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# JIS G 4404 : 2006

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# Alloy tool steels

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## Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.
Consequently **JIS G 4404** : 2000 is replaced with this Standard.

This revision has been made based on **ISO 4957** : 1999 *Tool steels* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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# Alloy tool steels

**Introduction** This Japanese Industrial Standard has been prepared based on the second edition of **ISO 4957** *Tool steels* published in 1999 with some modifications of the technical contents.

The portions given sidelines are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex 2 (informative).

**1 Scope** This Standard specifies alloy tool steels (hereafter referred to as "steels") manufactured by hot-rolling or forging.

Remarks : The International Standard corresponding to this Standard is as follows :

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

ISO 4957 : 1999 *Tool steels* (MOD)

**2 Normative references** The following standards contain provisions which, 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 0320 *Standard test methods for heat analysis of steel products*

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

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

JIS G 0553 *Macrostructure detecting method for steel*

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

JIS G 0556 *Method of macro-streak-flaw test for steel*

JIS G 0558 *Methods of measuring decarburized depth for steel*

JIS G 0565 *Method for magnetic particle testing of ferromagnetic materials and classification of magnetic particle indication*

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

JIS G 3193 *Dimensions, mass and permissible variations of hot rolled steel plates, sheets and strips*

JIS G 3194 *Dimensions, mass and permissible variations of hot rolled flat steel*

JIS Z 2243 *Brinell hardness test—Test method*

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JIS Z 2244 *Vickers hardness test—Test method*

JIS Z 2245 *Rockwell hardness test—Test method*

JIS Z 2344 *General rule of ultrasonic testing of metals by pulse echo technique*

**3 Grade and designation** Steels shall be classified into 32 grades and the designations shall be as given in table 1.

**Table 1 Designation of grade**

| Designation of grade | Application |
|---|---|
| SKS 11<br>SKS 2<br>SKS 21<br>SKS 5<br>SKS 51<br>SKS 7<br>SKS 81<br>SKS 8 | Mainly used for cutting tool |
| SKS 4<br>SKS 41<br>SKS 43<br>SKS 44 | Mainly used for impact resistance tool |
| SKS 3<br>SKS 31<br>SKS 93<br>SKS 94<br>SKS 95<br>SKD 1<br>SKD 2<br>SKD 10<br>SKD 11<br>SKD 12 | Mainly used for cold working mold |
| SKD 4<br>SKD 5<br>SKD 6<br>SKD 61<br>SKD 62<br>SKD 7<br>SKD 8<br>SKT 3<br>SKT 4<br>SKT 6 | Mainly used for hot forming mold |

Informative reference : Designations of grades in **JIS** and corresponding designations in **ISO** are shown in Annex 1.

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**4 Method of manufacture** The method of manufacture shall be as follows :

a) Steel shall be made of killed steel.

b) Unless otherwise specified, steels shall be rolled or forged with a forming ratio of 4S or over. However, if this forming ratio is under 4S owing to the dimension of the steel, it may be overcome by upset forging.

c) Unless otherwise specified, steels shall be subjected to annealing.

Information : The designation of forming ratio conforms to **JIS G 0701**.

**5 Chemical composition** The chemical composition of steels shall be determined by the test of **11.1** and the values obtained by the cast analysis shall be as given in tables 2 to 5.

**Table 2 Chemical composition (for cutting tools)**

Unit : %

| Designation of grade | Chemical composition (1) (2) | | | | | | | | | Example of application (informative) |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Ni | Cr | W | V | |
| SKS 11 | 1.20 to 1.30 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | — | 0.20 to 0.50 | 3.00 to 4.00 | 0.10 to 0.30 | Cutting tool, dies for cold drawing, drill |
| SKS 2 | 1.00 to 1.10 | 0.35 max. | 0.80 max. | 0.030 max. | 0.030 max. | — | 0.50 to 1.00 | 1.00 to 1.50 | (3) | Tap, drill, cutter, die for press, die for thread cutting |
| SKS 21 | 1.00 to 1.10 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | — | 0.20 to 0.50 | 0.50 to 1.00 | 0.10 to 0.25 | |
| SKS 5 | 0.75 to 0.85 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | 0.70 to 1.30 | 0.20 to 0.50 | — | — | Circular saw, band saw |
| SKS 51 | 0.75 to 0.85 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | 1.30 to 2.00 | 0.20 to 0.50 | — | — | |
| SKS 7 | 1.10 to 1.20 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | — | 0.20 to 0.50 | 2.00 to 2.50 | (3) | Hack saw |
| SKS 81 | 1.10 to 1.30 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | — | 0.20 to 0.50 | — | — | Spare cutting tool, cutting tool, hack saw |
| SKS 8 | 1.30 to 1.50 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | — | 0.20 to 0.50 | — | — | Blade file, file set |

Notes (1) Elements not specified in table 2 shall not intentionally be added except for the purpose to finish the melt steel, unless otherwise the agreement between the purchaser and the manufacturer has been settled.

