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JAPANESE INDUSTRIAL STANDARD

Steel Plates for Pressure Vessels for Intermediate Temperature Service

JIS G 3115—1990

Translated and Published

by

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JAPANESE INDUSTRIAL STANDARD

J I S

Steel Plates for Pressure Vessels for
Intermediate Temperature ServiceG 3115-1990
(Reaffirmed: 1995)**1. Scope**

This Japanese Industrial Standard specifies the hot-rolled steel plates (hereafter referred to as the "steel plates") with improved weldability to be used for pressure vessels, equipments for high pressure service, etc. (excluding those to be used for high temperature and low temperature services).

Remark: The units and numerical values given in { } in this Standard are based on the International System of Units (SI) and are appended for informative reference.

Further, the traditional units accompanied by numerical values in this Standard shall be converted to the SI units and numerical values on January 1, 1991.

2. Grades and Symbols

Steel plates shall be classified into six categories, and their symbols shall be as given in Table 1-1 or Table 1-2.

Table 1-1. Symbols of Grades
(Applicable till the end of 1990)

Grade	Applicable thickness mm
SPV 24	6 or over up to and including 200
SPV 32	6 or over up to and including 100
SPV 36	6 or over up to and including 75
SPV 42	6 or over up to and including 75
SPV 46	6 or over up to and including 75
SPV 50	6 or over up to and including 75

Table 1-2. Symbols of Grades
(Applicable on and after January 1, 1991)

Grade		Applicable thickness mm
SI units	(Informative reference) Traditional units	
SPV 235	SPV 24	6 or over up to and including 200
SPV 315	SPV 32	6 or over up to and including 100
SPV 355	SPV 36	6 or over up to and including 75
SPV 410	SPV 42	6 or over up to and including 75
SPV 450	SPV 46	6 or over up to and including 75
SPV 490	SPV 50	6 or over up to and including 75

3. Chemical Composition

Steel plates shall be tested in accordance with 9.1 and their cast analysis values shall be as given in Table 2-1 or Table 2-2.

Table 2-1. Chemical Composition
(Applicable till the end of 1990)

Unit: %

Grade	C	Si	Mn	P	S
SPV 24	0.18 max. for plates of 100 mm max. in thickness	0.15 to 0.35	1.40 max.	0.030 max.	0.030 max.
	0.20 max. for plates of over 100 mm in thickness				
SPV 32	0.18 max.	0.15 to 0.55	1.50 max.	0.030 max.	0.030 max.
SPV 36	0.20 max.	0.15 to 0.55	1.60 max.	0.030 max.	0.030 max.
SPV 42	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.
SPV 46	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.
SPV 50	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.

Remarks 1. Alloy elements other than those given in Table 2-1 may be added if necessary.

2. For steel plates of SPV 46 and SPV 50, for which quench hardening and tempering are not performed, additional alloy element and carbon equivalent shall be agreed between the purchaser and supplier.

Table 2-2. Chemical Composition
(Applicable on and after January 1, 1991)
Unit: %

Grade	C	Si	Mn	P	S
SPV 235	0.18 max. for plates of 100 mm max. in thickness 0.20 max. for plates of over 100 mm in thickness	0.15 to 0.35	1.40 max.	0.030 max.	0.030 max.
SPV 315	0.18 max.	0.15 to 0.55	1.50 max.	0.030 max.	0.030 max.
SPV 355	0.20 max.	0.15 to 0.55	1.60 max.	0.030 max.	0.030 max.
SPV 410	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.
SPV 450	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.
SPV 490	0.18 max.	0.15 to 0.75	1.60 max.	0.030 max.	0.030 max.

Remarks 1. Alloy elements other than those given in Table 2-2 may be added if necessary.

2. For steel plates of SPV 450 and SPV 490, for which quench hardening and tempering are not performed, additional alloy element and carbon equivalent shall be agreed between the purchaser and supplier.

4. Carbon Equivalent or Chemical Composition on Sensitivity of Welding Crack

4.1 Carbon Equivalent or Chemical Composition on Sensitivity of Welding Crack for SPV 46 (SPV 450 on and after January 1, 1991) and SPV 50 (SPV 490 on and after January 1, 1991) The carbon equivalent or chemical composition on sensitivity of welding crack for SPV 46 (SPV 450 on and after January 1, 1991) and SPV 50 (SPV 490 on and after January 1, 1991) shall be as follows.

Further, the carbon equivalent shall be applied to quench hardening and tempered steel products.

