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KS D 3512

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Ⓢ Cold-reduced carbon steel sheets and strip  
KS D 3512:2007  
(Reaffirmed 2012)

**Translated and Published by Korean Standards Association**

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# Ⓜ Cold-reduced carbon steel sheets and strip

## Introduction

This is a Korean Industrial Standard prepared based on the 3<sup>rd</sup> edition of ISO 3574, Cold-reduced carbon steel sheet of commercial and drawing qualities published in 1999 by modifying technological details.

## 1 Scope

This Korean Industrial Standard specifies cold-reduced carbon steel sheets and strip (hereinafter, referred to as “Steel Sheet and Strip”) including strip steel (cold-reduced steel strip less than 500 mm in width) and the steel sheet cut from strip steel.

## 2 Normative References

The following referenced standards are indispensable for the application of this document. The latest edition of the referenced document applies.

KS A 3251 – 1, Statistical interpretation of data — Part 1: Statistical presentation of data

KS B 0801, Test pieces for tensile test for metallic materials

KS B 0802, Method of tensile test for metallic materials

KS B 0804, Metallic materials — Bend test

KS B 0806, Metallic materials — Test method of rockwell hardness

KS B 0811, Metallic materials — Vickers hardness test — Part1: Test method

KS B ISO 10113, Metallic materials — Sheet and strip — Determination of plastic strain ratio

KS D 0001, General rules for inspection of steel

KS D 0228, Product analysis and its tolerance for wrought steel

## 3 Type and Designations

There are 5 types of steel sheets and strips and the Table 1 shall apply for their designation and Tables 2 and 3 shall apply for the division of refining and surface finish, respectively.

**Table 1 — Designation**

| Designation                                                                                                                                                                                                                     | Remarks                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|
| SPCC                                                                                                                                                                                                                            | Commercial                    |
| SPCD                                                                                                                                                                                                                            | Drawing                       |
| SPCE                                                                                                                                                                                                                            | Deep Drawing                  |
| SPCF                                                                                                                                                                                                                            | Non-ageing Deep Drawing       |
| SPCG                                                                                                                                                                                                                            | Non-ageing Extra Deep Drawing |
| NOTE 1 Standard refining and annealing steel sheet and strip of SPCC shall be indicated as SPCCT by suffixing it with "T" if the tensile strength and elongation percentage are guaranteed upon the designation of the orderer. |                               |
| NOTE 2 SPCG is normally manufactured with IF steel. IF refers to the steel manufactured in a fashion that extremely minimizes C and N used.                                                                                     |                               |

**Table 2 — Division of Refining**

| Division of Refining | Designation of Refining |
|----------------------|-------------------------|
| Annealed             | A                       |
| Standard Refining    | S                       |
| 1/8 Hardness         | 8                       |
| 1/4 Hardness         | 4                       |
| 1/2 Hardness         | 2                       |
| Hardness             | 1                       |

**Table 3 — Division of Surface Finish**

| Division of Surface Finish                                               | Designation of Surface Finish | Remarks                                                                  |
|--------------------------------------------------------------------------|-------------------------------|--------------------------------------------------------------------------|
| Dull Finishing                                                           | D                             | Physically or chemically eliminates roll gloss by roughening the surface |
| Bright Finishing                                                         | B                             | Finishes the surface smoothly with the smooth roll.                      |
| NOTE Rules of Table 3 are not applied to annealed steel sheet and strip. |                               |                                                                          |

## 4 Chemical Composition

Test steel sheet and strip in accordance with clause 12.1 and refer to Table 4 for its ladle analysis value. However, apply the rules of Table 4 to steel sheet and strip put under standard refining or annealing only.

**Table 4 — Chemical Composition**

Unit: %

| Designation                                                                                                              | C            | Mn           | P             | S             |
|--------------------------------------------------------------------------------------------------------------------------|--------------|--------------|---------------|---------------|
| SPCC                                                                                                                     | 0.15 or Less | 0.60 or Less | 0.050 or Less | 0.050 or Less |
| SPCD                                                                                                                     | 0.12 or Less | 0.50 or Less | 0.040 or Less | 0.040 or Less |
| SPCE                                                                                                                     | 0.10 or Less | 0.45 or Less | 0.030 or Less | 0.030 or Less |
| SPCF                                                                                                                     | 0.08 or Less | 0.45 or Less | 0.030 or Less | 0.030 or Less |
| SPCG <sup>a</sup>                                                                                                        | 0.02 or Less | 0.25 or Less | 0.020 or Less | 0.020 or Less |
| NOTE Alloy elements other than those listed in Table 4 can be added upon necessity.                                      |              |              |               |               |
| <sup>a</sup> The upper limit of Mn, P, or S can be adjusted according to the agreement between orderer and manufacturer. |              |              |               |               |