(2) The contents of Ni (excluding SKS 5 and SKS 51) and Cu for each grade shall not exceed 0.25 %, respectively, as the impurities.

(3) SKS 2 and SKS 7 may be added V not exceeding 0.20 %, respectively.

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**Table 3 Chemical composition (for impact resistance tools)**

Unit : %

| Designation of grade | Chemical composition (4) (5) | | | | | | | | Example of application (informative) |
|---|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Cr | W | V | |
| SKS 4 | 0.45 to 0.55 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | 0.50 to 1.00 | 0.50 to 1.00 | — | Chisel, punch, shear knife |
| SKS 41 | 0.35 to 0.45 | 0.35 max. | 0.50 max. | 0.030 max. | 0.030 max. | 1.00 to 1.50 | 2.50 to 3.50 | — | |
| SKS 43 | 1.00 to 1.10 | 0.10 to 0.30 | 0.10 to 0.40 | 0.030 max. | 0.030 max. | (6) | — | 0.10 to 0.20 | Piston for rock borer, heading die |
| SKS 44 | 0.80 to 0.90 | 0.25 max. | 0.30 max. | 0.030 max. | 0.030 max. | (6) | — | 010 to 0.25 | Chisel, heading die |

Notes (4) Elements not specified in table 3 shall not intentionally be added except for the purpose to finish the melt steel, unless otherwise the agreement between the purchaser and the manufacturer has been settled.

(5) The contents of Ni and Cu for each grade shall not exceed 0.25 %, respectively, as the impurities.

(6) SKS 43 and SKS 44 shall not contain over 0.20 % Cr as the impurity.

**Table 4 Chemical composition (for cold working mold)**

Unit : %

| Designation of grade | Chemical composition (7) | | | | | | | | | Example of application (informative) |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Cr | Mo | W | V | |
| SKS 3 | 0.90 to 1.00 | 0.35 max. | 0.90 to 1.20 | 0.030 max. | 0.030 max. | 0.50 to 1.00 | — | 0.50 to 1.00 | — | Gauge, shear knife, die for press, die for thread cutting |
| SKS 31 | 0.95 to 1.05 | 0.35 max. | 0.90 to 1.20 | 0.030 max. | 0.030 max. | 0.80 to 1.20 | — | 1.00 to 1.50 | — | Gauge, die for press, die for thread cutting |
| SKS 93 | 1.00 to 1.10 | 0.50 max. | 0.80 to 1.10 | 0.030 max. | 0.030 max. | 0.20 to 0.60 | — | — | — | Shear knife, gauge, die for press |
| SKS 94 | 0.90 to 1.00 | 0.50 max. | 0.80 to 1.10 | 0.030 max. | 0.030 max. | 0.20 to 0.60 | — | — | — | |
| SKS 95 | 0.80 to 0.90 | 0.50 max. | 0.80 to 1.10 | 0.030 max. | 0.030 max. | 0.20 to 0.60 | — | — | — | |
| SKD 1 | 1.90 to 2.20 | 0.10 to 0.60 | 0.20 to 0.60 | 0.030 max. | 0.030 max. | 11.00 to 13.00 | — | — | (8) | Wire drawing die, die for press, die for brick press, die for powder press |
| SKD 2 | 2.00 to 2.30 | 0.10 to 0.40 | 0.30 to 0.60 | 0.030 max. | 0.030 max. | 11.00 to 13.00 | — | 0.60 to 0.80 | — | |
| SKD 10 | 1.45 to 1.60 | 0.10 to 0.60 | 0.20 to 0.60 | 0.030 max. | 0.030 max. | 11.00 to 13.00 | 0.70 to 1.00 | — | 0.70 to 1.00 | Gauge, die for thread rolling, cutting tool for metal, forming roll, die for press |
| SKD 11 | 1.40 to 1.60 | 0.40 max. | 0.60 max. | 0.030 max. | 0.030 max. | 11.00 to 13.00 | 0.80 to 01.20 | — | 0.20 to 0.50 | |
| SKD 12 | 0.95 to 1.05 | 0.10 to 0.40 | 0.40 to 0.80 | 0.030 max. | 0.030 max. | 4.80 to 5.50 | 0.90 to 1.20 | — | 0.15 to 0.35 | |

Notes (7) Elements not specified in table 4 shall not intentionally be added except for the purpose to finish the melt steel, unless otherwise the agreement between the purchaser and the manufacturer has been settled.