(1) The carbon equivalent shall be as given in Table 3-1 or Table 3-2. The carbon equivalent shall be calculated by using the cast analysis values conforming to 9.1 from the following formula.

Table 3-1. Carbon Equivalent
(Applicable till the end of 1990)

Unit: %

Grade	Carbon equivalent	
	50 mm max. thickness	Over 50 mm up to and including 75 mm thickness
SPV 46	0.44 max.	0.46 max.
SPV 50	0.45 max.	0.47 max.

$$\text{Carbon equivalent (\%)} = C + \frac{\text{Mn}}{6} + \frac{\text{Si}}{24} + \frac{\text{Ni}}{40} + \frac{\text{Cr}}{5} + \frac{\text{Mo}}{4} + \frac{\text{V}}{14}$$

Table 3-2. Carbon Equivalent
(Applicable on and after January 1, 1991)

Unit: %

Grade	Carbon equivalent	
	50 mm max. thickness	Over 50 mm up to and including 75 mm thickness
SPV 450	0.44 max.	0.46 max.
SPV 490	0.45 max.	0.47 max.

$$\text{Carbon equivalent (\%)} = C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14}$$

- (2) The chemical composition on sensitivity of welding crack may be applied instead of carbon equivalent by agreement between the purchaser and supplier. In this case, the chemical composition on sensitivity of welding crack shall be as given in Table 4-1 or Table 4-2. The chemical composition on sensitivity of welding crack shall be calculated by using the cast analysis values conforming to 9.1 from the following formula:

Table 4-1. Chemical Composition on Sensitivity of Welding Crack
(Applicable till the end of 1990)

Unit: %

Grade	Chemical composition on sensitivity of welding crack	
	50 mm max. thickness	Over 50 mm up to and including 75 mm thickness
SPV 46	0.28 max.	0.30 max.
SPV 50	0.28 max.	0.30 max.

$$\text{Chemical composition on sensitivity of welding crack (\%)} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

Table 4-2. Chemical Composition on Sensitivity of Welding Crack
(Applicable on and after January 1, 1991)

Unit: %

Grade	Chemical composition on sensitivity of welding crack	
	50 mm max. thickness	Over 50 mm up to and including 75 mm thickness
SPV 450	0.28 max.	0.30 max.
SPV 490	0.28 max.	0.30 max.

$$\text{Chemical composition on sensitivity of welding crack (\%)} = C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$$

4.2 Carbon Equivalent and Chemical Composition on Sensitivity of Welding Crack for SPV 32 (SPV 315 on and after January 1, 1991), SPV 36 (SPV 355 on and after January 1, 1991), and SPV 42 (SPV 410 on and after January 1, 1991) for Which Quench Hardening and Tempering Are Performed The carbon equivalent and chemical composition on sensitivity of welding crack for SPV 32 (SPV 315 on and after January 1, 1991), SPV 36 (SPV 355 on and after January 1, 1991), and SPV 42 (SPV 410 on and after January 1, 1991) for which quench hardening and tempering are performed shall be agreed between the purchaser and supplier.

4.3 Carbon Equivalent and Chemical Composition on Sensitivity of Welding Crack for Steel Plates for Which Thermo-Mechanical Control Process Is Performed The carbon equivalent for steel plates for which thermo-mechanical control process is performed and its calculation formula shall conform to the statement of Y 1. in Annex Supplementary Quality Requirements.

Further, the chemical composition on sensitivity of welding crack may be applied instead of carbon equivalent by agreement between the purchaser and supplier. In this case, the chemical composition on sensitivity of welding crack and its calculation formula shall conform to the statement of Y 2. in Annex Supplementary Quality Requirements.

5. Mechanical Properties

5.1 Yield Point or Proof Stress, Tensile Strength, Elongation and Bendability Steel plates shall be tested in accordance with 9.2, and their yield point or proof stress, tensile strength, elongation and bendability shall comply with Table 5-1 or Table 5-2.

In the case of bend test, it shall be bent without crack on the outside of the bent portion.

However, the bend test may be omitted, unless otherwise specified by the purchaser.

