Design of Process Equipment

Piping Systems

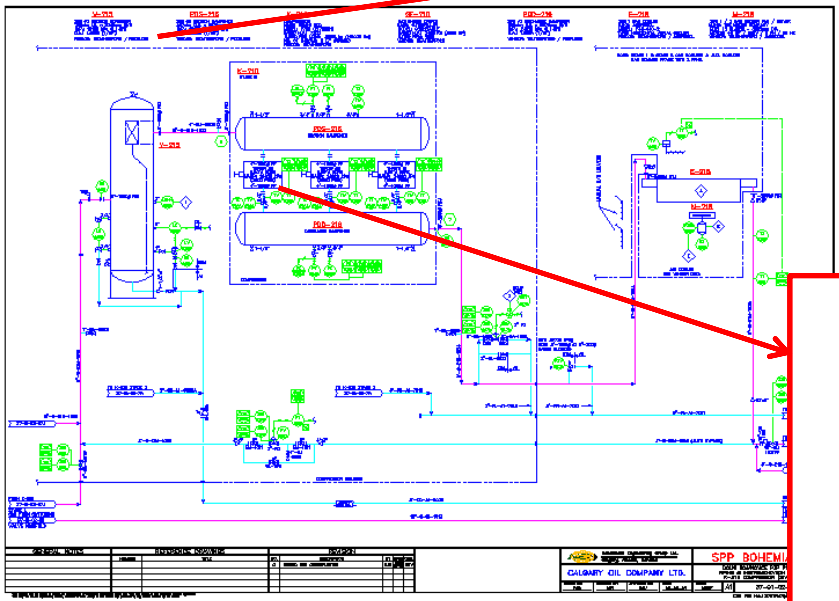
Lecture

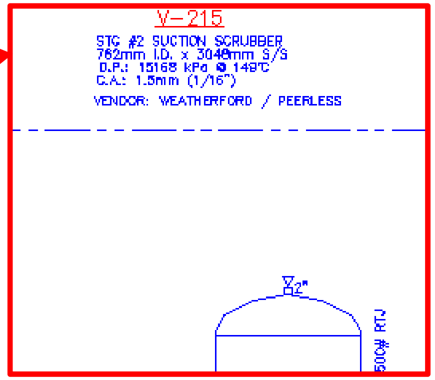
doc. Ing. Martin Juriga, PhD.

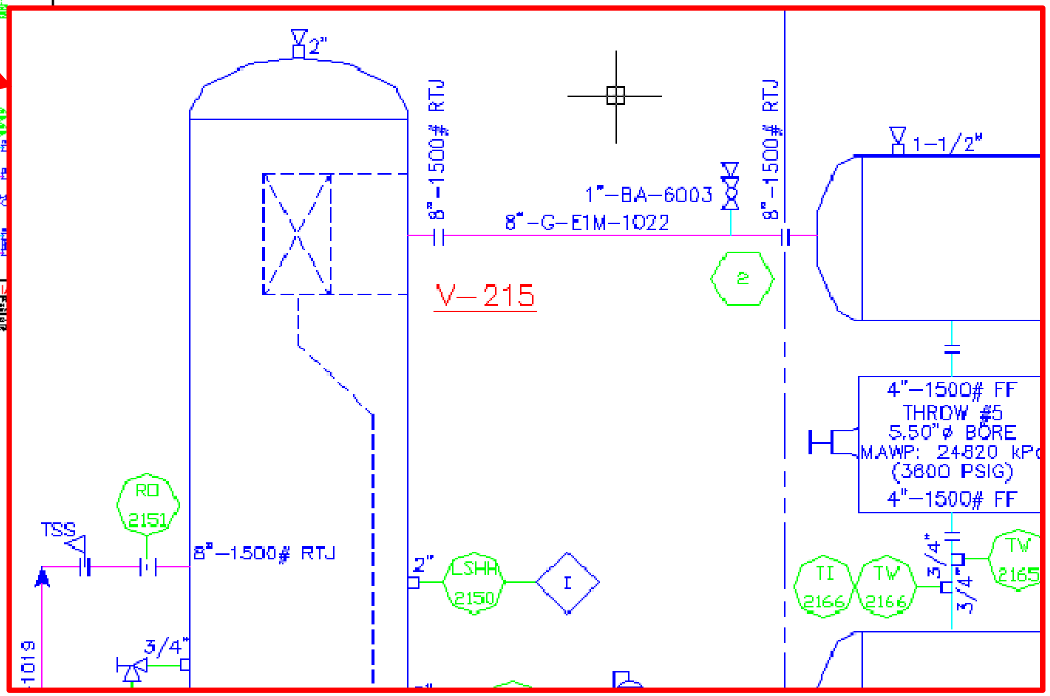
Bratislava, February 2024

Piping system.

