

## VALVE MATERIALS - SUITABILITY, PERFORMANCE & APPLICATIONS

### COMPLETE VALVE SOLUTIONS FOR ALL INDUSTRIES

Australian Pipeline Valve (APV) offers valves in a wide variety of material combinations in carbon steel, stainless steels, exotic and special materials. Australian Pipeline Valve manufactures the following valves in all grades:-

- Ball Valves (Firesafe & non Firesafe)
- Check Valves (Piston, Swing, Tilt)
- Wafer Check Valves (Dual flap/ Single flap)
- Gate Valves (API603 & API600)
- Globe Valves (ANSI B16.34 & BS1873)
- Needle Valves (Plug and Globe type)
- Plug Valves (Lined & Sleeved)
- Strainers (Y, Basket & Duplex type)

### Major Categories of Common Valve Materials

FORGED	CAST
<b>CARBON STEEL</b>	
ASTM A105/A105N	ASTM A216 WCB/WCC
ASTM A350 LF2	ASTM A352 LCB/LCC
<b>ALLOY STEEL</b>	
ASTM A350 LF3	ASTM A352 LF3
ASTM A182 F5a/F5	ASTM A217 C5
ASTM A182 F9	ASTM A217 C12
ASTM A182 F11	ASTM A217 WC6
ASTM A182 F22	ASTM A217 WC9
ASTM A182 F91	ASTM A217 C12A
<b>AUSTENITIC STAINLESS STEEL</b>	
ASTM A182 F304/F304L	ASTM A351 CF8/CF3
ASTM A182 F316/F316L	ASTM A351 CF8M/CF3M
ASTM A182 F321	
ASTM A182 F347	ASTM A351 CF8C
ASTM A182 F44 (6MO)	ASTM CK3MCuN
ASTM A182 F20* (ALLOY 20)	A351 CN7M
<b>FERRITIC-AUSTENITIC STAINLESS STEEL</b>	
ASTM A182 F51 - UNS S31803† (DUPLEX S.S.)	A995* GR.4A/A351 CD3MN
ASTM A182 F53 - UNS S32750 (SUPER DUPLEX S.S.)	A995* GR.5A/A351 CE3MN
ASTM A182 F55 - UNS S32760 (SUPER DUPLEX S.S.)	A995* CD3MWCuN/A995 GR.6A
<b>NICKEL ALLOY</b>	
INCONEL 825 - UNS N08825 - ASTM B564 N08825	A484 CU 5MCuC*
INCONEL 600 - UNS N06600 - ASTM B564 N06600	A494 CY40*
INCONEL 625 - UNS N06625 - ASTM B564 N06625	A494 CW6MC*
MONEL 400 - UNS N04400 - ASTM B564 N04400	A494 M35-1
<b>TITANIUM</b>	
ASTM B381 GR.F2	ASTM B367 GR.C2
ASTM B381 GR.F3	ASTM B367 GR.C3

† Grade UNS31803 now supplemented by UNS32205. UNS32205 which dual conforms and is now often specified.  
\*A995 optionally supercedes A890.

## 304/304L STAINLESS VALVES

Valves are manufactured in ASTM A182 304/304L forgings and ASTM A351 CF8/CF3 castings. Trim components can also be in UNS S30403 and AISI-SAE 304/304L. Welded end valves can be in 304 but 304L is often preferred due to the lower carbon content which avoids intergranular corrosion in the as-welded state thereby providing superior corrosion resistance compared to 304.

### Design features 304/316L Stainless Steel

- General corrosion resistance
- Non magnetic and non hardenable except by cold working
- Appropriate in field working applications
- Susceptible to chloride stress corrosion cracking

### GRADE 304

One of the most versatile and commonly used stainless steels on the market, Grade 304 stainless steel is the most standard used alloy of this type. Essentially, Grade 304 is an austenitic chromium alloy which is also known as an “18/8” stainless as the make-up of the steel is 18% chromium and 8% nickel. 304 grade is also cheaper than 316 grade.

The chromium content promotes the material’s considerable resistance to the effects of corrosion and oxidation. The stainless steel alloy resists most oxidising acids and will withstand ordinary rusting though this does not mean that the steel will not tarnish over time. The steel needs to be cold worked to generate higher tensile strength. For valves which are welded heavily, post-weld annealing may be necessary to provide maximum corrosive resistance.

Type 304 Stainless Steel has excellent welding and deep drawing characteristics.

### Applications of Grade 304 Stainless Steel

Grade 304 can also be found in heat exchangers, chemical containers, pipelines and throughout the food industry. It can be used as a fabricated material where high temperature petroleum gases or steam production gases are stored such as pressure vessels.

304 & 304L valves & piping components have similar properties and in certain cases are manufactured with dual certification, where it is confirmed that each item has properties and a composition which comply with both steel types. Grade 304H cannot be included in this equation due to the steel’s higher carbon content which is intended for use in elevated temperature applications.

### GRADE 304L

Type 304L is a lower carbon variant of Grade 304 - the steel can be welded without the resulting issue of carbon precipitation (precipitation of chromium carbide as heat is applied during the welding process which depletes the chromium element of the steel thus reducing its anti-corrosive/oxidation effectiveness). It’s corrosive and strength properties are similar to 304.

Type 304L stainless steel is a sort after material for use in severely corrosive conditions. Weld annealing is only necessary in applications where stress loads are excessive. 304L has a slightly lower pressure rating at very high temperatures compared to 304.

This steel Grade is found in a variety of commercial sectors, particularly in the chemical industry.

## Benefits of using 304L Stainless Steel

- Low carbon content eliminates carbon precipitation in the welding process
- Can be used in severe corrosive environments
- Weld annealing only required in high stress applications
- Very similar to Type 304

304 & 304L valves & piping components have similar properties and in certain cases are manufactured with dual certification, where it is concluded that each item has properties and a composition which comply with both steel types. Grade 304H cannot be included in this equation due to the steel's higher carbon content which is intended for use in elevated temperature applications.

