National Standard of the
People’s Republic of China

GB 19189-xxxx
Replacing GB 19189-2003

Quenched and tempered high strength steel plates for pressure vessels

(Draft for Approval)
Foreword

Sections 2, 3 & 4, Articles 5.2.1, 6.1.3, 6.4.4 & 6.7 and Appendix A are recommendatory while the rest is mandatory.

This standard is drafted in accordance with the rules put forward in GB/T1.1 -2009.

GB 19189-2003 (Quenched and Tempered High Strength Steel Plates for Pressure Vessels) shall cease to be effective as of the day on which this standard comes into effect.

In comparison with GB 19189 -2003, this standard contains the following major changes:

- Expanding the range of the thickness of steel plates, with the minimum thickness extended to 12mm from 10mm;
- Changing the grade 07MnCrMoVR in the previous standard to 07MnMoVR, and 07MnNiMoVDR to 07MnNiVDR; adding the new grade 07MnNiMoDR;
- Lowering the content of P and S in each grade;
- Raising the KV₂ norm in each grade from 47J to 80J.

The steel grades 07MnMoVR, 07MnNiVDR and 07Mn NiMoDR in this standard are low-welding crack-sensitive steel, and the grade 12MnNiVR is large heat input steel for welding (welding heat input shall not exceed 100 kJ/cm).

The consistency of this standard with the corresponding part in JIS G3115 -2005 (steel plates for pressure vessels) shall not be construed as equivalence.

This standard is put forward by China Iron and Steel Association.

This standard is under the jurisdiction of the National Steel Standardization Technical Committee.

This standard has been drafted by the following companies/institutions: Wuhan Iron & Steel Group, China National General Machinery Engineering Corporation, China Metallurgical Information and Standardization Institute, Xinyu Iron & Steel Group, Hunan Hualing Xiangtan Iron & Steel Co., Ltd., Hefei General Machinery Institute, Nanjing Iron and Steel Union Company Limited, Angang Steel Company Limited, Shougang Group, and China Special Equipment Inspection and Research Institute.

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This standard was first released in June 2003.
Quenched and Tempered High Strength Steel Plates for Pressure Vessels

1 Scope

This standard specifies the dimensions, appearance, technical requirements, test method, inspection rules, packing, labelling and quality certificates concerning quenched and tempered high strength steel plates for pressure vessels.

This standard is applicable to quenched and tempered high strength steel plates for pressure vessels with a thickness of 10-60mm.

2 Normative References

The following documents are indispensable for the application of this document. For dated references, only the dated editions are applicable to this document; for all undated references, the latest edition (including all the amendments) shall apply.

GB/T 222 Tolerances for the chemical composition of finished steel

GB/T 223.3 Method of chemical analysis of iron, steel and alloys: the measurement of phosphorus content by the diantipyryl methane phosphomolybdate gravimetric method

GB/T 223.11 The measurement of chromium content in iron, steel and alloys by visual titration or potentiometric titration

GB/T 223.14 Method of chemical analysis of iron, steel and alloys: the measurement of vanadium by the tantalum extraction photometric method

GB/T 223.18 Method of chemical analysis of iron, steel and alloys: the measurement of copper content by the sodium thiosulfate separation - iodimetry method

GB/T 223.19 Method of chemical analysis of iron, steel and alloys: the measurement of copper content by the neocuproine - chloroform extraction photometric method

GB/T 223.23 The measurement of nickel content in iron, steel and alloys by the dimethylglyoxime spectrophotometric method

GB/T 223.26 The measurement of molybdenum content in iron, steel and alloys by the thiocyanate spectrophotometric method

GB/T 223.54 Method of chemical analysis of iron, steel and alloys: the measurement of nickel content by flame atomic absorption spectrometry

GB/T 223.58 Method of chemical analysis of iron, steel and alloys: the measurement of manganese content by sodium arsenite - sodium titration
GB/T 223.59 The measurement of phosphorous content in iron, steel and alloys by bismuth phosphomolybdate blue spectrophotometry and antimony phosphomolybdate blue spectrophotometry

GB/T 223.60 Method of chemical analysis of iron, steel and alloys: the measurement of silicon content by the perchloric acid dehydration gravimetric method

GB/T 223.61 Method of chemical analysis of iron, steel and alloys: the measurement of phosphorous content by the ammonium phosphomolybdate volumetric method