P&ID



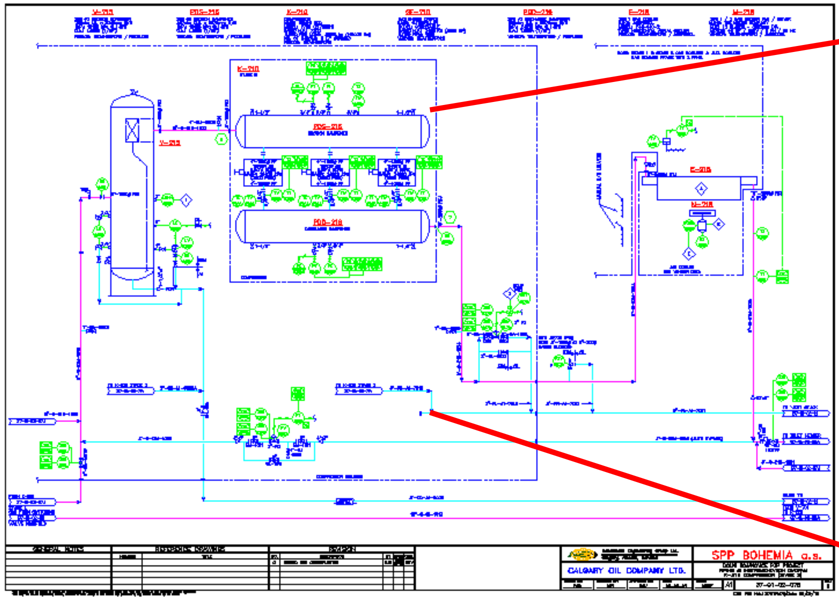




Process design
Mechanical design

Piping system. Process design

P&ID



Process design for pipelines

Calculation of pipeline pressure losses

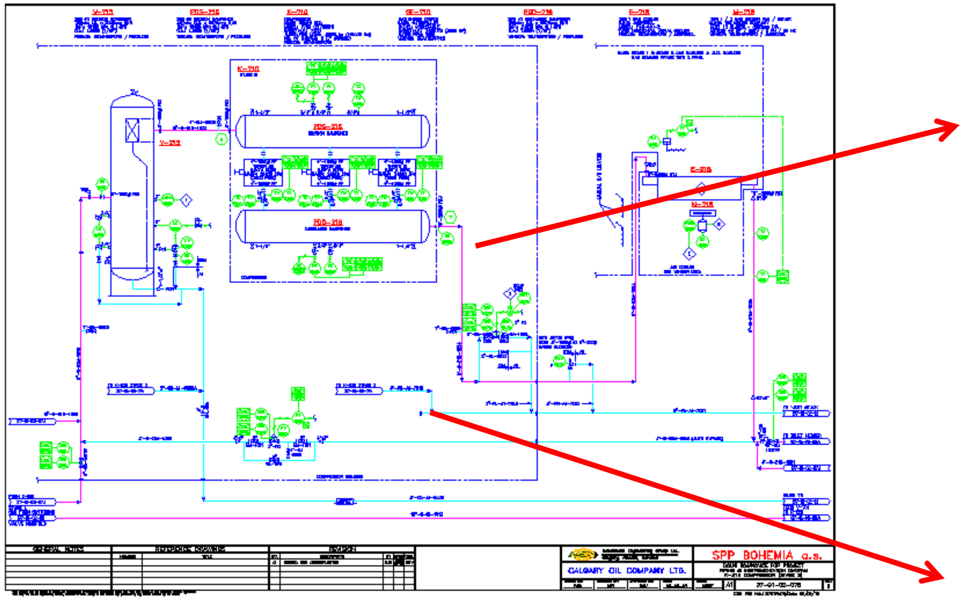
Design and optimization Controls valves and safety valves, etc.

Design and optimization of energy sources in pipeline systems (pumps, compressors, etc.)

Energy aspects of transport in pipelines (losses of energy to the surroundings, etc.)