The below tables are correct as per ASTM A182/A182M-13

## Chemical Composition

Grade	C (Max)	Si (Max)	Mn (Max)	P (Max)	S (Max)	Cr	Mo	Ni	N (Max)
304L	0.030	1.00	2.00	0.045	0.030	18.00/20.00	-	8.00/13.00	0.10
304	0.080	1.00	2.00	0.045	0.030	18.00/20.00	-	8.00/11.00	0.10

## Mechanical Properties

Grade	Yield Strength	Tensile Strength	Elongation (%)	Reduction of Area (%)	Hardness Max	
	Min (Mpa)	Min (Mpa)	Min	Min (50mm)	HB	HRB
304L	170	485	30	50	201*	92*
304	205	515	30	50	201*	92*

\* Maximum hardness not specified in ASTM A182/A182M-13

## Equivalent Standards/ Specifications

The following standards may be utilised for valve & trim components in valve construction:-

### ASTM

A312, A376, A358, A269, A249, A403, A182, A351

### ASME

SA312, SA376, SA358, SA269, SA249, SA403, SA182, SA351

## Applications

FORGING SPECIFICATION	COMMON DESIGNATION	MATERIAL SUFFIX	WROUGHT BAR SPECIFICATION	SERVICE RECOMMENDATIONS (1)	COMMON API TRIM # FOR BASE MATERIAL	
					150 TO 600 #	900 TO 2500 #
ASTM A182 F304	18% Chrome; 8% Nickel; 0.08% C Stainless Steel	ASTM A351 Grade CF8	ASTM A479 304	Corrosive or extremely high temperature non-corrosive services between -450°F (-268°C) and +1200°F (+649°C). Above +800°F (+425°C) specify carbon content of 0.04% or greater.	2	2, 15
ASTM A182 304L	18% Chrome; 8% Nickel; 0.03% C Low Carbon Stainless Steel	ASTM A351 Grade CF3	ASTM A479 304L	Brackish water, phosphate solutions, pressurised water @ 570°F (299°C), sea water, steam.	304L+HFS	304L+HF
ASTM A182 F304H	18% Chrome; 8% Nickel; 0.08% C Stainless Steel	ASTM A351 Grade CF10	ASTM A479 304H	Corrosive or extremely high temperature non-corrosive services between -450°F (-268°C) and +1200°F (+649°C). Above +800°F (+425°C) specify carbon content of 0.04% or greater.	304H+HFS	304H+HF

For technical references and ASTM/ASME cross reference information on stainless, duplex, chrome-moly and alloy steel used in valves & piping systems in the petrochemical and refining go to the technical section of our website: <http://www.australianpipelinevalve.com.au>

## 316/316L STAINLESS VALVES

Valves are manufactured in ASTM A182 316/316L forgings and ASTM A351 CF8/CF3 castings. Trim components can also be in UNS S31600 and AISI-SAE 316/316L. Welded end valves can be in 316 but 316L is often preferred due to the lower carbon content which avoids inter granular corrosion in the as-welded state thereby providing superior corrosion resistance compared to 316. However 316 can be post-weld annealed to promote maximum corrosion resistance.

316 and 316L are molybdenum steels with enhanced resistance to pitting by solutions with chlorides and other halides. These grades offer tensile, creep and stress-rupture strength in higher-temperature applications. 316 and 316L offer better resistance to atmospheric and mild environments than 304 and 304L.

### Design Features 316/316L

- 316 is resistant to dilute solutions (1-5%) of sulfuric acid to 49°C (120°F), except in some oxidising acids, where 316 is less resistant than 304.
- 316 is susceptible to inter granular corrosion in the as-welded condition
- 316 is prone to carbide precipitation from 427°C to 816°C (800°F to 1500°F)
- Corrosion resistance can be restored by post-welding annealing
- 316L offers same composition but with less than 0.03% carbon
- 316L presents similar corrosion resistance and other characteristics as 316 but with added resistance to inter granular attack in the as-welded condition or with short exposures in the 427°C to 816°C (800°F to 1500°F) range
- 316L is appropriate in applications where it's impossible to avoid exposure in the carbide precipitation range and when post-welding annealing isn't practical; lengthy exposure in this range may make the material brittle and susceptible to inter granular attack
- 316 maximum temperature for scaling resistance is 899°C (1650°F) in continuous service and 816°C (1500°F) in intermittent service applications
- 316L has a slightly lower pressure rating at very high temperatures compared to 316
- Susceptible to stress-corrosion cracking
- Slightly magnetic in the cold-worked condition
- Nonmagnetic and non harden able in the annealed condition
- Enhanced resistance to chlorides

### GRADE 316

After 304, 316 is the most common stainless steel on the market. It is an austenitic grade with the addition of 2-3% molybdenum which further improves corrosion resistance. It is often referred to as a marine grade stainless steel because of its effective resistance to chloride corrosion in comparison to other stainless steel grades.

The material has superior welding and forming qualities. Grade 316 will require post-weld annealing to promote maximum corrosion resistance, though this is not necessary if Type 316L is used.

### Applications of Grade 316 Stainless Steel

Typical applications for this material are now widespread due to its superior corrosion resistance properties when compared to Grade 304. Type 316 stainless can be found in heat exchangers, pharmaceutical equipment, refineries, food industry, mining, process industries, etc.

316 & 316L steel valves have common properties and are often manufactured by Australian Pipeline Valve with dual certification, where it is determined that both have properties and composition which comply with both steel types.

Type 316H is excluded from this overview but as a brief explanation, 316H is engineered to constantly work in even higher working temperatures than 316/316L. It should also be noted that 316L has a slightly lower maximum temperature rating and maximum cold working pressure rating than 316.

## GRADE 316L

Type 316L is the low carbon version of 316 stainless. Again compared to 304/304L having the addition of molybdenum, the steel is popular for use in severe corrosion environments due to the materials immunity from boundary carbide precipitation (sensitisation) caused by welding.

Weld annealing is only required where the material is for use in high stress environments. 316L has an extensive variety of uses especially in highly corrosive applications.

## Benefits of using Type 316L Stainless Steel

- Low carbon content eliminates carbon precipitation in the welding process
- Can be used in severe corrosive environments
- Improved anti-corrosion scope due to added molybdenum
- Very similar to Grade 316 in chemical composition and mechanical properties

316 & 316L valves have common properties and are often manufactured by Australian Pipeline Valve with dual certification, where it is determined that both have properties and composition which comply with both steel types.