Table 5-1. Yield Point or Proof Stress, Tensile Strength, Elongation and Bendability (Applicable till the end of 1990)

Grade	Yield point or proof stress kgf/mm ² {N/mm ² }			Tensile strength kgf/mm ² {N/mm ² }	Elongation			Bendability		
	Thickness mm							Bending angle	Inside radius	Test piece
	6 or over up to and incl. 50	Over 50 up to and incl. 100	Over 100 up to and incl. 200		Thickness mm	Test piece	%			
SPV 24	24 min. {235}	22 min. {216}	20 min. {196}	41~52 {402~510}	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	17 min. 21 min. 24 min.	180°	Thickness × 1.0, for 50 mm max. thickness Thickness × 1.5, for over 50 mm thickness	No. 1 Transversely to rolling direction
SPV 32	32 min. {314}	30 min. {294}	—	50~62 {490~608}	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	16 min. 20 min. 23 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 36	36 min. {353}	(¹) 34 min. {333}	—	53~65 {520~637}	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	14 min. 18 min. 21 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 42	42 min. {412}	(¹) 40 min. {392}	—	56~68 {549~667}	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	12 min. 16 min. 18 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 46	46 min. {451}	(¹) 44 min. {431}	—	58~71 {569~696}	16 max. Over 16 Over 20	No. 5 No. 5 No. 4	19 min. 26 min. 20 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 50	50 min. {490}	(¹) 48 min. {471}	—	62~75 {608~735}	16 max. Over 16 Over 20	No. 5 No. 5 No. 4	18 min. 25 min. 19 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction

Note (¹) Those figures shall be applied for steel plates of 75 mm max. in thickness.

Table 5-2. Yield Point or Proof Stress, Tensile Strength, Elongation and Bendability (Applicable on and after January 1, 1991)

Grade	Yield point or proof stress N/mm ²			Tensile strength N/mm ²	Elongation			Bendability		
	Thickness mm							Bending angle	Inside radius	Test piece
	6 or over up to and incl. 50	Over 50 up to and incl. 100	Over 100 up to and incl. 200		Thickness mm	Test piece	%			
SPV 235	235 min.	215 min.	195 min.	400-510	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	17 min. 21 min. 24 min.	180°	Thickness × 1.0, for 50 mm max. thickness Thickness × 1.5, for over 50 mm thickness	No. 1 Transversely to rolling direction
SPV 315	315 min.	295 min.	—	490-610	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	16 min. 20 min. 23 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 355	355 min.	⁽¹⁾ 335 min.	—	520-640	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	14 min. 18 min. 21 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 410	410 min.	⁽¹⁾ 390 min.	—	550-670	16 max. Over 16 Over 40	No. 1 A No. 1 A No. 4	12 min. 16 min. 18 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 450	450 min.	⁽¹⁾ 430 min.	—	570-700	16 max. Over 16 Over 20	No. 5 No. 5 No. 4	19 min. 26 min. 20 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction
SPV 490	490 min.	⁽¹⁾ 470 min.	—	610-740	16 max. Over 16 Over 20	No. 5 No. 5 No. 4	18 min. 25 min. 19 min.	180°	Thickness × 1.5	No. 1 Transversely to rolling direction

Note ⁽¹⁾ Those figures shall be applied for steel plates of 75 mm max. in thickness.

5.2 Charpy Absorbed Energy The steel plate over 12 mm in thickness shall be tested in accordance with 9.2, and its Charpy absorbed energy shall be as given in Table 6-1 or Table 6-2. However, for the steel plate 12 mm or under in thickness, when specified at the time of ordering, the impact test by using a subsize test piece shall be carried out. The minimum absorbed energy value in this case shall be as given in Table 7-1 or Table 7-2.

Table 6-1. Charpy Absorbed Energy
(Applicable till the end of 1990)

Unit: kgf · m (J)

Grade	Test temperature	Charpy absorbed energy		Test piece
		Average of tested values of three test pieces	Value on each test piece	
SPV 24	0°C	4.8 {47.1} min.	2.8 {27.5} min.	No. 4, in rolling direction
SPV 32	0°C	4.8 {47.1} min.	2.8 {27.5} min.	
SPV 36	0°C	4.8 {47.1} min.	2.8 {27.5} min.	
SPV 42	-10°C	4.8 {47.1} min.	2.8 {27.5} min.	
SPV 46	-10°C	4.8 {47.1} min.	2.8 {27.5} min.	
SPV 50	-10°C	4.8 {47.1} min.	2.8 {27.5} min.	

- Remarks 1. The direction of a test piece may be specified to be perpendicular to its rolling direction. However, the Charpy absorbed energy in this case shall be agreed between the purchaser and supplier.
2. For steel plates of SPV 32, SPV 36 and SPV 42 for which thermo-mechanical control process is carried out, Y 3. of Annex Supplementary Quality Requirements may be applied by agreement between the purchaser and supplier.

