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**Low-alloyed steels for cold heading —
Part 1: Wire rods**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry based on the provision of Article 14, paragraph (1) of the Industrial Standardization Act applied mutatis mutandis pursuant to the provision of Article 16 of the said Act in response to a proposal for revision of Japanese Industrial Standard with a draft being attached, submitted by The Japan Iron and Steel Federation (JISF), an accredited standards development organization. This edition replaces the previous edition (**JIS G 3509-1:2010**), which has been technically revised.

However, **JIS G 3509-1: 2010** may be applied in the **JIS** mark certification based on the relevant provisions of Article 30, paragraph (1), etc. of the Industrial Standardization Act until 19 April 2022.

This **JIS** document is protected by the Copyright Act.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, published patent application or utility model rights. The relevant Minister is not responsible for identifying any of such patent rights, published patent application or utility model rights.

JIS G 3509 series consists of the following 2 parts under the general title *Low-alloyed steels for cold heading*:

Part 1 : Wire rods

Part 2 : Wires

Low-alloyed steels for cold heading — Part 1 : Wire rods

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4954** : 2018, Edition 3, with some modifications of the technical contents.

Annex JA is unique to **JIS** and not given in the corresponding International Standard. The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JB.

1 Scope

This Standard specifies requirements for the low-alloyed steel wire rods for cold heading (hereafter referred to as wire rods) which are mainly used for manufacture of the low-alloyed steel wires for cold heading.

NOTE The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 4954 : 2018 *Steels for cold heading and cold extruding* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

Part or all of the provisions of the following standards, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0201 *Glossary of terms used in iron and steel (Heat treatment)*

JIS G 0202 *Glossary of terms used in iron and steel (Testing)*

JIS G 0203 *Glossary of terms used in iron and steel (Products and quality)*

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0321 *Product analysis and its tolerance for wrought steel*

JIS G 0404 *Steel and steel products — General technical delivery requirements*

JIS G 0415 *Steel and steel products — Inspection documents*

JIS G 0551 *Steels — Micrographic determination of the apparent grain size*

JIS G 0555 *Microscopic testing method for the non-metallic inclusions in steel*

JIS G 0558 *Steels — Determination of depth of decarburization*

JIS G 0561 *Method of hardenability test for steel (End quenching method)*

JIS G 3191 *Dimensions, mass and permissible variations of hot rolled steel bars and bar in coil*

3 Terms and definitions

For the purpose of this Standard, the following term and definition, and those given in JIS G 0201, JIS G 0202 and JIS G 0203 apply.

3.1

forging ratio

degree of metal deformation during forging, expressed as the ratio of the cross-sectional area of the metal at the time of the casting to that after hot-rolling

Note 1 to entry It is a forging ratio obtained by reducing the cross-sectional area and increasing the length, and indicated as 4S when the cross-sectional area is reduced to 1/4.

4 Symbols of grade

This Standard covers wire rods of 51 steel grades. Their symbols are as given in Table 1.

