

## ADDITIONAL PRODUCTS - SHEET & PLATE



**INSTRUMENTATION**

**PIPE FITTINGS**

**PIPING SOLUTIONS**

**ADDITIONAL PRODUCTS**

## Mechanical Test Requirements for Stainless Steel Plates

UNS Designation	Type <sup>a</sup>	Tensile Strength, min		Yield strength <sup>b</sup> , min		Elongation in 2 in. or 50 mm, min, %	Hardness, max <sup>c</sup>		Cold Bend <sup>d</sup>
		ksi	MPa	ksi	MPa		Brinell	Rockwell B	
Austenitic (Chromium-Nickel) (Chromium-Manganese-Nickel)									
N08904	904L <sup>e</sup>	71	490	31	220	35.0	...	90	not required
S20200	202	90	620	38	260	40.0	241	...	...
S30400	304	75	515	30	205	40.0	201	92	not required
S30403	304L	70	485	25	170	40.0	201	92	not required
S30409	304H	75	515	30	205	40.0	201	92	not required
S30453	304LN	75	515	30	205	40.0	201	92	not required
S30908	309S	75	515	30	205	40.0	217	95	not required
S31008	310S	75	515	30	205	40.0	217	95	not required
S31600	316	75	515	30	205	40.0	217	95	not required
S31603	316L	70	485	25	170	40.0	217	95	not required
S31653	316LN	75	515	30	205	40.0	217	95	not required
S31609	316H	75	515	30	205	40.0	217	95	not required
S31635	316Ti <sup>f</sup>	75	515	30	205	40.0	217	95	not required
S31700	317	75	515	30	205	35.0	217	95	not required
S31703	317L	75	515	30	205	40.0	217	95	not required
S31753	317N	80	550	35	240	40.0	217	95	not required
S32100	321	75	515	30	205	40.0	217	95	not required
S32109	321H	75	515	30	205	40.0	217	95	not required
S34700	347	75	515	30	205	40.0	201	92	not required
S34709	347H	75	515	30	205	40.0	201	92	not required
S40500	405	60	415	25	170	20.0	179	88	180
S41000	410	65	450	30	205	20.0	217	96	180
S41008	410S	60	415	30	205	22.0 <sup>g</sup>	183	89	180
S42900	429 <sup>h</sup>	65	450	30	205	22.0 <sup>g</sup>	183	89	180
S43000	430	65	450	30	205	22.0 <sup>g</sup>	183	89	180
S43035	439	60	415	30	205	22.0	183	89	180

<sup>a</sup> Unless otherwise indicated, a grade designation originally assigned by the American Iron Steel Institute (AISI).

<sup>b</sup> Yield strength shall be determined by the offset method at 0.2 % in accordance with Test methods and Definitions A 370. Unless otherwise specified (see Specification A 480/A 480M, paragraph 4.1.11 in Ordering Information), an alternative method of determining yield strength may be based on total extension under load of 0.5 %.

<sup>c</sup> Either Brinell or Rockwell B Hardness is permissible.

<sup>d</sup> Common name, not a trademark, widely used, not associated with any one producer.

<sup>e</sup> Material 0.050 in (1.27 mm) and under in thickness shall have a minimum elongation of 20.0 %.

<sup>g</sup> Although every care has been taken during the production of this brochure, we regret that we cannot accept any liability in respect of any incorrect information it may contain or any damages which may arise through the misinterpretation of its contents.

