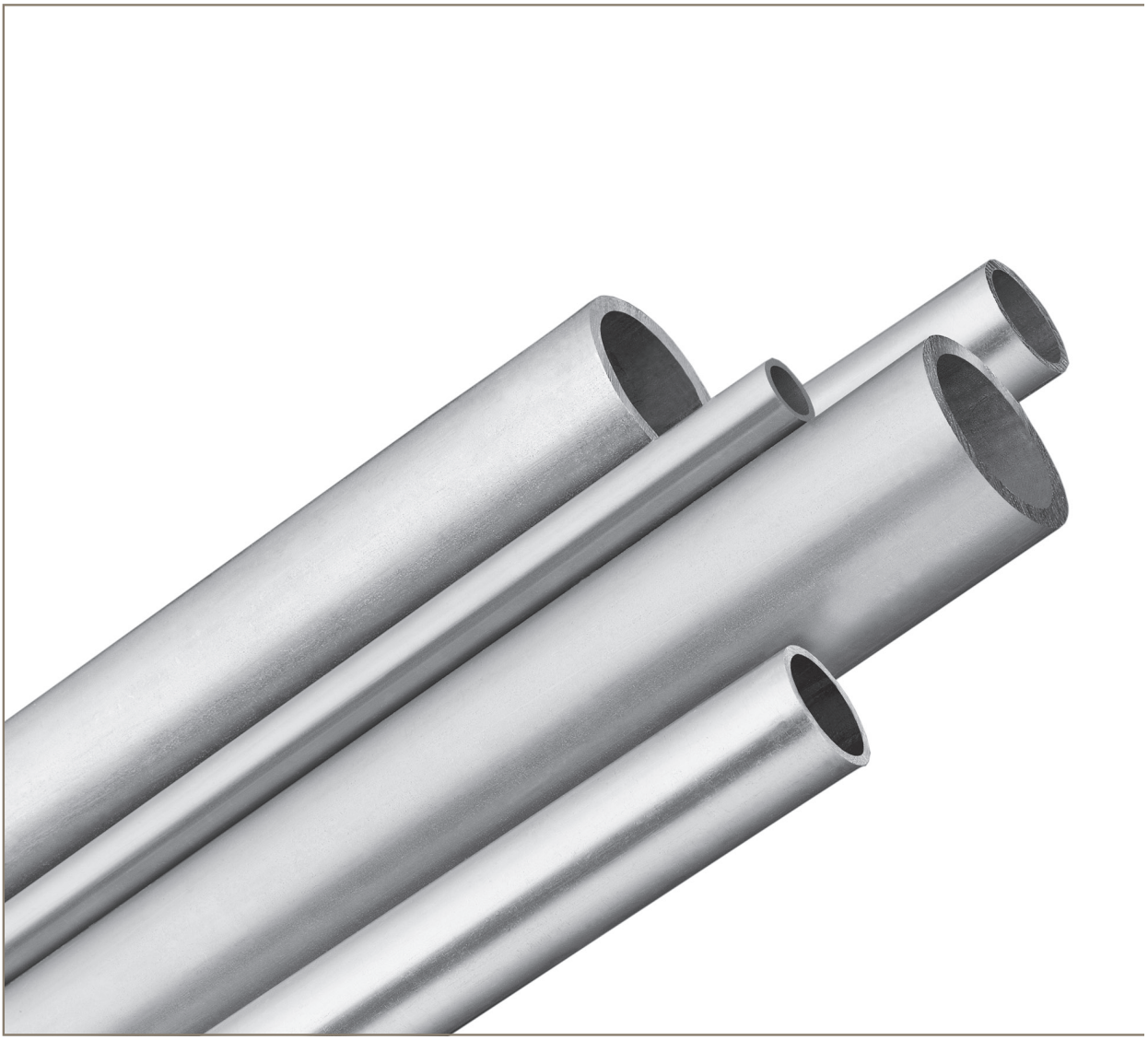


Pipes and tubes

This chapter contains only a small selection.
An extended part range and more details can be found in chapter S of the catalogue 4100.

ENGINEERING YOUR SUCCESS.

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Tube and pipe specification

Recommended carbon steel tubes and pipes
Parker recommends the use of cold drawn seamless and regular annealed (abbreviation +N) hydraulic tubes and pipes acc.:
DIN-EN 10305 (old DIN 2391) and ISO 3304
For the assembly of steel fittings, steel tubes made of material E235 (ST37.4 +N) and E355 (ST52.4 +N) are recommended.

+ precision dimension/shape
+ high pressure capability
+ clean inside (no scale)
+ excellent scaling surface after roll flaring

Recommended stainless steel tubes and pipes
Parker reccommends the use of seamless cold drawn stainless steel tubes and pipes acc. to:
DIN EN 10216-5, ASTM A269/A213, ASTM A312.

EO precision stainless steel tube meets and exceeds these standards. The tolerances of the pipe outer diameter and wall thickness are even closer to ensure a safe interplay with our fitting systems.

For the assembly of stainless steel tube fittings, EO precision stainless steel tubes made of material 316 Ti and 316L are recommended.

+ precision dimension/shape
+ high pressure capability
+ excellent scaling surface after roll flaring

Welded tubes and pipes
Tubes and pipes acc. to below specification but welded and cold redrawn instead of seamless drawn are usually suitable.
Pressure capability might be reduced due to the welding seam zone.
Welding seam quality might effect roll flaring surface results.

Hot rolled pipes
Hot rolled pipes are not recommended for the following reasons:
Hot rolled pipes do not have precision dimensions and may slip in machine dies.
They have scales inside and outside. The inside scales effect the cleanliness level of the fluid and reduces fatigue levels. Used in roll flaring process the scales will contaminate the flaring tools (high cleaning effort) and cause poor flare surface quality.

The required maximum working pressure is calculated either acc. to DIN or DNV.