Table 1 Symbols of grade

Symbol of grade	Remarks	Symbol of grade	Remarks	Symbol of grade	Remarks		
SMn420RCH ^{b)}	Manganese steel	SCr435HRCH ^{a)}	Chromium steel	SCM445HRCH ^{a)}	Chromium molybdenum steel		
SMn420HRCH ^{a)} ^{b)}		SCr440RCH		SCM822RCH ^{b)}			
SMn433RCH		SCr440HRCH ^{a)}		SCM822HRCH ^{a) b)}			
SMn433HRCH ^{a)}		SCM415RCH ^{b)}	Chromium molybdenum steel	SNC415RCH ^{b)}	Nickel chromium steel		
SMn438RCH		SCM415HRCH ^{a) b)}		SNC415HRCH ^{a) b)}			
SMn438HRCH ^{a)}		SCM418RCH ^{b)}		SNC631RCH			
SMn443RCH		SCM418HRCH ^{a) b)}		SNC631HRCH ^{a)}			
SMn443HRCH ^{a)}		SCM420RCH ^{b)}		SNC815RCH ^{b)}			
SMnC420RCH ^{b)}	Manganese chromium steel	SCM420HRCH ^{a) b)}		SNC815HRCH ^{a) b)}	Nickel chromium molybdenum steel		
SMnC443RCH		SCM425RCH ^{b)}		SNCM220RCH ^{b)}			
SCr415RCH ^{b)}	Chromium steel	SCM425HRCH ^{a) b)}		SNCM220HRCH ^{a) b)}			
SCr415HRCH ^{a)} ^{b)}		SCM430RCH		SNCM240RCH			
SCr420RCH ^{b)}		SCM435RCH		SNCM420RCH ^{b)}			
SCr420HRCH ^{a)} ^{b)}		SCM435HRCH ^{a)}		SNCM420HRCH ^{a) b)}			
SCr430RCH		SCM440RCH		SNCM439RCH			
SCr430HRCH ^{a)}		SCM440HRCH ^{a)}		SNCM447RCH			
SCr435RCH		SCM445RCH		SNCM616RCH ^{b)}			
Note ^{a)} HRCH : hardenability guaranteed.							
Note ^{b)} Primarily intended for case hardening.							

5 Manufacturing method

The manufacturing method shall be as follows.

- a) Wire rods shall be manufactured from killed steel.
- b) Wire rods shall be rolled from steel ingot at a forging ratio of 4S or over.

6 Chemical composition

The results of heat analysis obtained according to 9.1 shall satisfy the composition given in Table 2.

If a product analysis is requested by the purchaser, the test specified in 9.1 shall be carried out and the results shall conform to Table 2 within the tolerances specified in Table 4 of JIS G 0321.

Table 2 Chemical composition

Unit: %

Symbol of grade	C	Si ^{a)}	Mn	P	S	Ni	Cr	Mo
SMn420RCH	0.17 to 0.23	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn420HRCH	0.16 to 0.23	0.15 to 0.35	1.15 to 1.55	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn433RCH	0.30 to 0.36	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn433HRCH	0.29 to 0.36	0.15 to 0.35	1.15 to 1.55	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn438RCH	0.35 to 0.41	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn438HRCH	0.34 to 0.41	0.15 to 0.35	1.30 to 1.70	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn443RCH	0.40 to 0.46	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMn443HRCH	0.39 to 0.46	0.15 to 0.35	1.30 to 1.70	0.030 max.	0.030 max.	0.25 max.	0.35 max.	—
SMnC420RCH	0.17 to 0.23	0.15 to 0.35	1.20 to 1.50	0.030 max.	0.030 max.	0.25 max.	0.35 to 0.70	—
SMnC443RCH	0.40 to 0.46	0.15 to 0.35	1.35 to 1.65	0.030 max.	0.030 max.	0.25 max.	0.35 to 0.70	—
SCr415RCH	0.13 to 0.18	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	—
SCr415HRCH	0.12 to 0.18	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	—
SCr420RCH	0.18 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	—
SCr420HRCH	0.17 to 0.23	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	—
SCr430RCH	0.28 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	—

Table 2 (continued)

