated in this standard, shall be free from completely decarburized zones.

The depth of partial decarburization of steel as specified in this standard shall not exceed the values given in table 2.

Table 2. Permissible depth of partial decarburization

Diameter, d , in mm	Maximum permissible depth of partial decarburization, in mm
≤ 8	0,10
$> 8 \leq 12$	0,12
$> 12 \leq 17$	0,16
$> 17 \leq 23$	0,20
$> 23 \leq 27$	0,24
> 27	$(0,007 \cdot d) + 0,05$

●● If, in particular cases, lower values of permissible partial decarburization are required, this shall be the subject of particular agreement at the time of ordering.

Peeled or ground steel bars and peeled or ground wire made from steel as specified in DIN 1654 Parts 3 to 5 shall be free from partially or completely decarburized zones.

7.7 Cast separation

When supplying steel as specified in DIN 1654 Parts 2 to 5, products originating from the same cast shall be batched together.

8 Testing

8.1 Materials testing certificates

8.1.1 General

The manufacturer shall be responsible for devising and implementing a quality control system for his production so as to ensure that the requirements specified in clause 7 are met.

●● The issue of a certificate as specified in DIN 50 049 for materials testing carried out at the manufacturer's works or by independent inspectors may be agreed at the time of ordering.

8.1.2 ●● Materials testing certificates issued by the manufacturer's works

8.1.2.1 If a test report (DIN 50 049—2.2) is to be issued in accordance with the agreements made at the time of ordering, this report shall specify the results of the ladle analysis for all the elements listed in table 2 of DIN 1654 Parts 2 to 5, respectively, for the relevant steel grade.

8.1.2.2 If a manufacturer's test certificate (DIN 50 049—2.3) is to be issued, the required tests shall be agreed.

The document shall give the following details:

- the results of a ladle analysis for all the elements listed in table 2 of DIN 1654 Parts 2 to 5, respectively, for the relevant steel grade;
- the results of the agreed tests.

8.1.3 Materials testing certificates issued by independent inspectors

●● These certificates shall be issued on the basis of acceptance inspection.

● The required methods of test or the tests to be carried out in keeping with official regulations and the relevant codes of practice shall be subject to agreement.

●● If acceptance inspection is not to be carried out by a works expert, the body responsible for acceptance inspection or the inspector shall be named.

Table 3. Test units and scope of testing

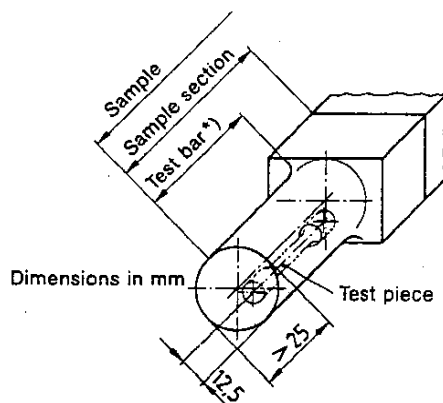
1	2	3	4	5
No.	Property	Test unit ¹⁾	Number of samples ²⁾ test pieces per sample	
1	Chemical composition			
1a	Ladle analysis	S	—	—
1b	Product analysis	S	At least one per cast	
2	Hardenability			
2a	in end quench test	S	One per cast.	1
2b	Core hardness of oil quenched round test pieces	S	One per cast.	1
3	Mechanical properties			
3a	of products in an initial condition usual for cold forming ³⁾	S+A ⁴⁾ +W	One per 5t, but not more than three.	1
3b	of quenched and tempered reference test pieces having a diameter of 16 mm	S	} One per cast.	} Three impact test pieces ⁵⁾ and one tensile test piece.
3c	of products in the quenched and tempered condition, for the equivalent diameter ⁶⁾	S		
3d	of stainless steel products	S ⁸⁾		
3e	of reference test pieces at ambient temperature ⁷⁾	S ⁸⁾		
3e	of reference test pieces at temperatures from 50 up to 300 °C ⁷⁾	S ⁸⁾		One tensile test piece. ⁹⁾
4	Microstructure			
4a	Austenitic grain size	S	One per cast.	1
4b	Spheroidization of carbides	S+A ⁴⁾ +W	One per 5t.	1
5	Surface condition and soundness			
5a	Cold heading test piece/reverse torsion test	S+A+W	Subject to agreement at the time of ordering.	
5b	Surface crack test	S+A+W	Subject to agreement at the time of ordering.	
5c	Decarburization	S+A+W	One per 5t.	1
5d	Microscopic cleanliness	S	Subject to agreement at the time of ordering.	
¹⁾ Testing of products separated by cast (S), by size (A) or by heat treatment batch (W).				
²⁾ The mass data (X) refer in each case to the test unit. The number of test pieces to be taken here also applies to any part of one tonne.				
³⁾ See table 1 of DIN 1654 Parts 2 to 5, respectively.				
⁴⁾ Where a consignment consists of bars and wires with cross-sectional areas that differ by not more than 3:1, these may be combined to form one test unit.				
⁵⁾ ●● Unless otherwise agreed at the time of ordering, it is at the manufacturer's discretion to use either ISO U-notch or V-notch test pieces.				
⁶⁾ In selecting a steel, a major consideration is whether the steel in the shape and size at the time of heat treatment will exhibit the required mechanical properties. That portion which is most important from the point of view of the mechanical properties obtained by heat treatment is referred to as the ruling section and should always be expressed in terms of the diameter of an equivalent round bar ('equivalent diameter').				
⁷⁾ In the heat treatment condition specified in tables 5 or 6 and 8 of DIN 1654 Part 5. Unless otherwise agreed at the time of ordering, in cases of arbitration, the diameter of the test bar (see figure 1) shall be equal to the diameter of the product.				
⁸⁾ Where considered appropriate (e.g. for martensitic steel), separate testing of products according to cast, size or heat treatment batch (S+A+W) may also be agreed at the time of ordering.				
⁹⁾ In the case of X 10 Cr 13 steel, unless otherwise agreed at the time of ordering, and where possible, three additional ISO U-notch test pieces shall be taken and tested as described in DIN 50 115. In the case of austenitic steel, it may also be agreed at the time of ordering that additional ISO U-notch or V-notch test pieces be taken and tested.				