Piping system. Mechanical design

P&ID



Mechanical design of the pipeline

Design of Pipe Class and optimization

Calculation of wall thicknesses for individual pipeline components with respect to the chosen calculation standard (Europe: EN 13 480, USA: Power Piping 31.1, Process Piping 31.3)

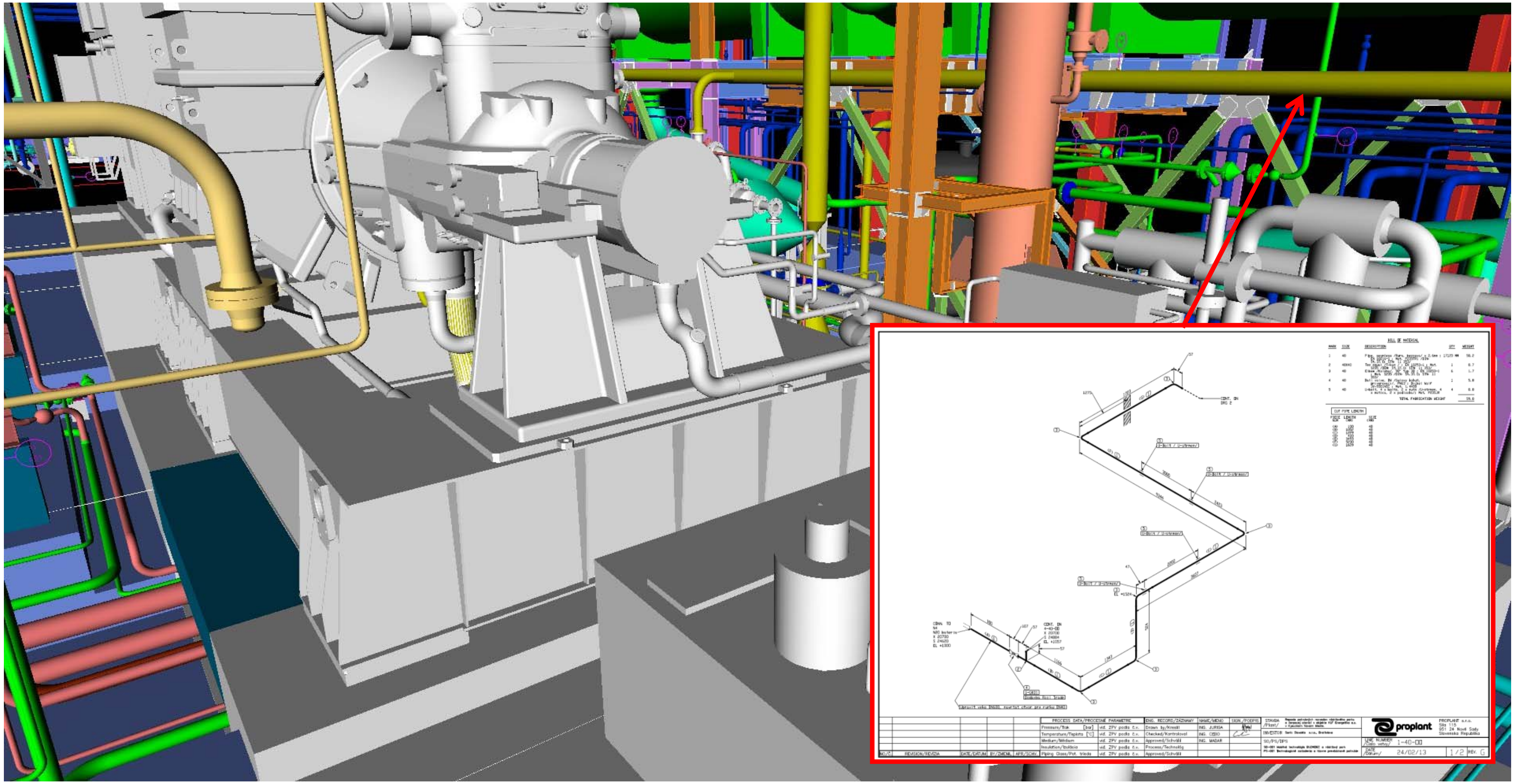
Complete structural design - 3D model (assembly, production drawings)