*The below tables are correct as per ASTM A182/A182M-13*

## Chemical Composition

Grade	C (Max)	Si (Max)	Mn (Max)	P (Max)	S (Max)	Cr	Mo	Ni	N (Max)
316L	0.030	1.00	2.00	0.045	0.030	16.00/18.00	2.00/3.00	10.00/15.00	0.10
316	0.080	1.00	2.00	0.045	0.030	16.00/18.00	2.00/3.00	10.00/14.00	0.10

## Mechanical Properties

Grade	Yield Strength	Tensile Strength	Elongation (%)	Reduction of Area (%)	Hardness Max	
	Min (Mpa)	Min (Mpa)	Min	Min (50mm)	HB	HRB
316L	170	485	30	50	217*	95*
316	205	515	30	50	217*	95*

*\* Maximum hardness not specified in A182/A182M-13*

## Equivalent Standards/ Specifications

The following standards may be utilised for valve & trim components in valve construction:-

### ASTM

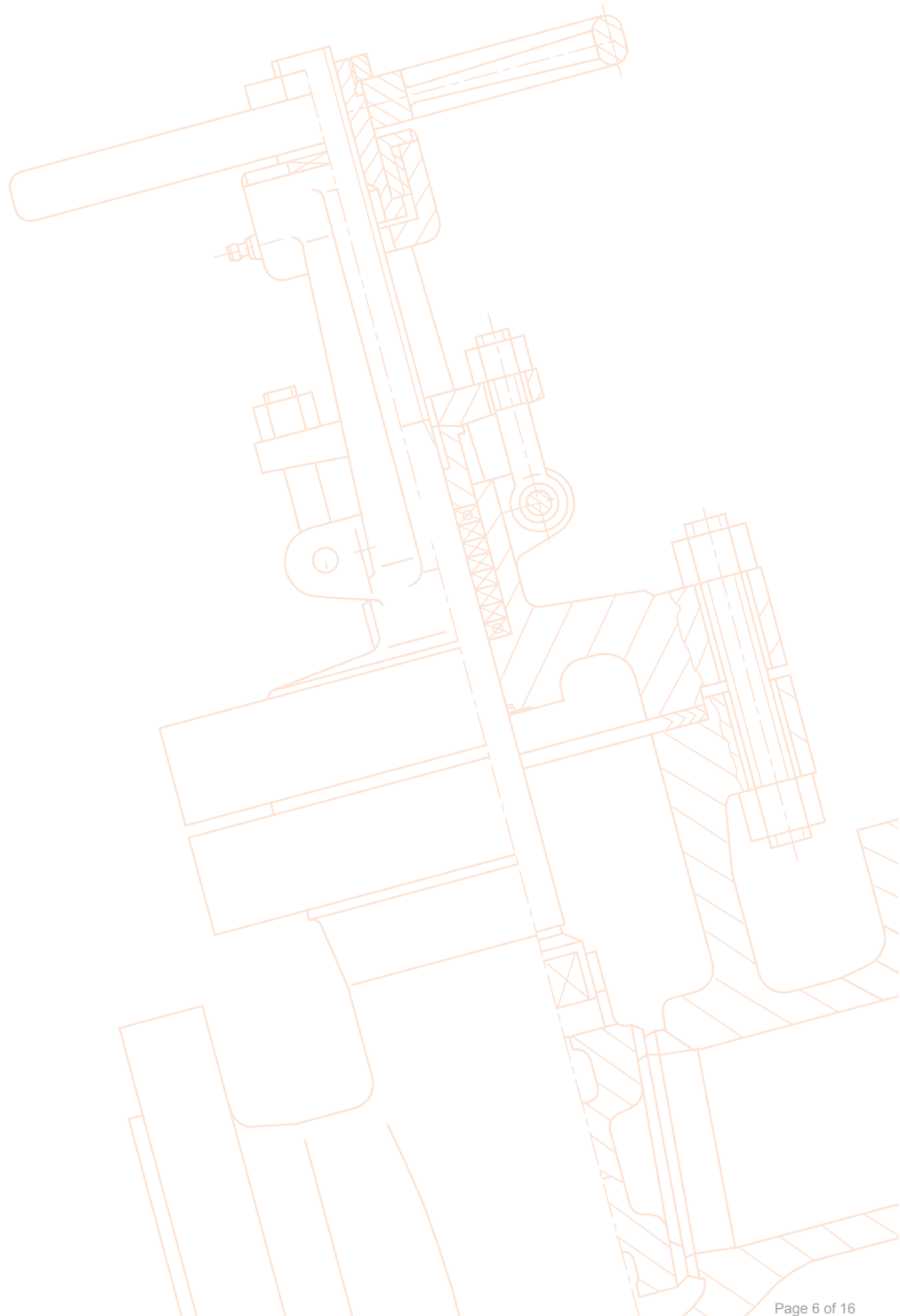
A312, A376, A358, A269, A249, A403, A182, A351

### ASME

SA312, SA376, SA358, SA269, SA249, SA403, SA182, SA351

# Applications

FORGING SPECIFICATION	COMMON DESIGNATION	MATERIAL SUFFIX	WROUGHT BAR SPECIFICATION	SERVICE RECOMMENDATIONS (1)	COMMON API TRIM # FOR BASE MATERIAL	
					150 TO 600 #	900 TO 2500 #
ASTM A182 F316	18% Chrome; 12% Nickel; 2% Mo; 0.08% C Stainless Steel	ASTM A351 Grade CF8M	ASTM A479 316	Corrosive or either extremely low or high temperature non-corrosive services between -450°F (-268°C) and +1200°F (+649°C). Above +800°F (+425°C) specify carbon content of 0.04% or greater.	10, 12	12, 16
ASTM A182 F316L	18% Chrome; 12% Nickel; 2% Mo; 0.03% C Low Carbon Stainless Steel	ASTM A351 Grade CF3M	ASTM A479 316L	Acetic acid, calcium carbonate, calcium lactate, potable water, sea water, steam, sulfites.	316L+HFS	316L+HF
ASTM A182 F316H	18% Chrome; 8% Nickel; 2% Mo; 0.08% C Stainless Steel	ASTM A351 Grade CF10M	ASTM A479 316H	Corrosive or extremely high temperature non-corrosive services between -450°F (-268°C) and +1200°F (+649°C). Above +800°F (+425°C) specify carbon content of 0.04% or greater.	310H+HFS	310H+HF



## DUPLEX STAINLESS VALVES (F51/F53/F55/S31803/2205/CD3MN/CE3MN)

Australian Pipeline Valve manufactures valves in duplex stainless steel materials such as forged ASTM A182-F51 cast A351-CD3MN and ASTM A351 CE8MN/CD4MCuN. Other grades are exotic and special stainless steels such as Super Duplex forged A182 F53 and A182 F55 (Zeron 100) and it's cast equivalent A995 Grade 6A (CD3MWCuN) and A182 F44 and it's cast equivalent A351 CK3MCuN are available upon request. Duplex A182-F51 is equivalent to:- UNS31803† and DIN 1.4462 and it is similar to:- 329LN, SAF2205, Uranus 45N.

### F51/2205/CD3MN DUPLEX STEEL

Duplex stainless is a mixed microstructure of austenitic and ferrite (50/50) which has improved strength over ferritic and austenitic steel grades with similar corrosion resistance qualities.