Material Specifications & Values

E235+N / St.37.4 (1.0308) acc. to DIN EN 10305-4	
Tensile strength	min. 340 N/mm²
Yield strength	min. 235 N/mm²
Fatigue strength	225 N/mm² [1]
Elongation at break	min.. 25%

E355+N / St.52.4 (1.0580) acc. to DIN EN 10305-4	
Tensile strength	min. 490 N/mm²
Yield strength	min. 355 N/mm²
Fatigue strength	265 N/mm² [2]
Elongation at break	min.. 22 %

316Ti (1.4571) cold drawn (CFA) acc. to DIN EN 10216-5	
Tensile strength	min. 500 N/mm²
0.2 % proof stress	min. 210 N/mm²
1 % proof stress	min. 245 N/mm²
Fatigue strength	220 N/mm² [2]
Elongation at break	min. 35 %

316L (1.4404) cold drawn (CFA)[3] acc. to DIN EN 10216-5	
Tensile strength	min. 500 N/mm²
0.2 % proof stress	min. 210 N/mm²
1 % proof stress	min. 245 N/mm²
Elongation at break	min. 35 %

316L (1.4404) acc. to ASTM A269 / A213	
Tensile strength	min. 530 N/mm²
Yield strength	min. 276 N/mm²
0.2 % proof stress / 1.6 [4]	172.5 N/mm²

316L (1.4404) acc. to ASTM A312 / A530	
Tensile strength	min. 515 N/mm²
Yield strength	min. 234 N/mm²
0.2 % proof stress / 1.6 [4]	146 N/mm²

[1] DIN 2413, 6.331
[2] No standard value, Experience value
[3] Strength increase due to cold forming following 1.4571
[4] Pressure rating calculation based on this mechanical properties require certification according to 3.1 - EN 10204 that confirmes the mechanical properties.

Tube calculation for industrial and mobile applications acc. to DIN rules

DIN 2413 I, only for static load

Calculation of working pressure of steel tubes for static stress up to 120°C. Corrosion - additional allowancess are not considered for the calculation of pressures. Tubes with a diameter of OD/ ID > 2 are calculated for static stress in accordance with DIN 2413 III, but with K = yield strength.

$$P = \frac{20 * K * s * c}{S * D}$$

P = permissible working pressure [bar]
K = yield strength [N/mm²]
s = tube wall thickness [mm]
c = factor for wall thickness allowance
= 0.8 for Tube-OD 4-5
= 0.85 for Tube-OD 6-8
= 0.9 from Tube-OD 10
= 0.9 for all stainless steel tubes
S = Safety factor = 1.5
D = tube outside diameter [mm]

Burst pressure calculation

Calculation of static burst pressure for seamless tubes acc. to Faupel-von-Mises.

$$BP = R_{p0.2} * 10 \frac{2}{\sqrt{3}} \ln \frac{D}{d} * (2 - \frac{R_{p0.2}}{R_m})$$

BP = Min. static burst pressure [bar]
R = tensile strength [N/mm²]
R_{p02} = 0.2% proof stress, yield strength [N/mm²]
D = Tube outside diameter [mm]r
d = Tube inside diameter [mm]

DIN 2413 III, for dynamic load

Calculation of working pressure of steel tubes for dynamic stress up to 120°C.
Corrosion - additional allowances are not considered for the calculation of pressures.

$$P = \frac{20 * K * s * c}{S * (D + s * c)}$$

P = permissible working pressure [bar]
K = fatigue strength [N/mm²]
s = tube wall thickness [mm]
c = factor for wall thickness allowance
= 0.8 for Tube-OD 4-5
= 0.85 for Tube-OD 6-8
= 0.9 for Tube-OD 10-80
= 0.9 for all stainless steel tubes
S = safety factor = 1.5
D = tube outside diameter [mm]

Tube calculation for marine and offshore acc. to DNV rules

Calculation of working pressure of steel and stainless steel tubes for ship building acc. to DNV Part 4, Chapter 6, Section 6.

$$P = \frac{20 * \sigma_t * e * t_0}{D - t_0}$$

Calculation of burst pressure:

$$BP = \frac{20 * R_m * t_n * a}{D - t_n * a}$$

P = permissible working pressure [bar]
BP = approximate burst pressure [bar]
σ_t = permissible stress [N/mm²]
calculated from the lower value off:

stainless steel: $\sigma_t = \frac{R_m}{2.7}$ or $\frac{K}{1.6}$

carbon steel: $\sigma_t = \frac{R_m}{2.7}$ or $\frac{K}{1.8}$

t_0 = tube wall thickness without allowences [mm]

$t_0 = t_n \cdot a - c - b$

t_n = tube wall thickness nominal [mm]
a = factor for wall thickness allowence
= 0.8 for Tube-OD 4-5, 0.85 for Tube-OD 6-8, 0.9 for Tube-OD >=10
= 0.875 for Schedule Pipes
= 0.9 for all stainless steel tubes
b = bending allowence

$$b = \frac{1}{2.5} * \frac{D}{R} * t_0$$

$b = 0.1333 * t_0$ (at R/D=3) $\rightarrow$ $t_0 = \frac{t_n * a - c}{1.1333}$

c = corrosion tolerance, c = 0.3 mm for hydraulic steel tube, c = 0 mm for SS tubes
e = strength ratio: for seamless tubes e = 1
D = tube outside diameter [mm]
R_m = min. tensile strength [N/mm²]
K = min. yield strength or min 0.2% proof stress [N/mm²]

Pressure reductions and temperatures

Required pressure reductions (depending on the material) with reference to the catalogue pressures for higher temperatures.
Both metal fitting material and elastomeric sealing compound have to be selected according to the temperature range of the system.

DNV may require different pressure reduction based on application

Material	Pressure reduction of permissable operating temperatures TB in °C														
	-60	-54	-40	-35	-25	+20	+50	+100	+120	+150	+175	+200	+250	+300	+400
Steel components			-10%				0%			-11 %	-19 %				
Steel, tubes			-10%				0%			-19 %			-27 %		
Stainless steel components	0%						-5%	-15%	-23%		-29%		-33%	-37%	-42%
Stainless steel, tubes	0 %						-5.5 %	-11.5%	-21.5 %				-29 %		-34%
Sealing material NBR (e.g. Perbunan)															
Sealing material FKM															
Sealing material Polyurethan (P5008)															

Permissible operating temperature
Ambient temperature of hydraulic and pneumatic applications
Temperature not permissible

Calculation example:
Temperature = 200°C
Material = Stainless steel
Pressure reduction = 29%
Pressure reduction tubes = 21.5%
PN tube 16x2.5/71. DIN2413 III = 362 bar