Stress design of pipelines, determination of stress in pipeline, reactions to restrains, control of forces on apparatus nozzles.

Solving dynamic tasks in pipelines (water hammer, vibrations, etc....)

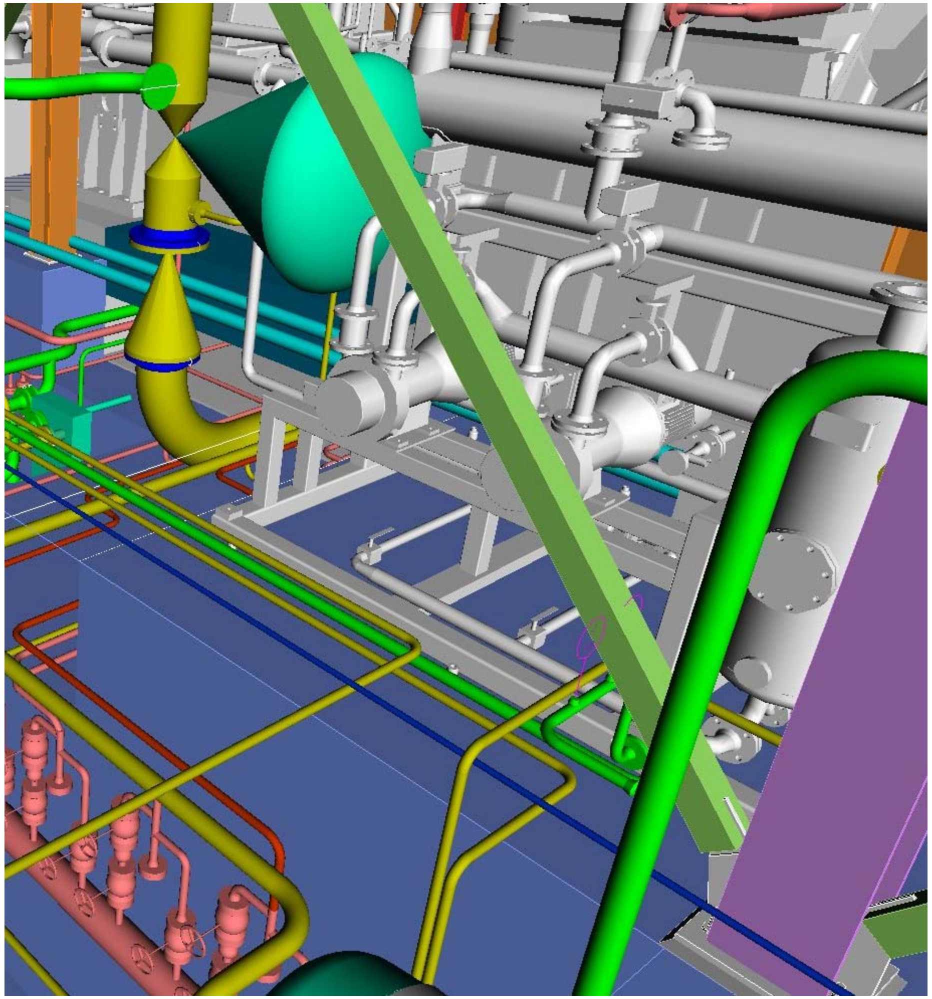
Piping system. Mechanical design

3D model and drawing outputs

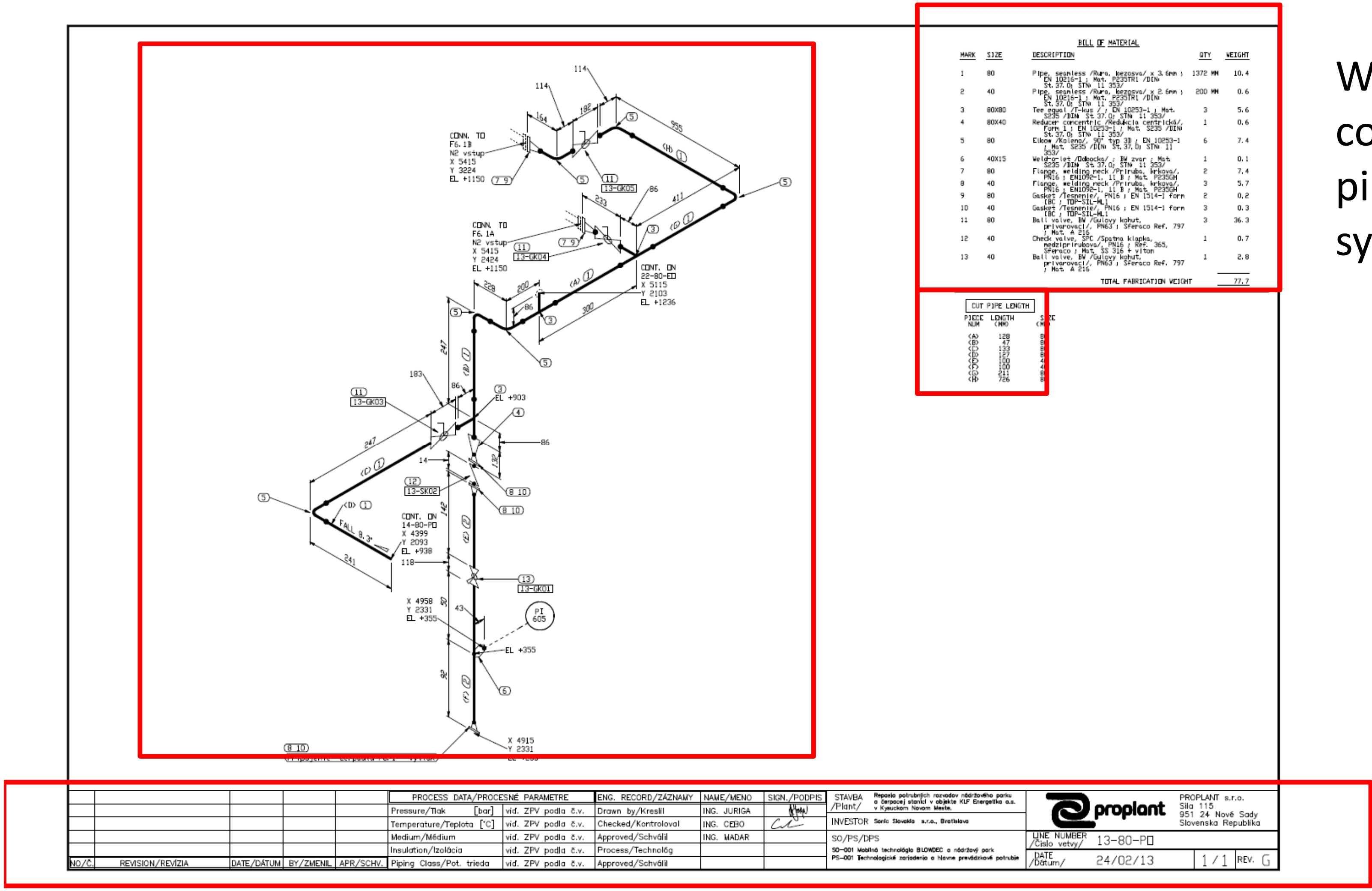


Piping system. Mechanical design

- a lot of attention, especially pipeline II. and III. Categories. (high temperature, high pressure)
- stress calculation (EN, ASME, BS)
- optimization
- design of suitable compensation elements / expansion joint …etc/
- Design of pipe supports
- analysis of the nozzle connection
- detailed analysis of possible all load cases.



Isometric drawing.



What does it consist of pipeline system?

Isometric drawing.