## CHEMICAL COMPOSITION REQUIREMENTS, %<sup>A</sup> FOR STAINLESS STEEL PLATES

UNS <sup>B</sup> Designation	Type <sup>C</sup>	Carbon <sup>D</sup>	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Molybdenum	Nitrogen	Copper	Other Elements
<b>AUSTENITIC (CHROMIUM-MANGANESE-NICKEL)</b>												
N08904	904L <sup>D</sup>	0.020	2.00	0.045	0.035	1.00	19.00-23.00	23.00-28.00	4.0-5.0	0.10	1.0-2.0	max
S20200	202	0.15	7.50-10.0	0.060	0.030	1.00	17.00-19.00	4.00-6.00	...	0.25	...	...
S30400	304	0.07	2.00	0.045	0.030	0.75	17.50-19.50	8.00-10.50	max	0.10	max	max
S30403	304L	0.030	2.00	0.045	0.030	0.75	17.50-19.50	8.00-12.00	...	0.10	...	...
S30409	304H	0.045-0.10	2.00	0.045	0.030	0.75	18.00-20.00	8.00-10.50	...	...	...	...
S30453	304LN	0.030	2.00	0.045	0.030	0.75	18.00-20.00	8.00-12.00	...	0.10-0.16	...	...
S30908	309S	0.08	2.00	0.045	0.030	0.75	22.00-24.00	12.00-15.00	...	...	...	...
S31008	310S	0.08	2.00	0.045	0.030	1.50	24.00-26.00	19.00-22.00	...	...	...	...
S31600	316	0.08	2.00	0.045	0.030	0.75	16.00-18.00	10.00-14.00	2.00-3.00	0.10	...	...
S31603	316L	0.030	2.00	0.045	0.030	0.75	16.00-18.00	10.00-14.00	2.00-3.00	0.10	...	...
S31609	316H <sup>D</sup>	0.04-0.10	2.00	0.045	0.030	0.75	16.00-18.00	10.00-14.00	2.00-3.00	...	...	...
S31635	316Ti	0.08	2.00	0.045	0.030	0.75	16.00-18.00	10.00-14.00	2.0-3.0	0.10	...	Ti 5 x (C+N) min, 0.70 max
S31653	316LN	0.030	2.00	0.045	0.030	0.75	16.00-18.00	10.00-14.00	2.00-3.00	0.10-0.16	max	max
S31700	317 <sup>D</sup>	0.08	2.00	0.045	0.030	0.75	18.00-20.00	11.00-15.00	3.00-4.00	0.10	...	...
S31703	317L	0.030	2.00	0.045	0.030	0.75	18.00-20.00	11.00-15.00	3.00-4.00	0.10	...	...
S31753	317LN	0.030	2.00	0.045	0.030	0.75	18.00-20.00	11.00-15.00	3.00-4.00	0.10-0.22	...	...
S32100	321	0.08	2.00	0.045	0.030	0.75	17.00-19.00	9.00-12.00	...	0.10	...	Ti 5 x (C+N) min, 0.70 max
S32109	321H	0.04-0.10	2.00	0.045	0.030	0.75	17.00-19.00	9.00-12.00	...	...	...	Ti 4 x (C+N) min, 0.70 max
S34700	347	0.08	2.00	0.045	0.030	0.75	17.00-19.00	9.00-13.00	...	...	...	Cb 10 x C min, 1.00 max
S34709	347H	0.04-0.10	2.00	0.045	0.030	0.75	17.00-19.00	9.00-13.00	...	...	...	Cb 8 x C min, 1.00 max
<b>FERRITIC OR MARTENSITIC (CHROMIUM)</b>												
S40500	405	0.08	1.00	0.040	0.030	1.00	11.50-14.50	0.60	max	max	max	AU 0.10-0.30 <sup>D</sup>
S41000	410	0.15	1.00	0.040	0.030	1.00	11.50-13.50	0.75	...	...	...	...
S41008	410S	0.08	1.00	0.040	0.030	1.00	11.50-13.50	0.60	...	...	...	...
S42900	429 <sup>D</sup>	0.12	1.00	0.040	0.030	1.00	14.00-16.00	...	...	...	...	...
S43000	430	0.12	1.00	0.040	0.030	1.00	16.00-18.00	0.75	...	...	...	...
S43035	439	0.07	1.00	0.040	0.030	1.00	17.00-19.00	0.050	...	0.04	...	Ti 0.20 + 4 (C+N) min, 1.10

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## CARBON STEEL: CHEMICAL COMPOSITION OF STANDARD GRADES

Grades	% Chemical Composition									Deoxidation
	C	Mn	Si	S	P	Al	Cu	Nb+V+Ti	Ce	
IS 1079 Gr O	0.15 max	0.60 max	-	0.055 max	0.055 max	-	-	-	-	Semi Killed / Killed
IS 1079 Gr D	0.12 max	0.50 max	-	0.040 max	0.040 max	-	-	-	-	Semi Killed / Killed
IS 1079 Gr DD	0.10 max	0.40 max	-	0.035 max	0.035 max	0.02 min	-	-	-	Al Killed
IS 1079 Gr EDD	0.08 max	0.40 max	-	0.030 max	0.030 max	0.02 min	-	-	-	Al Killed
IS 2062 E 250 A	0.23 max	1.50 max	0.40 max	0.045 max	0.045 max	-	-	0.25	0.25	Semi Killed / Killed
IS 2062 E 250 B	0.22 max	1.50 max	0.40 max	0.045 max	0.045 max	-	-	0.25 max	0.41 max	Killed
IS 2062 E250 C	0.20 max	1.50 max	0.04 max	0.040 max	0.040 max	-	0.20- 0.35	0.25 max	-	Killed
IS 2062 E 250 Cu C	0.20 max	1.60 max	0.45 max	0.045 max	0.045 max	-	-	0.25 max	0.44 max	Killed
IS 2062 E410	0.20 max	1.60 max	0.45 max	0.045 max	0.045 max	-	-	0.25 max	0.44 max	Killed
IS 2060 E450 D	0.22 max	1.60 max	0.45 max	0.045 max	0.045 max	-	-	0.25 max	0.45 max	Killed
IS 2062 E450 E	0.22 max	1.80 max	0.45 max	0.045 max	0.045 max	-	-	0.25 max	0.48 max	Killed
IS 5986 Fe 410	0.20 max	1.20 max	- max	0.040 max	0.040 max	-	-	-	0.42 max	Killed
IS 10748 Gr1	0.10 max	0.50 max	- max	0.040 max	0.040 max	-	-	-	-	Killed