Formula:

$$PN_{200°C} = \frac{400\ \text{bar}}{100\%} \times (100\% - 29\%) = 284\ \text{bar}$$

$$PN_{\text{tube } 200°C} = \frac{362\ \text{bar}}{100\%} \times (100\% - 21.5\%) = 284\ \text{bar}$$

Flow diameter of tube lines

Determining tube sizes for hydraulic systems

Proper tube material, type and size for a given application and type of fitting are critical for efficient and trouble-free operation of the fluid system. Selection of proper tubing involves choosing the right tube material, and determining the optimum tube size (O.D. and wall thickness).
Proper sizing of the tube for various parts of a hydraulic system results in an optimum combination of efficient and cost effective performance.
A tube that is too small causes high fluid velocity, which has many detrimental effects. In pressure lines, it causes high friction losses and turbulence, both resulting in high pressure drops and heat generation. High heat accelerates wear in moving parts and rapid aging of seals and hoses, all resulting in reduced component life. High heat generation also means wasted energy, and hence, low efficiency. Too large tubes increase system cost. Thus, optimum tube sizing is very critical. The following is a simple procedure for sizing tubes.

Determine required flow diameter

Use table to determine recommended flow diameter for the required flow rate and type of line.

The table is based on the following recommended flow rates that are common in the shipbuilding and offshore engineering:

Pressure lines – 3 –>7.2 $\left[\frac{m}{s}\right]$

Return lines – 2 –>4.5 $\left[\frac{m}{s}\right]$

Suction lines – 1 –>1.8 $\left[\frac{m}{s}\right]$

Avoid flow rates > 8 m/s!
The resulting forces are high and can destroy the tube lines.

If you desire to use different velocities than the above, use the following formula to determine the required flow diameter.

$$\text{Tube – I.D. [mm]} = 4{,}61 \times \sqrt{\frac{\text{Flow } \left[\frac{\text{ltr.}}{\text{min}}\right]}{\text{Velocity } \left[\frac{m}{s}\right]}}$$

Determine required wall thickness

Use tube/pressure calculation tables shown in the tube chapter to determine recommended wall thickness for the required working pressure and flow diameter of the line. Therefore choose a working pressure which is equal or higher than the required working pressure.

Flow characteristics

Hydraulic systems are in most cases only rated with a flow velocity defined on the basis of experience. The pressure losses in lines are not taken into account, or measured later on when testing the system. As the pressure losses increase porportionally greater than the flow resistance, it is important to achieve the best rating of the system, so that they are already taken into account when planning the tube connections. Calculation is not as difficult as it is often thought, and this chapter is intended to provide a guideline. Besides, it provides information on how excessive pressure losses can be avoided, because pressure losses result in losses in performance and excessive heat. Noise occurs and possibly cavitation in suction lines.

Medium

All indication given with regard to flow restrictions and to flow properties refer exclusively to liquids. For gaseous media, the variable density of the gas must additionally be taken into account.

Units

c = Flow velocity [ ]

d = Pipe inside diameter [m]
L = Pipe length [m]
p = Pressure [Pa], 1 bar = 100000 Pa

V = Flow rate [ ], 1 = 60000
λ = Pipe friction factor

$\upsilon(T)$ = Kinematic viscosity of the medium depending on temperature $\left[\frac{m^2}{s}\right]$

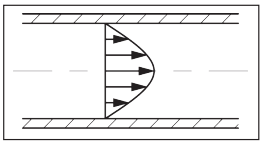
$\rho(T)$ = Density of the medium depending on temperature $\left[\frac{kg}{m^3}\right]$

ζ = Individual pressure loss coefficient

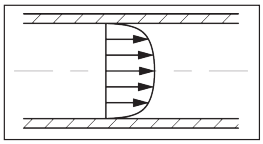
Only base units have been used. This has the advantage that the formula do not contain correction factors and there is no danger of confusion, e.g. that values are used with the wrong unit. In case values are given in other units – the flow rate is e.g. often given in l/min – it is advisable to convert them into the base units before starting calculation.

Pressure losses in pipe lines

To calculate pressure losses in pipe lines, it must first be determined whether there is a laminar or a turbulent flow. Laminar flow is homogenous and without turbulence. In case of turbulent flow, the losses increase much more quickly.



Flow profile with laminar flow



Flow profile with turbulent flow

The kind of flow is defined by the Reynolds' number. With a Reynolds' number of more than 2320, the flow changes to turbulent. The Reynolds' number is calculated according to the formula:

$$Re = \frac{c \cdot d}{\upsilon(T)}$$

The Reynolds' number is a non-dimensional number. The critical fluid velocity at which the flow regime can change, is thus calculated from:

$$c_{cr} = 2320 \cdot \frac{\upsilon(T)}{d} \left[\frac{m}{s}\right]$$

With a given flow rate, the fluid velocity can be calculated according to the formula:

$$c = \frac{\dot{V} \cdot 4}{d^2 \cdot \pi} \left[\frac{m}{s}\right]$$

Subsequently, the pipe friction factor λ can be calculated. The pipe friction factor λ is a function of the Reynolds' number and also depends on the roughness of the pipe. As hydraulically smooth pipes can generally be assumed in hydraulic applications, the pipe friction factor λ is calculated according to the following formula:

$$\text{laminar flow, } (Re < 2320): \lambda = \frac{64}{Re}$$

$$\textit{turbulent flow, } (Re > 2320): \lambda = \frac{0.3164}{\sqrt[4]{Re}}$$

Finally, if all factors are known, the pressure loss in a certain pipe line can be calculated according to the formula:

$$\Delta p = \lambda \cdot \frac{L}{d} \cdot \frac{\rho(T) \cdot c^2}{2} \text{ [Pa]}$$

Calculation of individual losses

A hydraulic system does not only incorporate pipes, but also valves, fittings, pipe bends etc. that cause flow losses. These individual losses are often much higher than the pipe losses and are calculated according to the following formula:

$$\Delta p = \zeta \cdot \rho(T) \cdot \frac{c^2}{2} \text{ [Pa]}$$

EO-Tubes – Marine and offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances.
2 DNV Straight pipe including manufacturing and corrosion tolerances.
3 Burst pressure (B.P.) calculation = Based on Tensile value, wall thickness tolerance not included.