Table 6-2. Charpy Absorbed Energy
(Applicable on and after January 1, 1991)

Unit: J

Grade	Test temperature	Charpy absorbed energy		Test piece
		Average of tested values of three test pieces	Value on each test piece	
SPV 235	0°C	47 min.	27 min.	No. 4, in rolling direction
SPV 315	0°C	47 min.	27 min.	
SPV 355	0°C	47 min.	27 min.	
SPV 410	-10°C	47 min.	27 min.	
SPV 450	-10°C	47 min.	27 min.	
SPV 490	-10°C	47 min.	27 min.	

- Remarks 1. The direction of a test piece may be specified to be perpendicular to the rolling direction. However, the Charpy absorbed energy in this case shall be agreed between the purchaser and supplier.
2. For steel plates of SPV 315, SPV 355 and SPV 410 for which thermo-mechanical control process is carried out, Y3. of Annex Supplementary Quality Requirements may be applied by agreement between the purchaser and supplier.

Table 7-1. Charpy Absorbed Energy Obtained on Subsize Test Piece
(Applicable till the end of 1990) Unit: . kgf · m {J}

Charpy absorbed energy obtained on 10 mm × 10 mm test piece Thickness × width of test piece mm		Charpy absorbed energy	
		10×7.5	10×5
When a difference between the thickness of steel plate and the width of test piece is up to and including 3 mm	4.8 {47.1}	3.6 {35.3}	2.4 {23.5}
	2.8 {27.5}	2.2 {21.6}	1.4 {13.7}
When a difference between the thickness of steel plate and the width of test piece is over 3 mm	4.8 {47.1}	4.0 {39.2}	3.2 {31.4}
	2.8 {27.5}	2.3 {22.6}	1.9 {18.6}

Table 7-2. Charpy Absorbed Energy Obtained on Subsize Test Piece
(Applicable on and after January 1, 1991) Unit: J

Charpy absorbed energy obtained on 10 mm × 10 mm test piece Thickness × width of test piece mm		Charpy absorbed energy	
		10×7.5	10×5
When a difference between the thickness of steel plate and the width of test piece is up to and including 3 mm	47	35	24
	27	22	14
When a difference between the thickness of steel plate and the width of test piece is over 3 mm	47	39	31
	27	23	19

6. Shape, Dimensions, Mass and Tolerances

The shape, dimensions, mass and their tolerances for steel plates shall comply with JIS G 3193. However, they shall meet the following conditions:

- (1) The tolerances on length for steel plates and on width for cut edges steel plates shall be in accordance with tolerance A of JIS G 3193 unless otherwise specified, and the tolerances on thickness shall be as given in Table 8.

Table 8. Tolerances on Thickness

Unit: mm

Thickness \ Width	Under 1600	1600 or over to and excl. 2000	2000 or over to and excl. 2500	2500 or over to and excl. 3150	3150 or over to and excl. 4000	4000 or over to and excl. 5000
6.00 or over to and excl. 10.0	+0.95	+1.05	+1.25	+1.45	+1.65	+1.85
10.0 or over to and excl. 16.0	+0.95	+1.15	+1.35	+1.55	+1.75	+1.95
16.0 or over to and excl. 25.0	+1.15	+1.35	+1.55	+1.75	+2.15	+2.35
25.0 or over to and excl. 40.0	+1.35	+1.55	+1.75	+1.95	+2.35	+2.55
40.0 or over to and excl. 63.0	+1.55	+1.75	+2.15	+2.35	+2.55	+2.75
63.0 or over to and excl. 100	+1.95	+2.15	+2.55	+2.75	+2.95	+3.15
100 or over to and excl. 160	+2.35	+2.55	+2.95	+3.15	+3.35	+3.55
160 or over	+2.95	+3.15	+3.55	+3.75	+3.95	+4.15

Remarks 1. The minus side tolerance on thickness shall be 0.25 mm.

2. In the case of 5000 mm or over width, the tolerances on thickness shall be agreed between the purchaser and supplier.

(2) In order to calculate the mass of a steel plates, the sum of the nominal thickness and the numerical value given in Table 9 shall be used instead of the nominal thickness.