The document shall give the following details:

- a) the information referred to in items a) and b) of sub-clause 8.1.2.2;
- b) the mark identifying the inspector.

8.2 Test unit

The details given in table 3 shall apply.



8.3 Scope of testing

The details given in table 3 shall apply.

8.4 Sampling and sample preparation

8.4.1 The general specifications given in EURONORM 18 shall apply.

8.4.2 Sample sections from coils shall be taken at a distance of not less than 300 mm from the beginning or end of the coil. In cases of arbitration, the distance shall be not less than 1000 mm.

8.4.3 The manufacturer shall state the chemical composition of the cast. Sample chips for the product analysis shall be taken at points uniformly distributed over the entire cross section of the product to be tested. Where this is not practicable, the chips shall be taken at a suitable place²⁾ characterizing the entire cross section (see *Stahl-Eisen-Prüfblatt* (Iron and steel test sheet) 1805).

^{*)} Test bar is that section of a product which has been reduced to the size in which it is to be heat treated.

²⁾ This may be the tensile test piece taken as illustrated in figure 1.

Round cross sections		Square and rectangular cross sections		
d up to 25 mm	d over 25 mm ¹⁾	a up to 25 mm b over 10 up to 25 mm	a over 25 mm b over 25 mm	a over 25 mm b over 25 mm
<div style="display: flex; justify-content: space-around; align-items: center;"> <div> Tensile test piece </div> <div> Notch </div> <div> Impact test piece </div> </div>				
¹⁾ At the manufacturer's discretion, for products with diameters over 25 up to 40 mm, the test piece may also be taken from the centre of the product.				

Figure 1. Test piece location in the case of steel bars and wire

8.4.4 If checking of the mechanical properties using reference test bars of given diameters has been specified (see lines 3b to 3e of table 3), products of other cross-sectional shape or larger size shall be reduced to the required diameter by rolling or forging (adequate allowance for machining being made where expedient) prior to the specified heat treatment. The test bars shall then be heat treated in accordance with the specifications regarding quenching and tempering given in table 9 of DIN 1654 Part 4 or in accordance with those given in tables 5 and 8 of DIN 1654 Part 5.

Tensile and impact test pieces shall be taken from the reference test bars, or from the products if testing is to be carried out in the usual treatment condition of the material on delivery, as illustrated in figure 1, except for sample sections up to 16 mm in diameter for tensile testing in the usual treatment condition of the material on delivery, which shall be tested without prior machining.

Where a number of test pieces are to be taken from the same test bar, these shall be immediately adjacent and equidistant to the surface or, if this is not possible, in line with each other. In cases of doubt, for products not less than 6 mm in diameter, bars with an original gauge length, L_0 , equal to $5 d_0$ shall be used as tensile test pieces. For products less than 6 mm diameter, L_0 shall be equal to $10 d_0$.

In the case of steel as covered in DIN 1654 Part 2, ISO V-notch test pieces shall be used as impact test pieces and in the case of steel as covered in DIN 1654 Parts 4 and 5, unless otherwise agreed, at the manufacturer's discretion, ISO U-notch or V-notch test pieces as specified in DIN 50115, with the notch axis perpendicular to the bar or wire surface (see figure 1). The three impact test pieces per sample shall be immediately adjacent and equidistant to the surface or, if this is not possible, in line with each other. If the product dimensions do not permit impact test pieces of standard size to be taken, sampling and sample preparation shall be agreed at the time of ordering, where required.

8.4.5 End quench test pieces shall be taken and pretreated as described in DIN 50191.

8.4.6 In cases of arbitration, the test pieces for determining the core hardness, after having been quench hardened in oil, shall, where possible, have the maximum diameter specified in table 8 of DIN 1654 Part 4. Where the consignment consists of wire or bars of diameters smaller than those specified in table 8 of DIN 1654 Part 4, the test piece shall be taken from a product the diameter of which is closest to that specified in table 8 of DIN 1654 Part 4. Where sample sections have larger diameters, in cases of arbitration, test pieces with diameters equal to those specified in table 8 of DIN 1654 Part 4 shall be prepared, taking into account the rules relevant for taking end quench test pieces (cf. DIN 50191). The test piece length shall be not less than $4d$ (d being the test piece diameter). In cases of arbitration, prior to quench hardening, the test pieces shall be spheroidized and shall exhibit a bright surface.