Seamless EO steel tubes - Material E235+N / St. 37.4 (1.0308) acc. to DIN EN 10305-4

Material E235+N / St.37.4 (1.0308)		d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DNV PN bar	2 DNV PN bar		
Phosphated and oiled	Cr(VI)-free								
Order code									
R12X1.5	**R12X1.5CF**	12	±0.08	1.5	9.0	218	250	1114	0.388
R16X2	**R16X2CF**	16	±0.08	2.0	12.0	235	270	1114	0.691
R18X2	**R18X2CF**	18	±0.08	2.0	14.0	207	237	975	0.789
R20X2	**R20X2CF**	20	±0.08	2.0	16.0	185	212	867	0.888
R20X2.5	**R20X2.5CF**	20		2.5	15.0	246	282	1114	1.079
R25X2.5	**R25X2.5CF**	25	±0.08	2.5	20.0	193	221	867	1.387
R25X3	**R25X3CF**	25		3.0	19.0	242	277	1064	1.628
R30X3	**R30X3CF**	30	±0.08	3.0	24.0	198	227	867	1.998
R30X4	**R30X4CF**	30		4.0	22.0	281	323	1200	2.565
	R38X2.5CF	38	±0.15	2.5	33.0	124	141	549	2.189
R38X3	**R38X3CF**	38		3.0	32.0	154	176	669	2.589
R38X4	**R38X4CF**	38		4.0	30.0	217	248	918	3.354
R38X5	**R38X5CF**	38		5.0	28.0	282	324	1182	4.069
R42X2	**R42X2CF**	42	±0.20	2.0	38.0	85	97	390	1.973
R42X3	**R42X3CF**	42		3.0	36.0	139	158	600	2.885
R42X4	**R42X4CF**	42		4.0	34.0	194	223	821	3.748
R50X3	**R50X3CF**	50	±0.20	3.0	44.0	115	132	498	3.477
R50X6		50		6.0	38.0	258	296	1064	6.511
R60X3	**R60X3CF**	60	±0.25	3.0	54.0	95	109	411	4.217
R65X8		65	±0.30	8.0	49.0	270	310	1095	11.245
R75X3	**R75X3CF**	75	±0.35	3.0	69.0	76	86	325	5.327
R90X3.5	**R90X3.5CF**	90	±0.40	3.5	83.0	75	85	316	7.466
R100X4		100	±0.45	4.0	92.0	78	89	325	9.470
R115X4		115	±0.50	4.0	107.0	68	77	281	10.949
R140X4.5		140	±0.70	4.5	131.0	63	72	259	15.037
R165X5		165	±0.90	5.0	155.0	60	68	244	19.729
R220X6		220	±1.10	6.0	208.0	55	62	219	31.665
R273X6		273	±1.40	6.0	261.0	44	50	175	39.507

Other sizes on request

Surface finish:
- Tubes with I.D. 1.5-5 mm: outside and inside oiled.
- Tubes from 6 mm I.D.: outside and inside phosphated and oiled.
- Cr(VI)-free:
These dimensions are externally thick coat passivated (thickness of coat 8-12µm), inside oilded.

Pipes and tubes

EO-Tubes – Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance.
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance.
3 Burst pressure (B.P.) calculation acc. to Faupel-von-Mises.

Seamless EO steel tubes - Material E235+N / St.37.4 (1.0308) acc. to DIN EN 10305-4

Material E235+N / St.37.4 (1.0308)		d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DIN 2413 I static PN bar	2 DIN 2413 III dynamic PN bar		
Phosphated and oiled	Cr(VI)-free								
Order code									
R12X1.5	**R12X1.5CF**	12	±0.08	1.5	9.0	353	303	1022	0.388
R16X2	**R16X2CF**	16	±0.08	2.0	12.0	353	303	1022	0.691
R18X2	**R18X2CF**	18	±0.08	2.0	14.0	313	273	893	0.789
R20X2	**R20X2CF**	20	±0.08	2.0	16.0	282	248	793	0.888
R20X2.5	**R20X2.5CF**	20		2.5	15.0	353	303	1022	1.079
R25X2.5	**R25X2.5CF**	25	±0.08	2.5	20.0	282	248	793	1.387
R25X3	**R25X3CF**	25		3.0	19.0	338	292	975	1.628
R30X3	**R30X3CF**	30	±0.08	3.0	24.0	282	248	793	1.998
R30X4	**R30X4CF**	30		4.0	22.0	376	321	1102	2.565
	R38X2.5CF	38	±0.15	2.5	33.0	186	168	501	2.189
R38X3	**R38X3CF**	38		3.0	32.0	223	199	610	2.589
R38X4	**R38X4CF**	38		4.0	30.0	297	260	840	3.354
R38X5	**R38X5CF**	38		5.0	28.0	371	318	1085	4.069
R42X2	**R42X2CF**	42	±0.20	2.0	38.0	134	123	355	1.973
R42X3	**R42X3CF**	42		3.0	36.0	201	181	547	2.885
R42X4	**R42X4CF**	42		4.0	34.0	269	237	750	3.748
R50X3	**R50X3CF**	50	±0.20	3.0	44.0	169	154	454	3.477
R50X6		50		6.0	38.0	338	292	975	6.511
R60X3	**R60X3CF**	60	±0.25	3.0	54.0	141	129	374	4.217
R65X8		65	±0.30	8.0	49.0	347	299	1004	11.245
R75X3	**R75X3CF**	75	±0.35	3.0	69.0	113	104	296	5.327
R90X3.5	**R90X3.5CF**	90	±0.40	3.5	83.0	110	101	288	7.466
R100X4		100	±0.45	4.0	92.0	113	104	296	9.470
R115X4		115	±0.50	4.0	107.0	98	91	256	10.949
R140X4.5		140	±0.70	4.5	131.0	91	84	236	15.037
R165X5		165	±0.90	5.0	155.0	85	80	222	19.729
R220X6		220	±1.10	6.0	208.0	77	72	199	31.665
R273X6		273	±1.40	6.0	261.0	62	58	160	39.507

Other sizes on request

Surface finish:
- Tubes with I.D. 1.5-5 mm: outside and inside oiled.
- Tubes from 6 mm I.D.: outside and inside phosphated and oiled.
- Cr(VI)-free:
These dimensions are externally thick coat passivated (thickness of coat 8-12µm), inside oilded.