## CARBON STEEL : MECHANICAL PROPERTIES OF STANDARD GRADES

Grades	YS N/mm <sup>2</sup>	UTS N/mm <sup>2</sup>	% El (Min) GL= 5.65√So	Bend Test (t)	Hard R <sub>e</sub>	Charpy V-Notch Impact Energy (min)
IS 1079 Gr O	-	-	-	2t	-	-
IS 1079 Gr D	-	240 - 400	25	1 t	-	-
IS 1079 Gr DD	-	260 - 390	28	Close	-	-
IS 1079 Gr EDD	-	260 - 380	32	Close	-	-
IS 2062 E250 A	250 min	410 min	23	3 t	-	-
IS 2062 E250 B	250 min	410 min	23	2 t	-	27 J at Room temp See Note
IS 2062 E250 C	250 min	410 min	23	2 t	-	27 J at Roomtemp See Note
IS 2062E250Cu C	250 min	410 min	23	2 t	-	27 J at Roomtemp See Note
IS 2062 E410	410 min	540 min	23	2 t	-	50 J at Roomtemp See Note
IS 2062 E450 D	450 min	570 min	20	2 t	-	45 J at Room temp See Note
IS 2062 E450 E	450 min	590 min	20	2 t	-	45 J at Room temp See Note
IS 5986 Fe410	255 min	410-520	24 for t>3/0 mm*	2 t	-	-

\*t = Nominal thickness of test piece, % = Elongation 15 min N in 80mm GL for t ≤ 3.0 mm

Note : For grade IS 2062 E250B, E250C, E410, E450E Impact Test shall be certified for product thickness of 12mm or more.

The testing temperature will be room temperature unless otherwise specified in the order.

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## EQUIVALENT SPECIFICATIONS OF IS STANDARDS

TITLE (1)	Indian Standard No. and Grade (2)		Near Equivalent Non IS Specifications (3)
Steel Plates for Pressure vessels for Intermediate and high temperature service including boilers.	IS 2002	Grade 1 Grade 2 Grade 3	A/SA 515 Grade 60 A/SA 515 Grade 65 A/SA 515 Grade 70
Steel Plates for Pressure vessels used at moderate and low temperature	IS 2041	Grade R220 Grade R220 Grade R260 Grade R260 Grade R355 Grade H235 Grade H235 Grade H265 Grade H295 Grade H355	A/SA 515 Grade 55 A/SA 515 Grade 60 A/SA 515 Grade 65 A/SA 515 Grade 70 A/SA 537 Class 1 DIN 17155 Gr. HI EN 10028-P2-P235GH EN 10028-P2-P235GH EN 10028-P2-P295GH EN 10028-P2-P355GH
Hot Rolled medium and high tensile structural steel (excluding bars and rods of diameter or thickness less than 6mm and structural below 50mm x 50mm x 6mm)	IS 2062	E250 A E250 A E300 A E350 A E350 A or E 410 E250 BR E250 BR E300 BR E250 BR, B0, C E275 BR, B0, C E350 BR, B0, C E250 A E350 C E300 A E300 C E350 A E350 C E410 A E410 C E450 A E450 BR E550 A E550 BR E550 A	A/SA 36 A/SA 283 Grade D A/SA 572 Grade 42 A/SA 572 Grade 50 A/SA 572 Grade 55 A/SA 573 Grade 58 A/SA 573 Grade 65 A/SA 573 Grade 70 EN 10025 S235 JR,J0,J2 EN 10025 S275 JR,J0,J2 EN 10025 S355 JR,J0,J2 DIN 17100 Rst 37.2, St 44.2 DIN 17100 St 52.9 SALIMA 300 SALIMA 300 HI SALIMA 350 SALIMA 350 HI SALIMA 410 SALIMA 410 HI SALIMA 450 SALIMA 450 HI SALIMA 550 SALIMA 550 HI SAIL HITEN

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## CARBON STEEL PLATES - IS 8500

CHEMICAL COMPOSITION						
Grade IS 8500	Ladle Analysis					
	C% Max	Mn% Max	S% Max	P% Max	Si% Max	C.E% Max
Fe 440	0.20	1.30	0.040	0.040	0.45	0.40
Fe 490	0.20	1.50	0.040	0.040	0.45	0.42
Fe 540	0.20	1.60	0.040	0.040	0.45	0.44
Fe 570	0.22	1.60	0.040	0.040	0.45	0.46
Fe 590	0.22	1.80	0.040	0.040	0.45	0.48

