

PIPING REFERENCE HANDBOOK.

Pipe, fittings, flanges, valves, gaskets and bolting — dimensions, ratings, materials and inspection points for process-plant piping.

ASME B31.3 · B16.5 · B16.9 · API 6D / 600 / 602 · NACE MR0175 · EN 10204

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A working reference for engineers and buyers preparing RFQs, checking MTOs or verifying offers for piping packages.

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Anatomy of a piping package.

A process line is a system: every component has to agree on material, pressure class, connection type and test requirement. Mismatches at any interface are the most common cause of rejected deliveries.



FLANGED LINE WITH GATE VALVE, STUDS AND GASKETS

PIPE

Carries the fluid. Defined by NPS, schedule / wall thickness, grade, manufacturing route (seamless, ERW, SAW) and end preparation.

FITTINGS

Change direction or size and split flow: elbows, tees, reducers, caps, stub ends, couplings, olets.

FLANGES

Detachable joints for equipment, valves and spool connection, defined by type, class, facing and bore.

VALVES

Isolate, regulate, prevent back-flow or relieve pressure. Defined by type, class, body / trim and standard.

GASKETS

Seal the flange joint. Selected from the flange class, facing, fluid, temperature and seating stress.

BOLTING

Studs and nuts that load the gasket. Grade must suit temperature, sour service and the flange material.

THE LINE CLASS (PMS)

A piping material specification fixes, per service, the pipe schedule, fitting type, flange class and facing, valve body / trim, gasket, bolting, corrosion allowance and NDT. Everything in this handbook is organised so that you can build or verify a line class item by item.

Standards map — which code governs what.

Dimensions, materials and tests are usually governed by separate standards. Quote all three when raising an RFQ.

COMPONENT	DESIGN / DIMENSIONS	MATERIAL SPECIFICATION	TESTING & MARKING
Process piping	ASME B31.3 (design, fabrication, examination, testing)	Per PMS	B31.3 hydrotest ≥ 1.5 × design pressure
Pipe	ASME B36.10M (carbon / alloy), B36.19M (stainless); API 5L for line pipe	ASTM A106, A53, A333, A312, A335, A790; API 5L	ASTM A530 / A999 general requirements; hydrostatic / NDE per spec
Butt-weld fittings	ASME B16.9; MSS SP-75 (high-yield)	ASTM A234 WPB / WPC, A420 WPL6, A403 WP-S, A860	MSS SP-25 marking
Forged fittings	ASME B16.11 (SW / threaded, Class 3000 / 6000 / 9000)	ASTM A105, A182, A350	Hydro per B16.11 / MSS SP-79
Flanges	ASME B16.5 (NPS ½–24), B16.47 Series A / B (NPS 26–60)	ASTM A105, A350 LF2, A182 F-grades	MSS SP-25 marking; hardness for sour service
Gaskets	ASME B16.20 (metallic), B16.21 (non-metallic)	Winding / filler / ring materials per spec	Dimension and marking checks
Bolting	ASME B18.2.1 / B18.2.2 (heads, nuts)	ASTM A193 (studs), A194 (nuts), A320 (low-temp)	Grade stamped on stud and nut
Valves — steel	ASME B16.34 (ratings), B16.10 (face-to-face); API 600 / 602 / 603 / 608 / 609 / 6D	ASTM A216, A217, A351, A352, A105, A182	API 598 / ISO 5208 shell & seat tests; API 607 fire test
Sour service	NACE MR0175 / ISO 15156 (materials for H_2S environments)	Hardness ≤ 22 HRC (carbon steel, typical limit)	Hardness report with MTC
Certificates	EN 10204 (types 2.1, 2.2, 3.1, 3.2)	—	MTC / COC per PO

B31.3

Process piping

Governs chemical-plant and refinery piping: design conditions, allowable stress, fabrication and testing.

B16.X

Component standards

Each component family has its own ASME B16 sheet for dimensions and pressure–temperature rating.

API

Valve & line-pipe standards

API 6D, 600, 602, 608, 609 and 5L are the most common for oil, gas and petrochemical packages.

Values are nominal reference data compiled from the cited standards for quick selection and RFQ preparation. They do not replace the current edition of the standard, the project piping material specification (PMS) or the manufacturer's datasheet; always verify before ordering.

Pipe grades & mechanical properties.

Minimum specified properties for the pipe grades most frequently requested in oil, gas, petrochemical and power projects.

SPECIFICATION / GRADE	TYPE	MIN. YIELD (MPA)	MIN. TENSILE (MPA)	TYPICAL SERVICE & REMARKS
ASTM A106 Gr.B	Seamless carbon steel	240	415	High-temperature service; −29 to 427 °C normal use
ASTM A53 Gr.B	Seamless / ERW carbon steel	240	415	General process and utility lines, lower-criticality
API 5L Gr.B	Line pipe, SMLS / welded	241	414	Pipelines and plant piping (PSL 1 / PSL 2)
API 5L X52	Line pipe	359	455	Higher-strength transmission pipelines
API 5L X60	Line pipe	414	517	Gas and oil transmission
API 5L X65	Line pipe	448	531	High-pressure transmission lines
ASTM A333 Gr.6	Seamless / welded LTCS	240	415	Low-temperature service, impact tested to −46 °C
ASTM A335 P11	Seamless Cr-Mo alloy	205	415	1¼Cr–½Mo, elevated-temperature steam and process
ASTM A335 P22	Seamless Cr-Mo alloy	205	415	2¼Cr–1Mo, steam, hydrogen service
ASTM A335 P91	Seamless 9Cr-1Mo-V	415	585	Power-plant main steam, high-temperature, high-pressure
ASTM A312 TP304 / 304L	Austenitic stainless	205 / 170	515 / 485	General corrosion resistance, low-temperature
ASTM A312 TP316 / 316L	Austenitic stainless (Mo)	205 / 170	515 / 485	Chloride, acidic and marine media
		450		
		550		

SEAMLESS VS. WELDED

Seamless (SMLS) pipe is specified for high pressure, high temperature and critical service. ERW / SAW pipe has a longitudinal weld and carries a joint efficiency factor in B31.3 thickness calculations unless 100% examined.