Unit: %

Symbol of grade	C	Si ^{a)}	Mn	P	S	Ni	Cr	Mo
SCr430HRCH	0.27 to 0.34	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	—
SCr435RCH	0.33 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	—
SCr435HRCH	0.32 to 0.39	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	—
SCr440RCH	0.38 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	—
SCr440HRCH	0.37 to 0.44	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	—
SCM415RCH	0.13 to 0.18	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25
SCM415HRCH	0.12 to 0.18	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.30
SCM418RCH	0.16 to 0.21	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25
SCM418HRCH	0.15 to 0.21	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.30
SCM420RCH	0.18 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.25
SCM420HRCH	0.17 to 0.23	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.30
SCM425RCH	0.23 to 0.28	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30
SCM425HRCH	0.23 to 0.28	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.30
SCM430RCH	0.28 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30
SCM435RCH	0.33 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30
SCM435HRCH	0.32 to 0.39	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.35
SCM440RCH	0.38 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30
SCM440HRCH	0.37 to 0.44	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.35
SCM445RCH	0.43 to 0.48	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.15 to 0.30
SCM445HRCH	0.42 to 0.49	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.15 to 0.35
SCM822RCH	0.20 to 0.25	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.25 max.	0.90 to 1.20	0.35 to 0.45
SCM822HRCH	0.19 to 0.25	0.15 to 0.35	0.55 to 0.95	0.030 max.	0.030 max.	0.25 max.	0.85 to 1.25	0.35 to 0.45
SNC415RCH	0.12 to 0.18	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	2.00 to 2.50	0.20 to 0.50	—

Table 2 (concluded)

Unit: %

Symbol of grade	C	Si ^{a)}	Mn	P	S	Ni	Cr	Mo
SNC415HRCH	0.11 to 0.18	0.15 to 0.35	0.30 to 0.70	0.030 max.	0.030 max.	1.95 to 2.50	0.20 to 0.55	—
SNC631RCH	0.27 to 0.35	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	2.50 to 3.00	0.60 to 1.00	—
SNC631HRCH	0.26 to 0.35	0.15 to 0.35	0.30 to 0.70	0.030 max.	0.030 max.	2.45 to 3.00	0.55 to 1.05	—
SNC815RCH	0.12 to 0.18	0.15 to 0.35	0.35 to 0.65	0.030 max.	0.030 max.	3.00 to 3.50	0.60 to 1.00	—
SNC815HRCH	0.11 to 0.18	0.15 to 0.35	0.30 to 0.70	0.030 max.	0.030 max.	2.95 to 3.50	0.55 to 1.05	—
SNCM220RCH	0.17 to 0.23	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	0.40 to 0.70	0.40 to 0.60	0.15 to 0.25
SNCM220HRCH	0.17 to 0.23	0.15 to 0.35	0.60 to 0.95	0.030 max.	0.030 max.	0.35 to 0.75	0.35 to 0.65	0.15 to 0.30
SNCM240RCH	0.38 to 0.43	0.15 to 0.35	0.70 to 1.00	0.030 max.	0.030 max.	0.40 to 0.70	0.40 to 0.60	0.15 to 0.30
SNCM420RCH	0.17 to 0.23	0.15 to 0.35	0.40 to 0.70	0.030 max.	0.030 max.	1.60 to 2.00	0.40 to 0.60	0.15 to 0.30
SNCM420HRCH	0.17 to 0.23	0.15 to 0.35	0.40 to 0.70	0.030 max.	0.030 max.	1.55 to 2.00	0.35 to 0.65	0.15 to 0.30
SNCM439RCH	0.36 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	1.60 to 2.00	0.60 to 1.00	0.15 to 0.30
SNCM447RCH	0.44 to 0.50	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.030 max.	1.60 to 2.00	0.60 to 1.00	0.15 to 0.30
SNCM616RCH	0.13 to 0.20	0.15 to 0.35	0.80 to 1.20	0.030 max.	0.030 max.	2.80 to 3.20	1.40 to 1.80	0.40 to 0.60

Elements in the table with no limit values or elements not given in the table shall not be intentionally added for other purposes than finishing of the heat. However, Al may be added for the purpose of grain refining upon agreement between the purchaser and the manufacturer.

For all the steel grades in the table, Cu, as impurities, shall not exceed 0.30 %.

Note ^{a)} The lower limit of Si may be below 0.15 % upon agreement between the purchaser and the manufacturer.

7 Physical properties

7.1 Decarburized depth

If requested by the purchaser, the test specified in **9.2.1** shall be carried out and the determined average decarburized depth shall conform to Table 3.