MECHANICAL PROPERTIES									
Grade IS 8500	Tensile Strength (Min)  MPa	Yield Strength (Min)			Elongation Percent (Min)  5.65.√So	Bend (Internal diameter)		Charpy V -notch Impact toughness, Joules, Min	
		<16 mm	16-40 mm	>40 mm		Min 25 mm	>25 mm	RT	20°C
		MPa	MPa	MPa					
Fe 440	440	300	290	280	22	2t	3t	50	30
Fe 490	490	350	330	320	-	2t	3t	50	25
Fe 540	540	410	390	380	-	2t	3t	50	25
Fe 570	570	450	430	420	-	2t	3t	45	20
Fe 590	590	450	430	420	-	2t	3t	45	20

## SAILMA HIGH STRENGTH MICRO ALLOY STRUCTURAL STEEL (KILLED)

CHEMICAL COMPOSITION				
Grade	C% Max	Mn% Max	S% Max	P% Max
SAILMA 350	0.25	1.50	0.055	0.055
SAILMA 350HI	0.20	1.50	0.055	0.055
SAILMA 410	0.25	1.50	0.055	0.055
SAILMA 410HI	0.25	1.50	0.055	0.055
SAILMA 450	0.25	1.50	0.055	0.055
SAILMA 450HI	0.20	1.50	0.040	0.040

MECHANICAL PROPERTIES						
Grade	UTS (MPa)	YS (MPa) Min	El. % Min 5.65√So	Charpy V - notch Impact toughness, Joules, Min		Bend Test
				RT	20°C	
SAILMA350	490-610	350	20	-	-	3T
SAILMA350HI	490-610	350	21	35	25	3T
SAILMA410	510-660	410	19	-	-	3T
SAILMA410HI	540-660	410	20	30	20	3T
SAILMA450	570-720	450	18	-	-	3T
SAILMA450HI	570-720	450	19	*	*	3T

\*For SAILMA 450HI impact is for > 10mm for <12mm Impact to be given only if specified



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### ASTM A 283 LOW AND INTERMEDIATE TENSILE STRENGTH CARBON STEEL PLATES.

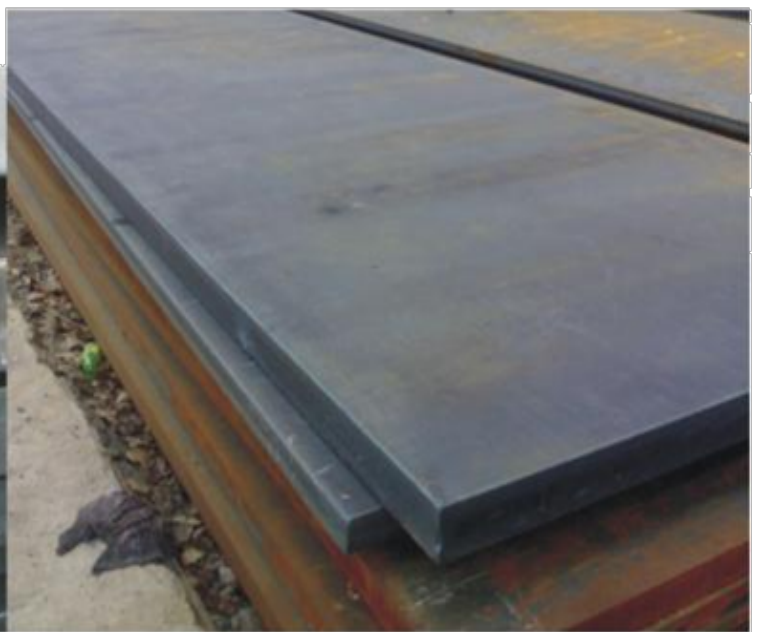
Designation	Chemical Composition				Mechanical Properties			
	C% max	Mn% max	P% max	S% max	Tensile Strength (Mpa)	Yield Strength (MPa)	Elongation %min	
							GL=8 in	GL=2 in
Grade A	0.14	0.90	0.035	0.040	310-415	165	27	30
Grade B	0.17	0.90	0.035	0.040	345-450	185	25	28
Grade C	0.24	0.90	0.035	0.040	380-515	205	22	25
Grade D	0.27	0.90	0.035	0.040	415-550	230	20	23

Note : 1) For Silicon: Thickness 40mm and under 0.40max & for Thickness over 40mm 0.15-0.40