(8) SKD 1 may be added V not exceeding 0.30 %.

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**Table 5 Chemical composition (for hot forming mold)**

Unit : %

| Designation of grade | Chemical composition (9) | | | | | | | | | | | Example of application (informative) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Ni | Cr | Mo | W | V | Co | |
| SKD 4 | 0.25 to 0.35 | 0.40 max. | 0.60 max. | 0.030 max. | 0.020 max. | — | 2.00 to 3.00 | — | 5.00 to 6.00 | 0.30 to 0.50 | — | Die for press, die for die-casting, die for extruding, shear knife |
| SKD 5 | 0.25 to 0.35 | 0.10 to 0.40 | 0.15 to 0.45 | 0.030 max. | 0.020 max. | — | 2.50 to 3.20 | — | 8.50 to 9.50 | 0.30 to 0.50 | — | |
| SKD 6 | 0.32 to 0.42 | 0.80 to 1.20 | 0.50 max. | 0.030 max. | 0.020 max. | — | 4.50 to 5.50 | 1.00 to 1.50 | — | 0.30 to 0.50 | — | |
| SKD 61 | 0.35 to 0.42 | 0.80 to 1.20 | 0.25 to 0.50 | 0.030 max. | 0.020 max. | — | 4.80 to 5.50 | 1.00 to 1.50 | — | 0.80 to 1.15 | — | |
| SKD 62 | 0.32 to 0.40 | 0.80 to 1.20 | 0.20 to 0.50 | 0.030 max. | 0.020 max. | — | 4.75 to 5.50 | 1.00 to 1.60 | 1.00 to 1.60 | 0.20 to 0.50 | — | Die for press, die for extruding |
| SKD 7 | 0.28 to 0.35 | 0.10 to 0.40 | 0.15 to 0.45 | 0.030 max. | 0.020 max. | — | 2.70 to 3.20 | 2.50 to 3.00 | — | 0.40 to 0.70 | — | Die for press, die for extruding |
| SKD 8 | 0.35 to 0.45 | 0.15 to 0.50 | 0.20 to 0.50 | 0.030 max. | 0.020 max. | — | 4.00 to 4.70 | 0.30 to 0.50 | 3.80 to 4.50 | 1.70 to 2.10 | 4.00 to 4.50 | Die for press, die for die-casting, die for extruding |
| SKT 3 | 0.50 to 0.60 | 0.35 max. | 0.60 max. | 0.030 max. | 0.020 max. | 0.25 to 0.60 | 0.90 to 1.20 | 0.30 to 0.50 | — | (10) | — | Die for forging, die for press, die for extruding |
| SKT 4 | 0.50 to 0.60 | 0.10 to 0.40 | 0.60 to 0.90 | 0.030 max. | 0.020 max. | 1.50 to 1.80 | 0.80 to 1.20 | 0.35 to 0.55 | — | 0.05 to 0.15 | — | |
| SKT 6 | 0.40 to 0.50 | 0.10 to 0.40 | 0.20 to 0.50 | 0.030 max. | 0.020 max. | 3.80 to 4.30 | 1.20 to 1.50 | 0.15 to 0.35 | — | — | — | |

Notes (9) Elements not specified in table 5 shall not intentionally be added except for the purpose to finish the melt steel, unless otherwise the agreement between the purchaser and the manufacturer has been settled.

(10) SKT 3 may be added V not exceeding 0.20 %.

**6 Hardness in annealed condition** The annealed hardness for steels shall be determined by the test of **11.2** and as given in table 6. Pertaining to steels for which the measurement by Brinell hardness is difficult, however, it may be made by Rockwell hardness or Vickers hardness. In this case, the values shall be agreed upon between the purchaser and the manufacturer.

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**Table 6 Annealed hardness of steel**