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EO-Tubes – Marine and Offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances.
2 DNV Straight pipe including manufacturing and corrosion tolerances.
3 Burst pressure (B.P.) calculation = Based on Tensile value, wall thickness tolerance not included.

Seamless EO steel tubes - Material E355+N / St. 52.4 (1.0580) acc. to DIN EN 10305-4

Material E355+N / St. 52.4 (1.0580)		d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DNV PN bar	2 DNV PN bar		
Phosphated and oiled	Cr(VI)-free								
Order code									
	R12X1.5ST52CF	12	±0.08	1.5	9.0	330	378	1523	0.388
R16X2ST52	**R16X2ST52CF**	16	±0.08	2.0	12.0	355	408	1523	0.691
	R18X2ST52CF	18	±0.08	2.0	14.0	313	358	1333	0.789
R20X2ST52	**R20X2ST52CF**	20	±0.08	2.0	16.0	279	319	1184	0.888
R20X2.5ST52	**R20X2.5ST52CF**	20		2.5	15.0	371	426	1523	1.079
	R25X2.5ST52CF	25		2.5	20.0	291	333	1184	1.387
R25X3ST52	**R25X3ST52CF**	25	±0.08	3.0	19.0	365	418	1454	1.628
	R25X4ST52CF	25		4.0	17.0	519	599	2030	2.072
R30X3ST52	**R30X3ST52CF**	30		3.0	24.0	299	343	1184	1.998
	R30X4ST52CF	30	±0.08	4.0	22.0	424	487	1640	2.565
	R30X5ST52CF	30		5.0	20.0	555	641	2132	3.083
	R38X3ST52CF	38		3.0	32.0	233	266	914	2,589
R38X4ST52	**R38X4ST52CF**	38	±0.15	4.0	30.0	327	375	1254	3.354
	R38X5ST52CF	38		5.0	28.0	426	490	1615	4.069
	R38X6ST52CF	38		6.0	26.0	529	611	1999	4.735
	R39X7.5ST52CF	39	±0.15	7.5	24.0	673	781	2538	5.826
	R42X3ST52CF	42		3.0	36.0	209	239	820	2.885
	R42X4ST52CF	42	±0.20	4.0	34.0	294	336	1122	3.748
	R42X5ST52CF	42		5.0	32.0	381	438	1441	4.562
	R46X8ST52CF	46	±0.20	8.0	30.0	601	695	2244	7.497
	R50X3ST52CF	50		3.0	44.0	174	199	680	3.477
R50X5ST52	**R50X5ST52CF**	50	±0.20	5.0	40.0	315	361	1184	5.549
	R50X6ST52CF	50		6.0	38.0	390	448	1454	6.511
	R50X8ST52CF	50		8.0	34.0	546	631	2030	8.286
R56X8.5ST52	**R56X8.5ST52CF**	56	±0.25	8.5	39.0	516	595	1908	9.957
	R60X3ST52CF	60		3.0	54.0	144	164	561	4.217
	R60X5ST52CF	60	±0.25	5.0	50.0	259	297	969	6.782
R60X6ST52	**R60X6ST52CF**	60		6.0	48.0	319	366	1184	7.990
	R60X8ST52CF	60		8.0	44.0	445	512	1640	10.259
	R65X8ST52CF	65	±0.30	8.0	49.0	407	468	1496	11.245
R66X8.5ST52	**R66X8.5ST52CF**	66	±0.30	8.5	49.0	429	494	1576	12.053
R73X7ST52	**R73X7ST52CF**	73	±0.35	7.0	59.0	308	353	1131	11.393
R75X5ST52	**R75X5ST52CF**	75	±0.35	5.0	65.0	205	234	761	8.631
R75X12.5ST52		75		12.5	50.0	583	674	2132	19.266
R80X3ST52		80		3.0	74.0	107	122	415	5.697
R80X8ST52		80	±0.35	8.0	64.0	325	372	1184	14.205
R80X10ST52		80		10.0	60.0	418	481	1523	17.263
R88X14ST52		88	±0.40	14.0	60.0	554	640	2017	25.549
R90X3.5ST52		90		3.5	83.0	113	129	431	7.466
R90X5ST52		90	±0.40	5.0	80.0	169	193	627	10.481
R90X9ST52		90		9.0	72.0	326	374	1184	17.978
R97X12ST52		97	±0.45	12.0	73.0	416	478	1505	25.154
R115X15ST52		115	±0.50	15.0	85.0	444	511	1599	36.992
R120X20ST52		120	±0.50	20.0	80.0	590	682	2132	49.322
R130X15ST52		130	±0.70	15.0	100.0	388	445	1390	42.540
R150X15ST52		150	±0.80	15.0	120.0	332	380	1184	49.939
R190X20ST52		190	±1.00	20.0	150.0	353	405	1254	83.847
R250X25ST52		250	±1.30	25.0	200.0	335	384	1184	138.718

Other sizes on request

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Pipes and tubes

EO-Tubes – Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance.
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance.
3 Burst pressure (B.P.) calculation acc. to Faupel-von-Mises.

Seamless EO steel tubes - Material E355+N / St. 52.4 (1.0580) acc. to DIN EN 10305-4