8.4.7 •• Unless otherwise agreed at the time of ordering, for determining the austenitic grain size, the samples shall be taken and prepared as described in DIN 50601.

The quenching grain size shall be determined as described in DIN 50601 using test pieces not more than 20 mm in diameter, which have been heated to the treatment temperature in a furnace (not in a salt bath).

Unless otherwise agreed at the time of ordering, for determining the quenching grain size, the test pieces shall be heat treated as follows:

- a) in the case of case hardening steels as covered in DIN 1654 Part 3: annealing at $(930 \pm 10)^\circ\text{C}$ for 4 hours and quenching in water;
- b) in the case of steels for quenching and tempering as covered in DIN 1654 Part 4, with a lower limit of carbon content of less than 0,35%: annealing at $(880 \pm 10)^\circ\text{C}$ for 90 minutes and quenching in water;
- c) in the case of steels for quenching and tempering as covered in DIN 1654 Part 4, with a lower limit of carbon content of not less than 0,35%: annealing at $(850 \pm 10)^\circ\text{C}$ for 90 minutes and quenching in water.

In cases of arbitration, for producing a uniform initial condition of the test piece, a preliminary treatment including annealing at 1150°C for 30 minutes and cooling in air shall be carried out.

8.4.8 For checking the spheroidization of carbides, transverse sections shall be prepared and etched using an appropriate solution.

8.4.9 •• Unless otherwise agreed at the time of ordering, for the cold heading tests (to be carried out on products 5,0 to 40 mm in diameter for steel as covered in DIN 1654 Part 2, and products 5,0 to 30 mm in diameter for steel as covered in DIN 1654 Parts 3 to 5), straight test pieces with plane-parallel end faces and an original height, h_0 , equal to $1,5 \cdot d_0$ (d_0 being the test piece diameter) shall be prepared without the surface condition being altered. Test pieces from products supplied in the hot formed condition may be transformed into the condition usual for cold forming as specified in subclause 7.2 of DIN 1654 Parts 3 to 5.

8.4.10 For the surface crack testing of steel bars using non-destructive test methods, the number of test pieces shall be agreed at the time of ordering (see item No. 5b of table 3).

A surface inspection of bright wire or steel bars is most commonly performed directly on the coil or bar. In the case of a scaled product surface, test pieces of about 200 mm length shall be taken and pickled using a suitable solution until the oxide layer has dissolved.

8.4.11 For the reverse torsion test, to be carried out on products less than 5,0 mm in diameter, the test piece length shall always be 50 times the nominal diameter.

8.4.12 DIN 50602 shall apply for the testing for nonmetallic inclusions.

8.4.13 Normally, for determining decarburization, transverse sections with sharp edges shall be prepared from products in the as delivered condition, in accordance with DIN 50192, and etched, and examined microscopically.

In cases of arbitration, to determine the extent of partial decarburization of steel as specified in table 2 of DIN 1654 Part 4 and of martensitic stainless steel as specified in table 2 of DIN 1654 Part 5, the transverse sections shall be quench hardened in accordance with the specifications given in table 9 of DIN 1654 Part 4 and table 8 of DIN 1654 Part 5, by preventing full or partial decarburization, using a high-duty quenching oil for the specified quenching treatment in oil. After quench hardening, the sections shall be prepared for microhardness measurements by grinding and polishing.

8.4.14 •• Unless otherwise agreed at the time of ordering, the procedure for visual examination and check of dimensions shall be at the manufacturer's discretion.

8.5 Test procedure

8.5.1 The chemical composition shall be determined in accordance with the methods³⁾ specified by the Chemists' Committee of the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgy Engineers). Other methods shall be the subject of particular agreement.

8.5.2 The end quench test shall be performed as described in DIN 50191, the quenching temperature being as specified in table 5 of DIN 1654 Part 3 or table 9 of DIN 1654 Part 4. The hardness shall be determined as described in DIN 50103 Part 1, method C.

8.5.3 The test pieces for core hardness testing shall be heated, in a neutral or reducing furnace atmosphere, to the hardness temperatures specified for the hardenability test in table 9 of DIN 1654 Part 4, and maintained at this temperature until they are completely austenitized. They shall then be taken out of the furnace and promptly quenched in a high-duty quenching oil, at a bath temperature of 50 °C and with a rate of immersion of about 0.25 m/s. The samples shall then be centrally notched, perpendicular to their longitudinal axis, and broken. One fracture surface shall be ground under conditions that do not lead to an excessive temperature rise. The Rockwell hardness in the core of the test piece shall then be determined, using method C described in DIN 50103 Part 1, as the mean from three individual measurements.

8.5.4 DIN 50 115, DIN 50 145, DIN 51 210 Parts 1 and 2 shall apply for the testing of mechanical properties.

8.5.5 The austenitic grain size shall be determined as described in DIN 50 601, using test pieces as specified in subclause 8.4.7.