| Category | Designation of grade | Annealing temperature °C | Annealed hardness HBW |
|---|---|---|---|
| Steel for cutting tool | SKS 11 | 780 to 850 slow cooling | 241 max. |
| | SKS 2 | 750 to 800 slow cooling | 217 max. |
| | SKS 21 | 750 to 800 slow cooling | 217 max. |
| | SKS 5 | 750 to 800 slow cooling | 207 max. |
| | SKS 51 | 750 to 800 slow cooling | 207 max. |
| | SKS 7 | 750 to 800 slow cooling | 217 max. |
| | SKS 81 | 750 to 800 slow cooling | 212 max. |
| | SKS 8 | 750 to 800 slow cooling | 217 max. |
| Steel for impact resistance tool | SKS 4 | 740 to 780 slow cooling | 201 max. |
| | SKS 41 | 760 to 820 slow cooling | 217 max. |
| | SKS 43 | 750 to 800 slow cooling | 212 max. |
| | SKS 44 | 730 to 780 slow cooling | 207 max. |
| Steel for cold working mold | SKS 3 | 750 to 800 slow cooling | 217 max. |
| | SKS 31 | 750 to 800 slow cooling | 217 max. |
| | SKS 93 | 750 to 780 slow cooling | 217 max. |
| | SKS 94 | 740 to 760 slow cooling | 212 max. |
| | SKS 95 | 730 to 760 slow cooling | 212 max. |
| | SKD 1 | 830 to 880 slow cooling | 248 max. |
| | SKD 2 | 830 to 880 slow cooling | 255 max. |
| | SKD 10 | 830 to 880 slow cooling | 255 max. |
| | SKD 11 | 830 to 880 slow cooling | 255 max. |
| | SKD 12 | 830 to 880 slow cooling | 241 max. |
| Steel for hot forming mold | SKD 4 | 800 to 850 slow cooling | 235 max. |
| | SKD 5 | 800 to 850 slow cooling | 241 max. |
| | SKD 6 | 820 to 870 slow cooling | 229 max. |
| | SKD 61 | 820 to 870 slow cooling | 229 max. |
| | SKD 62 | 820 to 870 slow cooling | 229 max. |
| | SKD 7 | 820 to 870 slow cooling | 229 max. |
| | SKD 8 | 820 to 870 slow cooling | 262 max. |
| | SKT 3 | 760 to 810 slow cooling | 235 max. |
| | SKT 4 | 740 to 800 slow cooling | 248 max. |
| | SKT 6 | 720 to 780 slow cooling | 285 max. |

Remarks : For hot-rolled steel plate and sheet in coils and cut lengths, the hardness value in annealed condition shall be agreed upon between the purchaser and the manufacturer.

**7 Hardness in quenched and tempered condition** The test piece for hardness in quenched and tempered condition which is sampled in accordance with **11.2** shall be subjected to heat treatment at the temperature given in table 7 and the hardness on the test piece in quenched and tempered condition shall be as given in table 7. The allowable range of the heat treatment temperature for the test piece shall be ±10°C of the temperature given in table 7 for both quenching and tempering treatment.

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**Table 7 Quenched and tempered hardness of test piece**

| Category | Designation | Heat treatment temperature °C | | Quenched and hardness of grade |
|---|---|---|---|---|
| | | Quenching | Tempering | HRC |
| Steel for cutting tool | SKS 11 | 790 water quenching | 180 air cooling | 62 min. |
| | SKS 2 | 860 oil quenching | 180 air cooling | 61 min. |
| | SKS 21 | 800 water quenching | 180 air cooling | 61 min. |
| | SKS 5 | 830 oil quenching | 420 air cooling | 45 min. |
| | SKS 51 | 830 oil quenching | 420 air cooling | 45 min. |
| | SKS 7 | 860 oil quenching | 180 air cooling | 62 min. |
| | SKS 81 | 790 water quenching | 180 air cooling | 63 min. |
| | SKS 8 | 810 water quenching | 180 air cooling | 63 min. |
| Steel for impact resistance tool | SKS 4 | 800 water quenching | 180 air cooling | 56 min. |
| | SKS 41 | 880 oil quenching | 180 air cooling | 53 min. |
| | SKS 43 | 790 water quenching | 180 air cooling | 63 min. |
| | SKS 44 | 790 water quenching | 180 air cooling | 60 min. |
| Steel for cold working mold | SKS 3 | 830 oil quenching | 180 air cooling | 60 min. |
| | SKS 31 | 830 oil quenching | 180 air cooling | 61 min. |
| | SKS 93 | 820 oil quenching | 180 air cooling | 63 min. |
| | SKS 94 | 820 oil quenching | 180 air cooling | 61 min. |
| | SKS 95 | 820 oil quenching | 180 air cooling | 59 min. |
| | SKD 1 | 970 air cooling | 180 air cooling | 62 min. |
| | SKD 2 | 970 air cooling | 180 air cooling | 62 min. |
| | SKD 10 | 1 020 air cooling | 180 air cooling | 61 min. |
| | SKD 11 | 1 030 air cooling | 180 air cooling | 58 min. |
| | SKD 12 | 970 air cooling | 180 air cooling | 60 min |
| Steel for hot forming mold | SKD 4 | 1 080 oil quenching | 600 air cooling | 42 min. |
| | SKD 5 | 1 150 oil quenching | 600 air cooling | 48 min. |
| | SKD 6 | 1 050 air cooling | 550 air cooling | 48 min. |
| | SKD 61 | 1 020 air cooling | 550 air cooling | 50 min. |
| | SKD 62 | 1 020 air cooling | 550 air cooling | 48 min. |
| | SKD 7 | 1 040 air cooling | 550 air cooling | 46 min. |
| | SKD 8 | 1 120 oil quenching | 600 air cooling | 48 min. |
| | SKT 3 | 850 oil quenching | 500 air cooling | 42 min. |
| | SKT 4 | 850 oil quenching | 500 air cooling | 42 min. |
| | SKT 6 | 850 oil quenching | 180 air cooling | 52 min. |

**8 Appearance** Steels shall have a well workmanlike finish, and shall be free from defects that are detrimental to practical use.