WHAT TO STATE IN AN RFQ

Standard + grade + manufacturing route + NPS + schedule + ends (PE / BE / TBE) + length (SRL / DRL) + certificate type (EN 10204 3.1) + NDT / PMI + coating / marking.



HEAT NUMBER AND MARKING TRACEABLE TO THE MTC

Values are nominal reference data compiled from the cited standards for quick selection and RFQ preparation. They do not replace the current edition of the standard, the project piping material specification (PMS) or the manufacturer's datasheet; always verify before ordering.

Pipe dimensions: wall thickness by schedule.

Outside diameter and nominal wall thickness (mm) per ASME B36.10M (carbon and alloy steel). Schedule 40 equals STD and Schedule 80 equals XS up to NPS 10 and NPS 8 respectively; stainless pipe to B36.19M uses the S-schedules (5S, 10S, 40S, 80S).

NPS (IN)	DN	OD (MM)	SCH 10	SCH 40 / STD	SCH 80 / XS	SCH 160	XXS
½	15	21.3	2.11	2.77	3.73	4.78	7.47
¾	20	26.7	2.11	2.87	3.91	5.56	7.82
1	25	33.4	2.77	3.38	4.55	6.35	9.09
1½	40	48.3	2.77	3.68	5.08	7.14	10.15
2	50	60.3	2.77	3.91	5.54	8.74	11.07
3	80	88.9	3.05	5.49	7.62	11.13	15.24
4	100	114.3	3.05	6.02	8.56	13.49	17.12
6	150	168.3	3.40	7.11	10.97	18.26	21.95
8	200	219.1	3.76	8.18	12.70	23.01	22.23
10	250	273.1	4.19	9.27	15.09	28.58	25.40
12	300	323.9	4.57	10.31	17.48	33.32	25.40
14	350	355.6	6.35	11.13	19.05	35.71	—
16	400	406.4	6.35	12.70	21.44	40.49	—
18	450	457.2	6.35	14.27	23.83	45.24	—
20	500	508.0	6.35	15.09	26.19	50.01	—
24	600	609.6	6.35	17.48	30.96	59.54	—

NPS

Nominal Pipe Size

A designation, not a measurement: NPS 4 pipe has an outside diameter of 114.3 mm.

SCH

Schedule

Wall thickness index that rises with pressure capability; the same schedule gives different walls at different NPS.

TOL

Mill tolerance

Commonly −12.5% on wall for seamless pipe — included when calculating minimum required thickness.

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Pipe weights & water capacity.

Calculated plain-end mass of carbon-steel pipe (kg per metre, density 7 850 kg/m³) and internal volume at Schedule 40 — useful for freight planning, hydrotest water volume and support design.

NPS (IN)	DN	OD (MM)	SCH 40 KG/M	SCH 80 KG/M	SCH 160 KG/M	XXS KG/M	SCH 40 BORE L/M
½	15	21.3	1.27	1.62	1.95	2.55	0.20
¾	20	26.7	1.69	2.20	2.90	3.64	0.35
1	25	33.4	2.50	3.24	4.24	5.45	0.56
1½	40	48.3	4.05	5.41	7.25	9.55	1.32
2	50	60.3	5.44	7.48	11.11	13.44	2.16
3	80	88.9	11.29	15.27	21.35	27.68	4.77
4	100	114.3	16.07	22.32	33.54	41.03	8.21
6	150	168.3	28.26	42.56	67.56	79.22	18.65
8	200	219.1	42.55	64.64	111.27	107.92	32.28
10	250	273.1	60.31	96.01	172.33	155.15	50.89
12	300	323.9	79.73	132.08	238.76	186.97	72.24
14	350	355.6	94.55	158.10	281.70	—	87.27
16	400	406.4	123.30	203.53	365.36	—	114.01
18	450	457.2	155.87	254.67	459.59	—	144.32
20	500	508.0	183.42	311.17	564.81	—	179.32
24	600	609.6	255.24	441.78	807.63	—	259.35

MASS FORMULA

W = 0.02466 × (OD − t) × t kg/m
OD and t in mm, steel density 7 850 kg/m³. For stainless steel multiply by about 1.015; for P91-type alloys by about 0.99.

HYDROTEST WATER

Bore volume in litres per metre × line length gives the water required to fill the test section. Allow for fittings, valves and equipment volume separately.

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Wall thickness basics: ASME B31.3.

For straight pipe under internal pressure, the pressure design thickness is calculated first; allowances are then added and the next standard schedule that covers the result is selected.

PRESSURE DESIGN THICKNESS

$$t = \frac{P \cdot D}{2\,(S \cdot E + P \cdot Y)}$$

P = design gauge pressure • D = outside diameter
S = allowable stress at design temperature
E = quality (joint) factor • Y = coefficient (0.4 for ferritic steel below 482 °C)

REQUIRED NOMINAL WALL

$t_m = t + c$ (c = corrosion / mechanical allowance)
$t_{nom} \geq t_m / 0.875$ (12.5% mill tolerance)

THEN SELECT

The smallest schedule whose nominal wall is ≥ t_{nom} (see the dimension table).

WORKED EXAMPLE (ILLUSTRATIVE)

STEP	INPUT / CALCULATION	RESULT
Line	NPS 6 (D = 168.3 mm), seamless ASTM A106 Gr.B	
Design	P = 4.0 MPa (40 bar), design temperature 150 °C	
Allowable stress	S = 138 MPa (confirm in B31.3 Table A-1), E = 1.0, Y = 0.4	
Pressure thickness	t = (4.0 × 168.3) / [2 × (138 × 1.0 + 4.0 × 0.4)]	2.41 mm
Add allowance	t_m = t + 3.0 mm corrosion allowance	5.41 mm
Mill tolerance	t_{nom} = 5.41 / 0.875	6.18 mm
Selection	Sch 40 (7.11 mm) ≥ 6.18 mm → **NPS 6 Sch 40 is adequate**	Sch 40

TEST

Hydrostatic test

Typically 1.5 × design pressure (adjusted for temperature stress ratio) held for the time specified.