GB/T 223.62 Method of chemical analysis of iron, steel and alloys: the measurement of phosphorous content by butyl acetate extraction spectrophotometry

GB/T 223.63 Method of chemical analysis of iron, steel and alloys: the measurement of manganese content by the sodium/potassium periodate photometric method

GB/T 223.64 The measurement of manganese content in iron, steel and alloys by flame atomic absorption spectrometry

GB/T 223.67 The measurement of sulphur content in iron, steel and alloys by the methylene blue spectrophotometric method

GB/T 223.68 Method of chemical analysis of iron, steel and alloys: the measurement of sulphur content by potassium iodate titration after combustion in tube furnace

GB/T 223.69 The measurement of carbon content in iron, steel and alloys by the gas volumetric method after combustion in tube furnace

GB/T 223.71 Method of chemical analysis of iron, steel and alloys: the measurement of carbon content by the gravimetric method after combustion in tube furnace

GB/T 223.72 The measurement of sulphur content in iron, steel and alloys by the gravimetric method

GB/T 223.74 Method of chemical analysis of iron, steel and alloys: the measurement of non-combined carbon content

GB/T 223.75 The measurement of boron content in iron, steel and alloys by the methanol distillation - curcumin spectrophotometric method

GB/T 223.76 Method of chemical analysis of iron, steel and alloys: the measurement of vanadium content by flame atomic absorption spectrometry

GB/T 228 Room temperature tension test for metal materials

GB/T 229 Charpy pendulum impact test for metal materials

GB/T 232 Bending test for metal materials

GB/T 247 General regulations on the packing, labeling and quality certificate of steel plates and steel bands
GB/T 709  The dimensions, appearance, weight and tolerances of hot rolled steel plates and steel bands

GB/T 2970  Ultrasonic test for thick steel plates

GB/T 2975  Sampling position and sample preparation for mechanical properties: test of steel and steel products

GB/T 4336  Spark source atomic emission spectrometry (conventional method) for carbon steel and mild & low alloy steel

GB/T 8170  Rules for rounding off numbers and the expression and judgement of limiting values

GB/T 17505  General technical requirements for the delivery of steel and steel products

GB/T 20066  Sampling and sample preparation method for the determination of the chemical composition of iron and steel

GB/T 20123  The measurement of total carbon and sulphur content in iron and steel by infrared spectroscopy after combustion in high-frequency induction furnace (conventional method)

JB/T 4730.3  Nondestructive testing of pressure equipment - Part 3: ultrasonic testing

3 Contents of Ordering

A contract or order for ordering under this standard shall include the following:

a) Standard number;
b) Name of product;
c) Grade;
d) Dimensions;
e) Weight;
f) Additional technical requirements.

4 Method of Grade Expression

The suffixes 'R' and 'D' of the grades listed in this standard are the first letters of the pinyin spelling of rong for 'pressure vessels' and di for 'low temperature'.

5 Dimensions, Appearance, Weight and Tolerances
5.1 The dimensions, appearance, weight and tolerances of steel plates shall conform to the specifications in GB/T 709.

5.2 The tolerances for the thickness of steel plates shall conform to the B-type requirements for tolerances in GB/T 709.

5.2.1 Delivery can be made according to the C-type tolerances in GB/T 709 as required by the demand side and as agreed on by the supply side and the demand side.

5.3 Steel plates shall be delivered by the theoretical weight. The thickness adopted for theoretical weight calculation shall be the arithmetic mean of the maximum thickness and minimum thickness of steel plates permitted. The density for calculation shall be 7.85g/cm³.

6 Technical Requirements

6.1 Grades and chemical composition

6.1.1 The grades and chemical composition of steel shall conform to Table 1.

Table 1 Chemical composition

<table>
<thead>
<tr>
<th>Grade</th>
<th>Chemical components (quantity percent) %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>07MnMoVR</td>
<td>0.09</td>
</tr>
<tr>
<td>07MnNiVDR</td>
<td>0.09</td>
</tr>
<tr>
<td>07MnNiMoDR</td>
<td>0.09</td>
</tr>
<tr>
<td>12MnNiVR</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*Pcm means the composition of welding crack sensitivity. It is calculated by the formula

\[\text{Pcm} = \text{C} + \text{Si}/30 + (\text{Mn} + \text{Cu} + \text{Cr})/20 + \text{Ni}/60 + \text{Mo}/15 + \text{V}/10 + 5 \times \text{B} (\%)\]

6.1.2 To improve the properties of steel, micro-alloying elements other than those in Table 1 can be added.

6.1.3 For 07MnMoVR steel plates with a thickness not exceeding 36mm and 07MnNiMoDR steel plates with a thickness not exceeding 30mm, there can be no lower limit for Mo content.