### Benefits of using Duplex Stainless Steel

- Similar corrosion resistance to Type 316
- Greater tensile and yield strength
- Good ductility and toughness
- Good stress corrosion cracking resistance (SSC)

Duplex stainless steel is designed to combine improved resistance to stress corrosion cracking (including sulfide stress corrosion cracking), pitting, crevice corrosion and high strength when compared with other stainless alloys. This alloy resists chloride environments and sulfide stress corrosion. It is also roughly double the strength of standard austenitic stainless steels.

### Applications

- Petrochemical
- Desalination plants
- Chemical processing and transportation
- Chloride-handling industries
- Valve stems

### Metallurgical Chemical Composition

UNS S31803/A182 F51/1.4462								
C	Cr	Mn	Mo	N	Ni	P	S	Si
0.030	21.0-	2.00	2.50-	0.08-	4.50-	0.030	0.020	1.00
max	23.0	max	3.50	0.20	6.50	max	max	max

Correct as per A182/A182M-13. Based on A182 F51 (UNS31803 is equivalent).

UNS S32205								
C	Cr	Mn	Mo	N	Ni	P	S	Si
0.030	22.0-	2.00	3.00-	0.14-	4.50-	0.030	0.020	1.00
max	23.0	max	3.50	0.20	6.50	max	max	max

### Metallurgical Mechanical Properties A182 F51

Yield Strength	Tensile Strength	Elongation (Min)	Reduction of Area (50mm)	Charpy Impact @ Rt J	Hardness HB
>450 Mpa (65KSI)	>620 Mpa (90KSI)	25%	45%	100*	270HB* Max

Correct as per ASTM A182/A182M-13. (UNS31803 is similar but slightly different).

\* Not shown in ASTM A182/A182M-13

PREn = Pitting Resistance Equivalent

PREn = Cr% + 3.3Mo% + 16N%

## Applicable Standards

As well as ASTM A182 and A351 other standards such as ASTM A240, A789 and A790 also cover Duplex grades of valve bodies and trim materials.

Trade Name	UNS	Industry Specifications
SAF 2205	UNS S31803*	<b>ASME</b> SA-182 (F51), SA-240, SA-798, SA-790, SA-815 <b>ASTM</b> A240, A276, A479, A789, A790, A815, A923, A928, A988 <b>SAE</b> J405
SAF 2205	UNS S32205	<b>ASTM</b> A240, A240M, A276, A479, A480, A480M, A798, A7901, A815, A923, A928, A988 <b>SAE</b> J40

\* UNS31803 has been supplemented by S32205 (F60).

## General Duplex Stainless Steel Information

2205 is the most widely used duplex (ferritic/austenitic) stainless steel grade. It finds applications due to both excellent corrosion resistance and high strength. The standard duplex S31803 (A182 F51) composition has been refined over many years, and the resulting composition range was endorsed as UNS S32205 in 1996. Duplex S32205 provides excellent guaranteed corrosion resistance, but it should be noted much of the Duplex S31803 currently produced also dual conforms with Duplex S32205. 2205 is not generally suitable for use at temperatures above 300°C as it suffers from precipitation of brittle micro-constituents, nor below -50°C because of its ductile-to-brittle-transition.

## Equivalent Grades

GRADE	A990-1A*	A990/A995-1B	A990-1C*	A990/A995-2A*	A990/A995-3A*	A990/A995-4A*	A990/A995-5A*	A990/A995-6A	A990/A995-7A	
Type	25Cr5NiMoCu	25Cr5Ni2Mo3Cu	25Cr6NiMoCuN	24Cr10Ni4MoV	25Cr5NiMoV	22Cr5Ni3MoN	25Cr7Ni4MoN	25Cr7Ni3.5MoWcb	27Cr7Ni-Mo-W-N	25Cr7Ni3.5MoWcb
UNS No.	J93370	J93372	J93373	J93345	J93371	S31803/S32205†	S32750	S32760		S31254
ASTM No.	A351-CD4MCuN	A995-1B	A351-CD3MCuN*	A351-CE8MN/CD3MCuN	A351-CD6MN*	A351-CD3MN	A351-CE3MN*	A995-CD3MWCuN-6A	A351-CD3MWN	A351-CK3MCuN
Forged Equiv.	A182-F50*		F61*			A182-F51	A182-F53	A182-F55	(Zeron 100™)	A182-F44
Common Name	Duplex	Duplex	Duplex	Duplex	Duplex	Duplex 2205	Super Duplex 32750	Super Duplex	Super Austenitic/Duplex	Super Duplex
European (DIN)						1.4462	1.4410	1.4501	UNS J93379	

† S31803 has been supplemented by S32205 which has a higher minimum N, CR and Mo.

\* Not referenced in ASME B16.34 - 2009.

## Applications

FORGING SPECIFICATION	COMMON DESIGNATION	MATERIAL SUFFIX	WROUGHT BAR SPECIFICATION	SERVICE RECOMMENDATIONS (1)
ASTM A182 F44	20% Chrome; 18% Nickel; 6% Mo; 0.25% C Super Stainless Steel	ASTM A351 Grade CK3MCuN Super Austenitic	ASTM A479 S31254	(2.54 SMO) Acetic acid, antibiotics and drugs, bleaching compounds, formic acid, fruit and juices, hot air, hot water, hydrocarbons, hydrochloric acid, organic liquids and acids, nitric acid, organic salts, oxalic acid, phosphoric acid, sea water, sewage, sodium bisulfite, steam, sulfamic acid, 10% sulfuric acid.
	25.5% Chrome; 5.5% Nickel; 2% Mo; 0.040% C Super Stainless Steel	ASTM A351 Grade CD4MCu	ASTM A479 S32550	Concentrate brine, fatty acids, potable water, pulp water, pulp liquors at 220°F (104°C), sea water, steam, sulfuric acid (15-30% @ 140-160°F (60-71°C), sulfuric acid (35-40% @ 185°F (85°C), plus 5% organics).
	24% Chrome; 9.5% Nickel; 4% Mo; 0.080% C Duplex Stainless Steel	ASTM A351 Grade CE8MN		Concentrate brine, fatty acids, potable water, pulp water, pulp liquors at 220°F (104°C), sea water, steam, sulfuric acid (15-30% @ 140-160°F (60-71°C), sulfuric acid (35-40% @ 185°F (85°C), plus 5% organics).
ASTM A182 F51	22% Chrome; 5% Nickel; 3% Mo; N; 0.030% C Duplex Stainless Steel	ASTM A351 Grade CD3MN	ASTM A479 31803	Concentrate brine, fatty acids, potable water, pulp water, pulp liquors at 220°F (104°C), sea water, steam, sulfuric acid (15-30% @ 140-160°F (60-71°C), sulfuric acid (35-40% @ 185°F (85°C), plus 5% organics).
ASTM A182 F53	25% Chrome; 7% Nickel; 4.5% Mo; N; 0.030% C Duplex Stainless Steel Grade 5A	ASTM A995 Grade CE3MN		Concentrate brine, fatty acids, potable water, pulp water, pulp liquors at 220°F (104°C), sea water, steam, sulfuric acid (15-30% @ 140-160°F (60-71°C), sulfuric acid (35-40% @ 185°F (85°C), plus 5% organics). Useful where the Pitting Resistance Number (PREN) is required.
	25% Chrome; 7.5% Nickel; 3.5% Mo; N; 0.030% C Duplex Stainless Steel Grade 6A	ASTM A995 Grade CD3MWCuN 6A		Concentrate brine, fatty acids, potable water, pulp water, pulp liquors at 220°F (104°C), sea water, steam, sulfuric acid (15-30% @ 140-160°F (60-71°C), sulfuric acid (35-40% @ 185°F (85°C), plus 5% organics). Useful where the Pitting Resistance Number (PREN) is required.