SERVICE

Not covered here

Bends, miters, branch reinforcement, external pressure and cyclic service require separate B31.3 checks.

NOTE

Verify inputs

Allowable stress, quality factor and allowances come from the project PMS and the applicable code edition.

Fittings: change direction, size and flow.



Butt-weld fittings dominate process piping above NPS 2; forged socket-weld and threaded fittings are used for small-bore and instrument lines.

FITTING	COMMON FORMS	STANDARD	MATERIALS (TYPICAL)
Elbows	90° LR / SR, 45°, 180° return	ASME B16.9	A234 WPB, A420 WPL6, A403 WP316L, A234 WP11 / WP22
Tees	Equal, reducing, barred	ASME B16.9	A234 WPB / WPC and equivalents
Reducers	Concentric, eccentric	ASME B16.9	A234 WPB, A403 stainless grades
Caps & stub ends	Dished cap; Type A / B / C stub ends	ASME B16.9, MSS SP-43	Match pipe material
Crosses	Equal and reducing	ASME B16.9	As for tees
Forged fittings	SW / threaded elbows, tees, couplings, plugs; Class 3000 / 6000 / 9000	ASME B16.11	A105, A182 F316L, A350 LF2
Branch connections	Weldolet, sockolet, thredolet, nipolet, sweepolet	MSS SP-97	A105, A182, A350 LF2
Swages & nipples	Concentric / eccentric swage, pipe nipple	BS 3799, ASTM A733	A234, A105, pipe-grade

LR / SR

Elbow radius

Long-radius (1.5 × NPS) is the default; short-radius (1.0 × NPS) only where space or the PMS demands.

STD / XS

Fitting wall

Fittings are normally ordered to match the pipe schedule at the weld bevel — state it as “to match pipe” or give the schedule.

BEVEL

Weld ends

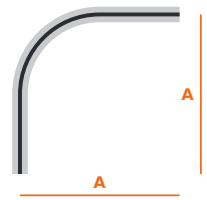
Standard bevel 37.5° (±2.5°) with 1.6 mm root face for BW fittings per ASME B16.25.



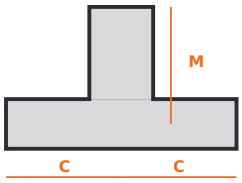
BUTT-WELD FITTINGS IN A PROCESS UNIT

ASME B16.9
butt-weld fitting dimensions.

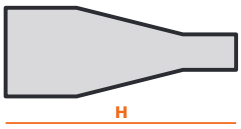
Centre-to-end and overall-length dimensions in millimetres (rounded) for the most common standard-wall fittings. Letters refer to the sketches.



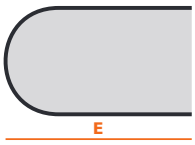
90° ELBOW A



TEE C / M



REDUCER H



CAP E

NPS	OD (MM)	90° LR A	90° SR A	45° LR B	TEE C = M	CONC. REDUCER H	CAP E
2	60.3	76	51	32	64	76	38
3	88.9	114	76	48	86	89	51
4	114.3	152	102	64	105	102	64
6	168.3	229	152	95	143	140	89
8	219.1	305	203	127	178	152	102
10	273.1	381	254	159	216	178	127
12	323.9	457	305	190	254	203	152
14	355.6	533	356	222	279	330	165
16	406.4	610	406	254	305	356	178
18	457.2	686	457	286	343	381	203
20	508.0	762	508	318	381	508	229
24	609.6	914	610	381	432	508	267

READING THE TABLE

Elbows: A is the centre-to-end distance (LR = 1.5 × NPS, SR = 1.0 × NPS). Tees: C is run length from centre, M is branch height. Reducers: H is overall length (same for concentric and eccentric). Caps: E is overall length for standard wall; heavier walls may require the E_1 length.

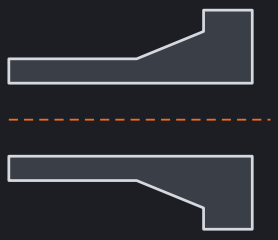
CHECK AT RECEIVING

Marking (manufacturer, grade, size, schedule, heat no.), bevel angle, wall at the weld end, ovality and the MTC heat number. For critical service add PMI and hardness.

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Flange types — choose by service.

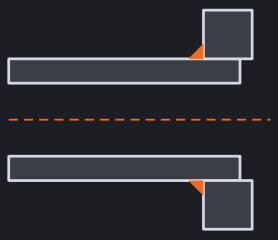
Six flange types are covered by ASME B16.5. The sketches show half-sections through the pipe axis; welds are highlighted in orange.



WN

Weld neck

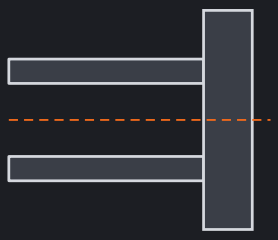
Long tapered hub gives the best stress transition. First choice for high pressure, high temperature, cyclic and critical service. Butt-welded to pipe; bore must match the pipe schedule.



SO

Slip-on

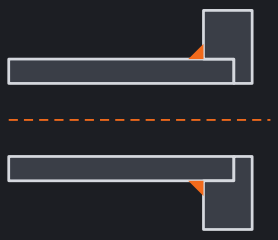
Slips over the pipe and is fillet-welded inside and outside. Lower cost and easier alignment; lower fatigue strength. Suitable for moderate, non-critical service.



BL

Blind

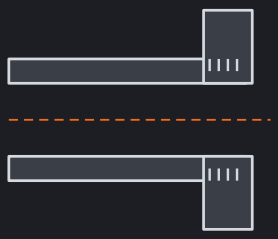
Closes the end of a line or a nozzle. Subject to the highest bending stress; thickness is critical at higher classes.