8.5.6 The spheroidization of carbides shall normally be examined at a $\times 500$ magnification, using the reference charts as illustrated in *Stahl-Eisen-Prüfblatt 1520*, to be agreed at the time of ordering.

8.5.7 ●● Unless otherwise agreed at the time of ordering, in the cold heading test, the test pieces shall be upset to one third of their original height, the test being normally performed at ambient temperature.

8.5.8 Non-destructive surface crack testing shall be performed using appropriate methods, surface inspection being one of these.

If a permissible depth of surface cracks has been agreed at the time of ordering, a presumable defect shall be filed down until it disappears and its depth be determined from the difference in the product thickness before and after filing. Where there are doubts whether a defect is permitted or not, a cold heading test as described in subclauses 8.4.9 and 8.5.7 or, for products less than 5.0 mm in diameter, a reverse torsion test as described in subclauses 8.4.11 and 8.5.9 shall be carried out on a test piece containing the defect concerned or an equivalent defect.

8.5.9 DIN 51212 shall apply for the reverse torsion test (taking into account subclause 8.4.11) except that the test is not to be performed unidirectionally until the test piece fractures, but in alternating directions and limited to the number of torsions specified in subclause 7.8.1 of that standard.

8.5.10 Testing for nonmetallic inclusions shall be performed as described in DIN 50 602.

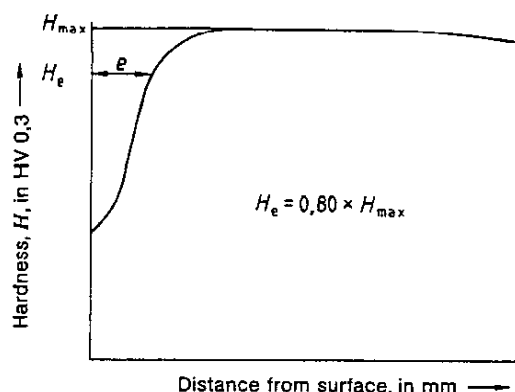


Figure 2. Determination of depth of decarburization

8.5.11 Decarburization shall normally be examined on an etched transverse section using a microscope with a $\times 100$ magnification, partially and completely decarburized zones (see DIN 17 014 Part 1 for concepts) being assessed separately. The depth of decarburization shall be the mean from four measurements made at the ends of two sections normal to one another, each value representing two-thirds of the total depth of the decarburized zone.

In cases of arbitration, however, for steel as covered in DIN 1654 Part 4 and for martensitic stainless steel as covered in DIN 1654 Part 5, the extent of partial decarburization shall be determined by measuring the microhardness HV 0,3 along the outer zone of two sections normal to one another. The mean of the four distances e_1, e_2, e_3 and e_4 shall be taken as the depth of partial decarburization. In accordance with figure 2, values e_1 to e_4 represent the distance between the surface and a specific point on the Jominy curve, where the hardness equals 80 % of the maximum hardness occurring in the case of partial decarburization in the outer zone of the section.

8.6 Retests

8.6.1 The specifications given in DIN 17 010 shall apply for a renewed product analysis or for retests for determining the mechanical properties.

8.6.2 Consignments containing products which have not satisfied the requirements when tested for surface condition (including the cold heading test or reverse torsion test) or when tested for accuracy to size may be presented for renewed testing after the unsatisfactory products have been sorted out and unless the relevant dimensional standard states otherwise.

9 Marking

9.1 The manufacturer shall mark the products or the bundles or packages, as far as possible in compliance with DIN 1599, so that the cast, the steel grade and the source of the consignment can be identified.

9.2 If consignments are to be accompanied by documents covering acceptance inspection, the marking shall additionally include the test piece number and the inspector's mark.

9.3 ●● Any further requirements with regard to the marking of the products may be agreed at the time of ordering.

³⁾ See *Handbuch für das Eisenhüttenlaboratorium* (Handbook for the Ferrous Metallurgy Laboratory).

10 Heat treatment and further processing

It is recommended that the manufacturer be consulted as regards heat treatment and further processing of the steel.

11 Complaints

11.1 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 extent. This shall apply unless otherwise agreed at the time of ordering.

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

Appendix A

Dimensional standards relating to products covered by this standard

DIN 668	Bright round steel; dimensions and permissible deviations according to ISO tolerance zone h11
DIN 671	Bright round steel; dimensions and permissible deviations according to ISO tolerance zone h9
DIN 1013 Part 1	Steel bars; hot rolled round steel for general purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1013 Part 2	Steel bars; hot rolled round steel for special purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1014 Part 1	Steel bars; hot rolled squares for general purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1014 Part 2	Steel bars; hot rolled squares for special purposes; dimensions, permissible dimensional deviations and deviations of form
DIN 1015	Steel bars; hot rolled hexagons; dimensions, permissible deviations and mass
DIN 1017 Part 1	Steel bars; hot rolled flats for general purposes; dimensions, permissible deviations and mass
DIN 1017 Part 2	Steel bars; hot rolled flats for special applications (in bar drawing shops, screw works, etc.); dimensions, permissible deviations and mass
DIN 59 110	Steel wire rod; dimensions, permissible deviations and mass
DIN 59 115	Steel wire rod for bolts; nuts and rivets; dimensions, permissible deviations and mass
DIN 59 130	Steel bars; hot rolled round steel for bolts and rivets; dimensions, permissible dimensional deviations and deviations of form