## 5 Mechanical Properties

### 5.1 Yield Point, Yield Strength, Tensile Strength, and Elongation Percentage

Test steel sheet and strip, put under standard refining or annealed, according to clause 12.2, and refer to Table 5 for its yield point, yield strength, tensile strength, and elongation percentage.

**Table 5 — Yield Point or Yield Strength, Tensile Strength, Elongation Percentage, and Non-Ageing Property**

| Designation        | Yield Point or Yield Strength N/mm <sup>2</sup> | Tensile Strength N/mm <sup>2</sup> | Elongation Percentage %           |                                   |                                   |                                  |                                 |                                 |               | Tensile Test Specimen                              |
|--------------------|-------------------------------------------------|------------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|----------------------------------|---------------------------------|---------------------------------|---------------|----------------------------------------------------|
|                    | Division by Nominal Thickness mm                |                                    |                                   |                                   |                                   |                                  |                                 |                                 |               |                                                    |
|                    | 0.25 or Higher                                  | 0.25 or Higher                     | 0.25 or Higher and Less than 0.30 | 0.30 or Higher and Less than 0.40 | 0.40 or Higher and Less than 0.60 | 0.60 or Higher and Less than 1.0 | 1.0 or Higher and Less than 1.6 | 1.6 or Higher and Less than 2.5 | 2.5 or Higher |                                                    |
| SPCC               | —                                               | —                                  | —                                 | —                                 | —                                 | —                                | —                               | —                               | —             | Reducing Direction of Size 5 Specimen <sup>b</sup> |
| SPCCT <sup>a</sup> | —                                               | 270 or Higher                      | 28 or Less                        | 31 or Higher                      | 34 or Higher                      | 36 or Higher                     | 37 or Higher                    | 38 or Higher                    | 39 or Higher  |                                                    |
| SPCD               | (240 or Less)                                   | 270 or Higher                      | 30 or Higher                      | 33 or Higher                      | 36 or Higher                      | 38 or Higher                     | 39 or Higher                    | 40 or Higher                    | 41 or Higher  |                                                    |
| SPCE               | (220 or Less)                                   | 270 or Higher                      | 32 or Higher                      | 35 or Higher                      | 38 or Higher                      | 40 or Higher                     | 41 or Higher                    | 42 or Higher                    | 43 or Higher  |                                                    |
| SPCF               | (210 or Less)                                   | 270 or Higher                      | —                                 | —                                 | 40 or Higher                      | 42 or Higher                     | 43 or Higher                    | 44 or Higher                    | 45 or Higher  |                                                    |
| SPCG               | (190 or Less)                                   | 270 or Higher                      | —                                 | —                                 | 42 or Higher                      | 44 or Higher                     | 45 or Higher                    | 46 or Higher                    | —             |                                                    |

NOTE 1 Omit tensile test for material less than 0.6 mm in thickness as a rule.

NOTE 2 The elongation percentage of Table 5 is not applied to the steel sheet and strip put under standard refining or ground with pearlite.

NOTE 3 Non-ageing property of SPCF and SPCG is guaranteed for 6 months after shipping from the factory of production.

NOTE 4 The upper limit of yield point or yield strength inside bracket is the reference value and can be applied according to the agreement between orderer and manufacturer.

NOTE 5 1 N/mm<sup>2</sup> = 1 MPa

<sup>a</sup> SPCC guaranteeing tensile strength and elongation percentage.

<sup>b</sup> If it is not possible to obtain Size 5 specimen, refer to the agreement between orderer and manufacturer for the shape and elongation percentage of the specimen.

## 5.2 Mean Plastic Strain Ratio

For SPCG steel sheet and strip, perform the test in clause 12.2 and refer to Table 6 for its mean plastic strain ratio  $\bar{r}$ .