Material E355+N / St. 52.4 (1.0580)		d_a Outer-Ø (mm)	OuterØ Tolerance (mm)	s Wal-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DIN 2413 I static PN bar	2 DIN 2413 III dynamic PN bar		
Phosphated and oiled	Cr(VI)-free								
Order code									
	R12X1.5ST52CF	12	±0.08	1,5	9.0	533	357	1504	0.388
R16X2ST52	**R16X2ST52CF**	16	±0.08	2.0	12.0	533	357	1504	0.691
	R18X2ST52CF	18	±0.08	2.0	14.0	473	321	1314	0.789
R20X2ST52	**R20X2ST52CF**	20	±0.08	2.0	16.0	426	292	1167	0.888
R20X2.5ST52	**R20X2.5ST52CF**	20		2.5	15.0	533	357	1504	1.079
	R25X2.5ST52CF	25		2.5	20.0	426	292	1167	1.387
R25X3ST52	**R25X3ST52CF**	25	±0.08	3.0	19.0	511	344	1435	1.628
	R25X4ST52CF	25		4.0	17.0	682	445	2016	2.072
R30X3ST52	**R30X3ST52CF**	30		3.0	24.0	426	292	1167	1.998
	R30X4ST52CF	30	±0.08	4.0	22.0	568	379	1622	2.565
	R30X5ST52CF	30		5.0	20.0	710	461	2120	3.083
	R38X3ST52CF	38		3.0	32.0	336	234	899	2.589
R38X4ST52	**R38X4ST52CF**	38	±0.15	4.0	30.0	448	306	1236	3.354
	R38X5ST52CF	38		5.0	28.0	561	374	1597	4.069
	R38X6ST52CF	38		6.0	26.0	673	440	1984	4.735
	R39X7.5ST52CF	39	±0.15	7.5	24.0	819	521	2539	5.826
	R42X3ST52CF	42		3.0	36.0	304	213	806	2.885
	R42X4ST52CF	42	±0.20	4.0	34.0	406	279	1105	3.748
	R42X5ST52CF	42		5.0	32.0	507	342	1422	4.562
	R46X8ST52CF	46	±0.20	8.0	30.0	741	478	2235	7.497
	R50X3ST52CF	50		3.0	44.0	256	181	668	3.477
R50X5ST52	**R50X5ST52CF**	50	±0.20	5.0	40.0	426	292	1167	5.549
	R50X6ST52CF	50		6.0	38.0	511	344	1435	6.511
	R50X8ST52CF	50		8.0	34.0	682	445	2016	8.286
R56X8.5ST52	**R56X8.5ST52CF**	56	±0.25	8.5	39.0	647	425	1892	9.957
	R60X3ST52CF	60		3.0	54.0	213	152	551	4.217
	R60X5ST52CF	60	±0.25	5.0	50.0	355	247	953	6.782
R60X6ST52	**R60X6ST52CF**	60		6.0	48.0	426	292	1167	7.990
	R60X8ST52CF	60		8.0	44.0	568	379	1622	10.259
	R65X8ST52CF	65	±0.30	8.0	49.0	524	352	1477	11.245
R66X8.5ST52	**R66X8.5ST52CF**	66	±0.30	8.5	49.0	549	367	1557	12.053
R73X7ST52	**R73X7ST52CF**	73	±0.35	7.0	59.0	408	281	1113	11.393
R75X5ST52	**R75X5ST52CF**	75	±0.35	5.0	65.0	284	200	748	8.631
R75X12.5ST52		75		12.5	50.0	710	461	2120	19.266
R80X3ST52		80		3.0	74.0	160	115	408	5.697
R80X8ST52		80	±0.35	8.0	64.0	426	292	1167	14.205
R80X10ST52		80		10.0	60.0	533	357	1504	17.263
R88X14ST52		88	±0.40	14.0	60.0	678	443	2002	25.549
R90X3.5ST52		90		3.5	83.0	166	119	423	7.466
R90X5ST52		90	±0.40	5.0	80.0	237	168	616	10.481
R90X9ST52		90		9.0	72.0	426	292	1167	17.978
R97X12ST52		97	±0.45	12.0	73.0	527	354	1486	25.154
R115X15ST52		115	±0.50	15.0	85.0	556	371	1580	36.992
R120X20ST52		120	±0.50	20.0	80.0	710	461	2120	49.322
R130X15ST52		130	±0.70	15.0	100.0	492	332	1372	42.540
R150X15ST52		150	±0.80	15.0	120.0	426	292	1167	49.939
R190X20ST52		190	±1.00	20.0	150.0	448	306	1236	83.847
R250X25ST52		250	±1.30	25.0	200.0	426	292	1167	138.718

Other sizes on request

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EO-Tubes – Marine and Offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances.
2 DNV Straight pipe including manufacturing and corrosion resistance.
3 Burst pressure (B.P.) calculation = Based on Tensile value, wall thickness tolerance not included.

Seamless cold drawn EO stainless steel tube - Material 316 Ti (1.4571) acc. to ASTM A269/A213, DIN EN 10305-4

Material 316Ti (1.4571) Surface bright annealed Order code	d_a Outer-Ø (mm)	OuterAußen-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure 1 DNV PN bar	Design pressure 2 DNV PN bar	3 Burst pressure bar	Weight kg/m
R12X1.571	12	±0.08	1.5	9.0	380	437	1514	0.394
R16X271	16	±0.08	2.0	12.0	380	437	1514	0.701
R18X271	18	±0.08	2.0	14.0	334	383	1325	0.801
R20X271	20	±0.08	2.0	16.0	298	341	1178	0.901
R20X2.571	20		2.5	15.0	380	437	1514	1.096
R25X2.571	25	±0.08	2.5	20.0	298	341	1178	1.409
R25X371	25		3.0	19.0	363	418	1445	1.653
R30X371	30	±0.08	3.0	24.0	298	341	1178	2.028
R30X471	30		4.0	22.0	409	470	1631	2.604
R38X2.571	38	±0.15	2.5	33.0	190	217	746	2.222
R38X471	38		4.0	30.0	315	361	1247	3.405
R42X371	42	±0.20	3.0	36.0	207	237	815	2.930

Other sizes on request

Pipes and tubes

EO-Tubes - Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance.
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance.
3 Burst pressure (B.P.) calculation acc. to Faupel-von-Mises.

Seamless cold drawn EO stainless steel tube - Material 316 Ti (1.4571) acc. to ASTM A269/A213, DIN EN 10305-4

Material 316Ti (1.4571) / Surface bright annealed / Order code	d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure 1 DIN 2413 I static PN bar	Design pressure 2 DIN 2413 III dynamic PN bar	3 Burst pressure bar	Weight kg/m
R12X1.571	12	±0.08	1.5	9.0	368	297	1229	0.394
R16X271	16	±0.08	2.0	12.0	368	297	1229	0.701
R18X271	18	±0.08	2.0	14.0	327	267	1074	0.801
R20X271	20	±0.08	2.0	16.0	294	242	953	0.901
R20X2.571	20		2.5	15.0	368	297	1229	1.096
R25X2.571	25	±0.08	2.5	20.0	294	242	953	1.409
R25X371	25		3.0	19.0	353	286	1172	1.653
R30X371	30	±0.08	3.0	24.0	294	242	958	2.028
R30X471	30		4.0	22.0	392	314	1325	2.604
R38X2.571	38	±0.15	2.5	33.0	193	164	603	2.222
R38X471	38		4.0	30.0	309	254	1010	3.405
R42X371	42	±0.20	3.0	36.0	210	177	659	2.930

Other sizes on request

EO-Tubes – Marine and Offshore applications (DNV Rules)

1 DNV Bended pipe including manufacturing and corrosion tolerances.
2 DNV Straight pipe including manufacturing and corrosion tolerances.
3 Burst pressure (B.P.) calculation = Based on Tensile value, wall thickness tolerance not included.