Table 3 Average decarburized depth

Unit: mm		
Diameter	Ferrite de- carburized depth	Total decar- burized depth
15 or under	0.02 max.	0.12 max.
Over 15 up to and incl. 25		0.15 max.
Over 25 up to and incl. 32		0.20 max.
Over 32 up to and incl. 40	0.03 max.	0.25 max.
Over 40 up to and incl. 50		0.30 max.
For wire rods with diameters over 50 mm, the limit of decarburized depth shall be as agreed between the purchaser and the manufacturer.		

7.2 Non-metallic inclusion

If requested by the purchaser, the non-metallic inclusion test specified in **9.2.2** shall be carried out and the determined index of cleanliness shall satisfy the permissible limit given in Table 4.

Table 4 Non-metallic inclusion

Inclusion type	Index of cleanliness (%)
Type A	0.25 max.
Type B + C	0.10 max.
Type A + B + C	0.35 max.
Definitions of Type A, Type B and Type C inclusions are provided in JA.5 of JIS G 0555 .	

7.3 Hardenability

The hardenability of wire rods of grade symbols with HRCH (hardenability guaranteed) attached at the end shall be as follows.

- The wire rods shall be tested in accordance with **9.2.3** and the determined hardenability at a specified distance shall satisfy the requirements in Tables 8 to 29. For any distance from the quenched end of test piece not given in the table, the minimum and maximum values shall be agreed upon between the purchaser and the manufacturer based on the values read off the chart.
- The purchaser and the manufacturer may agree upon a range of upper or lower 75 % of the hardenability band for indicating the hardness range. See **JA.1** for hardness ranges for respective steel grades. Similarly to **a)**, for any distance from the quenched end of test piece not given in the table, the minimum and maximum values shall be agreed upon between the purchaser and the manufacturer based on the values read off the chart.
- Hardenability shall be specified by the minimum and maximum hardness values at

the specified distance.

Example At A—A' shown in Figure 1, $J7 \text{ mm} = 31/44$.