**Table 6 — Mean Plastic Strain Ratio  $\bar{r}$**

| Designation | Division by Nominal Thickness<br>mm |                                  |                                    |                 |
|-------------|-------------------------------------|----------------------------------|------------------------------------|-----------------|
|             | Less than 0.5                       | 0.5 or Higher<br>and 1.0 or Less | Higher than 1.0<br>and 1.6 or Less | Higher than 1.6 |
| SPCG        | —                                   | 1.4 or Higher                    | 1.3 or Higher                      | —               |

## 5.3 Hardness

Test steel sheet and strip of 1/8 hardness, 1/4 hardness, 1/2 hardness, and hardness (hereinafter, referred to as “Hard Material”) according to clause 12.2, and refer to Table 7 for the hardness. However, if the material is thin and cannot be measured with HRB, measure hardness using HR30T, HR15T, or HV and convert the measurement into HRB according to the calculating table in Tables 8~11. Reference Table 2 shows the example of HRB and minimum applied thickness. For the hardness not indicated in the conversion table, convert it based on interpolation.

NOTE KS B 0806 specifies that “the thickness of the sample shall not influence the inner side of the sample.” For a spherical press, the formula for calculating the minimum thickness of the sample is shown in Reference Table 1.

**Reference Table 1 — Formula for Calculation of Minimum Thickness of Sample**

| Press                                                                      | Rockwell Hardness        | Rockwell Special Hardness |
|----------------------------------------------------------------------------|--------------------------|---------------------------|
| Spherical Press                                                            | $15h$ or $0.03(130 - H)$ | $15h$ or $0.015(100 - H)$ |
| Here,<br>$h$ : Permanent Deformation of Indentation (mm)<br>$H$ : Hardness |                          |                           |

**Table 7 — Rockwell Hardness (HRB) and Vickers Hardness (HV) of Hard Material**

| Division of Refining                       | Designation of Refining | Hardness     |               |
|--------------------------------------------|-------------------------|--------------|---------------|
|                                            |                         | HRB          | HV            |
| 1/8 Hardness                               | 8                       | 50 ~ 71      | 95 ~ 130      |
| 1/4 Hardness                               | 4                       | 65 ~ 80      | 115 ~ 150     |
| 1/2 Hardness                               | 2                       | 74 ~ 89      | 135 ~ 185     |
| Hardness                                   | 1                       | 85 or Higher | 170 or Higher |
| NOTE For hardness, apply either HRB or HV. |                         |              |               |

**Reference Table 2 — Example of HRB and Minimum Applied Thickness**

| HRB Hardness                    | 50   | 65   | 74   | 85   |
|---------------------------------|------|------|------|------|
| Minimum Applied Thickness<br>mm | 2.40 | 1.95 | 1.68 | 1.35 |

**Table 8 — Hardness Conversion from HR30T to HRB**

| HR30T                                                                                                                                   | Converted<br>HRB | HR30T | Converted<br>HRB | HR30T | Converted<br>HRB | HR30T | Converted<br>HRB |
|-----------------------------------------------------------------------------------------------------------------------------------------|------------------|-------|------------------|-------|------------------|-------|------------------|
| 35.0                                                                                                                                    | 28.1             | 47.0  | 46.0             | 59.0  | 63.9             | 71.0  | 81.9             |
| 36.0                                                                                                                                    | 29.6             | 48.0  | 47.5             | 60.0  | 65.4             | 72.0  | 83.4             |
| 37.0                                                                                                                                    | 31.1             | 49.0  | 49.0             | 61.0  | 66.9             | 73.0  | 84.9             |
| 38.0                                                                                                                                    | 32.5             | 50.0  | 50.5             | 62.0  | 68.4             | 74.0  | 86.4             |
| 39.0                                                                                                                                    | 34.0             | 51.0  | 52.0             | 63.0  | 69.9             | 75.0  | 87.9             |
| 40.0                                                                                                                                    | 35.5             | 52.0  | 53.5             | 64.0  | 71.4             | 76.0  | 89.4             |
| 41.0                                                                                                                                    | 37.0             | 53.0  | 55.0             | 65.0  | 72.9             | 77.0  | 90.8             |
| 42.0                                                                                                                                    | 38.5             | 54.0  | 56.5             | 66.0  | 74.4             | 78.0  | 92.3             |
| 43.0                                                                                                                                    | 40.0             | 55.0  | 58.0             | 67.0  | 75.9             | 79.0  | 93.8             |
| 44.0                                                                                                                                    | 41.5             | 56.0  | 59.5             | 68.0  | 77.4             | 80.0  | 95.3             |
| 45.0                                                                                                                                    | 43.0             | 57.0  | 60.9             | 69.0  | 78.9             | 81.0  | 96.8             |
| 46.0                                                                                                                                    | 44.5             | 58.0  | 62.4             | 70.0  | 80.4             | 82.0  | 98.3             |
| NOTE The conversion table in Table 8 is based on ASTM E140 Table 2. However, for the hardness not indicated in ASTM, use interpolation. |                  |       |                  |       |                  |       |                  |