Seamless cold drawn EO stainless steel tube - Material 316L (1.4404) acc. to ASTM A269/A213, DIN EN 10305-4

Material 316L (1.4404)		d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DNV PN bar	2 DNV PN bar		
pickled	bright annealed								
Order code									
	R12X1.5-316BA	12	±0.08	1.5	9.0	380	437	1514	0.394
R16X2-316		16	±0.08	2.0	12.0	380	437	1514	0.701
R18X2-316		18	±0.08	2.0	14.0	334	383	1325	0.801
R20X2-316		20	±0.08	2.0	16.0	298	341	1178	0.901
R20X2.5-316		20		2.5	15.0	380	437	1514	1.096
R25X2.5-316		25	±0.08	2.5	20.0	298	341	1178	1.409
R25X3-316		25		3.0	19.0	363	418	1445	1.653
R30X3-316		30	±0.08	3.0	24.0	298	341	1178	2.028
R30X4-316		30		4.0	22.0	409	470	1631	2.604
R38X2.5-316		38	±0.15	2.5	33.0	190	217	746	2.222
R38X3-316		38		3.0	32.0	231	264	909	2.629
R38X4-316		38		4.0	30.0	315	361	1247	3.405
R38X5-316		38		5.0	28.0	403	463	1606	4.132
R42X3-316		42	±0.20	3.0	36.0	207	237	815	2.930
R50X3-316		50	±0.20	3.0	44.0	173	197	677	3.531
R50X5-316		50		5.0	40.0	298	341	1178	5.634
R50X6-316		50		6.0	38.0	363	418	1445	6.611
R60X3-316		60	±0.25	3.0	54.0	143	163	558	4.282
R60X5-316		60		5.0	50.0	244	280	964	6.886
R60X6-316		60		6.0	48.0	298	341	1178	8.113
R66X8.5-316		66	±0.30	8.5	49.0	393	452	1567	12.238
R73X7-316		73	±0.35	7.0	59.0	284	326	1124	11.568
R75X3-316		75	±0.35	3.0	69.0	113	129	442	5.409
R75X5-316		75		5.0	65.0	193	220	757	8.764
R80X10-316		80	±0.35	10.0	60.0	380	437	1514	17.528

Other sizes on request

EO-Tubes - Landbased and industrial applications (DIN Rules)

1 DIN 2413 I static pressure (W.P.) capability for straight pipe including manufacturing tolerance.
2 DIN 2413 III dynamic pressure (W.P.) capability for straight pipe including manufacturing tolerance.
3 Burst pressure (B.P.) calculation acc. to Faupel-von-Mises.

Seamless cold drawn EO stainless steel tube - Material 316L (1.4404) acc. to ASTM A269/A213, DIN EN 10305-4

Material 316L (1.4404)		d_a Outer-Ø (mm)	Outer-Ø Tolerance (mm)	s Wall-thickness (mm)	d_i Inner-Ø (mm)	Design pressure		3 Burst pressure bar	Weight kg/m
Surface						1 DIN 2413 I static PN bar	2 DIN 2413 III dynamic PN bar		
pickled	bright annealed								
Order code									
	R12X1.5-316BA	12	±0.08	1.5	9.0	368	297	1229	0.394
R16X2-316		16	±0.08	2.0	12.0	368	297	1229	0.701
R18X2-316		18	±0.08	2.0	14.0	327	267	1074	0.801
R20X2-316		20	±0.08	2.0	16.0	294	242	953	0.901
R20X2.5-316		20		2.5	15.0	368	297	1229	1.096
R25X2.5-316		25	±0.08	2.5	20.0	294	242	953	1.409
R25X3-316		25		3.0	19.0	353	286	1172	1.653
R30X3-316		30	±0.08	3.0	24.0	294	242	953	2.028
R30X4-316		30		4.0	22.0	392	314	1325	2.604
R38X2.5-316		38	±0.15	2.5	33.0	193	164	603	2.222
R38X3-316		38		3.0	32.0	232	195	734	2.629
R38X4-316		38		4.0	30.0	309	254	1010	3.405
R38X5-316		38		5.0	28.0	387	311	1305	4.132
R42X3-316		42	±0.20	3.0	36.0	210	177	659	2.930
R50X3-316		50	±0.20	3.0	44.0	176	150	546	3.531
R50X5-316		50		5.0	40.0	294	242	953	5.634
R50X6-316		50		6.0	38.0	353	286	1172	6.611
R60X3-316		60	±0.25	3.0	54.0	147	126	450	4.282
R60X5-316		60		5.0	50.0	245	205	779	6.886
R60X6-316		60		6.0	48.0	294	242	953	8.113
R66X8.5-316		66	±0.30	8.5	49.0	379	305	1272	12.238
R73X7-316		73	±0.35	7.0	59.0	282	233	910	11.568
R75X3-316		75	±0.35	3.0	69.0	118	102	356	5.409
R75X5-316		75		5.0	65.0	196	166	611	8.764
R80X10-316		80	±0.35	10.0	60.0	368	297	1229	17.528

Other sizes on request

EO-Tubes - Scheduled sizes

Pressure table acc. to DNV Rules for Classification fo Ships Newbuilding and Mobile Offshore Units Drilling Plants.
1 DNV Bended pipe including manufacturing and corrosion tolerances.
2 DNV Straight pipe including manufacturing and corrosion tolerances.
3 Burst pressure (B.P.) calculation = Bases on Tensile value, wall thickness tolerance not included.