## 9 Dimension and tolerances

**9.1 Standard dimension** The standard diameter of the hot-rolled round steel bar shall be as given in table 8.

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**Table 8 Standard diameter**

Unit : mm

| | | | | |
|---|---|---|---|---|
| 10 | 20 | 30 | 50 | 100 |
| 11 | 21 | 32 | 55 | 110 |
| 12 | 22 | 34 | 60 | 120 |
| 13 | 23 | 36 | 65 | 130 |
| 14 | 24 | 38 | 70 | 140 |
| 15 | 25 | 40 | 75 | 150 |
| 16 | 26 | 42 | 80 | |
| 17 | 27 | 44 | 85 | |
| 18 | 28 | 46 | 90 | |
| 19 | 29 | 48 | 95 | |

Remarks : Table 8 is applicable to wire rods and bar in coils whose cross-section is round.

**9.2 Dimensional tolerances** The tolerances on diameter for the hot-rolled round steel bar shall be as given in table 9.

**Table 9 Tolerances on diameter**

Unit : mm

| Specified diameter | Tolerance on diameter | Allowable deviation on diameter (11) |
|---|---|---|
| 10 or over to and excl. 16 | +0.6<br>−0.3 | Up to and incl. 70 % of the full range of tolerance on diameter |
| 16 or over to and excl. 30 | +0.7<br>−0.3 | |
| 30 or over up to and incl. 150 | +2.5 %<br>−1.0 % | |

Note (11) The allowable deviation on diameter means the deference between the maximum and minimum diameters on the same cross-section of the round steel bar.

Remarks 1 The tolerances on diameter for the round steel bar whose diameter is under 10 mm and over 150 mm shall be agreed upon between the purchaser and the manufacturer.

2 Table 9 is applicable to wire rods and bar in coils whose cross-section is round.

**9.3 Dimension and tolerances on dimension of steels other than hot-rolled round steel bars** The dimensions and the tolerances on dimension of steels other than the hot-rolled round steel bar shall be agreed upon between the purchaser and the manufacturer.

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**10 Decarburized depth** The decarburized depth of steels shall be measured in accordance with **11.3** and the allowable limit of decarburized depth of hot-rolled round steel bars shall be as given in table 10. The allowable limit of decarburized depth of steels other than hot-rolled round steel bars shall be agreed upon between the purchaser and the manufacturer.

**Table 10 Allowable limit of decarburized depth of hot-rolled round steel bar**

Unit : mm

| Specified diameter | Allowable limit |
|---|---|
| Under 15 | 0.30 |
| 15 or over to and excl. 25 | 0.50 |
| 25 or over to and excl. 50 | 0.80 |
| 50 or over to and excl. 75 | 1.10 |
| 75 or over to and excl. 100 | 1.40 |
| 100 or over to and excl. 130 | 1.80 |
| 130 or over up to and incl. 150 | 2.00 |

Remarks 1 The allowable limit of decarburized depth of round steel bars whose diameter is over 150 mm shall be agreed upon between the purchaser and the manufacturer.

2 Table 10 is applicable to wire rods and bar in coils whose cross-section is round.

## 11 Test

### 11.1 Chemical analysis

**11.1.1 General requirement for chemical analysis and sampling method of specimen for analysis** The chemical composition shall be determined by the cast analysis. The general requirement for chemical analysis and sampling method of specimen for analysis conforms to clause **8** of **JIS G 0404**.

**11.1.2 Analytical method** The analytical method conforms to **JIS G 0320**.

### 11.2 Hardness test

**11.2.1** The measurement of hardness on the annealed steels shall be made at arbitrary place of the steel.

**11.2.2** Pertaining to the sampling plan, one test specimen for quenched and tempered hardness test shall be taken from each same heat of the steel and each same heat treatment condition.

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**11.2.3** The test piece for quenched and tempered hardness test shall be machined from the test specimen prepared according to **11.2.2** to furnish approximately 15 mm square or circle, and approximately 20 mm length. The test piece with thickness or diameter not more than 15 mm, respectively, shall be regarded as equivalent to thickness × approximately 15 mm × approximately 20 mm or diameter × approximately 20 mm. When it is difficult to apply these dimensions of the test piece, it shall be agreed upon between the purchaser and the manufacturer.