2) Min% when copper is specified 0.20

### ASTM A 285 PRESSURE VESSEL PLATES, CARBON STEEL LOW AND INTERMEDIATE TENSILE STRENGTH

Designation	Chemical Composition				Mechanical Properties			
	C% max	Mn% max	P% max	S% max	Tensile Strength (Mpa)	Yield Strength (MPa)	Elongation %min	
							GL=8 in	GL=2 in
Grade A	0.17	0.90	0.035	0.035	310-415	165	27	30
Grade B	0.22	0.90	0.035	0.040	345-485	185	25	28
Grade C	0.28	0.90	0.035	0.040	380-515	205	22	23



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## EQUIVALENT GRADES IN VARIOUS SPECIFICATION

### Alloy Steels

Equivalent Grades				
BS	DIN	IS	EN	SAE/AISI
530A40	37Cr4	40Cr1	EN18	5140
817M40	34CrNiMo6	40NiCr4Mo3	EN24	4340
709M40	-	40Cr4Mo3	EN19C	4140, 4142
709M40	-	40Cr4Mo3	EN19	4140, 4142
530A40	37Cr4	40Cr1	EN18D	5140
530A40	37Cr4	40Cr1	EN18C	5140
530A40	37Cr4	40Cr1	EN18A	5140
-	28Mn6	27C15	-	1527
-	20MnCr5	20MnCr1	-	-
150MB	-	20Mn2	EN14A	1524
-	16MnCr5	17Mn1Cr95	-	5120
530A40	37Cr4	40Cr1	EN18B	5140
805M20	-	20NiCrMo2	EN362	8620
805M20	-	20Ni2CrMo2	-	8622
815M17	-	15NiCr1Mo12	EN353	-
820M17	-	15NiVCr1Mo15	EN354	4320
-	17Cr3	-	-	-
41Cr4	41Cr4	40Cr4	EN 18D	5140
34Cr4	34Cr4	-	EN 18	5130

### Carbon Steels

Equivalent Grades				
BS	DIN	IS	EN	SAE/AISI
150M36	36Mn5	37Mn2, 37C15	EN15B	1536
-	CK15	C14	EN32B	1015, 1016, 1018
-	CK38	-	-	1038
-	-	C50	EN43C	1050
-	CK45	45C8	1045	-
070M55	CK55	C55	EN9	1055
-	C35	35C8, C35Mn75	-	1035
-	CK75	60C6	EN42	1074
-	C67	65C6	EN42B	1065
080M50	C55	60C6	EN43	1055
080A47	CK45	-	EN43B	1045

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## ASTM 515 PRESSURE VESSEL PLATES, CARBON STEEL FOR INTERMEDIATE AND HIGHER TEMPERATURE SERVICES

CHEMICAL COMPOSITION

Elements	Composition %		
	Grade 60 (Grade 415)	Grade 65 (Grade 450)	Grade 70 (Grade 485)
Carbon, Max (A) :			
1 in. [25 mm] and under	0.24	0.28	0.31
Over 1 in. to 2 in. [25 to 50 mm], incl.	0.27	0.31	0.33
Over 2 in. to 4 in. [50 to 100 mm], incl.	0.29	0.33	0.35
Over 4 to 8 in. [100 to 200 mm], incl.	0.31	0.33	0.35
Over 8 in. [200 mm]	0.31	0.33	0.35
Manganese max:			
Heat analysis	0.90	0.90	1.20
Product analysis	0.98	0.98	1.30
Phosphorus, Max (A)	0.035	0.035	0.035
Sulfur, max (A)	0.035	0.035	0.035
Silicon:			
Heat analysis	0.15-0.40	0.15-0.40	0.15-0.40
Product analysis	0.13-0.45	0.13-0.45	0.13-0.45

Note : (A) Applies to both heat and product analysis.

TENSILE REQUIREMENTS

Elements	Composition %		
	Grade 60 (Grade 415)	Grade 65 (Grade 450)	Grade 70 (Grade 485)
Tensile Strength, ksi [Mpa]	60-80 [415-550]	65-85 [450-585]	70-90 [485-620]
Yield Strength, min, ksi [Mpa]	32 [220]	35 [240]	38 [260]
Elongation in 8 in. [200 mm], min % (A)	21	19	17
Elongation in 2 in. [50 mm], min, % (A)	25	23	21

Note : (A) See Specification A20/A20M for elongation adjustment.