Seamless stainless steel tubes - Material 316L (1.4404) acc. to ASTM A 312/A999

Material 316L (1.4404) Surface pickled Order code	d_a Outer-Ø SCH	d_a Outer-Ø mm	s Wallthickness SCH	s Wallthickness mm	d_i Inner-Ø (mm)	Design pressure 1 DNV PN bar	Design pressure 2 DNV PN bar	3 Burst pressure bar	Weight kg/m
R21.34X2.11-316	1/2"	21,.34	SCH 10	2.11	17.12	241	277	1130	1.014
R21.34X2.77-316			SCH 40	2.77	15.80	325	374	1536	1.285
R21.34X3.73-316			SCH 80	3.73	13.88	456	527	2182	1.641
R21.34X4.78-316			SCH 160	4.78	11.78	611	712	2973	1.977
R26.67X2.11-316	3/4"	26.67	SCH 10	2.11	24.56	190	217	885	1.299
R26.67X2.81-316			SCH 40	2.81	21.05	259	297	1213	1.713
R26.67X3.91-316			SCH 80	3.91	18.85	373	430	1769	2.231
R26.67X5.56-316			SCH 160	5.56	15.55	560	651	2713	2.943
R33.40X2.77-316-A999	1"	33.40	SCH 10	2.77	27.86	200	228	931	2.125
R33.40X3.38-316-A999			SCH 40	3.38	30.02	247	284	1160	2.541
R33.40X4.55-316-A999			SCH 80	4.55	24.30	343	395	1624	3.287
R33.40X6.35-316-A999			SCH 160	6.35	20.70	502	583	2418	4.301
R42.16X2.77-316-A999	1 1/4"	42.16	SCH 10	2.77	36.62	156	178	724	2.735
R42.16X3.56-316-A999			SCH 40	3.56	35.04	204	233	950	3.444
R42.16X4.85-316-A999			SCH 80	4.85	32.46	285	327	1339	4.536
R42.16X6.35-316-A999			SCH 160	6.35	29.46	384	443	1826	5.700
R48.26X2.77-316-A999	1 1/2"	48.26	SCH 10	2.77	42.72	135	154	627	3.158
R48.26X3.68-316-A999			SCH 40	3.68	40.90	183	209	850	4.112
R48.26X5.08-316-A999			SCH 80	5.08	38.10	258	296	1212	5.498
R48.26X7.14-316-A999			SCH 160	7.14	33.98	377	434	1788	7.359
R60.33X2.77-316-A999	2"	60.33	SCH 10	2.77	54.76	107	122	496	3.990
R60.33X3.91-316-A999			SCH 40	3.91	52.48	154	176	714	5.521
R60.33X5.54-316-A999			SCH 80	5.54	49.22	223	255	1041	7.596
R60.33X8.74-316-A999			SCH 160	8.74	42.82	368	424	1745	11.284
R73.03X3.05-316-A999	2 1/2"	73.03	SCH 10	3.05	66.90	97	111	449	5.342
R73.03X5.16-316-A999			SCH 40	5.16	62.68	168	192	783	8.765
R73.03X7.01-316-A999			SCH 80	7.01	58.98	234	268	1094	11.583
R73.03X9.53-316-A999			SCH 160	9.53	53.94	327	376	1546	15.146
R88.90X3.05-316	3"	88.90	SCH 10	3.05	82.80	79	90	366	6.557
R88.90X5.49-316-A999			SCH 40	5.49	77.92	146	167	678	11.466
R88.90X7.62-316-A999			SCH 80	7.62	73.56	207	237	966	15.509
R88.90X11.13-316-A999			SCH 160	11.13	66.64	312	359	1474	21.674
R114.30X3.05-316	4"	114.30	SCH 10	3.05	108.20	61	70	282	8.496
R114.30X6.02-316-A999			SCH 40	6.02	102.16	124	141	573	16.322
R114.30X8.56-316-A999			SCH 80	8.56	97.18	179	205	834	22.665
R114.30X13.49-316-A999			SCH 160	13.49	87.32	293	336	1378	34.053
R141.30X6.55-316-A999	5"	141.30	SCH 40	6.55	128.20	108	123	501	22.101
R141.30X9.53-316-A999			SCH 80	9.53	122.24	160	183	745	31.444
R141.30X15.88-316-A999			SCH 160	15.88	109.54	277	318	1304	49.871
R168.28X3.40-316	6"	168.28	SCH 10	3.40	161.48	46	53	212	14.039
R168.28X7.11-316-A999			SCH 40	7.11	154.08	98	112	454	28.697
R168.28X18.26-316-A999			SCH 160	18.26	131.78	267	306	1254	68.603
R219.08X8.18-316	8"	219.08	SCH 40	8.18	202.74	87	99	399	43.202
R219.08X23.01-316-A999			SCH 160	23.01	173.08	258	296	1209	112.981

Other sizes on request

Temperature conversion table

Celsius to Fahrenheit

°C	°F
150	302
145	293
140	284
135	275
130	266
125	257
120	248
115	239
110	230
105	221
100	212
95	203
90	194
85	185
80	176
75	167
70	158
65	149
60	140
55	131
50	122
45	113
40	104
35	95
30	86
25	77
20	68
15	59
10	50
5	41
0	32
-5	23
-10	14
-15	5
-20	-4
-25	-13
-30	-22
-35	-31
-40	-40
-45	-49
-50	-58

Fahrenheit to Celsius

°F	°C
340	171
330	166
320	160
310	154
300	149
290	143
280	138
270	132
260	127
250	121
240	116
230	110
220	104
210	99
200	93
190	88
180	82
170	77
160	71
150	66
140	60
130	54
120	49
110	43
100	38
90	32
80	27
70	21
60	16
50	10
40	4
30	-1
20	-7
10	-12
0	-18
-10	-23
-20	-29
-30	-34
-40	-40
-50	-46
-60	-51

Pressure conversion table

bar to psi

bar	psi
1000	14505
800	11604
600	8703
500	7253
400	5802
250	3626
160	2321
100	1451
60	870
40	580
35	508
25	363
16	232
10	145
6	87
4	58
2.5	36
1.6	23
1	15

psi to bar

psi	bar
10000	689
9000	620
7000	483
6000	414
4000	276
3000	207
2500	172
1000	69
900	62
600	41
500	34
400	28
250	17
150	10.3
100	6.9
90	6.2
60	4.1
40	2.8
25	1.7
10	0.7

Examples

Temperature conversion

Initial value: 100
°C in °F: 212 °F
°F in °C: 37.78 °C

Pressure conversion

Initial value: 35
bar in psi: 507.675 psi
psi in bar: 2.41296 bar