Standards and other documents referred to

DIN 1599	Identification marking of steel
DIN 1654 Part 2	Cold heading and cold extruding steels; technical delivery conditions for killed unalloyed steels not intended for heat treatment
DIN 1654 Part 3	Cold heading and cold extruding steels; technical delivery conditions for case hardening steels
DIN 1654 Part 4	Cold heading and cold extruding steels; technical delivery conditions for steels for quenching and tempering
DIN 1654 Part 5	Cold heading and cold extruding steels; technical delivery conditions for stainless steels
DIN 17 010	General technical delivery conditions for steel and steel products
DIN 17 014 Part 1	Heat treatment of ferrous materials; terminology
DIN 50 049	Materials testing certificates
DIN 50 103 Part 1	Testing of metallic materials; Rockwell hardness tests; C, A, B, F scales
DIN 50 115	Testing of metallic materials; impact test
DIN 50 145	Testing of metallic materials; tensile test
DIN 50 191	Hardenability testing of steel by end quenching
DIN 50 192	Determination of depth of decarburization
DIN 50 601	Metallographic examination; determination of the ferritic or austenitic grain size of steel and ferrous materials
DIN 50 602	Metallographic examination; microscopic examination of special steels using standard diagrams to assess the content of non-metallic inclusions
DIN 51 210 Part 1	Testing of metallic materials; tensile testing of wires without using an extensometer
DIN 51 210 Part 2	Testing of metallic materials; tensile testing of wires using an extensometer

- DIN 51 212 Testing of metallic materials; torsion testing of wires
- EURONORM 18 Sélection and preparation of samples and test pieces from steel and iron and steel products
- EURONORM 79 Terminology and classification of steel products by shape and dimensions
- Stahl-Eisen-Lieferbedingungen 055*)*
(at present at the stage of draft) *Warmgewalzter Stabstahl und Walzdraht mit rundem Querschnitt und nicht profilierter Oberfläche, Oberflächengüteklassen; technische Lieferbedingungen* (Hot rolled steel bars and wire rod of circular cross section and with non-profiled surface; surface quality classes; technical delivery conditions)
- Stahl-Eisen-Prüfblatt 1520*)*
Mikroskopische Prüfung der Carbidausbildung in Stählen mit Bildreihen (Microscopic examination of carbide spheroidization of steel using standard charts)
- Stahl-Eisen-Prüfblatt 1805*)*
Probenahme und Probenvorbereitung für die Stückanalyse bei Stählen (Sampling and preparation of samples for product analysis of steel)
- Handbuch für das Eisenhüttenlaboratorium*)* (in loose-leaf form)
- DIN-Normenheft 3 *Kurznamen und Werkstoffnummern der Eisenwerkstoffe in DIN-Normen und Stahl-Eisen-Werkstoffblättern* (Material designations and material numbers for ferrous materials dealt with in DIN Standards and Iron and steel materials sheets)
- See appendix A for other relevant standards.

Other relevant standards

- DIN 17 111 Low carbon unalloyed steels for bolts, nuts and rivets; technical delivery conditions
- DIN 17 200 Steels for quenching and tempering; technical delivery conditions
- DIN 17 210 Case hardening steels; technical delivery conditions
- DIN 17 240 Heat resisting and highly heat resisting materials for bolts and nuts; quality specifications
- DIN 17 440 Stainless steels; technical delivery conditions for plate and sheet, hot rolled strip, wire rod, drawn wire, steel bars, forgings and semi-finished products

Amendments

The following amendments have been made to the March 1980 edition.

- Requirement classes are no longer specified; the standard has been revised editorially, its layout being harmonized with that of DIN 17 200, March 1987 edition and DIN 17 210, September 1986 edition.
- A reference has been made to *Stahl-Eisen-Lieferbedingungen 055* covering specifications on the surface condition.
- The requirements regarding the microscopic degree of cleanness of case hardening steels and steels for quenching and tempering as specified in DIN 1654 Parts 3 and 4 have been quantified.
- In the impact test to be performed on steels as covered in DIN 1654 Parts 4 and 5, ISO U-notch or ISO V-notch test pieces may be used.

Explanatory notes

Re DIN 1654 Parts 1 to 5

As already mentioned in the Explanatory notes of the previous edition, it was intended to bring Parts 3 to 5 of this standard into line with DIN 17 200, DIN 17 210 and DIN 17 440, which were being revised at that time, and to publish them under the abridged procedure. It then became evident that a, largely editorial, revision of Parts 1 and 2 of DIN 1654 was required.

A large number of the steel grades specified in DIN 1654 Parts 3 and 5 are also covered in DIN 17 200 (March 1987 edition), DIN 17 210 (September 1986 edition) and DIN 17 440 (July 1985 edition). The steels are identified by the same material designation and number, their chemical composition is identical, as are, generally, the mechanical properties; it should be borne in mind, however, that some of the standards of the DIN 1654 series specify considerably more stringent requirements regarding freedom from decarburization or surface cracks. Where the values given in DIN 1654 Parts 3 to 5 are in agreement with those specified in DIN 17 200, DIN 17 210 and DIN 17 440, this has been marked in the relevant table.