## ASTM 516 PRESSURE VESSEL PLATES, CARBON STEEL FOR MATERATE AND LOWER TEMPERATURE SERVICES

CHEMICAL COMPOSITION

Elements	Composition %			
	Grade 55 (Grade 380)	Grade 60 (Grade 415)	Grade 65 (Grade 450)	Grade 70 (Grade 485)
Carbon, Max <sup>a</sup>				
1/4 in. [12.5 mm] and under	0.18	0.21	0.24	0.27
Over 1/4 in. to 2 in. [12.5 to 50mm], incl.	0.20	0.23	0.26	0.28
Over 2 in. to 4 in. [50 to 100mm], incl.	0.22	0.25	0.28	0.30
Over 4 to 8 in. [100 to 200 mm], incl.	0.24	0.27	0.29	0.31
Over 8 in. [200 mm]	0.26	0.27	0.29	0.31
Manganese :				
1/4 in. [12.5 mm] and under	0.60-0.90	0.60-0.90	0.85-1.20	0.85-1.20
Heat analysis <sup>b</sup>	0.55-0.98	0.55-0.98	0.79-1.30	0.79-1.30
Product analysis <sup>b</sup>				
Over 1/4 in. [12.5] :				
Heat analysis <sup>b</sup>	0.60-1.20	0.85-1.20	0.85-1.20	0.85-1.20
Product analysis <sup>b</sup>	0.55-1.30	0.79-1.30	0.79-1.30	0.79-1.30
Phosphorus, Max <sup>d</sup>	0.035	0.035	0.035	0.035
Sulfur, max <sup>d</sup>	0.035	0.035	0.035	0.035
Silicon :				
Heat analysis <sup>e</sup>	0.15-0.40	0.15-0.40	0.15-0.40	0.15-0.40
Product analysis <sup>e</sup>	0.13-0.45	0.13-0.45	0.13-0.45	0.13-0.45

<sup>a</sup>Applies to both heat and product analysis.

<sup>b</sup>Grade 60 plates 1/4 in [12.5mm] and under in thickness may have 0.85-1.20% manganese on heat analysis, and 0.79-1.30% manganese on product analysis.

TENSILE REQUIREMENTS

Elements	Composition %			
	Grade 55 (Grade 380)	Grade 60 (Grade 415)	Grade 65 (Grade 450)	Grade 70 (Grade 485)
Tensile Strength, ksi [Mpa]	55-75 [380-515]	60-80 [415-550]	65-85 [450-585]	70-90 [485-620]
Yield Strength, min, ksi [Mpa]	30 [205]	30 [220]	35 [240]	38 [260]
Elongation in 8 in. [200 mm], min %	23 <sup>f</sup>	21 <sup>f</sup>	19 <sup>f</sup>	17 <sup>f</sup>
Elongation in 2 in. [50 mm], min, %	27 <sup>f</sup>	25 <sup>f</sup>	23 <sup>f</sup>	21 <sup>f</sup>

<sup>f</sup>See Specification A20/A 20M

<sup>e</sup>Determined by either the 0.2% offset method or the 0.5% extension under load method.

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## ALLOY STEEL PLATES

### CHEMICAL COMPOSITION

Grade	C	Si	Mn	P	S	Cr	Mo	Ni	Nb	Ti	V	Al	N	Cu
13CrMo45	0.08/0.18	0.35	0.40/1.00	0.025	0.010	0.70/1.15	0.40/0.60	-	-	-	-	-	0.012	0.30

### MECHANICAL PROPERTIES

Grade	Thickness mm	Yield Strength Mpa	Tensile Strength Mpa	Elongation (A) %	Impact energy KV at test temperature		
					-20°C J	0°C J	+20°C J
13CrMo45	<16	300	450/600	19	-	-	31
	>16<60	290	450/600	19	-	-	31
	>60<100	270	440/590				27
	>100<150	255	430/580				27
	>150<250	245	420/570				27

### CHEMICAL COMPOSITION

Grade	C	Si	Mn	P	S	Cr	Mo	Ni	Nb	Ti	V	Al	N	Cu
16Mo3	0.12/0.20	0.35	0.40/0.90	0.025	0.010	0.30	0.25/0.35	0.30	-	-	-	-	0.012	0.30

### MECHANICAL PROPERTIES

Grade	Thickness (mm)	Temperature (°C)									
		50° MPa	100° MPa	150° MPa	200° MPa	250° MPa	300° MPa	350° MPa	400° MPa	450° MPa	500° MPa
16Mo3	<16	273	264	250	233	213	194	175	159	147	141
	>16<40	268	259	245	228	209	190	172	156	145	139
	>40<60	258	250	236	220	202	183	165	150	139	134
	>60<100	238	230	218	203	186	169	153	139	129	123
	>100<150	218	211	200	186	171	155	140	127	118	113
>150<250	208	202	191	178	163	148	134	121	113	108	