In the case when the test specimen is prepared from un-annealed steels, the test piece for quenched and tempered hardness test shall be annealed according to table 6 followed by quenching and tempering specified in table 7.

**11.2.4** The test method conforms to any one of the following standards :

**JIS Z 2243**, **JIS Z 2244**, **JIS Z 2245**

**11.3 Measurement of decarburized depth** The measurement of decarburized depth shall be made by the total decarburized depth (DM-T) according to **4.1** of **JIS G 0558**. However, when it is difficult to carry out microscopic measurement of the steel other than that for hot forming mold, it is recommended to apply the practical decarburized depth (DH-P) according to **4.2** of **JIS G 0558**. In this case, the heat treatment of the test piece shall be as given in table 7 and the practical decarburized depth shall be the depth from the surface obtained when the hardness reaches that given in table 7.

## 12 Inspection

**12.1 Inspection** Inspection shall be as follows :

a) General requirements given in **JIS G 0404** shall apply.

b) Chemical composition shall comply with clause **5**.

c) Annealed hardness of steels shall comply with clause **6**.

d) Hardness in quenched and tempered condition shall comply with clause **7**.

e) Appearance shall comply with clause **8**.

f) Dimension and tolerances shall comply with clause **9**.

g) The decarburized depth shall comply with clause **10**.

**12.2 Other inspection** In addition to the inspections specified in **12.1**, the following inspections may be conducted by agreement between the purchaser and the manufacturer.

Macrostructure inspection, non-metallic inclusions inspection, macro-streak-flaw inspection, magnetic particle inspection, ultrasonic flaw detection inspection, microstructure inspection

Test methods for inspections other than the microstructure inspection shall be as follows.

| | |
|---|---|
| Macrostructure inspection | **JIS G 0553** |
| Non-metallic inclusions inspection | **JIS G 0555** |
| Macro-streak-flaw inspection | **JIS G 0556** |

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| | |
|---|---|
| Magnetic particle inspection | **JIS G 0565** |
| Ultrasonic flaw detection inspection | **JIS Z 2344** |

The test method of microstructure inspection shall be agreed upon between the purchaser and the manufacturer.

In this case, the sampling position of test specimen and test piece, acceptance criteria, and others shall previously be agreed between the purchaser and the manufacturer.

**13 Marking** Pertaining to the marking on steels, the following items shall be marked by suitable means on every steel. Steel plates and sheets, steel in coils and cut lengths, flat steels and steel bars and wires whose diameter or width across flats is under 30 mm may be bundled and the items may be marked on each bundle by suitable means. When approved by the purchaser, a part of the following items may be omitted.

a) Designation of grade

b) Heat number or alternative manufacturing (inspection) number

c) Dimension ([12])

d) Quantity or mass

e) Manufacture's name or its identifying brand

Note ([12]) Marking shall conform to **JIS G 3191**, **JIS G 3193** and **JIS G 3194**.

**14 Report** The report conforms to the requirements of clause **13** of **JIS G 0404**. Unless otherwise specified by the purchaser, inspection documents shall be Specific test report (designation 2.3) or Inspection certificate (designation 3.1 B) in table 1 of **JIS G 0415**.

Reports according to **12.2** shall be agreed upon between the purchaser and the manufacturer.

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# Annex 1 (informative)

# Designation of grade correspondence between JIS and International Standard

This Annex (informative) is to supplement the matters related to the text and not to constitute the provisions of this Standard.

**1 Designation of grade correspondence between JIS and International Standard** The designations of grades of **JIS** and those of the International Standard (**ISO 4957** : 1999) whose chemical composition is equivalent to or similar to are shown in Annex 1 table 1.

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## Annex 1 Table 1 Designation of grade correspondence between JIS and International Standard

| Designation of grade | | Category |
|---|---|---|
| **JIS** | **ISO** | |
| SKS 11 | — | Mainly used for cutting tool |
| SKS 2 | — | |
| SKS 21 | — | |
| SKS 5 | — | |
| SKS 51 | — | |
| SKS 7 | — | |
| SKS 81 | — | |
| SKS 8 | — | |
| SKS 4 | — | Mainly used for impact resistance tool |
| SKS 41 | — | |
| SKS 43 | 105V | |
| SKS 44 | — | |
| SKS 3 | — | Mainly used for cold working mold |
| SKS 31 | — | |
| SKS 93 | — | |
| SKS 94 | — | |
| SKS 95 | — | |
| SKD 1 | X210Cr12 | |
| SKD 2 | X210CrW12 | |
| SKD 10 | X153CrMoV12 | |
| SKD 11 | — | |
| SKD 12 | X100CrMoV5 | |
| SKD 4 | — | Mainly used for hot forming mold |
| SKD 5 | X30WCrV9-3 | |
| SKD 6 | — | |
| SKD 61 | X40CrMoV5-1 | |
| SKD 62 | X35CrWMoV5 | |
| SKD 7 | 32CrMoV12-28 | |
| SKD 8 | 38CrCoWV18-17-17 | |
| SKT 3 | — | |
| SKT 4 | 55NiCrMoV7 | |
| SKT 6 | 45NiCrMo16 | |