6.1.4 Tolerances for the chemical composition of finished steel plates shall conform to GB/T 222, with P+0.003% and S+0.002%.
6.2  Smelting method

Steel is smelted in oxygen converter or electric furnace and subject to vacuum treatment.

6.3  Delivery state

6.3.1  Before delivery, steel plates shall undergo a quenched and tempered heat treatment at a temperature of tempering not lower than 600 °C.

6.3.2  Before delivery, steel plates shall be sheared or flame cut.

6.4  Mechanical and processing properties

6.4.1  The mechanical and processing properties of steel plates shall conform to the specifications listed in Table 2.

6.4.2  Charpy (V-notch) impact energy shall be calculated by the arithmetic mean of three samples. A single value of one of them can be under the value specified in Table 2, but by no more than 70% of the latter.

6.4.3  For steel plates with a thickness of less than 12mm, a supplementary sample shall be used for the Charpy (V-notch) impact test. The dimensions of the supplementary sample shall be 7.5mm×10mm×55mm, and the test result shall not be less than 75% of the value specified in Table 2.

6.4.4  For steel plates with a thickness exceeding 36mm, a set of impact samples can be added at half of the thickness as required by the demand side and as agreed on by the supply side and the demand side. The norm of impact shall be agreed on by both sides.
Table 2 - Mechanical and processing properties

<table>
<thead>
<tr>
<th>Grade</th>
<th>Thickness of steel plate /mm</th>
<th>Tensile test</th>
<th>Impact test</th>
<th>Bending test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yield strength(a)</td>
<td>Tensile strength</td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(R_{eL}) /MPa</td>
<td>(R_m) /MPa</td>
<td>/°</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elongation percentage after fracture /%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07MnMoVR</td>
<td>10-60</td>
<td>• 490</td>
<td>610-730</td>
<td>• 17</td>
</tr>
<tr>
<td>07MnNiVDR</td>
<td>10-60</td>
<td>• 490</td>
<td>610-730</td>
<td>• 17</td>
</tr>
<tr>
<td>07MnNiMoDR</td>
<td>10-60</td>
<td>• 490</td>
<td>610-730</td>
<td>• 17</td>
</tr>
<tr>
<td>12MnNiVR</td>
<td>10-60</td>
<td>• 490</td>
<td>610-730</td>
<td>• 17</td>
</tr>
</tbody>
</table>

\(a\) If yield is not obvious, adopt \(R_{p0.2}\).

6.5 Surface quality

6.5.1 Defects such as cracks, bubbles, scars, folds and impurities on the surface of steel plates shall not be allowed. If such defects exist, the clearing of them is permitted. The depth of clearing shall be measured from the actual dimensions of a steel plate and shall not exceed half of the common difference of its thickness; it shall also maintain the minimum thickness of the steel plate. The cleared part shall be smooth and without edges or corners. Steel plates shall not be layered.

6.5.2 Other defects are allowed. Their depth shall be measured from the actual dimensions of a steel plate and shall not exceed half of the permitted common difference of its thickness. It shall also be guaranteed that the thickness of the defective part shall not be less than the minimum thickness of the steel plate.

6.6 Ultrasonic testing

Ultrasonic testing shall be carried out for steel plates one by one. The method shall conform to JB/T 4730.3 or GB/T 2970 and the conformity level shall be Level I.

6.7 Special requirements

Special requirements can be raised for steel plates as agreed on by the supply side and the demand side and as specified in the contract.
7 Test Method

7.1 The test items, number of samples, method of sampling and test method for each batch of steel plates shall conform to the specifications listed in Table 3.