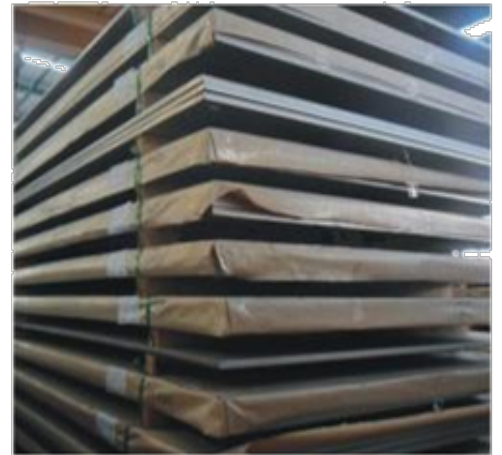
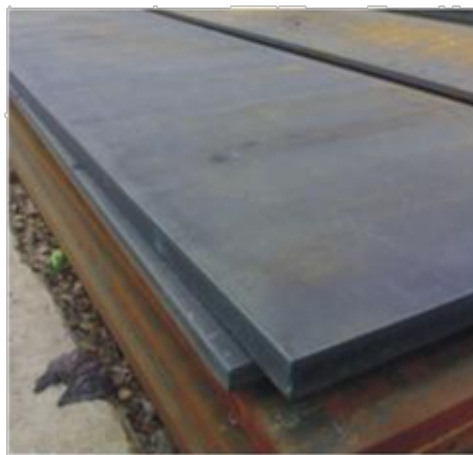
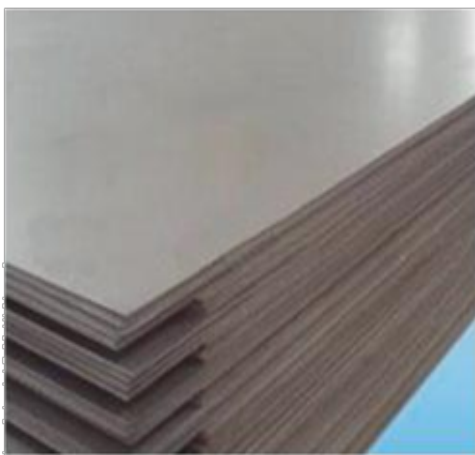
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## ALLOY STEEL PLATES

### ASTM A387 PRESSURE VESSEL PLATES, ALLOY STEEL, CHROMIUM - MOLYBDENUM

Specification	CHEMICAL COMPOSITION								MECHANICAL PROPERTIES			
	C% max	Si%	Mn%	P% max	S% max	Cr%	Mo%	V%	Tensile Strength Ksi (MPa)	Yield Strength (0.2% offset) Ksi (MPa) min	Elongation % min	
											GL = 8 in *2 or 200 mm	GL = 2 in. or 50 m
Grade 5 Class-2	0.15	0.50 max	0.30-0.60	0.035	0.030	4.00-6.00	0.45-0.65		75-100 (515-690)	45 (310)	-	18
Grade 9 Class-2	0.15	1.00 max	0.30-0.60	0.030	0.030	8.00-10.00	0.90-1.10	0.04 max	75-100 (515-690)	45 (310)	-	18
Grade 11 Class-2	0.05-0.17	0.50-0.80	0.40-0.65	0.035	0.035	1.00-1.50	0.45-0.65		75-100 (515-690)	43 (310)	18	22
Grade 12 Class-2	0.05-0.17	0.15-0.40	0.40-0.65	0.035	0.035	0.80-1.15	0.45-0.60		65-85 (450-585)	40 (275)	19	22
Grade 22 Class-2	0.05-0.15	0.50 max	0.30-0.60	0.035	0.035	2.00-2.50	0.90-1.10		75-100 (515-690)	45 (310)	-	18
Grade 91* Class-2	0.08-0.12	0.20-0.50	0.30-0.60	0.020	0.010	8.00-9.50	0.85-1.05	0.18-0.25	85-110 (585-760)	60 415	-	18

\*Additional Properties for Grade 91) Ni-0.40max, Cb-0.06-0.10, N-0.030-0.070, Al-0.02, Ti & Z : 0.01 max



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(Properties: minima unless stated)