In Germany, the steels dealt with in the DIN 1654 series are predominantly used for cold heading and cold extruding. Subject to agreement, other steel grades may be used for this purpose.

Standards of the DIN 1654 series are related to EURONORM 119, Cold heading and cold extruding steels; quality specifications (1974 edition), published by the European Coal and Steel Community (ECSC) and International Standard ISO 4954, Steels for cold heading and cold extruding, published by the International Organization for Standardization (ISO).

The following notes on Parts 2 to 5 of this standard (revised editions) include tables giving a survey of the steel grades covered in this standard and those specified in EURONORM 119-74 and ISO 4954 : 1979.

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

Re DIN 1654 Part 2

By way of departure from EURONORM 119 and ISO 4954, DIN 1654 Part 2 only specifies Al-killed steel; it also includes, at the users' request, guideline values of yield strength, tensile strength, elongation after fracture and impact strength of material in the normalized condition, although this condition is normally of no relevance for delivery purposes. As a further departure from the EURONORM and the ISO Standard, it has been specified that products originating from the same cast are to be batched together.

Comparison of cold heading and cold extruding steels specified in German documents with those covered in international documents

Table 4. Steels not intended for heat treatment

German documents			ISO 4954 : 1979		EURONORM 119-74	
Standard	Material designation	Material number	Type of steel	Degree of correspondence ¹⁾	Material designation	Degree of correspondence ¹⁾
—	—	—	A 1 R	—	CB 4 FU KD	—
DIN 1654 Part 2	QSt 32-3	1.0303	A 1 Al	X	CB 4 FF KD	X
—	—	—	A 2 R	—	CB 7 FU KD	—
DIN 1654 Part 2	QSt 34-3	1.0213	A 2 Al	•	CB 7 FF KD	X
DIN 17 111	UQSt 36	1.0204	A 3 R	○	CB 10 FU KD	○
DIN 17 111	RSt 38	1.0223	A 4 Si	○	CB 10 FS KD	○
DIN 1654 Part 2	QSt 36-3	1.0214	A 3 Al	•	CB 10 FF KD	•
DIN 1654 Part 2	QSt 38-3	1.0234	A 4 Al	•	CB 15 FF KD	•
—	—	—	A 5 Al	—	CB 20 FF KD	—
—	—	—	A 5 Si	—	—	—

¹⁾ This column indicates the degree of correspondence with regard to the chemical composition of the steels specified in German documents and those covered in ISO 4954 or EURONORM 119, the symbols having the following meanings: X identical; • slight differences; ○ significant differences.

Re DIN 1654 Part 3

All steel grades, except for steel grade Cq 15 (material number 1.1132), are also specified in DIN 17 210. The latter standard does not include any data comparable with those listed in table 4, giving mechanical properties of steels in the treatment condition in which they are usually supplied.

By way of departure from EURONORM 119 and ISO 4954, but on the lines of DIN 17 210, this standard does not give any information on the mechanical properties of blank hardened reference test pieces.

Re DIN 1654 Part 4

Steel grades 38 Cr 2 (material number 1.7003), 46 Cr 2 (material number 1.7006), 34 Cr 4 (material number 1.7033), 37 Cr 4 (material number 1.7034), 41 Cr 4 (material number 1.7035), 25 CrMo 4 (material number 1.7218), 34 CrMo 4 (material number 1.7220), 42 CrMo 4 (material number 1.7225), 34 CrNiMo 6 (material number 1.6582) and 30 CrNiMo 8 (material number 1.6580) are also covered in DIN 17 200 which specifies the same chemical composition (except for the maximum sulfur content which is 0,03 % in DIN 17 200 and 0,035 % in DIN 1654 Part 4) and the same values of mechanical properties of steels in the quenched and tempered condition and of hardness values determined in the end quench test.

The values of chemical composition, hardenability and mechanical properties of products in the quenched and tempered condition specified for Cq 22 (material number 1.1152), Cq 35 (material number 1.1172) and Cq 45 (material number 1.1192) steels, respectively, have been adopted from DIN 17 200 for Ck 22 (material number 1.1151), Ck 35 (material number 1.1181) and Ck 45 (material number 1.1191) steels, respectively.

The maximum values of tensile strength of steel in the treatment condition in which it is usually supplied (table 4) and the minimum values of reduction in area after fracture deviate from the respective values given in EURONORM 119 and ISO 4954 (DIN 1654 Part 4 specifying lower maximum values of tensile strength and higher minimum values of reduction in area after fracture).

The values given in table 8 with regard to the maximum diameters up to which a core hardness of 40, 45 or 48 HRC can be obtained after quench hardening in a high-duty quenching oil have been adopted from EURONORM 119, these values complying with the data given in ISO 4954 except for slight differences for 41 Cr 4 (material number 1.7035) and 25 CrMo 4 (material number 1.7218) steels, respectively.