SW

Socket weld

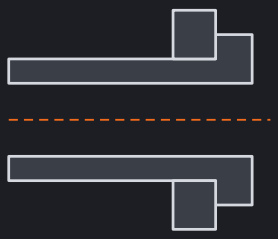
Pipe is inserted into a socket and fillet welded once. Small-bore lines (up to NPS 2) in high-pressure service.



THD

Threaded

Screwed on with NPT threads — no welding. Used on small-bore, non-cyclic lines and where welding is not allowed.



LJ

Lap joint

Used with a stub end; the flange rotates freely for easy bolt-hole alignment. Common in stainless and alloy lines to save on costly flange material.

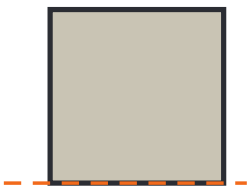
SELECTION RULE OF THUMB

Process lines in hydrocarbon service: **weld neck** as default. Slip-on / lap joint where the PMS allows. Socket weld and threaded only for small-bore, non-severe service. Always confirm the bore against the matching pipe schedule.



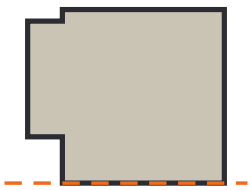
Facings, classes and material groups.

A flange is defined by its type, pressure class, facing and material group — together with the bore for weld-neck flanges.



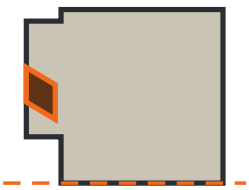
Flat face (FF)

Full flat surface; mates cast-iron or fibre-glass flanges and equipment to avoid bending.



Raised face (RF)

Gasket sits on a 1.6 mm (Class 150 / 300) or 6.4 mm (Class 400+) raised area. The standard facing.



Ring-type joint (RTJ)

Metal ring in a machined groove for high pressure and temperature; R, RX and BX ring styles.

PRESSURE CLASSES (ASME B16.5)

CLASS	MAX. WORKING PRESSURE AT 38 °C*	TYPICAL USE
150	19.6 bar	Utilities, water, low-pressure air
300	51.1 bar	General process and medium-pressure gas
600	102.1 bar	Refinery main lines, high pressure
900	153.2 bar	High-pressure hydrocarbon
1500	255.3 bar	Wellhead, high-pressure injection
2500	425.5 bar	Extreme pressure, small bore

* Material Group 1.1 (A105 carbon steel). Class is a dimensional class, not a pressure value — the actual rating falls with temperature.

MATERIAL GROUPS (EXAMPLES)

GROUP	TYPICAL MATERIAL
1.1	A105, A350 LF2 (Cl.1), A216 WCB
1.5 / 1.9	A182 F11 / F22 (Cr-Mo)
2.1	A182 F304
2.2	A182 F316
2.3	A182 F304L / F316L
3.x	Higher alloys (e.g. duplex, nickel alloys)

Stainless group 2.3 (316L) carries lower ratings at ambient than group 1.1 — for example Class 300: 41.4 bar versus 51.1 bar.

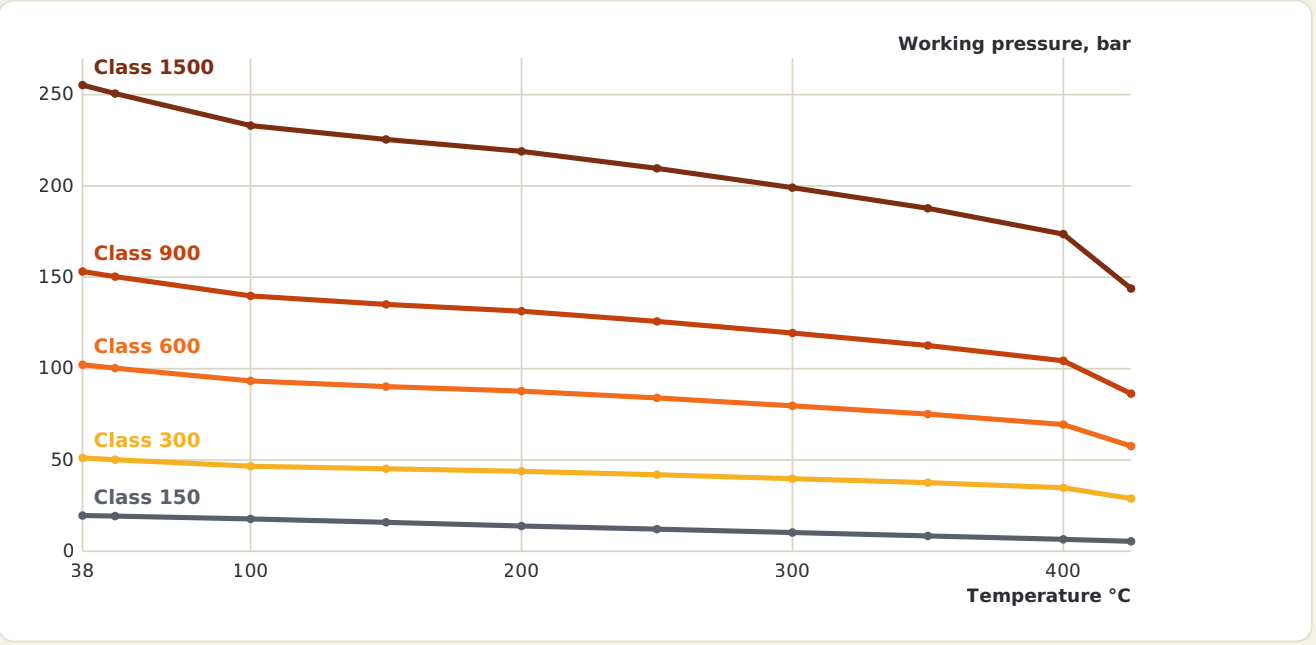
ORDERING A FLANGE

Example: 6″ WN RF flange, 300#, B16.5, bore Sch 40, ASTM A105, EN 10204 3.1, marked per MSS SP-25. For sour service add: hardness ≤ 22 HRC, NACE MR0175 / ISO 15156.