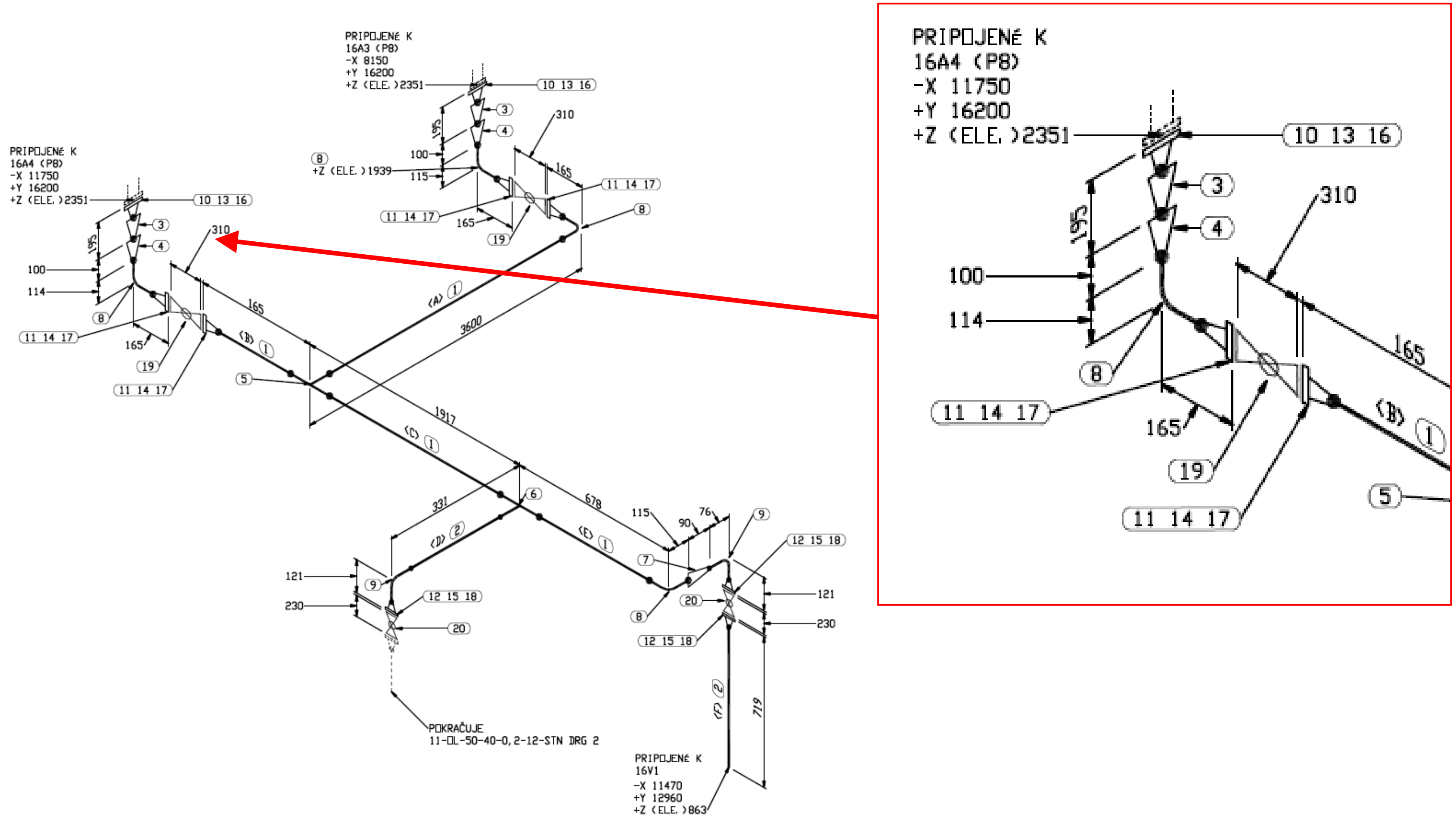
ZOZNAM MATERIÁLU

OZN.	DN/ROZ.	POPIS	QTY	HMOTN.
1	80	Rúrka, Hrúbka steny 3.6	5652 MM	42.8
2	50	Rúrka, Hrúbka steny 3.2	853 MM	3.9
3	150X100	Reducia, centrická časť 1 DIN2616	2	4.6
4	100X80	Reducia, centrická časť 1 DIN2616	2	1.9
5	80X80	T-kus, štandart časť 1 DIN2615	1	1.9
6	80X50	T-kus, redukcia časť 1 DIN2615	1	1.9
7	80X50	Reducia, centrická časť 1 DIN2616	1	0.6
8	80	90° Koleno DIN2606, časť 1, typ 3, R=1,5D	4	4.9
9	50	90° Koleno DIN2606, časť 1, typ 3, R=1,5D	2	1.0
10	150	Príruba krková, RFWN PN16 DIN 2633	2	15.5
11	80	Príruba krková, RFWN PN16 DIN 2633	4	14.8
12	50	Príruba krková, RFWN PN16 DIN 2633	3	7.6
13	150	Tesnenie, 3mm, DN16	2	2.0
14	80	Tesnenie, 3mm, DN16	4	4.0
15	50	Tesnenie, 3mm, DN16	3	3.0
16	20X110	(8) ks - Komplet (Skrutka,matica,podložka) pre PN16	2	2.0
17	16X65	(8) ks - Komplet (Skrutka,matica,podložka) pre PN16	4	4.9
18	16X60	(4) ks - Komplet (Skrutka,matica,podložka) pre PN16	3	1.8
19	80	Gulový kohút, PN 16 Prírubový, ZEUS Typ K91.1 (Armatury Group)	2	85.0
20	50	Gulový kohút, PN 16 Prírubový, ZEUS Typ K91.1 (Armatury Group)	2	42.6
		CELKOVÁ HMOTNOSŤ		yyyyyyyy 246.2 yyyyyyyy