Comparison of cold heading and cold extruding steels specified in German documents with those covered in international documents

Table 5. Case hardening steels

German documents			ISO 4954 : 1979		EURONORM 119-74	
Standard	Material designation	Material number	Type of steel	Degree of correspondence ¹⁾	Material designation	Degree of correspondence ¹⁾
SEL ²⁾	Cq 10	1.1122	B 1	●	C 10 KD	●
DIN 1654 Part 3	Cq 15	1.1132	B 2	●	C 15 KD	●
—	—	—	B 3	—	—	—
DIN 1654 Part 3	17 Cr 3	1.7016	—	—	15 Cr 2 KD	○
—	—	—	B 10	—	—	—
DIN 1654 Part 3	16 MnCr 5	1.7131	B 11	●	16 MnCr 5 KD	●
—	—	—	B 20	—	—	—
—	—	—	B 30	—	18 CrMo 4 KD	—
DIN 1654 Part 3	20 MoCr 4	1.7321	B 31	○	20 MoCr 4 KD	○
—	—	—	B 40	—	—	—
DIN 1654 Part 3	21 NiCrMo 2	1.6523	B 41	●	20 NiCrMo 2 KD	●
DIN 1654 Part 3	15 CrNi 6	1.5919	—	—	—	—

¹⁾ This column indicates the degree of correspondence with regard to the chemical composition of the steels specified in German documents and those covered in ISO 4954 or EURONORM 119, the symbols having the following meanings:
 ● slight differences; ○ significant differences.

²⁾ SEL signifies that the steel grade has been specified in the *Stahl-Eisen-Liste* (Iron and steel list), 1981: 7th edition (obtainable from *Verlag Stahleisen mbH*, Düsseldorf).

Boron alloy steel which, owing to its low carbon content, combines ease of working with adequate hardenability has been included both in EURONORM 119 and ISO 4954, and in the previous edition of this standard. This edition does not specify any data of quenched and tempered reference test pieces of boron alloy steels for the following reasons:

- the parties preparing the standard were not completely satisfied with the values given in EURONORM 119 (therefore, ISO 4954, in some cases, specifies considerably lower values of yield strength and tensile strength, particularly for smaller product sizes, and higher values of elongation after fracture and impact values; no values have been given for diameters up to 16 mm);
- these steels have preferably been used up until now for bolts for which no values of mechanical properties of quenched and tempered reference test pieces are usually given.

Re DIN 1654 Part 5

Except for X 3 CrNiCu 18 9 (material number 1.4567) steel, all steel grades are covered in DIN 17440. Compared with EURONORM 119, X 5 CrNi 18 10 (material number 1.4301), X 6 NiCr 18 16 and X 2 CrNiMo 17 13 2 (material number 1.4404), steels are no longer specified, whereas the titanium alloy steels X 6 CrNiTi 18 10 (material number 1.4541) and X 6 CrNiMoTi 17 12 2 (material number 1.4571), already specified in ISO 4954, have been included. In addition to this, ISO 4954 specifies one ferritic steel, two martensitic steels and seven austenitic steels, but does not cover the nitrogen alloy steels X 2 CrNiN 18 10 (material number 1.4311) and X 2 CrNiMoN 17 13 3 (material number 1.4429).

The values of mechanical properties of steel in the treatment condition in which it is usually supplied, listed in table 4, are largely in agreement with those given in EURONORM 119 and ISO 4954.

The values of mechanical properties in the annealed condition (ferritic steel), quenched and tempered condition (martensitic steel) and quenched condition (austenitic steels) given in table 5 are identical with those given in DIN 17440 where the steels are covered in both standards, DIN 1654 Part 5 specifying additional impact values for ISO U-notch test pieces.

Except for X 3 CrNiCu 18 9 steel, the values of 0,2 % and 1 % elevated temperature proof strength are identical with those given in DIN 17440, but, in agreement with EURONORM 119, have only been specified for temperatures up to 300 °C; ISO 4954 does not give any such values.

In the case of X 3 CrNiCu 18 9 steel, the values of physical properties given in table 7 and of heat treatment given in table 8 are identical with those specified in EURONORM 119, those for the other steels are in agreement with DIN 17440.

Comparison of cold heading and cold extruding steels specified in German documents with those covered in international documents