## SPECIALITY ALLOY VALVES A20/MONEL

Forged Alloy 20 (ASTM A182 F20) and its cast equivalent A351 CN7M is a speciality grade of Austenitic Stainless steel often referred to as 'super' stainless steels. Forged Monel 400 (UNS N14400) and its cast equivalent A494 M35-1 are Nickel Copper Alloy Steels as is Monel K500. Australian Pipeline Valve can also manufacture valves in other Nickel Alloys such as 600, 625, and 825. We can also manufacture other material grades of valves like hastelloy, titanium, etc.

### ALLOY 20 (A20)

Alloy 20 resists acid, general pitting attack, and chloride stress corrosion cracking. Ideal for fabrication and possessing exceptional mechanical capabilities. Alloy 20 can be welded with minimal carbide precipitation due to the inclusion of columbium. Alloy 20 is widely accepted for uses as diverse as chemical pharmaceutical processing, food, petrochemical and gasoline, solvents, plastics, synthetics, and explosives. Cast Alloy 20 grade A351-CN7M is suitable for service -46°C to 150°C. 'New Alloy 20' cast grade A990-CN3MCu is suitable for -29°C to 320°C. Forged Alloy 20 ASTM A182-F20 and B462 Grade N08062 (35Ni-35Fe-20Cr-Cb) is suitable up to 316°C.

### Design Features

- Exceptional stress-corrosion resistance in boiling 20% to 40% sulfuric acid
- Sulfuric acid general corrosion resistance
- Ideal fabricability and mechanical characteristics
- Welding products minimal carbide precipitation

### Applications

- Chemical and allied industries
- Pharmaceutical processing
- Food and dye
- Sulfur dioxide (SO<sub>2</sub>) scrubbers
- Pickling racks
- Tanks
- Severe environments

### Alloy 20 Chemical Composition

C	Cb	Cr	Cu	Mn	Mo	Ni	P	S	Si	Ta
MAX	8 Times			MAX			MAX	MAX	MAX	8 Times
0.070	Carbon-1.00	19.0-21.0	3.0-4.0	2.0	2.0-3.0	32.0-38.0	0.045	0.035	1.0	Carbon-1.00

### MONEL

Monels are a Nickel alloy material with the addition of copper (Cu), Silicon (Si) and Manganese (Mn). These materials are also known as Monel, Alloy 400 and Alloy K500.

### ASTM A296 gr. M-35 Monel (Monel 400) Chemical Composition

C	Cb	Cr	Cu	Mn	Mo	Ni	P	S	Si	Ta
MAX	8 Times			MAX			MAX	MAX	MAX	8 Times
0.070	Carbon-1.00	19.0-21.0	3.0-4.0	2.0	2.0-3.0	32.0-38.0	0.045	0.035	1.0	Carbon-1.00

## Common Material Specifications

### Ni Cu30 Fe3.5 Si1.5(+) (Monel 400)

- A494 M-35-1 (UNS N24135) (Low Si - weldable)
- A494 M-35-2 (UNS N04020)
- BS3071 : NA1
- BS3071 : NA3

### Others

- Wrought equivalent Alloy 400 (UNS N04400)

### Typical Properties

- Tensile 430 N/mm<sup>2</sup>
- Yield 170-205 N/mm<sup>2</sup>
- Elongation 20-25%
- Hardness HB 100-150
- Density 8.8 g/cm<sup>3</sup>
- Pressure temperature rating: B16.34 Group 3.4

### Corrosion Properties

- Good general corrosion for seawater service
- Especially good for higher flow rates
- Excellent trim material for NAB, gains cathodic protection with many alloys
- Not recommended for low velocities

### Additional Uses

- Variety of wrought/ bar specifications available, good for trim material. Excellent strength from K500
- Used for oxygen service
- Welded with lower Si content
- Excellent for hydrofluoric & other acids (not nitric)

### Cautions

- Ease of manufacture: trade-off between castability and weldability
- Pitting can be a problem at low velocities
- Don't use as trim for austenitic stainless

### Applications

FORGING SPECIFICATION	COMMON DESIGNATION	MATERIAL SUFFIX	WROUGHT BAR SPECIFICATION	SERVICE RECOMMENDATIONS (1)	COMMON API TRIM # FOR BASE MATERIAL	
					150 TO 600 #	900 TO 2500 #
ASTM B462 N08367	19% Chrome; 28% Nickel; Cu-Mo; 0.07% C Super Stainless Steel	ASTM A351 Grade CN7M (A20)	ASTM B473 N08020	Acetic acid (hot), brines, caustic solutions, (strong, hot), hydrochloric acid (dilute), hydrofluoric acid and hydrofluosilicic acid (dilute), nitric acid, (strong, hot), nitric-hydrofluoric pickling acids, sulfates and sulfites, sulfuric acid, all concentrations to 150°F (65.5°C), sulfuric acid, phosphoric acid.	13	14
ASTM B462 N08020	19% Chrome; 28% Nickel; Cu-Mo; 0.03% C Super Stainless Steel	ASTM A351 Grade CN3MN	ASTM B473 N08020	Acetic acid (hot), brines, caustic solutions, (strong, hot), hydrochloric acid (dilute), hydrofluoric acid and hydrofluosilicic acid (dilute), nitric acid, (strong, hot), nitric-hydrofluoric pickling acids, sulfates and sulfites, sulfuric acid, all concentrations to 150°F (65.5°C), sulfuric acid, phosphoric acid. Better weldability properties than CN7M.	13	14
ASTM B564 N04400	67% Ni; 30% Cu, Monel	ASTM A494 Grade M-35-1 (Monel)	ASTM B164 N04400	Weldable grade. Good resistance to corrosion by all common organic acids and salt water. Also high resistant to most alkaline solutions to +752°F (+400°C).	9, 11	9, 11