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Pressure–temperature ratings (Group 1.1).

Maximum allowable working pressure in bar gauge for ASME B16.5 flanges in material Group 1.1 (ASTM A105, A216 WCB, A350 LF2 Class 1 and equivalents). Rating falls as temperature rises.



CLASS	38 °C	50 °C	100 °C	150 °C	200 °C	250 °C	300 °C	350 °C	400 °C	425 °C
150	19.6	19.2	17.7	15.8	13.8	12.1	10.2	8.4	6.5	5.5
300	51.1	50.1	46.6	45.1	43.8	41.9	39.8	37.6	34.7	28.8
600	102.1	100.2	93.2	90.2	87.6	83.9	79.6	75.1	69.4	57.5
900	153.2	150.4	139.8	135.2	131.4	125.8	119.5	112.7	104.2	86.3
1500	255.3	250.6	233.0	225.4	219.0	209.7	199.1	187.8	173.6	143.8
2500	425.5	417.7	388.3	375.6	365.0	349.5	331.8	313.0	289.3	239.7

LOW TEMP

Below −29 °C

A105 is not suitable. Use A350 LF2 with impact tests; rating follows the same Group 1.1 curve down to the minimum permitted temperature.

HIGH TEMP

Above 425 °C

Carbon steel creeps and graphitises; use Cr-Mo alloys (Groups 1.5 / 1.9) or stainless as appropriate.

316L

Group 2.3

Ambient ratings: Class 150 15.9 bar • 300 41.4 bar • 600 82.7 bar • 900 124.1 bar • 1500 206.8 bar • 2500 344.7 bar.

Values are nominal reference data compiled from the cited standards for quick selection and RFQ preparation. They do not replace the current edition of the standard, the project piping material specification (PMS) or the manufacturer's datasheet; always verify before ordering.

Class 150 flange dimensions (ASME B16.5).

Connection dimensions in millimetres for raised-face weld-neck, slip-on and blind flanges. Raised-face height 1.6 mm is included in the thickness.

NPS (IN)	DN	FLANGE OD	MIN. THICKNESS	BOLT CIRCLE	BOLT HOLES (NO. × Ø MM)	STUD Ø (IN)	RF Ø
½	15	89	11.2	60.3	4 × 16	1/2	34.9
¾	20	98	12.7	69.9	4 × 16	1/2	42.9
1	25	108	14.3	79.4	4 × 16	1/2	50.8
1½	40	127	17.5	98.6	4 × 16	1/2	73.2
2	50	152	19.1	120.7	4 × 19	5/8	92.1
2½	65	178	22.3	139.7	4 × 19	5/8	104.8
3	80	190	23.9	152.4	4 × 19	5/8	127.0
4	100	229	23.9	190.5	8 × 19	5/8	157.2
6	150	279	25.4	241.3	8 × 22	3/4	215.9
8	200	343	28.6	298.5	8 × 22	3/4	269.7
10	250	406	30.2	362.0	12 × 25	7/8	323.9
12	300	483	31.8	431.8	12 × 25	7/8	381.0
14	350	533	35.1	476.3	12 × 29	1	412.8
16	400	597	36.6	539.8	16 × 29	1	469.9
18	450	635	39.7	577.9	16 × 32	1-1/8	533.4
20	500	699	42.9	635.0	20 × 32	1-1/8	584.2
24	600	813	47.8	749.3	20 × 35	1-1/4	692.2

BOLTS

Hole & stud

Hole diameter is stud diameter + 1/8 in (1.6 mm). Stud length depends on flange thickness, gasket and nut height.

MATCH

Mating flanges

Class 150 mates only with Class 150. Different classes may share an OD but not bolt-hole pattern or rating.

FACE

RF diameter

The raised-face diameter is the same for Class 150, 300 and 600 at a given NPS.

Class 300 flange dimensions (ASME B16.5).

Same OD-to-bore logic as Class 150 but with thicker flanges, larger bolt circles and more or heavier studs. Raised-face height 1.6 mm is included in the thickness.

NPS (IN)	DN	FLANGE OD	MIN. THICKNESS	BOLT CIRCLE	BOLT HOLES (NO. × Ø MM)	STUD Ø (IN)	RF Ø
½	15	95	14.3	66.7	4 × 16	1/2	34.9
¾	20	117	15.9	82.6	4 × 19	5/8	42.9
1	25	124	17.5	88.9	4 × 19	5/8	50.8
1½	40	156	20.6	114.3	4 × 22	3/4	73.2
2	50	165	22.3	127.0	8 × 19	5/8	92.1
2½	65	191	25.4	149.2	8 × 22	3/4	104.8
3	80	210	28.6	168.3	8 × 22	3/4	127.0
4	100	254	31.8	200.0	8 × 22	3/4	157.2
6	150	318	36.6	269.9	12 × 22	3/4	215.9
8	200	381	41.1	330.2	12 × 25	7/8	269.7
10	250	445	47.8	387.4	16 × 29	1	323.9
12	300	521	50.8	450.8	16 × 32	1-1/8	381.0
14	350	584	53.8	514.4	20 × 32	1-1/8	412.8
16	400	648	57.2	571.5	20 × 35	1-1/4	469.9
18	450	711	60.5	628.6	24 × 35	1-1/4	533.4
20	500	775	63.5	685.8	24 × 35	1-1/4	584.2
24	600	914	69.9	812.8	24 × 41	1½	692.2

CLASS 150 VS. CLASS 300 AT NPS 4

Class 150: OD 229 mm, 8 × 5/8″ studs on a 190.5 mm circle. Class 300: OD 254 mm, 8 × 3/4″ studs on a 200 mm circle — the flanges cannot be mixed.