Table 6. Steels for quenching and tempering

German documents			ISO 4954 : 1979		EURONORM 119-74	
Standard	Material designation	Material number	Type of steel	Degree of correspondence ¹⁾	Material designation	Degree of correspondence ¹⁾
DIN 1654 Part 4	Cq 22	1.1152	C 1	o	C 21 KD	•
—	—	—	C 2	—	—	—
DIN 1654 Part 4	Cq 35	1.1172	C 3	•	C 35 KD	•
—	—	—	C 4	—	—	—
—	—	—	C 5	—	—	—
DIN 1654 Part 4	Cq 45	1.1192	C 6	•	C 45 KD	•
SEL ²⁾	38 Cr 1	1.7001	C 10	•	38 Cr 1 KD	•
SEL ²⁾	46 Cr 1	1.7002	C 11	•	46 Cr 1 KD	•
DIN 1654 Part 4	38 Cr 2	1.7003	C 12	•	38 Cr 2 KD	•
—	—	—	—	—	41 Cr 2 KD	—
DIN 1654 Part 4	46 Cr 2	1.7006	C 13	•	46 Cr 2 KD	•
DIN 1654 Part 4	34 Cr 4	1.7033	C 14	•	34 Cr 4 KD	•
DIN 1654 Part 4	37 Cr 4	1.7034	C 15	•	37 Cr 4 KD	•
DIN 1654 Part 4	41 Cr 4	1.7035	C 16	•	41 Cr 4 KD	•
—	—	—	C 20	—	—	—
—	—	—	C 21	—	—	—
—	—	—	C 22	—	—	—
DIN 1654 Part 4	25 CrMo 4	1.7218	C 30	•	25 CrMo 4 KD	•
DIN 1654 Part 4	34 CrMo 4	1.7220	C 31	•	34 CrMo 4 KD	•
DIN 1654 Part 4	42 CrMo 4	1.7225	C 32	•	42 CrMo 4 KD	•
SEL ²⁾	30 NiCrMo 22	1.6545	—	—	30 NiCrMo 2 KD	X
SEL ²⁾	40 NiCrMo 22	1.6546	C 40	X	40 NiCrMo 2 KD	X
—	—	—	C 41	—	40 NiCrMo 4 KD	—
DIN 1654 Part 4	34 CrNiMo 6	1.6582	—	—	35 CrNiMo 6 KD	o
DIN 1654 Part 4	30 CrNiMo 8	1.6580	C 43	•	30 CrNiMo 8 KD	•
—	—	—	C 42	—	—	—
DIN 1654 Part 4	22 B 2	1.5508	E 1	•	C 22 B KD	X
DIN 1654 Part 4	28 B 2	1.5510	E 4	•	C 30 B KD	o
DIN 1654 Part 4	35 B 2	1.5511	E 5	•	C 35 B KD	•
SEL ²⁾	37 CrB 1	1.7007	E 10	o	38 CrB 1 KD	o
DIN 1654 Part 4	19 MnB 4	1.5523	E 2	o	—	—
—	—	—	E 3	—	—	—
—	—	—	E 6	—	—	—
—	—	—	E 7	—	—	—

1) This column indicates the degree of correspondence with regard to the chemical composition of the steels specified in German documents and those covered in ISO 4954 or EURONORM 119, the symbols having the following meanings:
X identical; • slight differences; o significant differences.

2) SEL signifies that the steel grade has been specified in *Stahl-Eisen-Liste*, 1981: 7th edition.

Comparison of cold heading and cold extruding steels specified in German documents with those covered in international documents

Table 7. Stainless steels

German documents			ISO 4954 : 1979		EURONORM 119-74	
Standard	Material designation	Material number	Type of steel	Degree of correspondence ¹⁾	Material designation	Degree of correspondence ¹⁾
DIN 1654 Part 5	X 6 Cr 17	1.4016	D 1	●	X 8 Cr 17 KD	●
DIN 17 441	X 6 CrMo 17 1	1.4113	D 2	●	—	—
DIN 1654 Part 5	X 10 Cr 13	1.4006	D 10	○	X 12 Cr 13 KD	○
—	—	—	D 11	—	—	—
DIN 17 440	X 20 CrNi 17 2	1.4057	D 12	○	—	—
DIN 1654 Part 5	X 2 CrNi 19 11	1.4306	D 20	○	X 3 CrNi 18 10 KD	○
DIN 17 440	X 5 CrNi 18 10	1.4301	D 21	●	X 6 CrNi 18 10 KD	●
—	—	—	D 22	—	—	—
DIN 1654 Part 5	X 5 CrNi 18 12	1.4303	D 23	●	X 8 CrNi 18 12 KD	●
—	—	—	D 24	—	—	—
—	—	—	D 25	—	X 6 NiCr 18 16 KD	—
DIN 1654 Part 5	X 6 CrNiTi 18 10	1.4541	D 26	X	—	—
DIN 17 440	X 6 CrNiNb 18 10	1.4550	D 27	X	—	—
DIN 17 440	X 2 CrNiMo 17 13 2	1.4404	D 28	●	X 3 CrNiMo 17 12 2 KD	●
DIN 1654 Part 5	X 5 CrNiMo 17 12 2	1.4401	D 29	●	X 6 CrNiMo 17 12 2 KD	●
DIN 1654 Part 5	X 6 CrNiMoTi 17 12 2	1.4571	D 30	●	—	—
DIN 17 440	X 6 CrNiMoNb 17 12 2	1.4580	D 31	●	—	—
DIN 1654 Part 5	X 2 CrNiN 18 10	1.4311	—	—	X 2 CrNiN 18 10 KD	●
DIN 1654 Part 5	X 2 CrNiMoN 17 13 3	1.4429	—	—	X 2 CrNiMoN 18 13 3 KD	●
DIN 1654 Part 5	X 3 CrNiCu 18 9	1.4567	D 32	○	X 6 CrNiCu 18 10 4 KD	○

¹⁾ This column indicates the degree of correspondence with regard to the chemical composition of the steels specified in German documents and those covered in ISO 4954 or EURONORM 119, the symbols having the following meanings: X identical; ● slight differences; ○ significant differences.

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