## LOW TEMPERATURE CARBON STEEL VALVES LCC/LCB/LF2

Australian Pipeline Valve manufactures a large range of carbon steel valves in low temperature carbon steel such as forged ASTM A350 LF2 and it's cast equivalent ASTM A352 LCB. Higher grades such as ASTM A352 LCC and Alloy (Nickel) based forged carbon steel A350-LF3 and it's cast equivalent A352-LC3 are also available on an indent basis. LF2 and LCB low temperature carbon steels are suitable for continuous service down to -46°C, up to 345°C. However alloy - Nickel based carbon steels like LCB, LF3, etc. are rated to lower temperatures (see below table). For cryogenic service colder than these temperatures austenitic stainless grades such as 304, 316 (CF8, CF8M) are required. Grades A352-LC4 and LC9 are no longer referenced in ASME B16.34 - 2009.

### Low Temperature Steel Types

Steel Type	Grade (forging)	Grade (cast)	Composition	Min Temperature
Austenitic	A182, F316	A351 CF8M	18Cr, 8Ni, 2Mo	-196°C
Nickel Based Steel	A350 LF3	A352 LC3	3 1/2 Ni	-101°C
Nickel Based Steel	NO EQUIV	A352 LC2	2 1/2 Ni	-73°C
Low Temp Carbon Steel	NO EQUIV	A352 LC1	0.5Mo	-59°C
Low Temp Carbon Steel	A350 LF2	A352 LCB	Carbon Steel	-46°C

### Applications

Other than temperature capabilities, LF2 and LCB are suitable for the same standard service applications as outlined at this website for A105 and WCB such as steam, hydrocarbons and general industrial services. The main difference between LF2/ LCB and A105/WCB is that LF2/LCB is Charpy impact tested at -46°C for this reason.

### Carbon Steel Grades

Material Group	Common Name	Material Type	UNS	Forging Spec.	Casting Spec. Equivalent	DIN	Din W No.	Application
Carbon Steel	CS	C-Mn-Fe	K03504	A105N	A216-WCB	C22.8 DIN 17243	1.0460	General non-corrosive service from -29°C (-20°F) to 427°C (800°F)
Low Temperature Carbon Steel	LTCS	C-Mn-Fe	K03011	A350-LF2	A352-LCB A352-LCC	TSTE 355 DIN 18103	1.0566	General non-corrosive service from -46°C (-50°F) to 340°C (650°F), LF2 -46°C ~ 427°C
Low Temperature Alloy Steel	Nickel Steel	3.1/2Ni	K32025	A350-LF3	A352-LC3	10Ni14	1.5637	-101°C (150°F) to 340°C (650°F)

## ASTM Carbon Steel Types Key Chemical Properties

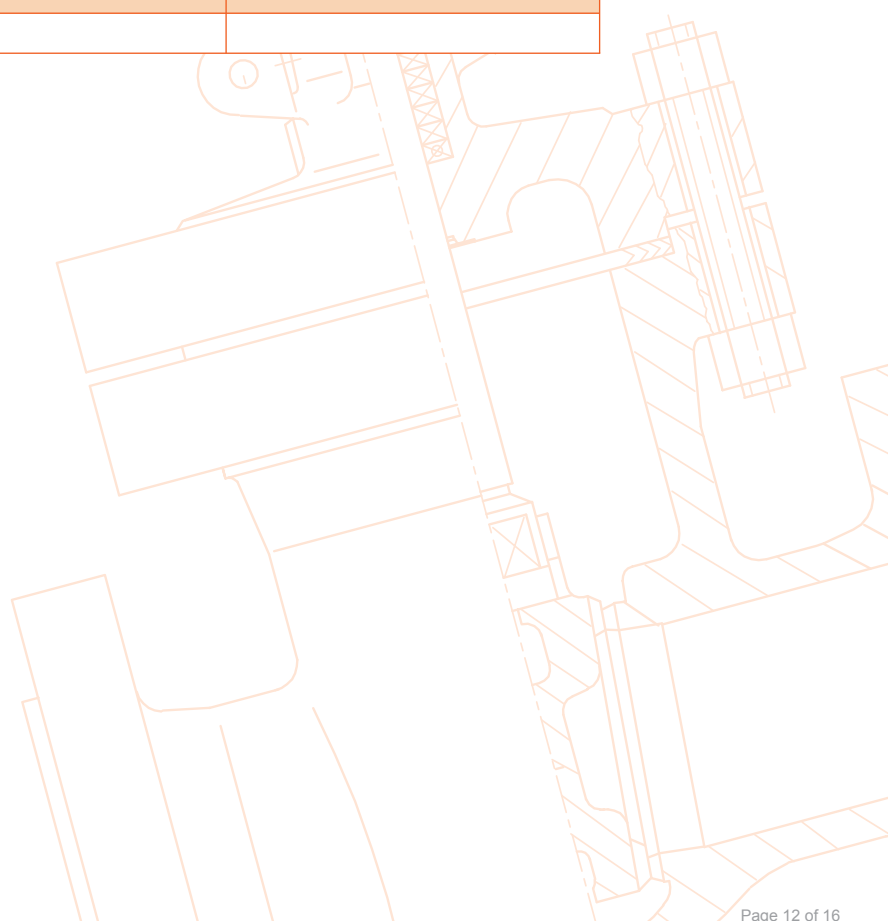
KEY PHYSICAL PROPERTIES	CAST	FORGED
<b>CARBON STEEL</b>		
0.30/0.35 MAX C	A216-WCB	A105
0.25/0.35 MAX C	A216-WCC	A105N
<b>LOW TEMPERATURE STEEL</b>		
0.25/0.30 MAX C	A352-LCB	A350-LF2
0.5 Mo	A352-LC1	
2.5 Ni	A352-LC2	
3.5 Ni	A352-LC3	A350-LF3
C-MN-Si-V (0.25 Max)	A352-LCC	
C-Mn-Si-N (1.15~1.50 Mn)		A350-LF6