IDENTIFY AN INSTALLED FLANGE

Measure OD, count bolt holes, measure one hole and the bolt circle across two opposite holes. Four numbers identify a row in the table with certainty.

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Class 600 flange dimensions (ASME B16.5).

Dimensions for NPS ½ to 12. For Class 600, the tabulated thickness excludes the 6.4 mm raised face. Sizes NPS 14–24 and Classes 900, 1500 and 2500 follow the same logic — request the data sheet for the exact size.

NPS (IN)	DN	FLANGE OD	MIN. THICKNESS	BOLT CIRCLE	BOLT HOLES (NO. × Ø MM)	STUD Ø (IN)	RF Ø
½	15	95	14.3	66.7	4 × 16	1/2	34.9
¾	20	117	15.9	82.6	4 × 19	5/8	42.9
1	25	124	17.5	88.9	4 × 19	5/8	50.8
1½	40	156	22.3	114.3	4 × 22	3/4	73.2
2	50	165	25.4	127.0	8 × 19	5/8	92.1
2½	65	191	28.6	149.2	8 × 22	3/4	104.8
3	80	210	31.8	168.3	8 × 22	3/4	127.0
4	100	273	38.1	215.9	8 × 25	7/8	157.2
6	150	356	47.8	292.1	12 × 29	1	215.9
8	200	419	55.6	349.2	12 × 32	1-1/8	269.7
10	250	508	63.5	431.8	16 × 35	1-1/4	323.9
12	300	559	66.7	489.0	20 × 35	1-1/4	381.0

RF 6.4

Raised-face height

From Class 400 upward the raised face is 6.4 mm and is not included in the minimum thickness.

WN

Prefer weld neck

From Class 600 upward, weld-neck flanges are the normal choice; slip-on is rarely accepted.

RTJ

Ring joints

Class 600+ lines in severe service often specify RTJ facings with R / RX rings in soft iron or low-carbon steel.

NEED A FLANGE OUTSIDE THESE TABLES?

Send the NPS, class, facing, type, bore and material through the PTF RFQ system — our technical team checks the dimensions and the vendor-list requirement before quoting.

Values are nominal reference data compiled from the cited standards for quick selection and RFQ preparation. They do not replace the current edition of the standard, the project piping material specification (PMS) or the manufacturer's datasheet; always verify before ordering.

Valves: types and governing standards.

Valve choice starts with the function — isolate, throttle, prevent reverse flow or relieve pressure — and ends with the standard that sets the construction and test requirements.

VALVE TYPE	PRIMARY FUNCTION	TYPICAL STANDARD	NOTES
Gate	On / off isolation, low pressure drop	API 600 (NPS ≥ 2), API 602 (≤ NPS 4 compact), BS 1414	Not for throttling; bolted bonnet; wedge types
Globe	Throttling and isolation	BS 1873 / API 623, API 602	Higher pressure drop; steam and control duties
Check (swing / piston)	Prevent reverse flow	BS 1868, API 594 (wafer), API 602	Orientation and minimum flow matter
Ball	Quick shut-off, tight shut-off	API 6D (pipeline), API 608 / ISO 17292	Floating or trunnion-mounted; fire-safe design
Butterfly	Large-bore isolation / throttling	API 609, EN 593	Concentric, double or triple offset
Plug	Quick shut-off, multi-port	API 599, API 6D	Lubricated or non-lubricated
Needle	Fine flow control, instruments	Manufacturer / ASME B16.34	Small bore, high pressure
Control valve	Modulate flow, pressure, level	IEC 60534, ISA / API 6D as applicable	Sized with Cv; trim, actuator, positioner
Safety / relief	Protect against overpressure	API 526, API 520, API 521, ASME VIII	Set pressure, orifice, capacity certification
Strainer	Protect equipment from debris	Manufacturer / ASME B16.34	Y-type or basket; mesh and body material



DEFINE EACH VALVE BY

- Type, size (NPS / DN) and pressure class
- Body material and trim (seat / disc / stem)
- End connection: RF, RTJ, BW, SW, threaded
- Operator: lever, gear, pneumatic, electric
- Standard and test (API 598 / ISO 5208)
- Special requirements: fire-safe, sour, cryogenic, low-emission

Face-to-face lengths, body materials and trims.

Flanged raised-face valve end-to-end dimensions (mm) per ASME B16.10 for the most common isolation valves, and the standard trim designations used with API 600 / 602 gate, globe and check valves.

NPS (IN)	2	3	4	6	8	10	12
ASME B16.10 — FLANGED, RAISED FACE, FACE-TO-FACE (MM)							
Gate 150	178	203	229	267	292	330	356
Gate 300	216	283	305	403	419	457	502
Gate 600	292	356	432	559	660	787	838
Globe 150	203	241	292	406	495	622	698
Globe 300	267	318	356	444	559	622	711

BODY MATERIALS (CAST / FORGED)

SERVICE	CASTING	FORGING
Carbon steel	A216 WCB	A105
Low-temp (−46 °C)	A352 LCC	A350 LF2
1¼Cr / 2¼Cr	A217 WC6 / WC9	A182 F11 / F22
316 stainless	A351 CF8M / CF3M	A182 F316 / F316L
Duplex / super duplex	A995 4A / 5A	A182 F51 / F53

API 600 TRIM NUMBERS

TRIM	SEAT / DISC (TYPICAL)
1	13Cr (410) / 13Cr (410)
5	Hardfaced Stellite on 13Cr (410)
8	13Cr (410) / hardfaced 13Cr
10	316 / 316
12	316 / hardfaced Stellite
16	Monel / hardfaced Monel

INTERFACE CHECK

Valve end flanges must match the line flange in **class, facing, bore and finish**. For RTJ ends add the ring groove type; for butt-weld ends state the pipe schedule. Face-to-face length governs spool fit-up — confirm it before ordering.

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Valve testing: API 598 and ISO 5208.

Production pressure tests prove body strength and seat tightness before shipment. Test pressures and hold times are tied to the valve rating and size.