**Table 9 — Hardness Conversion Table From HR15T to HRB**

| HR15T                                                                                                                                  | Converted<br>HRB | HR15T | Converted<br>HRB | HR15T | Converted<br>HRB | HR15T | Converted<br>HRB |
|----------------------------------------------------------------------------------------------------------------------------------------|------------------|-------|------------------|-------|------------------|-------|------------------|
| 70.0                                                                                                                                   | 28.8             | 76.0  | 47.3             | 82.0  | 65.8             | 88.0  | 84.3             |
| 70.5                                                                                                                                   | 30.3             | 76.5  | 48.8             | 82.5  | 67.3             | 88.5  | 85.8             |
| 71.0                                                                                                                                   | 31.9             | 77.0  | 50.4             | 83.0  | 68.8             | 89.0  | 87.3             |
| 71.5                                                                                                                                   | 33.4             | 77.5  | 51.9             | 83.5  | 70.4             | 89.5  | 88.9             |
| 72.0                                                                                                                                   | 35.0             | 78.0  | 53.4             | 84.0  | 71.9             | 90.0  | 90.4             |
| 72.5                                                                                                                                   | 36.5             | 78.5  | 55.0             | 84.5  | 73.5             | 90.5  | 92.0             |
| 73.0                                                                                                                                   | 38.0             | 79.0  | 56.5             | 85.0  | 75.0             | 91.0  | 93.5             |
| 73.5                                                                                                                                   | 39.6             | 79.5  | 58.1             | 85.5  | 76.6             | 91.5  | 95.0             |
| 74.0                                                                                                                                   | 41.1             | 80.0  | 59.6             | 86.0  | 78.1             | 92.0  | 96.6             |
| 74.5                                                                                                                                   | 42.7             | 80.5  | 61.1             | 86.5  | 79.6             | 92.5  | 98.1             |
| 75.0                                                                                                                                   | 44.2             | 81.0  | 62.7             | 87.0  | 81.2             | 93.0  | 99.7             |
| 75.5                                                                                                                                   | 45.7             | 81.5  | 64.2             | 87.5  | 82.7             |       |                  |
| NOTE Refer to Table 2 of ASTM E140 for the conversion table of Table 9. However, use interpolation for hardness not indicated in ASTM. |                  |       |                  |       |                  |       |                  |

**Table 10 — Hardness Conversion Table From HV to HRB**

| HV  | Converted HRB | HV  | Converted HRB | HV  | Converted HRB | HV  | Converted HRB |
|-----|---------------|-----|---------------|-----|---------------|-----|---------------|
| 85  | 41.0          | 115 | 65.0          | 145 | 76.6          | 175 | 86.1          |
| 90  | 48.0          | 120 | 66.7          | 150 | 78.7          | 180 | 87.1          |
| 95  | 52.0          | 125 | 69.5          | 155 | 79.9          | 185 | 88.8          |
| 100 | 56.2          | 130 | 71.2          | 160 | 81.7          | 190 | 89.5          |
| 105 | 59.4          | 135 | 73.2          | 165 | 83.1          | 195 | 90.7          |
| 110 | 62.3          | 140 | 75.0          | 170 | 85.0          | 200 | 91.5          |

NOTE Refer to Table 1 of SAE J417 for the conversion table of Table 10. However, use interpolation for hardness not indicated in SAE.

#### 5.4 Bending Property

Test hard steel sheet and strip and SPCC according to clause **12.2** and refer to Table 11 for bending property. In this case, the material must not develop a crack on the outside. However, the bending test can be omitted if not requested by the orderer.