## Chemical & Mechanical Composition A350-LF2†

CHEMICAL PROPERTIES	MECHANICAL PROPERTIES	
C 0.30 Max	TS Min psi (Mpa)	70,000 (485)
Mn 0.60 - 1.35	YS Min psi (Mpa)	36,000 (250)
Si 0.15 - 0.30	EL (2" Min)	22%
P .035 Max	RA Min	30%
S 0.040 Max	Hardness, Bhn	Max 197
Cr 0.30 Max	-50°F Charpy	Min Impact
Ni 0.40 Max	<i>Energy Ft/Lb (J):-</i>	
Mo 0.12 Max	Set of 3 Specimen*	15 (20)
V 0.08 Max	For One Specimen	12 (16)
Cb 0.02 Max		
Cu 0.40 Max		
Pb 0.02 Max		
Total Residuals = 0.50		

\* Average

† ASTM A350/A350M - 2012



## CARBON STEEL VALVES WCB/WCC/A105

Carbon steel valves are manufactured in forged ASTM A105 and its cast equivalent ASTM/A216-WCB. The European/DIN equivalent is C22.8 DIN17243 (1.0460). ASTM A216-WCC is also available. ASTM A216 WCC has a slightly higher pressure/ temperature rating than A216 WCB as it has a higher yield strength and a slightly higher manganese content. A216 LCC is basically the same as A216 WCC except it is charpies impact tested at -46°C for low temperature service. Refer to low temperature carbon steel overview previous page. A105 and WCB are for non corrosive service applications from -29°C (-20°F) to 427°C (800°F) for petrochemicals, gas, water, steam and general industrial applications. For H<sub>2</sub>S Sour Service, Australian Pipeline Valve manufactures carbon steel valves fully conforming to NACE MR0175/ISO 15156. This is specified for petroleum, natural gas and geothermal production services containing small amounts of H<sub>2</sub>S. For higher percentages of H<sub>2</sub>S, Australian Pipeline Valve also manufactures upstream wellhead, corrosion resistant, alloy valves and chokes manufactured in chrome-moly 4140 and 4130 that resists sulfide stress corrosion and hydrogen embrittlement cracking. A105 and WCB are compatible with A234 WPB fittings, and ASTM A106/API5LB line pipe.

### Chemical Composition A105/WCB/WCC/LF2

ELEMENT & PROPERTIES	ASTM A105	ASTM A216		ASTM A350
		Gr. WCB	Gr. WCC	LF2
CARBON MAX	0.35	0.30	0.25	0.30
MANGANESE	0.60 - 1.05	1.00 MAX	1.20 MAX	0.60 - 1.35
PHOSPHORUS MAX	0.035	0.04	0.04	0.035
SULFUR MAX	0.040	0.05	0.05	0.040
SILICON	0.10 - 0.35	0.6 MAX	0.60 MAX	0.15 - 0.30
NICKEL MAX	0.40 <sup>A</sup>	0.5	0.50	0.40 <sup>A</sup>
CHROMIUM MAX	0.30 <sup>A,B</sup>	0.5	0.50	0.30 <sup>A,B</sup>
MOLYBDENUM MAX	0.12 <sup>A,B</sup>	0.2	0.20	0.12 <sup>A,B</sup>
COPPER MAX	0.40 <sup>A</sup>	0.3	0.30	0.40 <sup>A</sup>
COLUMBIUM MAX	0.02	-	-	0.02 <sup>D</sup>
VANADIUM MAX	0.08	0.03	0.03	0.05
TENSILE STRENGTH PSI	70 000 MIN	70 000 - 95 000	70 000 MIN	70 000 - 95 000
YIELD STRENGTH PSI MIN	36 000	36 000	40 000	36 000
ELONGATION 2" % MIN	22	22	22	22
REDUCTION AREA % MIN	30	35	35	30
HARDNESS† (HB) MAX	187	185	185	197

The above table for A105 & LF2 is as per ASTM A350/A350M - 2012 for LF2 and A105/A105M-12.

† NACE MR-01-75 specifies 237 maximum brinell hardness. For LF2 refer ASTM A961/961M

<sup>A</sup> The sum of copper, nickel, chromium, molybdenum and vanadium shall not exceed 1.00%. <sup>B</sup> The sum of chromium and molybdenum shall not exceed 0.32%.

<sup>D</sup> By agreement, the limit for columbium may be increased up to 0.05% on heat analysis and 0.06% on product analysis.

### Carbon Steel Grades

Material Group	Common Name	Material Type	UNS	Forging Spec.	Casting ASTM Equivalent	DIN	Din W No.	Application
Carbon Steel	CS	C-Si	K03504	A105	A216-WCB	C22.8 DIN 17243	1.0460	General non-corrosive service from -29°C (-20°F) to 425°C (800°F)
Carbon Steel	CS	C-MN-Si		A105N	A216-WCC			General non-corrosive service from -29°C (-50°F) to 425°C (800°F). Slightly higher pressure ratings than WCB

## CHROME MOLY/ALLOY/STEEL VALVES F11/F22/F5

Australian Pipeline Valve manufactures a large range of ‘chrome-moly’ valves. These valves are manufactured from low alloy steel containing chromium and molybdenum making them suitable for higher temperature service especially for higher pressure and temperature combinations. In addition, these valves have the added advantage of anti-corrosive properties. Grades include forged ASTM A182 F5, F5a, F9, F11 and F22, and their cast equivalents ASTM A217 C5, C12, WC5, WC6 and WC9. Higher grades like A112 F9/ASTM A217 C12A are available on an indent basis.

### Description

Chrome moly alloy is lightweight but strong, (similar to AISI 4130). With the additions of molybdenum and chromium, chrome moly alloy offers exceptional weldability along with oxidation and scaling resistance.

### Design Features

- Resistant to scaling and oxidation
- Harden through heat treatment
- Excellent weldability
- Strong and tough
- Excellent ductility

### Applications

- Pressure piping
- Pressure vessels
- Welded tubing applications

### Chemical Composition & Mechanical Properties ASTM A182†

ELEMENT & PROPERTIES	LOW ALLOY STEEL		MEDIUM ALLOY STEEL	
	F11 CL2	F22 CL3	F5	F9
CARBON	0.10-0.20	0.05-.015	0.15 MAX	0.15 MAX
MANGANESE	0.30-0.80	0.30-0.60	0.30-0.60	0.30-0.60
PHOSPHORUS MAX	0.040	0.040	0.03	0.030
SULFUR MAX	0.040	0.040	0.03	0.030
SILICON	0.50-1.00	0.50 MAX	0.50 MAX	0.50-1.00
NICKEL MAX	-	-	0.50	-
CHROMIUM	1.00-1.50	2.00-2.50	4.00-6.00	8.0-10.0
MOLYBDENUM	0.44-0.65	0.87-1.13	0.44-0.65	0.90-1.10
COPPER MAX	-	-	-	-
COLUMBIUM MAX	-	-	-	-
VANADIUM MAX	-	-	-	-
TENSILE STRENGTH PSI	70,000 (485)	75,000 (515)	70,000 (485)	85,000 (585)
YIELD STRENGTH PSI MIN	40,000 (275)	45,000 (310)	40,000 (275)	55,000 (380)
ELONGATION 2" % MIN	20	20	20	20
REDUCTION AREA % MIN	30	30	35	40
HARDNESS (HB) MAX*	143 ~ 207	156 ~ 207	143 ~ 217	179 ~ 217

† A182/A182M-13

\* NACE MR-01-75 specifies 237 maximum brinell hardness.