API 598 TEST PRESSURES

TEST	PRESSURE	MEDIUM
Shell (hydro)	≥ 1.5 × 38 °C rating	Water
Backseat	≥ 1.1 × 38 °C rating	Water
Seat (hydro)	≥ 1.1 × 38 °C rating	Water
Seat (low-pressure gas)	5–7 bar (80–100 psi)	Air / nitrogen

MINIMUM HOLD TIME (S)

NPS	SHELL	SEAT
≤ 2	15	15
2½ – 6	60	60
8 – 12	120	120
≥ 14	300	120

ISO 5208 LEAKAGE RATES (LIQUID TEST)

RATE	A	B	C	D	E	F	G
Allowable leakage	No visible leakage	0.01 × DN mm³/s	0.03 × DN	0.1 × DN	0.3 × DN	1 × DN	3 × DN

Rate A is normally specified for soft-seated valves; metal-seated valves usually accept rate D or as stated in the project specification. DN in millimetres.

API 607

Fire-safe design

Fire-test qualification for soft-seated quarter-turn valves (also ISO 10497 / API 6FA).

ISO 15848

Fugitive emissions

Type-test classes for stem and body-seal tightness on emission-critical services.

API 6D

Pipeline valves

Adds requirements for DBB / DIB, cavity relief, bore and extended documentation.



WITNESSING

For critical valves request hydro / seat test witnessing under the ITP and record the test report number against the valve serial number. See Catalog 04 for the valve receiving checklist.

Gaskets & bolting: the joint that has to hold.

A flange joint is only as good as its gasket and the stud load that compresses it. Select both from the class, facing, fluid and temperature.

GASKET TYPE	CONSTRUCTION	STANDARD	TYPICAL USE
Spiral wound	316L / 304 winding with graphite or PTFE filler; inner & outer rings	ASME B16.20	Most process lines, Class 150 to 2500, RF and tongue / groove
Ring-type joint	Octagonal or oval metal ring; R, RX, BX styles	ASME B16.20 / API 6A	Class 600+ and high-pressure RTJ flanges
Kammprofile	Grooved metal core with soft facing layers	Manufacturer / EN 1514-6	Heat exchangers, high-temperature service
Sheet (soft cut)	Compressed fibre, graphite or PTFE sheet	ASME B16.21	Low-pressure utility, flat-face flanges
Metal jacketed	Metal shell around soft filler	Manufacturer	Heat-exchanger shells, special shapes

RTJ RING HARDNESS (MAX.)

RING MATERIAL	MAX. HARDNESS (HB)
Soft iron	90
Low-carbon steel	120
F5 (5Cr½Mo)	130
Type 304 / 316 / 347	160

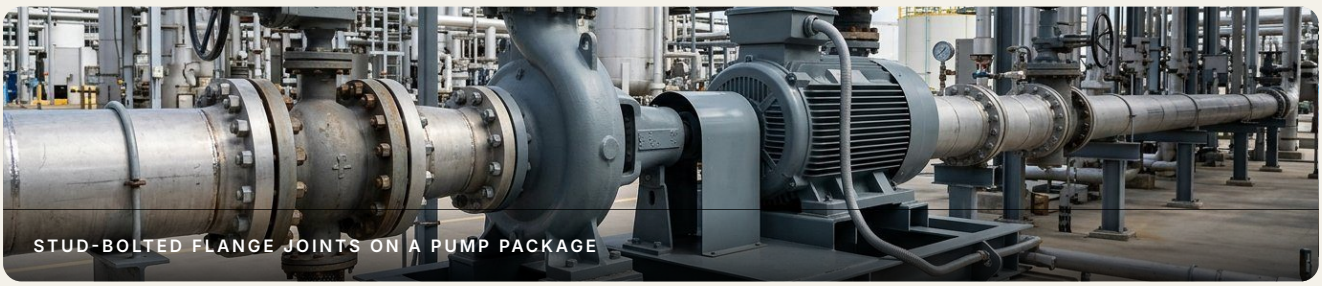
The ring must be softer than the flange groove.

ASTM STUD & NUT PAIRS

STUD	NUT	USE
A193 B7	A194 2H	Standard carbon-steel flanges
A193 B7M	A194 2HM	Sour service, hardness-controlled
A193 B8M Cl.2	A194 8M	Stainless, corrosive
A320 L7	A194 4 / 7	Low-temperature
A193 B16	A194 4	High-temperature

STUD LENGTH (APPROX.)

L ≈ 2 × flange thickness + gasket thickness + 2 × nut height + 2 × thread allowance (~3 mm). Add 6.4 mm per side for Class 400+ raised faces. Request thread class 2A / 2B, coating (PTFE / zinc-nickel, hot-dip galvanised where specified) and marking on the stud and nut.



STUD-BOLTED FLANGE JOINTS ON A PUMP PACKAGE

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Material selection by service.

Starting points for matching pipe, flange, fitting, valve body and bolting. The final choice always follows the project PMS, fluid composition and design code.

SERVICE	PIPE	FLANGE / FORGING	FITTING	VALVE BODY	BOLTING
Non-corrosive, −29 to 427 °C	A106 Gr.B	A105	A234 WPB	A216 WCB	B7 / 2H
Low temperature to −46 °C	A333 Gr.6	A350 LF2	A420 WPL6	A352 LCC	L7 / 4
Sour (NACE MR0175)	A106 Gr.B ≤ 22 HRC (PWHT, seamless)	A105 normalised, ≤ 22 HRC	A234 WPB, ≤ 22 HRC	A216 WCB / WCC with limits	B7M / 2HM
High-temperature steam	A335 P11 / P22 / P91	A182 F11 / F22 / F91	A234 WP11 / WP22 / WP91	A217 WC6 / WC9 / C12A	B16 / B7
Corrosive, chlorides	A312 TP316L	A182 F316L	A403 WP316L	A351 CF3M	B8M Cl.2 / 8M
Seawater, chloride SCC risk	A790 duplex / super duplex	A182 F51 / F53	A815 S31803 / S32750	A995 4A / 5A	B8M or duplex
Cryogenic (LNG)	A312 TP304L / 316L	A182 F304L / F316L	A403 WP304L	A351 CF8 / CF8M	B8 Cl.2 / A320 B8
Hydrogen service (Nelson curve)	A335 P11 / P22	A182 F11 / F22	A234 WP11 / WP22	A217 WC6 / WC9	B16 / B7

LOGIC

How to read it

Pick the row by fluid and temperature, then read across: every component in the line must be compatible with the same corrosion allowance and NDT level.