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## Annex 2 (informative)

## Comparison table between JIS and corresponding International Standard

| **JIS G 4404** : 2006 *Alloy tool steels* | | | **ISO 4957** : 1999 *Tool steels* | | | | |
|---|---|---|---|---|---|---|---|
| (I) Requirements in **JIS** | | (II) International Standard number | (III) Requirements in International Standard | | (IV) Classification and details of technical deviation between **JIS** and the International Standard by clause | | (V) Justification for the technical deviation and future measures |
| Clause | Content | | Clause | Content | Classification by clause | Detail of technical deviation | |
| 1 Scope | Steels manufactured by hot-rolling or forging · Alloy tool steels | **ISO 4957** | 1 | Scope : Applies to hot-rolled, forged, cold-drawn or cold-rolled products.<br>a) non-alloy cold-work tool steels<br>b) alloy cold-work tool steels<br>c) alloy hot-work tool steels<br>d) high-speed tool steels | MOD/deletion | **JIS** specifies carbon tool steels in **JIS G 4401** and high-speed tool steels in **JIS G 4403**. This comes from difference of standard system. This table provides comparison focusing on alloy tool steels based on **JIS**. | This comes from the usability of standard and does not give any problems when comparing difference between both Standards. For the time being difference should not be modified. |
| 2 Normative references | **JIS** Standards are referred to. | | | **ISO** Standards are referred to. | | | |
| 3 Grade and designation | **JIS** designation code is conformed. | | | **ISO** designation code is conformed. | MOD/alteration | The designation codes between **JIS** and **ISO** are different. | |

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| (I) Requirements in **JIS** | | (II) International Standard number | (III) Requirements in International Standard | | (IV) Classification and details of technical deviation between **JIS** and the International Standard by clause | | (V) Justification for the technical deviation and future measures |
|---|---|---|---|---|---|---|---|
| Clause | Content | | Clause | Content | Classification by clause | Detail of technical deviation | |
| 4 Method of manufacture | · Killed steel<br>· Forming ratio of 4S or over<br>· Unless otherwise specified, the steel shall be subjected to annealing. | | 5.1 | Manufacturing process<br>a) The manufacturing process of steels is left to the discretion of the manufacturer.<br>b) By the purchaser's requests, the steel making process shall be informed.<br>c) Unless otherwise specified in the order, the tool steels are delivered in the annealed condition except below.<br>C45U, 35CrMo7, X38CrMo16, 40CrMnNiMo8-6-4, 55NiCrMoV7 | MOD/addition | · a) and b) of **ISO** are general and ordinary. They should be described in **ISO 404**. This idea will be proposed when reviewing **ISO 404** next time.<br>· Forming ratio should be specified in light of domestic needs although it is not strict and widely satisfied.<br>· **JIS** specifies the plate and sheet in coils and cut lengths because they are not generally cut or cold-worked as they are. This will be also proposed when reviewing **ISO** next time. | The **JIS** description relating to forming ratio will be proposed when reviewing **ISO** next time. |
| 5 Chemical composition | Specifies 32 grades of steels by application such as for cutting tool, for impact resistance tool, for cold working mold and for hot forming mold. Consists of the conventional **JIS** and **ISO** grades. | | 5.2 | Specifies 26 grades of steels as alloy cold-work tool steels, alloy hot-work tool steels. | Combination of MOD/deletion and MOD/addition | Among 32 grades of steels of **JIS**, 12 grades of steels of **ISO** are adopted which are adaptable to domestic market needs. Twenty grades of steels of the conventional **JIS** widely used in the market are also specified. | Harmonization to **ISO** grades of steels will be promoted, while grades of steels indispensable for domestic market needs are left as they are. **JIS**-specific grades of steels will be proposed to be incorporated into **ISO**. |