**Table 11 — Bending Property**

| Division of Refining | Designation of Refining | Bending Test  |                     |                                                                                                                |
|----------------------|-------------------------|---------------|---------------------|----------------------------------------------------------------------------------------------------------------|
|                      |                         | Bending Angle | Inner Radius        | Bending Specimen                                                                                               |
| Annealing Status     | A                       | 180°          | Adhered             | See <b>5.</b> (Specimen) of KS B 0804. However, the specimen shall be collected in the direction of reduction. |
| Standard Refining    | S                       | 180°          | Adhered             |                                                                                                                |
| 1/8 Hardness         | 8                       | 180°          | Adhered             |                                                                                                                |
| 1/4 Hardness         | 4                       | 180°          | 0.5 Times Thickness |                                                                                                                |
| 1/2 Hardness         | 2                       | 180°          | 1.0 Times Thickness |                                                                                                                |
| Hardness             | 1                       | —             | —                   |                                                                                                                |

## 6 Dimensions Marking Method

Refer to the following for the marking of steel sheet and strip dimensions.

- The dimensions of steel sheet, thickness, width, and length shall be marked in millimeters.
- Dimensions of the steel strip, the thickness and width, shall be expressed in millimeters.

## 7 Standard Dimensions

Refer to Table 12 for the standard thickness of the steel sheet and strip cold-reduced to the width of 500 mm or greater.

**Table 12 — Standard Dimensions**

Dimensions in millimetres

|                                                                     |            |            |            |            |            |              |            |              |            |
|---------------------------------------------------------------------|------------|------------|------------|------------|------------|--------------|------------|--------------|------------|
| Standard Thickness                                                  | 0.4<br>1.6 | 0.5<br>1.8 | 0.6<br>2.0 | 0.7<br>2.3 | 0.8<br>2.5 | 0.9<br>(2.6) | 1.0<br>2.8 | 1.2<br>(2.9) | 1.4<br>3.2 |
| NOTE Requires the application of standard thickness other than ( ). |            |            |            |            |            |              |            |              |            |

## 8 Dimensions Tolerance

### 8.1 Dimensions Measuring Position

Refer to the following for the dimensions measuring position.

- Measure the thickness at an arbitrary spot at least 15 mm inside both edges for the top of the strip or the steel sheet. However, measure it in the center of the width if the width is less than 30 mm.
- Measure the length on the top of the strip or at an arbitrary spot on the steel sheet.
- Measure the length at an arbitrary spot on the steel sheet.

### 8.2 Thickness Tolerance

Refer to the following for thickness tolerance.

- Apply thickness tolerance to nominal thickness.
- Divide thickness tolerance into A and B and refer to Table 13 and Table 14, respectively. Commonly, A is applied for thickness tolerance. However, B can be applied according to the agreement between order and manufacturer.

**Table 13 — Thickness Tolerance A**

Dimensions in millimetres

| Division by Nominal Thickness     | Division by Nominal Width |                                   |                                     |                                     |                 |
|-----------------------------------|---------------------------|-----------------------------------|-------------------------------------|-------------------------------------|-----------------|
|                                   | Less than 630             | 630 or Higher and Less than 1 000 | 1 000 or Higher and Less than 1 250 | 1 250 or Higher and Less than 1 600 | 1 600 or Higher |
| Less than 0.25                    | ±0.03                     | ±0.03                             | ±0.03                               | —                                   | —               |
| 0.25 or Higher and Less than 0.40 | ±0.04                     | ±0.04                             | ±0.04                               | —                                   | —               |
| 0.40 or Higher and Less than 0.60 | ±0.05                     | ±0.05                             | ±0.05                               | ±0.06                               | —               |
| 0.60 or Higher and Less than 0.80 | ±0.06                     | ±0.06                             | ±0.06                               | ±0.06                               | ±0.07           |
| 0.80 or Higher and Less than 1.00 | ±0.06                     | ±0.06                             | ±0.07                               | ±0.08                               | ±0.09           |
| 1.00 or Higher and Less than 1.25 | ±0.07                     | ±0.07                             | ±0.08                               | ±0.09                               | ±0.11           |
| 1.25 or Higher and Less than 1.60 | ±0.08                     | ±0.09                             | ±0.10                               | ±0.11                               | ±0.13           |
| 1.60 or Higher and Less than 2.00 | ±0.10                     | ±0.11                             | ±0.12                               | ±0.13                               | ±0.15           |
| 2.00 or Higher and Less than 2.50 | ±0.12                     | ±0.13                             | ±0.14                               | ±0.15                               | ±0.17           |
| 2.50 or Higher and Less than 3.15 | ±0.14                     | ±0.15                             | ±0.16                               | ±0.17                               | ±0.20           |
| 3.15 or Higher                    | ±0.16                     | ±0.17                             | ±0.19                               | ±0.20                               | —               |