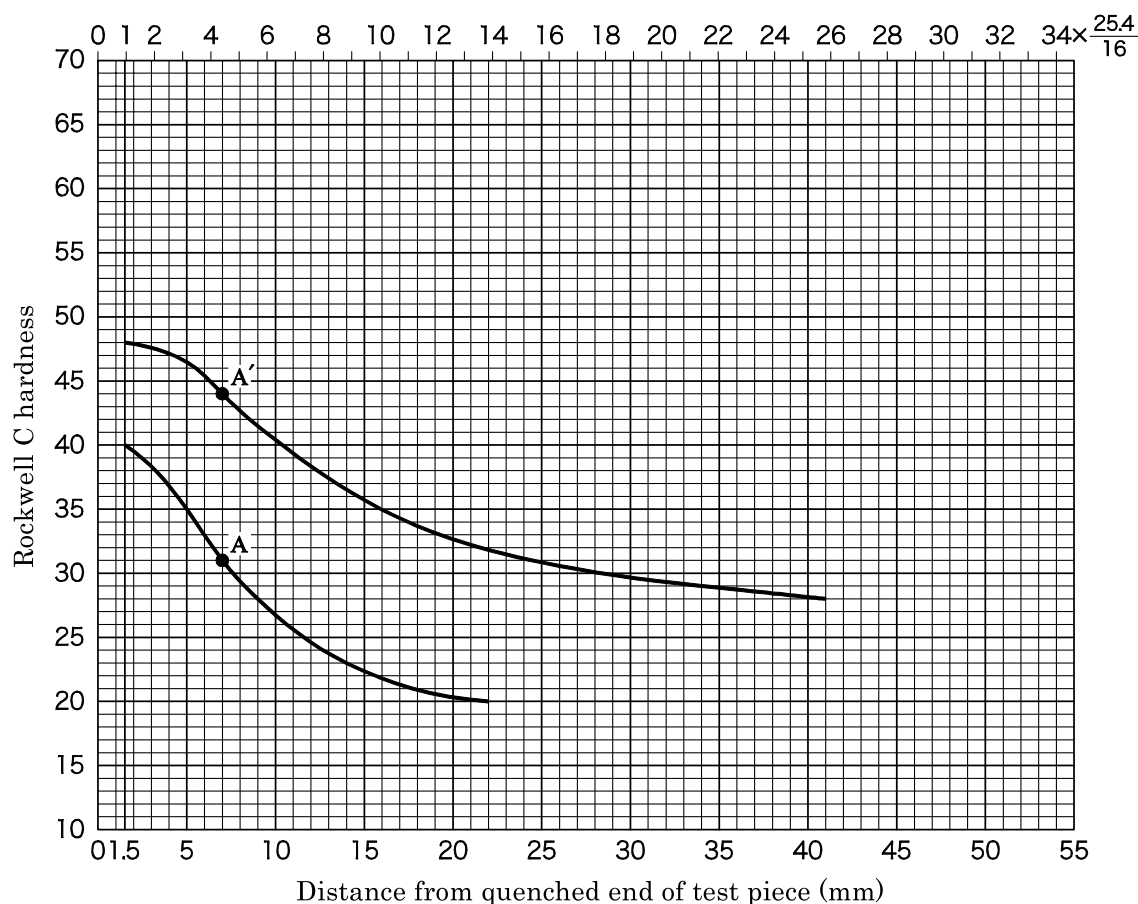


Figure 1 Specification of hardenability

7.4 Austenitic grain size

The austenitic grain size test shall be as follows.

- The wire rods of grade symbols with HRCH (hardenability guaranteed) attached at the end shall be tested in accordance with 9.2.4, and the determined austenitic grain size shall satisfy the requirements in Table 5.
- The wire rods of grade symbols with RCH attached at the end may also be tested for austenitic grain size as an additional requirement upon agreement between the purchaser and the manufacturer. In this case, the test method used and the required value shall be also agreed between the purchaser and the manufacturer.

Table 5 Austenitic grain size

Symbol of grade		Austenitic grain size
SMn433HRCH	SMn438HRCH	Heat treated average grain size number 5.0 min.
SMn443HRCH	SCr430HRCH	
SCr435HRCH	SCr440HRCH	
SCM435HRCH	SCM440HRCH	
SCM445HRCH	SNC631HRCH	
SMn420HRCH	SCr415HRCH	Carburized average grain size number 6.0 min.
SCr420HRCH	SCM415HRCH	
SCM418HRCH	SCM420HRCH	
SCM425HRCH	SCM822HRCH	
SNC815HRCH	SNC415HRCH	
SNCM220HRCH	SNCM420HRCH	

8 Appearance, dimensions and tolerances thereof

8.1 Appearance

The appearance of wire rods shall be as follows.

- Wire rods shall be free from flaws detrimental to use. However, the wire rods may inevitably contain some abnormal portions, since processing of wire rods generally does not allow overall inspection of defects, or opportunity for defects removal. Where necessary, the treatment of abnormal portions found in the coil that are considered detrimental to use shall be agreed between the purchaser and the manufacturer.
- Surface flaws of wire rods shall be tested according to 9.3 and the determined flaw depth shall not exceed 0.10 mm.
- If there is a special need to control flaw depth, for wire rods with diameters of 25 mm or under, Class A requirements given in Table JA.3 may be applied by agreement between the purchaser and the manufacturer.

8.2 Standard diameters

The standard diameters of wire rods shall be as given in Table 6.

Table 6 Standard diameters

Unit: mm													
5.5,	6,	6.4,	7,	8,	9,	9.5,	10,	11,	12,	13,	14,	15,	16,
17,	18,	19,	20,	22,	24,	25,	26,	28,	30,	32,	34,	36,	38,
40,	42,	44,	46,	48,	50								

8.3 Dimensional tolerances

The diameter tolerances and permissible ovality limits shall be as specified in Table 7. If there is a special need to control diameter tolerance and ovality, for wire rods with

diameters of 32 mm or under, Class A or Class B requirements given in Table JA.2 may be applied by agreement between the purchaser and the manufacturer.