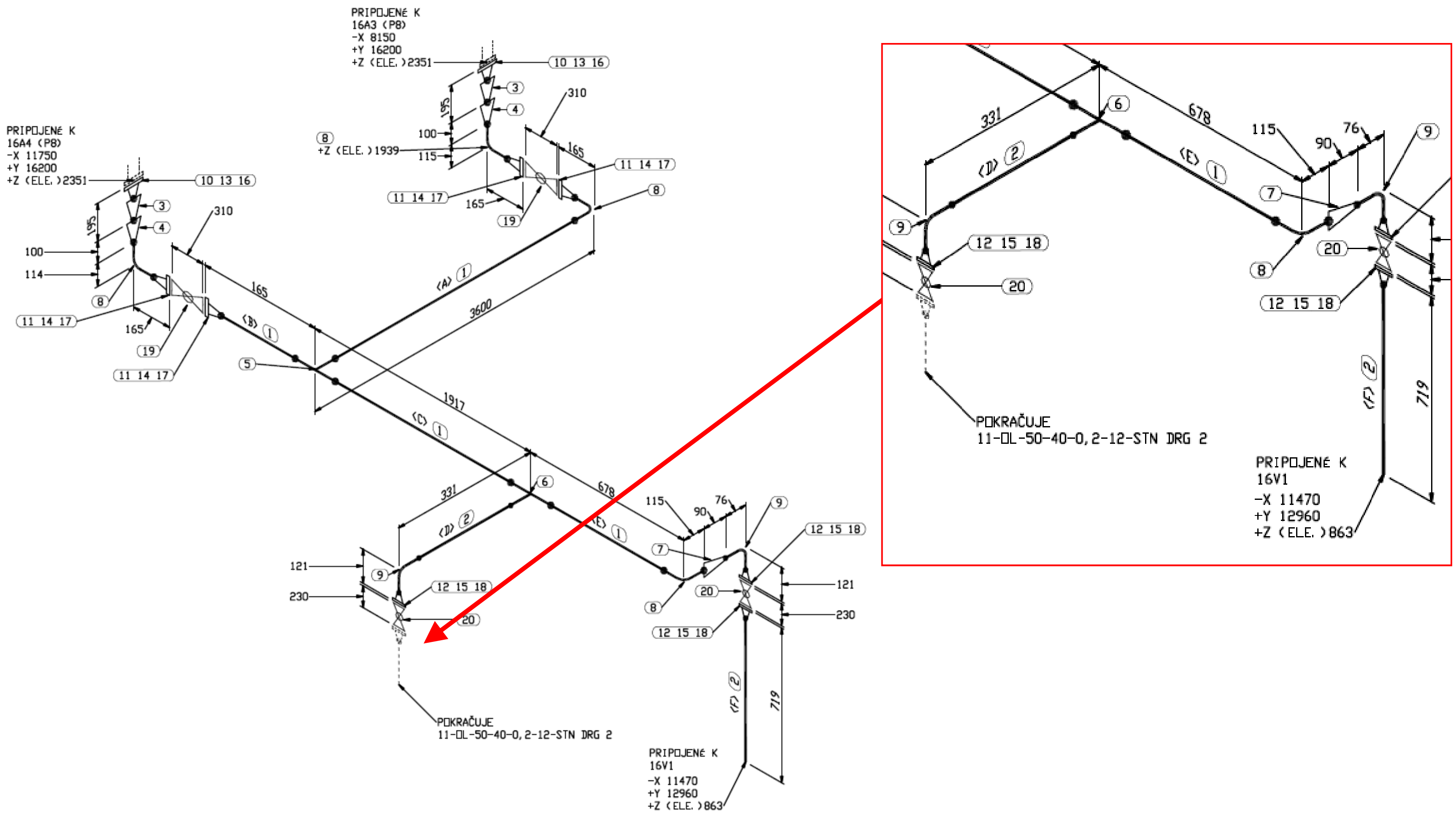
PRESNÁ DLŽKA RÚRKY

PIECE NUM	LENGTH (MM)	SIZE (MM)
<A>	3400	80
<B>	29	80
<C>	1745	80
<D>	179	50
<E>	478	80
<F>	674	50

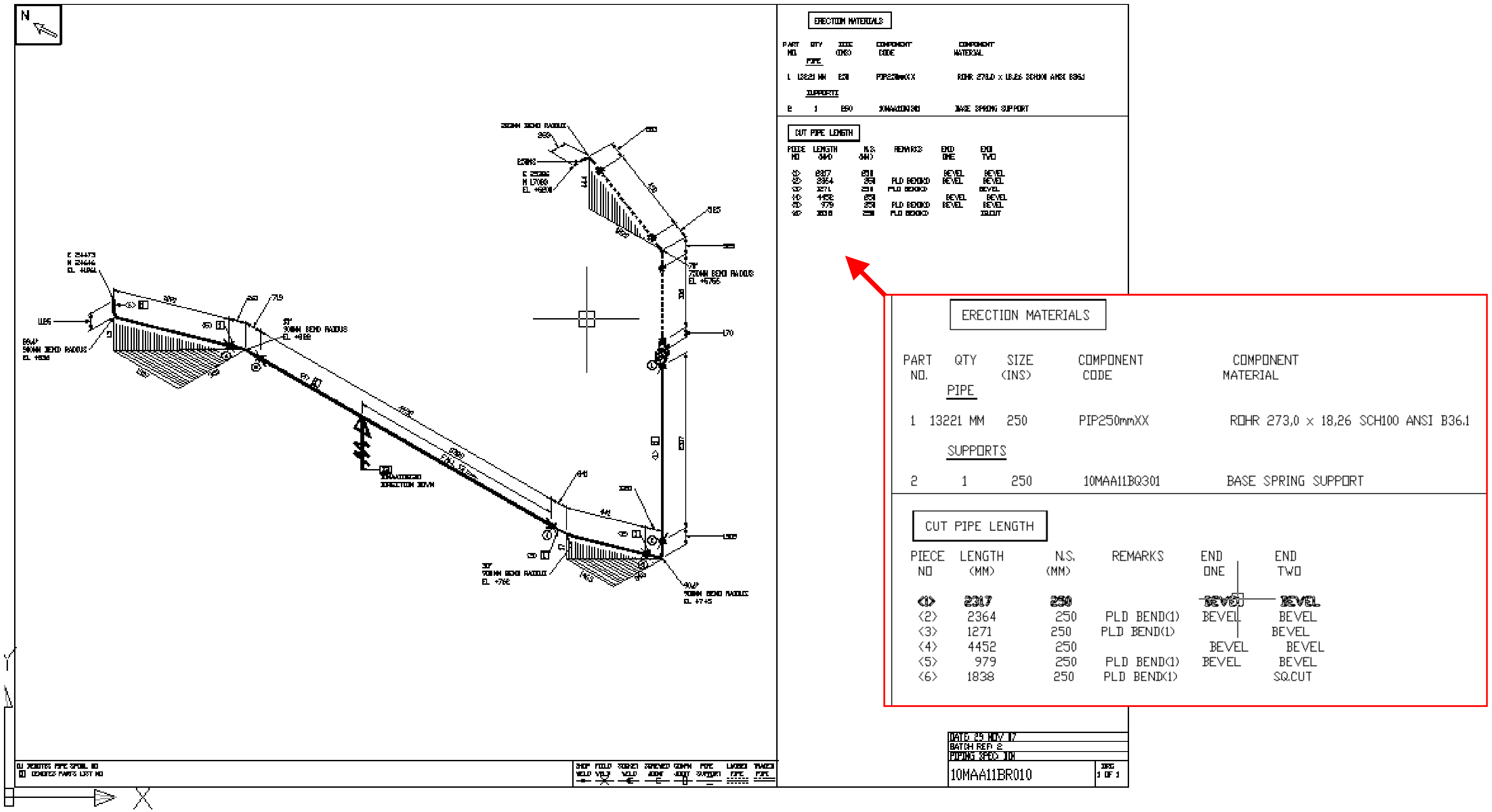
Isometric drawing.