Grade	S185 <sup>®</sup> Fe310-0 <sup>®</sup>	S235 <sup>®</sup> Fe360A <sup>®</sup>	S235JR <sup>®</sup> Fe360B <sup>®</sup>	S235JRG1 <sup>®</sup> Fe360B(FU) <sup>®</sup>	S235JRG2 Fe360B(FN)	S235JO Fe360C <sup>®</sup>	S235J2G3 Fe360D <sup>®</sup>	S235J2G4 Fe360D2	S275 <sup>®</sup> Fe430A <sup>®</sup>	S275JR Fe430B	S275JO Fe430C
ISO : Standard 630	-	40A	-	-	40B	40C	40D	-	43A	43B	BC
BS4360 Equivalent Grade	-	opt.	-	FU	FN	FN	FF	FF	FN.	FN	FN
Type of Deoxidation <sup>1)</sup>	opt.	opt.	opt.								
Thickness: (mm)											
Chemical Composition	≤ 16	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.21	0.21	0.18
	≥ 16 ≤ 40	0.20	0.20	0.20	0.17	0.17	0.17	0.17	0.21	0.21	0.18
≥ 40 <sup>2)</sup>	-	-	-	-	0.20	0.17	0.17	0.17	0.22	0.22	0.18 <sup>®</sup>
Si	-	-	-	-	-	-	-	-	-	-	-
Mn	-	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.50	1.50	1.50
P, % maximum	-	0.045	0.045	0.045	0.045	0.040	0.035	0.035	0.045	0.045	0.040
S	-	0.045	0.045	0.045	0.045	0.040	0.035	0.035	0.045	0.045	0.040
N <sup>3)</sup>	-	0.009	0.009	0.007	0.009	0.009	-	-	0.009	0.009	0.009
Yield Stress <sup>4)</sup>	≤ 16	185	235	235	235	235	235	235	275	275	275
	≥ 16 ≤ 40	175	225	225	225	225	225	225	265	265	265
	≥ 40 ≤ 63	-	-	-	215	215	215	215	255	255	255
	≥ 63 ≤ 80	-	-	-	215	215	215	215	245	245	245
≥ 80 ≤ 100	-	-	-	215	215	215	215	235	235	235	
≥ 100 ≤ 150	-	-	-	195	195	195	195	225	225	225	
≥ 150 ≤ 200	-	-	-	185	185	185	185	215	215	215	
≥ 200 ≤ 250	-	-	-	175	175	175	175	205	205	205	
Tensile Strength <sup>5)</sup>	< 3	310/540	360/510	360/510	360/510	360/510	360/510	360/510	430/580	430/580	430/580
	≥ 3 ≤ 100	290/510	340/470	340/470	340/470	340/470	340/470	340/470	410/560	410/560	410/560
R <sub>m</sub> <sup>6)</sup> N/mm <sup>2</sup>	≥ 100 ≤ 150	-	-	-	340/470	340/470	340/470	340/470	400/540	400/540	400/540
	> 150 ≤ 250	-	-	-	320/470	320/470	320/470	320/470	380/540	380/540	380/540
Elongation <sup>7)</sup> % (Values in Parentheses are Transverse Values)	≤ 1	10 (8)	17 (15)	17 (15)	17 (15)	17 (15)	17 (15)	17 (15)	14 (12)	14 (12)	14 (12)
	> 1 ≤ 1.5	11 (9)	18 (16)	18 (16)	18 (16)	18 (16)	18 (16)	18 (16)	15 (13)	15 (13)	15 (13)
	> 1.5 ≤ 2	12 (10)	19 (17)	19 (17)	19 (17)	19 (17)	19 (17)	19 (17)	16 (14)	16 (14)	16 (14)
	> 2 ≤ 2.5	13 (11)	20 (18)	20 (18)	20 (18)	20 (18)	20 (18)	20 (18)	17 (15)	17 (15)	17 (15)
	> 2.5 ≤ 3	14 (12)	21 (19)	21 (19)	21 (19)	21 (19)	21 (19)	21 (19)	18 (16)	18 (16)	18 (16)
	≥ 3 ≤ 40	18 (16)	26 (24)	26 (24)	26 (24)	26 (24)	26 (24)	26 (24)	22 (20)	22 (20)	22 (20)
	> 40 ≤ 63	-	25 (23)	25 (23)	25 (23)	25 (23)	25 (23)	25 (23)	21 (19)	21 (19)	21 (19)
	> 63 ≤ 100	-	24 (22)	24 (22)	24 (22)	24 (22)	24 (22)	24 (22)	20 (18)	20 (18)	20 (18)
	> 100 ≤ 150	-	22 (22)	22 (22)	22 (22)	22 (22)	22 (22)	22 (22)	18 (18)	18 (18)	18 (18)
	> 150 ≤ 250	-	21 (21)	21 (21)	21 (21)	21 (21)	21 (21)	21 (21)	17 (17)	17 (17)	17 (17)
Impact Temp °C	> 10 ≤ 150	-	27	27	27	27	27	27	27	27	27
	> 10 ≤ 150	-	-	-	-	-	-	-	-	-	-
	> 10 ≤ 150	-	-	-	-	-	27	27	-	-	-
	> 10 ≤ 150	-	-	-	-	-	-	-	-	-	-
Impact KV J	+20	-	-	-	-	-	-	-	-	-	-
	+20	-	-	-	23	-	-	-	-	23	-
0	-	-	-	-	-	23	-	-	-	23	
-20	-	-	-	-	-	-	-	-	-	-	
> 10 ≤ 150	-	-	-	-	-	23	-	-	-	-	
> 10 ≤ 150	-	-	-	-	-	-	-	-	-	-	
> 10 ≤ 150	-	-	-	-	-	-	-	-	-	-	
> 10 ≤ 150	-	-	-	-	-	-	-	-	-	-	

Note : 1), 2), 3), 4), 5), 6), 7) references shall be made to BS EN10155 Handbook

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