Table 7 Diameter tolerance and permissible ovality

Diameter	Tolerance	Unit: mm
		Ovality
15 or under	± 0.3	0.4 max.
Over 15 up to and incl. 25	± 0.4	0.5 max.
Over 25 up to and incl. 32	± 0.5	0.6 max.
Over 32 up to and incl. 50	± 0.6	0.7 max.
For wire rods with diameters over 50 mm, the diameter tolerance/ovality limit shall be as agreed between the purchaser and the manufacturer.		

9 Tests

9.1 Chemical analysis

The chemical analysis shall be as follows.

- The chemical composition shall be determined by the heat analysis. The general requirements for chemical analyses and the sampling method for the heat analysis shall be in accordance with Clause 8 of JIS G 0404.
- Sampling method for the product analysis shall be in accordance with Clause 4 of JIS G 0321.
- The heat analysis shall be carried out by the method specified in JIS G 0320, and the product analysis, by the method specified in JIS G 0321.

9.2 Metallographic test

9.2.1 Test of decarburized depth

The test of decarburized depth shall be as follows.

- One sample shall be taken from one end ¹⁾ of a coil belonging to a group of coils of the same heat, the same rolling chance and the same dimensions.

Note ¹⁾ Portion near the head or tail end of the rolled coil. For coils that are divided after or during rolling, this applies to either of the original ends before the division.

- The test shall be carried out by the method specified in 6.1 of JIS G 0558. The average of measurements at four positions quartering the circumference, starting from the zone of maximum decarburization, shall be determined.

9.2.2 Non-metallic inclusion test

The non-metallic inclusion test shall be as follows.

- The sampling method and number of test pieces shall be agreed between the purchaser and the manufacturer.

- b) The test shall be carried out by the method specified in Annex JA of **JIS G 0555**.

9.2.3 Hardenability test

The hardenability test shall be as follows.

- a) The test piece preparation and test method shall be in accordance with **JIS G 0561**.

One sample shall be taken from each lot of the same heat. The number of test pieces to be sampled shall be at least one, and left to the discretion of the manufacturer unless otherwise specified by the purchaser.

- b) If hardness measurements have been made at the positions specified in Tables 8 to 29 and an intermediate hardness value between those positions is required, the value may be calculated by the proportional distribution method using measurement results of adjacent positions upon agreement between the purchaser and the manufacturer.

9.2.4 Austenitic grain size test

The austenitic grain size test shall be as follows.

- a) The sampling method and number of test pieces shall be agreed between the purchaser and the manufacturer.
- b) The test shall be carried out by one of the methods specified in **JIS G 0551**. If the heat treated average grain size number is required, the heat treated grain size test method according to, unless otherwise specified, either the quenching and tempering method (G_H) or the oxidizing method (G_O) shall be performed. If the carburized grain size number is required, the carburized grain size test method shall be performed.

9.3 Surface flaw detection test

The surface flaw detection test shall be as follows.

- a) One test piece shall be taken from one end ¹⁾ of a coil belonging to a group of coils of the same heat, the same rolling chance and the same dimensions.
- b) Detection shall be carried out by an appropriate method such as the magnetic particle testing or the visual testing after acid cleaning. The surface shall be normally machined until it is free of flaws and the depth of removed flaws shall be measured with a device having an adequate precision.

10 Inspection

The inspection shall be as follows.

- a) The general requirements of the inspections are specified in **JIS G 0404**.
- b) The chemical composition shall conform to the requirements of Clause 6.
- c) The decarburized depth, when tested upon request by the purchaser, shall conform to the requirements of 7.1.
- d) The non-metallic inclusion, when tested upon request by the purchaser, shall con-