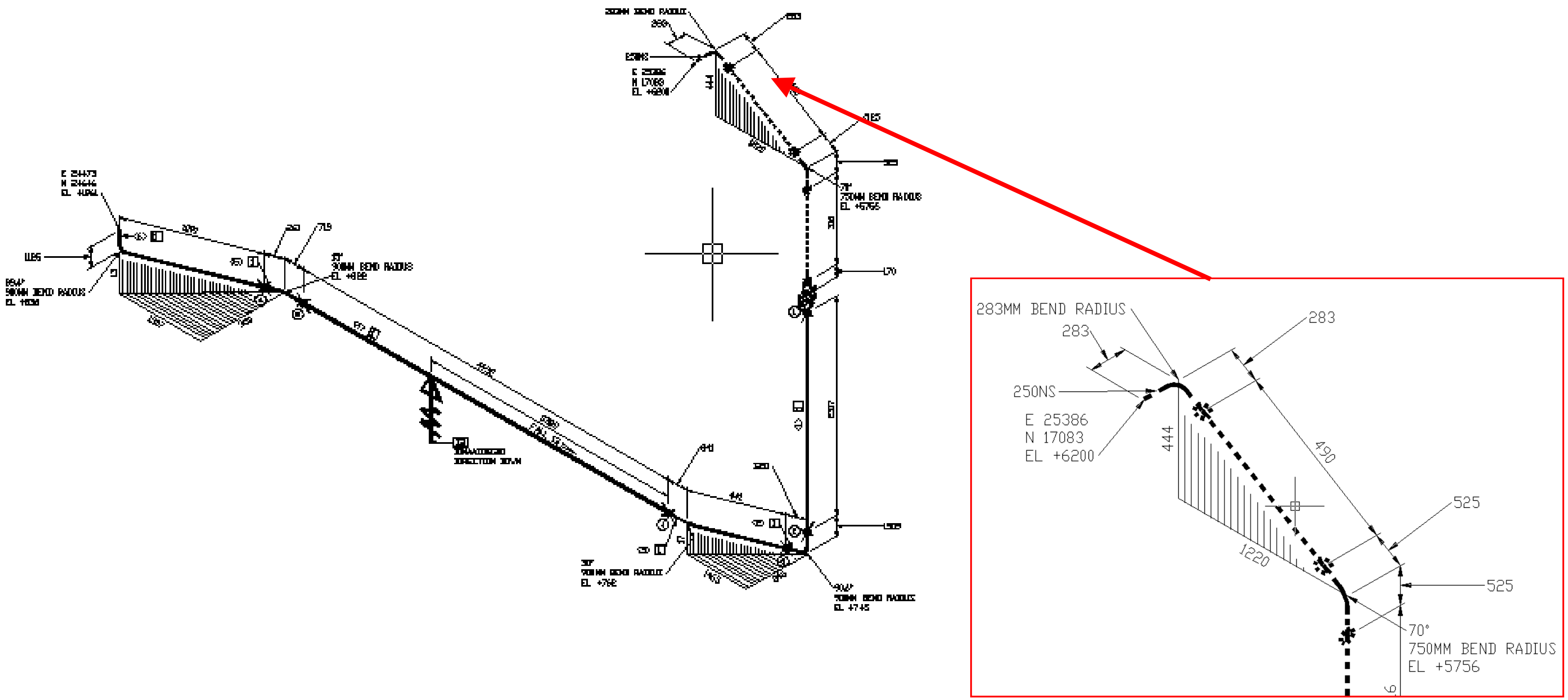
Isometric drawing.



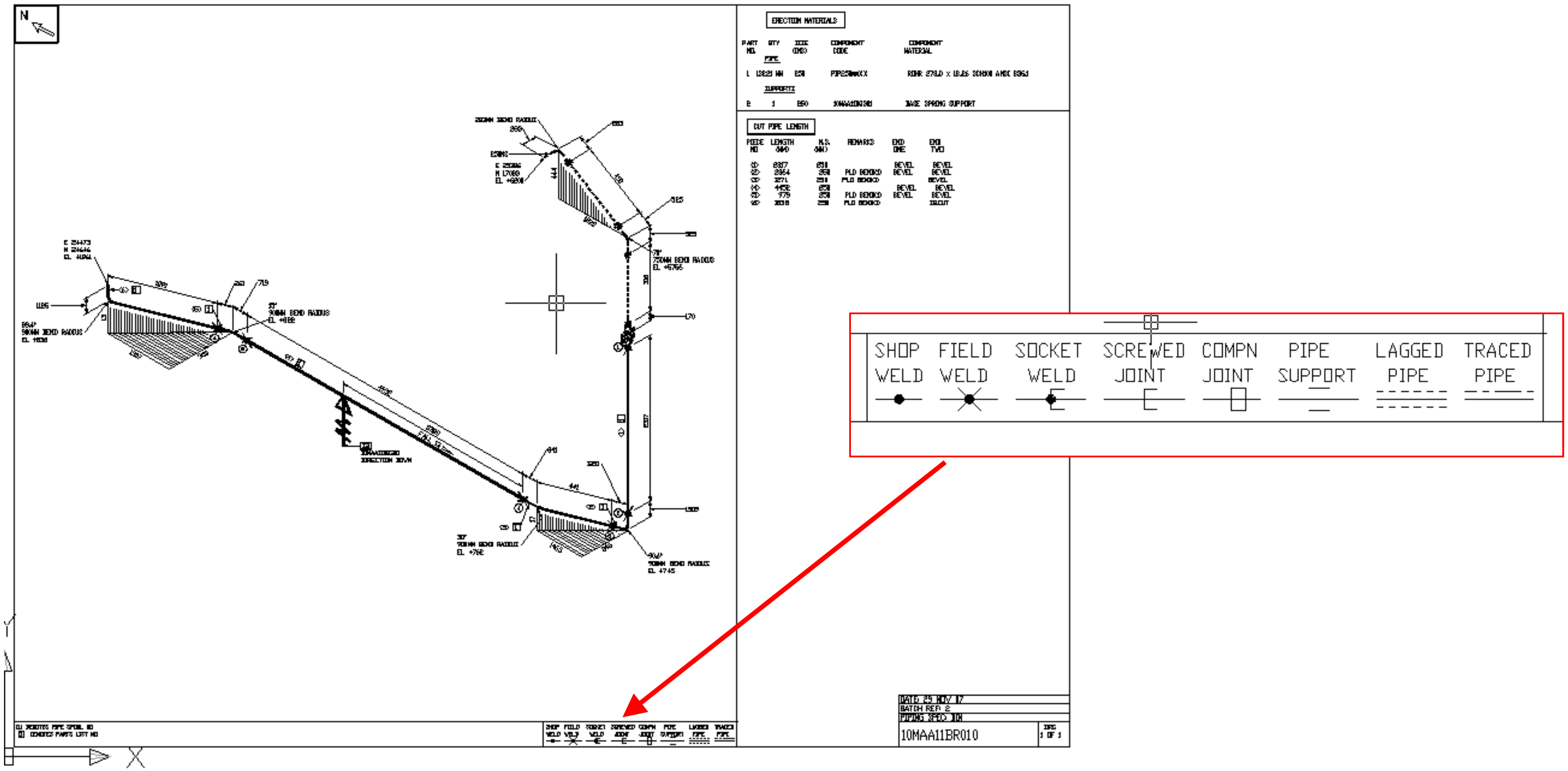
Isometric drawing.