Table 9. Values to Be Added for Calculation of Mass

Unit: mm

Thickness \ Width	Under 1600	1600 or over to and excl. 2000	2000 or over to and excl. 2500	2500 or over to and excl. 3150	3150 or over to and excl. 4000	4000 or over to and excl. 5000
6.00 or over to and excl. 10.0	+0.35	+0.40	+0.50	+0.60	+0.70	+0.80
10.0 or over to and excl. 16.0	+0.35	+0.45	+0.55	+0.65	+0.75	+0.85
16.0 or over to and excl. 25.0	+0.45	+0.55	+0.65	+0.75	+0.95	+1.05
25.0 or over to and excl. 40.0	+0.55	+0.65	+0.75	+0.85	+1.05	+1.15
40.0 or over to and excl. 63.0	+0.65	+0.75	+0.95	+1.05	+1.15	+1.25
63.0 or over to and excl. 100	+0.85	+0.95	+1.15	+1.25	+1.35	+1.45
100 or over to and excl. 160	+1.05	+1.15	+1.35	+1.45	+1.55	+1.65
160 or over	+1.35	+1.45	+1.65	+1.75	+1.85	+1.95

Remark: In the case of 5000 mm or over width, the tolerances on thickness shall be agreed between the purchaser and supplier.

7. Appearance

The appearance of steel plates shall comply with the requirement of 6. in JIS G 3193. However, repair by welding shall be agreed previously between the purchaser and supplier.

8. Heat Treatment and Symbol

8.1 Heat Treatment of Steel Plates The heat treatment of steel plates shall be as given in Table 10-1 or Table 10-2.

Table 10-1. Heat Treatment
(Applicable till the end of 1990)

Grade	Heat treatment
SPV 24	As rolled. However, normalizing may be applied if necessary.
SPV 32 SPV 36	As rolled. However, normalizing may be applied if necessary. Thermo-mechanical control process or quench hardening and tempering may be applied by agreement between the purchaser and supplier.
SPV 42	Thermo-mechanical control process. However, normalizing or quench hardening and tempering may be applied by agreement between the purchaser and supplier.
SPV 46 SPV 50	Quench hardening and tempering. However, normalizing may be applied by agreement between the purchaser and supplier.

Remark: In the case where the purchaser applies heat treatment by agreement between the purchaser and supplier, for SPV 42, SPV 46 and SPV 50, the manufacturer applies heat treatment only for the test piece, and may be shipped the steel plate as rolled.

Table 10-2. Heat Treatment
(Applicable on and after January 1, 1991)

Grade	Heat treatment
SPV 235	As rolled. However, normalizing may be applied if necessary.
SPV 315 SPV 355	As rolled. However, normalizing may be applied if necessary. Thermo-mechanical control process or quench hardening and tempering may be applied by agreement between the purchaser and supplier.
SPV 410	Thermo-mechanical control process. However, normalizing or quench hardening and tempering may be applied by agreement between the purchaser and supplier.
SPV 450 SPV 490	Quench hardening and tempering. However, normalizing may be applied by agreement between the purchaser and supplier.

Remark: In the case where the purchaser applies heat treatment by agreement between the purchaser and supplier, for SPV 410, SPV 450 and SPV 490, the manufacturer applies heat treatment only for the test piece, and may be shipped the steel plate as rolled.

8.2 Designation on Heat Treatment The designation on heat treatment shall be as follows:

- (1) The purchaser shall clearly specify the category of heat treatment of steel plates to be applied by the manufacturer on the order sheet, and if necessary, shall state the heat treatment conditions of the test piece and the number of times thereof.
- (2) In the case where the purchaser applies heat treatment for steel plates in accordance with Remark of Table 10-1 or that of Table 10-2, this matter shall be specified on the order sheet in which clearly states the heat treatment conditions.

8.3 Heat Treatment of Test Piece Heat treatment of the test piece shall be applied for the specimen taken from a steel plate without further processing, and the test piece shall be cut down out of the heat treated specimen.

8.4 Symbol of Heat Treatment The symbol standing for the heat treatment of the steel plate and test piece to be entered in the order sheet shall be as follows:

- (1) When thermo-mechanical control process is applied for the steel plate
TMC

- (2) When normalizing is applied for the steel plate by agreement between the purchaser and supplier N
- (3) When quench hardening and tempering are applied for the steel plate Q
- (4) When normalizing is applied only for the test piece TN
- (5) When heat treatment corresponding to post weld heat treatment is applied for the test piece SR

Example 1-1 (Applicable till the end of 1990)

- SPV 42 TMC : when thermo-mechanical control process is applied for the steel plate.
- SPV 46 Q : when quench hardening and tempering are applied for the steel plate.
- SPV 46 NSR : when normalizing is applied for the steel plate and further heat treatment corresponding to post weld heat treatment is applied once for the test piece by agreement.
- SPV 46 TN : when the steel plate is as-rolled condition, and normalizing is applied only for the test piece by agreement.
- SPV 50 TNSR : when the steel plate is as-rolled condition, and normalizing and heat treatment corresponding to post weld heat treatment are applied once only for the test piece by agreement.
- SPV 50 TN 3 SR : when the steel plate is as-rolled condition, and normalizing and heat treatment corresponding to post weld heat treatment are applied three times only for the test piece by agreement.