## Equivalent Grades & Applications

Material Group	Common Name	Type	UNS	Forging Spec.	Casting Spec. Equivalent	DIN	DIN W No.	Application
Low Alloy Steel	Moly Steel	C-1/2Mo	K12822	A182-F1 cl 1	A217-WC1	15M03	1.5415	Up to 470°C (875°F)
	Alloy Steel Chrome Moly	1.1/4Cr-1/2Mo-Si	K11572	A182-F11 cl 2	A217-WC6	13CRM044	1.7335	Up to 593°C (1100°F)
		2.1/4Cr-1Mo	K21590	A182-F22 cl 3	A217-WC9	10CRM0910	1.7380	Up to 593°C (1100°F), HP steam
		5Cr-1/2Mo	K41545	A182-F5a/F5	A217-C5	12CRMO195	1.7362	High temp. refinery service
		9Cr-1Mo	K90941	A182-F9	A27-C12	X 12 CrMo 9 1	1.7386	High temp. erosive refinery service
		9Cr-1Mo-V		A182-F91	A217-C12A	X 10 CrMoVNb 9 1	1.4903	High pressure steam

## Applications

FORGING SPECIFICATION	COMMON DESIGNATION	MATERIAL SUFFIX	WROUGHT BAR SPECIFICATION	SERVICE RECOMMENDATIONS	COMMON API TRIM # THIS BASE MATERIAL	
					150 TO 600 #	900 TO 2500 #
A182 F1	C-1/2 Mo Low Alloy Steel	ASTM A217 Grade WC1	A182 F1 Class 1	Non-corrosive applications including water, oil and gases at temperatures between -24°C (-20°F) and +593°C (1100°F).	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F2	0.75% Ni; Mo; 0.75% Cr Low Alloy Steel	ASTM A217 Grade WC5	A182 F2	Non-corrosive applications including water, oil and gases at temperatures WC5:- -29°C ~ 575°C, F2:- -29°C ~ 538°C. Not for prolonged use >470°C.	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F11	1 1/4% Chrome; 1/2% Moly Low Alloy Steel	ASTM A217 Grade WC6	A182 F11 Class 2	Non-corrosive applications including water, oil and gases at temperatures WC5:- -29°C ~ 575°C, F2:- -29°C ~ 538°C.	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F22	2 1/4% Chrome Low Alloy Steel	ASTM A217 Grade WC9	A182 F22 Class 3	Non-corrosive applications including water, oil and gases at temperatures between -30°C (-20°F) and +593°C (+1100°F).	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F5a/F5	5% Chrome; 1/2% Moly, Medium Alloy Steel	ASTM A217 Grade C5	A182 F5a/F5	Mild corrosive or erosive applications as well as non-corrosive applications at temperatures between -30°C (-20°F) and +650°C (+1200°F).	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F9	9% Chrome; 1% Moly, Medium Alloy Steel	ASTM A217 Grade C12	A182 F9	Mild corrosive or erosive applications as well as non-corrosive applications at temperatures between -30°C (-20°F) and +650°C (+1200°F).	8, 8A, 10, 12, 12A	5, 5A, 12, 12A
A182 F91	9% Chrome; 1% Moly; V-N, Medium Alloy Steel	ASTM A217 Grade C12-A	A182 F91	Mild corrosive or erosive applications as well as non-corrosive applications at temperatures between -30°C (-20°F) and +650°C (+1200°F).	8, 8A, 10, 12, 12A	5, 5A, 12, 12A



*For peace of mind, Australian Pipeline Valve have full in-house PMI facilities for Alloy grade verification.*

The information in this publication is a rough guide and should not be used for specifying the use of valves. Always consult latest relevant ASME and API publications.

We can manufacture exotic grades like Nickel, Super Duplex F55 and Monel (ASTM A494-M35-1), Cd4M-Cu, Hastelloy C (ASTM A-494 CW12MW), 317 (C8G8M) in short lead-time.

For other ANSI, ASME, ISO, API, BS, API valve related technical cross reference charts and tables relating to standards, codes, pressure, temperature, application, suitability, equivalents, body & trim materials, valve manufacturing & test standards, etc., go to the technical section of our website: <http://www.australianpipelinevalve.com.au>

We manufacture valves in API600, API602, API6D, BS1868, API603, API6A and numerous other standards including Ball, Butterfly, Check, Gate, Globe, Needle and Plug valves.

# PRODUCTS MANUFACTURED BY AUSTRALIAN PIPELINE VALVE

## Gate Valves

- API 603 & 600 150# - 2500#
- API 602 & ANSI B16.34 800#, 1500#, 2500#, 2690#

## Globe Valves

- ANSI B16.34 & BS1873 150# - 2690#
- API 602 & BS5352 & ANSI B16.34 800#, 1500#, 2500#

## Check Valves

- ANSI B16.34
- API 602 & BS5352 & ANSI B16.34 800#, 1500#, 2500#, 2690#

## Ball Valves

- ANSI Class 150# - 2500#

## Multi-way Ball Valve

- 3 Way
- 4 Way

## Wafer Check Valves

- Dual & Single flap
- ANSI Class 150# - 2500#

## Strainers (Y) Pattern & Basket

- ANSI Class 150# - 2690#

## CROSS REFERENCE CHARTS & VALVE MATERIAL REFERENCES

For technical references and ASTM/ANSI cross reference information on stainless, duplex, chrome-moly and Alloy steel used in valves & piping systems in the petrochemical and refining  
Go to our website: <http://www.australianpipelinevalve.com.au>

We can manufacture exotic grades like F55, Nickel, Super Duplex F55 and Monel (ASTM A494 M35-1) Cd4M-Cu, Hastelloy C (ASTM A-494 CW12MW), 317 (C8G8M) in short lead time.

*Major stockist and master distributors:- Global Supply Line Pty Ltd. Global Supply Line will provide a quotation or arrange for your Local Australian Pipeline Valve agent to contact you. You can also view catalogues and stocklists of Australian Pipeline Valves by going to the following website:- <http://australianpipelinevalve.com.au>*

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