Table 3 Test items, number of samples and test method

<table>
<thead>
<tr>
<th>Number</th>
<th>Testing item</th>
<th>Number of samples</th>
<th>Sampling method</th>
<th>Sampling direction</th>
<th>Test method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chemical analysis</td>
<td>1 from each furnace</td>
<td>GB/T 20066</td>
<td>-</td>
<td>GB/T 223, GB/T4336, GB/T20123</td>
</tr>
<tr>
<td>2</td>
<td>Tensile test</td>
<td>1 from each set</td>
<td>GB/T 2975</td>
<td>Transverse</td>
<td>GB/T 228</td>
</tr>
<tr>
<td>3</td>
<td>Impact test</td>
<td>3 from each set</td>
<td>GB/T 2975</td>
<td>Transverse</td>
<td>GB/T 229</td>
</tr>
<tr>
<td>4</td>
<td>Cold bending test</td>
<td>1 from each set</td>
<td>GB/T 2975</td>
<td>Transverse</td>
<td>GB/T 232</td>
</tr>
<tr>
<td>5</td>
<td>Ultrasonic testing</td>
<td>Sheet by sheet</td>
<td>-</td>
<td>-</td>
<td>JB/T 4730.3 or GB/T 2970</td>
</tr>
<tr>
<td>6</td>
<td>Dimensions and appearance</td>
<td>Sheet by sheet</td>
<td>-</td>
<td>-</td>
<td>Measuring tool with required precision</td>
</tr>
<tr>
<td>7</td>
<td>Surface</td>
<td>Sheet by sheet</td>
<td>-</td>
<td>-</td>
<td>Visual observation</td>
</tr>
</tbody>
</table>

7.2 The samples for tensile test, impact test and cold bending as specified in Table 3 can be taken from a single specimen, which shall be taken at 1/4 of the width of a steel plate. If the steel plate is less than 15m long after heat treatment, take the specimen at one end of it; if it is more than 15m long after heat treatment, take one specimen at each end. Take a set of samples from each specimen (1 for tensile test, 3 for impact test and 1 for cold bending). Specimens can be sheared or flame cut, but the dimensions must guarantee that the samples are clear of the hardened part or heat-affected part caused by shearing or flame cutting.
7.3 The axis of the samples for tensile test, impact test and cold bending as specified in Table 3 shall be perpendicular to the rolling direction of the steel plate; the axis of the notch of the Charpy (V-notch) impact sample shall be perpendicular to the rolling surface of the steel plate.

7.4 The sampling position for tensile test and impact test shall conform to specifications in GB/T 2975. For steel plates more than 25mm thick, the axis of the impact sample shall be at 1/4 of the thickness. The cold bending sample for a steel plate of any thickness shall retain at least one rolling surface, which shall be the outer surface for the bending test.

8 Inspection Rules

8.1 The inspection of steel plates shall be carried out by the quality inspection authorities of the supply side. The demand side is entitled to inspection and acceptance according to this standard.

8.2 Steel plates shall be divided into sets of heat treatment sheets and inspected for acceptance set by set.

8.3 If test results do not conform to the foregoing requirements in this standard, the testing process can be repeated.

8.3.1 If the results of impact test do not conform to Article 6.4.1 of this standard, three more samples shall be taken from the same steel plate for testing. The arithmetic mean of the impact energy of the six samples in the first and second sets shall not be under the specified value. The impact energy absorption of two of the samples can be under the specified value, but there shall only be one sample with an impact energy absorption less than 70% of the specified value.

8.3.2 The re-testing and judgment of the other testing items shall be carried out according to applicable specifications in GB/T 17505.

9 Packing, Labelling and Quality Certificate

The packing, labelling and quality certificate of steel plates shall conform to specifications in GB/T 247.

10 Rounding Numbers

The rounding of numbers shall conform to GB/T 8170.
Appendix A

(Informative Appendix)

Comparison between New and Old Standard Grades

See Table A.1 for a comparison between the grades in this standard and those in GB19189-2003.

Table A.1

<table>
<thead>
<tr>
<th>GB19189-20XX</th>
<th>GB19189-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td>07MnMoVR</td>
<td>07MnCrMoVR</td>
</tr>
<tr>
<td>07MnNiVDR</td>
<td>07MnNiMoVDR</td>
</tr>
<tr>
<td>07MnNiMoDR</td>
<td></td>
</tr>
<tr>
<td>12MnNiVR</td>
<td>12MnNiVR</td>
</tr>
</tbody>
</table>