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| (I) Requirements in **JIS** | | (II) International Standard number | (III) Requirements in International Standard | | (IV) Classification and details of technical deviation between **JIS** and the International Standard by clause | | (V) Justification for the technical deviation and future measures |
|---|---|---|---|---|---|---|---|
| Clause | Content | | Clause | Content | Classification by clause | Detail of technical deviation | |
| 6 Hardness in annealed condition | Specifies the maximum hardness for each grade in the standard annealing heat treatment. | | 5.2 | Mechanical properties : Specifies the maximum hardness in the usual annealed condition at delivery. | Combination of MOD/deletion and MOD/addition | Specification is linked with grades of steels. However, **ISO** Standard has no description on the annealed condition. | **ISO** Standard specifies only the guaranteed value of the maximum hardness in the annealed condition at delivery with the annealed condition randomly chosen. This differs from **JIS** which specifies the cold-work after annealing carried out by the user side, but for the time being **JIS**-specific content developed based on the domestic dealings is adopted as the **JIS** values are equivalent to **ISO** values. |
| 7 Hardness in quenched and tempered condition | Specifies the minimum hardness in the standard quenched and tempered condition. | | 5.2 | Hardness in quenched and tempered condition : Specifies the minimum hardness in the standard quenched and tempered condition. | Combination of MOD/deletion and MOD/addition | Specification is linked with grades of steels. | |
| 8 Appearance | Steels shall be free from defects that are detrimental to practical use. | | 3.7 | Almost the same with **JIS**. | MOD/alteration | Same as the left. | |
| 9 Dimension and tolerances | Specifies concrete values on dimension and tolerances. | | 5.4 | Tolerances on shape and dimension : Subject to the agreement between the purchaser and the manufacturer. | MOD/addition | **ISO** does not provide any specification explicitly. **JIS** provides the specification satisfied with domestic market needs explicitly. | **JIS** specification satisfied with domestic needs is employed. |

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| (I) Requirements in **JIS** | | (II) International Standard number | (III) Requirements in International Standard | | (IV) Classification and details of technical deviation between **JIS** and the International Standard by clause | | (V) Justification for the technical deviation and future measures |
|---|---|---|---|---|---|---|---|
| Clause | Content | | Clause | Content | Classification by clause | Detail of technical deviation | |
| 10 Decarburized depth | For round steel bars, **JIS** specifies the concrete limits of decarburized depth. | | — | Not specified. | MOD/addition | For round steel bars, **JIS** specifies the concrete allowable limits of decarburized depth. | The conventional **JIS** specification is employed in accordance with market needs. At the time of periodical review in 2004, the addition was proposed. |
| 11 Test | The following three tests are specified.<br>11.1 Chemical analysis<br>11.2 Hardness test<br>11.3 Measurement of decarburized depth | | 4 | The following three tests are specified.<br>– Chemical analysis<br>– Hardness test<br>– Surface quality test<br>Method of surface quality test shall be in accordance with the agreement between the purchaser and the manufacturer.<br>– Decarburized depth<br>– Surface defects | MOD/addition | The contents of tests are almost the same. Measurement of decarburized depth is decided to be in accordance with the agreement between the purchaser and the manufacturer. | At the time of periodical review in 2004, the addition of decarburized depth test was proposed. |
| 12 Inspection | 12.1 Inspection<br>– Chemical composition<br>– Hardness in quenched and tempered condition<br>– Appearance<br>– Dimension and tolerances<br>– Decarburized depth<br>12.2 Other inspection<br>Inspection other than 12.2 shall be agreed between the purchaser and the manufacturer. | | 3 | The following inspection items are specified.<br>– Chemical composition<br>– Hardness in quenched and tempered condition<br>– Surface condition<br>– Dimension | MOD/addition | Fundamental items are almost the same between **JIS** and **ISO**. However, **JIS** specifies more items to be in accordance with the agreement. | **JIS** specifies to perform the test items meeting with the requirement of domestic needs. |
| 13 Marking | Designation of grade, heat number, name of manufacturer, dimension, and mass. | | | Almost the same with **JIS**. | MOD/alteration | Same as the left. | |

| (I) Requirements in **JIS** | | (II) International Standard number | (III) Requirements in International Standard | | (IV) Classification and details of technical deviation between **JIS** and the International Standard by clause | | (V) Justification for the technical deviation and future measures |
|---|---|---|---|---|---|---|---|
| Clause | Content | | Clause | Content | Classification by clause | Detail of technical deviation | |
| 14 Report | Fundamental report form is specified. | | | Almost the same with **JIS**. | MOD/addition | Same as the left. | |
| Annex 1 (informative) | Designation codes of **JIS** and those corresponding to International Standard are listed as a reference. | | | | MOD/addition | | |

Designated degree of correspondence between **JIS** and International Standard : MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows :

– MOD/deletion : Deletes the specification item(s) and content(s) of International Standard.

– MOD/addition : Adds the specification item(s) and content(s) which are not included in International Standard.

– MOD/alteration : Alters the specification content(s) which are included in International Standard.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows :

– MOD : Modifies International Standard.

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