Example 1-2 (Applicable on and after January 1, 1991)

- SPV 410 TMC : when thermo-mechanical control process is applied for the steel plate.
- SPV 450 Q : when quench hardening and tempering are applied for the steel plate.
- SPV 450 NSR : when normalizing is applied for the steel plate and further heat treatment corresponding to post weld heat treatment is applied once for the test piece by agreement.

- SPV 450 TN : when the steel plate is as-rolled condition, and normalizing is applied only for the test piece by agreement.
- SPV 490 TNSR : when the steel plate is as-rolled condition, and normalizing and heat treatment corresponding to post weld heat treatment are applied once only for the test piece by agreement.
- SPV 490 TN 3 SR : when the steel plate is as-rolled condition, and normalizing and heat treatment corresponding to post weld heat treatment are applied three times only for the test piece by agreement.

9. Tests

9.1 Chemical Analysis

9.1.1 General Requirements for Chemical Analysis and Sampling Method of Specimen for Analysis The chemical composition of steel plates shall be determined by cast analysis, and general requirements for chemical analysis and sampling method of specimen for analysis shall be as specified in 3. of JIS G 0303.

9.1.2 Test Method The test method for chemical analysis shall conform to one of the following methods:

JIS G 1211	JIS G 1212	JIS G 1213	JIS G 1214
JIS G 1215	JIS G 1216	JIS G 1217	JIS G 1218
JIS G 1221	JIS G 1253	JIS G 1256	JIS G 1257
JIS G 1258			

9.2 Mechanical Tests

9.2.1 Tests in General General requirements for mechanical test shall be in accordance with the specification of 4. in JIS G 0303. With this respect, the sampling method of specimens shall conform to Class A, and the number of test pieces and the sampling position shall be as follows:

- (1) **Number of Test Pieces for Tensile Test and Bend Test** Each one test piece shall be taken from one of the as-rolled steel plates made from one slab or directly made from one ingot. Each test piece shall be taken transversely to the rolling direction. When steel plates are heat treated, each one test piece shall be taken from a batch of steel plates subjected to the same heat treatment condition as well as rolled from the aforementioned steels.
- (2) **Number of Test Pieces for Impact Test** Each one specimen shall be taken from one of the as-rolled steel plates made from one slab or directly made from one ingot. Three test pieces shall be taken from each specimen parallel to the rolling direction unless otherwise specified. When steel plates are heat treated, each one specimen shall be taken from a batch of steel plates subjected to the same heat treatment condition as well as rolled from the aforementioned steels.

- (3) Sampling Position of Test Pieces for Tensile Test and Bend Test The centre of a test piece shall be at a quarter-width from a side edge, and in the case of No. 4 test piece for tensile test, it shall be at a quarter-width from a edge as well as at a quarter-thickness from a surface. However, when it is infeasible to allow the center of a test piece to be at a quarter-width from the side edge, or at a quarter-thickness, the sampling shall be made as close to the specified position as possible.
- (4) Sampling Position of Test Piece for Impact Test The centre of a test piece shall be at a quarter-thickness from a surface as well as at a quarter-width from a side edge. However, when it is infeasible to secure this position, the sampling shall be made as close to the specified position as possible.

9.2.2 Test Pieces The test pieces for tensile test, bend test, and impact test shall be as follows:

- (1) Nos. 1 A, 4 or 5 test piece specified in JIS Z 2201
- (2) No. 1 test piece specified in JIS Z 2204
- (3) No. 4 test piece or subsize test piece (2 mm V notch) specified in JIS Z 2202. However, the longitudinal direction of the base of the notch of a test piece shall be perpendicular to the rolled surface.

9.2.3 Test Methods The methods for tensile test, bend test and impact test shall be as follows:

- (1) JIS Z 2241
- (2) JIS Z 2248
- (3) Charpy impact test method specified in JIS Z 2242.