CHECK

Always confirm

Hydrogen, wet H_2S, chlorides, CO_2 and temperature extremes each need an engineer-approved material selection report.



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Special services & documentation.

Non-standard services add requirements on top of the basic dimensional standards. Declare them in the RFQ so every supplier prices the same scope.

SOUR

H_2S service

NACE MR0175 / ISO 15156. Carbon steel hardness ≤ 22 HRC (≈ 248 HV); bolting B7M / 2HM; weld and HAZ hardness control; PWHT where specified.

LOW TEMP

Impact-tested

A333 Gr.6, A350 LF2, A420 WPL6, A352 LCC. Charpy V-notch at the design minimum metal temperature per the material specification and B31.3.

HIGH TEMP

Creep range

Cr-Mo alloys with defined heat treatment, hardness limits and PMI to prove alloy chemistry; P91 requires strict heat-treatment records.

TESTS THAT CAN BE ADDED

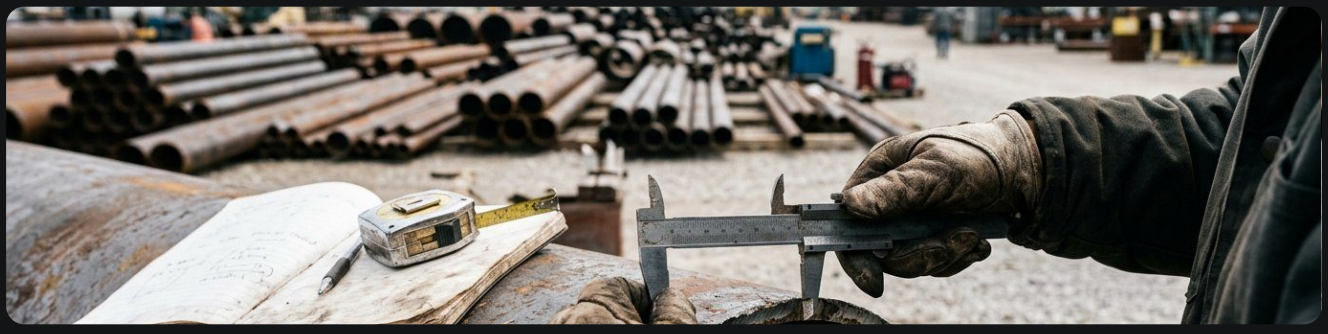
- PMI (positive material identification) — alloy verification
- Hardness — HRC / HBW with report
- Impact (Charpy) — low-temperature service
- IGC test (ASTM A262) — intergranular corrosion for stainless
- Ferrite content / duplex microstructure
- NDT — RT, UT, MT, PT per standard and acceptance level
- Hydrotest and pneumatic test records

TYPICAL RFQ CHECKLIST — PIPING

- Standard, grade and manufacturing route
- NPS, schedule / thickness, class, facing, bore
- Service flags: sour, low-temp, hydrogen, oxygen
- Certificates: EN 10204 3.1 / 3.2
- Inspection: TPI, ITP, witness / hold points
- Marking, coating, caps, packing and delivery
- Client AVL and project specification references

DOCUMENTS DELIVERED WITH PIPING MATERIALS

MTC (EN 10204 3.1) with heat numbers • Hardness / PMI / NDT reports where specified • Hydro and seat-test reports for valves • Dimensional report • Packing list and commercial invoice. See **Catalog 04** for the full QA/QC documentation guide.



Conversions & quick reference.

Frequently needed unit conversions and size equivalents for piping work.

NPS ↔ DN ↔ OD

NPS (IN)	DN	OD (IN)	OD (MM)
½	15	0.839	21.3
¾	20	1.051	26.7
1	25	1.315	33.4
1½	40	1.902	48.3
2	50	2.374	60.3
3	80	3.500	88.9
4	100	4.500	114.3
6	150	6.626	168.3
8	200	8.626	219.1
10	250	10.752	273.1
12	300	12.752	323.9
14	350	14.000	355.6
16	400	16.000	406.4
18	450	18.000	457.2
20	500	20.000	508.0
24	600	24.000	609.6

PRESSURE

BAR	PSI	MPA	KGF/CM²
1	14.5	0.10	1.0
5	72.5	0.50	5.1
10	145.0	1.00	10.2
16	232.1	1.60	16.3
20	290.1	2.00	20.4
25	362.6	2.50	25.5
40	580.2	4.00	40.8
50	725.2	5.00	51.0
63	913.7	6.30	64.2
100	1450.4	10.00	102.0

TEMPERATURE

°C	°F	°C	°F
-46	-51	150	302
-29	-20	200	392
0	32	250	482
20	68	300	572
38	100	400	752
50	122	425	797
100	212	500	932

LENGTH

1 in = 25.4 mm

1 ft = 304.8 mm • 1 m = 39.37 in

MASS

1 lb = 0.4536 kg

1 kg = 2.2046 lb • 1 t = 1 000 kg

FLOW

1 m^3/h = 4.403 USgpm

1 L/s = 3.6 m^3/h

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SCAN TO SUBMIT AN RFQ

INFORMATION CURRENT AS PUBLISHED AT PISHTAJ.IR / OCTOBER 2026
TECHNICAL DATA FOR REFERENCE ONLY — VERIFY AGAINST PROJECT DOCUMENTS