10. Inspection

10.1 Inspection The inspection shall be as follows:

- (1) General requirements for inspection shall conform to JIS G 0303.
- (2) The chemical composition shall conform to the requirements of 3.
- (3) The carbon equivalent or chemical composition on sensitivity of welding crack shall conform to the requirements of 4.
- (4) The mechanical properties shall conform to the requirements of 5.
- (5) The shape, dimensions, and mass shall conform to the requirements of 6.
- (6) The appearance shall conform to the requirements of 7.

- (7) The purchaser may designate the ultrasonic examination specified in JIS G 0801 and the like in addition to the inspections of (1) to (6). In this case, the test method, the criteria for acceptance and rejection, etc. shall be preliminarily agreed between the purchaser and supplier.

10.2 Re-inspection The re-inspection shall be as follows:

- (1) Steel plates having failed to meet the requirements of tensile test and bend test may be subjected to a retest for final acceptance in accordance with 4.4 in JIS G 0303.
- (2) In the case where the average value of three test results is 85 % or over the specified value as well as two or more individual test results conform to the requirements specified in Table 6-1 or Table 6-2, steel plates having failed to meet the requirements of impact test may be subjected to a retest. With this respect, three test pieces shall be taken from the vicinity where the original test pieces have been taken, and acceptance or rejection may be determined. In this case, when the average of tested values of six test pieces and three individual test results for retesting conform to Table 6-1 or Table 6-2, the steel plates are accepted.
- (3) Steel plates having failed to meet the requirements may be subjected to a reappraisal test for final acceptance, after carrying out heat treatment or reheat treatment.

11. Marking

Steel plates which have passed the inspection shall be marked on each steel plate with the following details by suitable means. However, a part of them may be omitted by agreement between the purchaser and supplier.

- (1) Symbol of grade (including 8.4 Symbol of Heat Treatment)
- (2) Heat number or inspection number
- (3) Dimensions
- (4) Manufacturer's name or its abbreviation

12. Report

The report shall be comply with the requirements of 8. in JIS G 0303.

Further, in the case where Remark 1 of Table 2-1 or Table 2-2 is applied, the contents of additional elements shall be appended to the test results.

Annex Supplementary Quality Requirements

This supplementary quality requirements shall be applied on request by the purchaser, and the specified details shall be implemented by the manufacturer.

Y 1. Carbon Equivalent for Steel Plate Produced by Thermo-Mechanical Control Process

The carbon equivalent for the steel plate produced by thermo-mechanical control process shall be as follows:

- (1) Calculation Formula of Carbon Equivalent Carbon equivalent shall be as follows by using the cast analysis values conforming to 9.1 in the text of this Standard.

$$\text{Carbon equivalent (\%)} = C + \frac{\text{Mn}}{6} + \frac{\text{Si}}{24} + \frac{\text{Ni}}{40} + \frac{\text{Cr}}{5} + \frac{\text{Mo}}{4} + \frac{\text{V}}{14}$$

- (2) Carbon Equivalent Carbon equivalent shall be as given in Annex Table 1-1 or Annex Table 1-2.

Annex Table 1-1. Carbon Equivalent
(Applicable till the end of 1990)

Unit: %

Grade	Carbon equivalent		
	Up to and including 50 mm	Over 50 mm up to and including 75 mm thickness	Over 75 mm up to and including 100 mm thickness
SPV 32	0.39 max.	0.41 max.	0.41 max.
SPV 36	0.40 max.	0.42 max.	—
SPV 42	0.43 max.	0.45 max.	—

Annex Table 1-2. Carbon Equivalent
(Applicable on and after January 1, 1991)

Unit: %

Grade	Carbon equivalent		
	Up to and including 50 mm	Over 50 mm up to and including 75 mm thickness	Over 75 mm up to and including 100 mm thickness
SPV 315	0.39 max.	0.41 max.	0.41 max.
SPV 355	0.40 max.	0.42 max.	—
SPV 410	0.43 max.	0.45 max.	—

Y 2. Chemical Composition on Sensitivity of Welding Crack for Steel Plate Produced by Thermo-Mechanical Control Process

Chemical composition on sensitivity of welding crack for the steel plate produced by thermo-mechanical control process shall be as follows:

- (1) **Calculation Formula of Chemical Composition on Sensitivity of Welding Crack** Chemical composition on sensitivity of welding crack shall be as follows by using the cast analysis values conforming to 9.1 in the text of this Standard.

Chemical composition on sensitivity of welding crack (%) = $C + \frac{Si}{30} + \frac{Mn}{20} + \frac{Cu}{20} + \frac{Ni}{60} + \frac{Cr}{20} + \frac{Mo}{15} + \frac{V}{10} + 5B$

- (2) **Chemical Composition on Sensitivity of Welding Crack** Chemical composition on sensitivity of welding crack shall be as given in Annex Table 2-1 or Annex Table 2-2.

Annex Table 2-1. Chemical Composition on Sensitivity of Welding Crack
(Applicable till the end of 1990)

Unit: %

Grade	Chemical composition on sensitivity of welding crack		
	Up to and including 50 mm	Over 50 mm up to and including 75 mm	Over 75 mm up to and including 100 mm thickness
SPV 32	0.24 max.	0.26 max.	0.26 max.
SPV 36	0.26 max.	0.27 max.	—
SPV 42	0.27 max.	0.28 max.	—

Annex Table 2-2. Chemical Composition on Sensitivity of Welding Crack (Applicable on and after January 1, 1991)

Unit: %

Grade	Chemical composition on sensitivity of welding crack		
	Up to and including 50 mm	Over 50 mm up to and including 75 mm	Over 75 mm up to and including 100 mm thickness
SPV 315	0.24 max.	0.26 max.	0.26 max.
SPV 355	0.26 max.	0.27 max.	—
SPV 410	0.27 max.	0.28 max.	—

Y 3. Charpy Absorbed Energy for Steel Plate Produced by Thermo-Mechanical Control Process

Charpy absorbed energy shall be as given in Annex Table 3-1 or Annex Table 3-2.

Annex Table 3-1. Charpy Absorbed Energy
(Applicable till the end of 1990)

Unit: $\text{kgf} \cdot \text{m} \{ \text{J} \}$

Grade	Test temperature	Charpy absorbed energy		Test piece
		Average of tested values of three test pieces	Value on each test piece	
SPV 32 SPV 36 SPV 42	-20°C	4.8 {47.1} min.	2.8 {27.3} min.	No. 4, in rolling direction

Annex Table 3-2. Charpy Absorbed Energy
(Applicable on and after January 1, 1991)

Unit: J

Grade	Test temperature	Charpy absorbed energy		Test piece
		Average of tested values of three test pieces	Value on each test piece	
SPV 315 SPV 355 SPV 410	-20°C	47 min.	27 min.	No. 4, in rolling direction

Applicable Standards:

- JIS G 0303-General Rules for Inspection of Steel
- JIS G 0801-Ultrasonic Examination of Steel Plates for Pressure Vessels
- JIS G 1211-Methods for Determination of Carbon in Iron and Steel
- JIS G 1212-Methods for Determination of Silicon in Iron and Steel
- JIS G 1213-Methods for Determination of Manganese in Iron and Steel
- JIS G 1214-Methods for Determination of Phosphorus in Iron and Steel
- JIS G 1215-Methods for Determination of Sulfur in Iron and Steel
- JIS G 1216-Methods for Determination of Nickel in Iron and Steel
- JIS G 1217-Methods for Determination of Chromium in Iron and Steel
- JIS G 1218-Methods for Determination of Molybdenum in Iron and Steel
- JIS G 1221-Methods for Determination of Vanadium in Iron and Steel
- JIS G 1253-Method for Photoelectric Emission Spectrochemical Analysis of Iron and Steel
- JIS G 1256-Method for X-Ray Fluorescence Spectrometric Analysis of Iron and Steel
- JIS G 1257-Methods for Atomic Absorption Spectrochemical Analysis of Iron and Steel
- JIS G 1258-Methods for Inductively Coupled Plasma Emission Spectrochemical Analysis of Steel
- JIS G 3193-Dimensions, Mass and Permissible Variations of Hot Rolled Steel Plates, Sheets and Strip
- JIS Z 2201-Test Pieces for Tensile Test for Metallic Materials
- JIS Z 2202-Test Pieces for Impact Test for Metallic Materials
- JIS Z 2204-Bend Test Pieces for Metallic Materials
- JIS Z 2241-Method of Tensile Test for Metallic Materials
- JIS Z 2242-Method of Impact Test for Metallic Materials
- JIS Z 2248-Method of Bend Test for Metallic Materials

Corresponding International Standard:

- ISO 2604-4 Steel products for pressure purposes-Quality requirements
-Part 4 : Plates

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