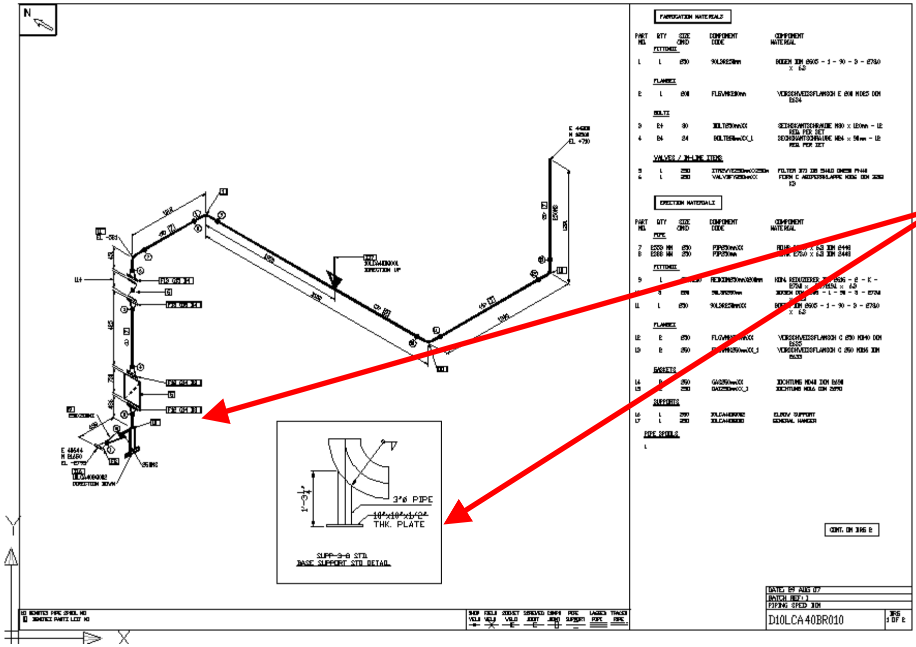
Isometric drawing.

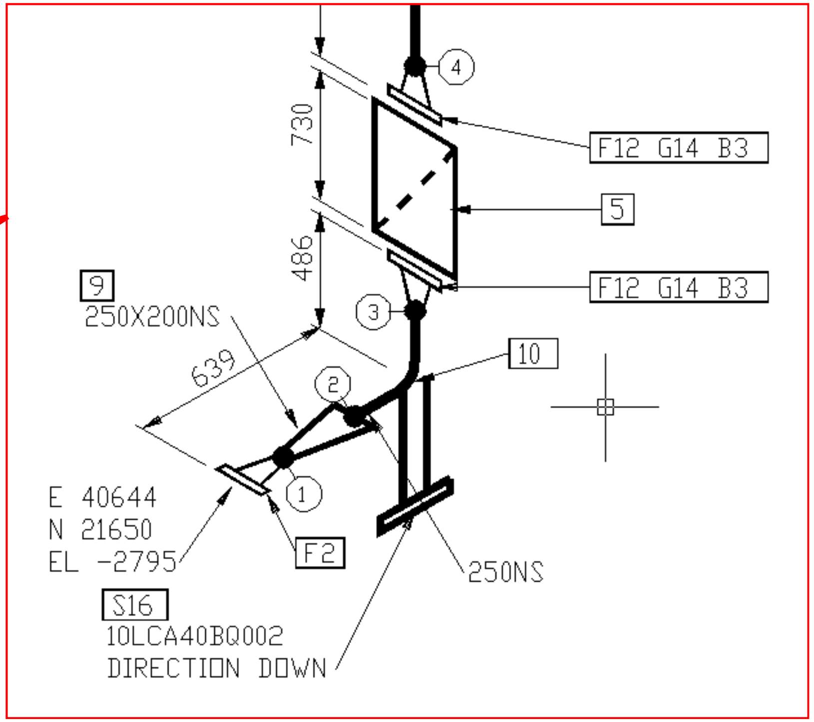


Isometric drawing.

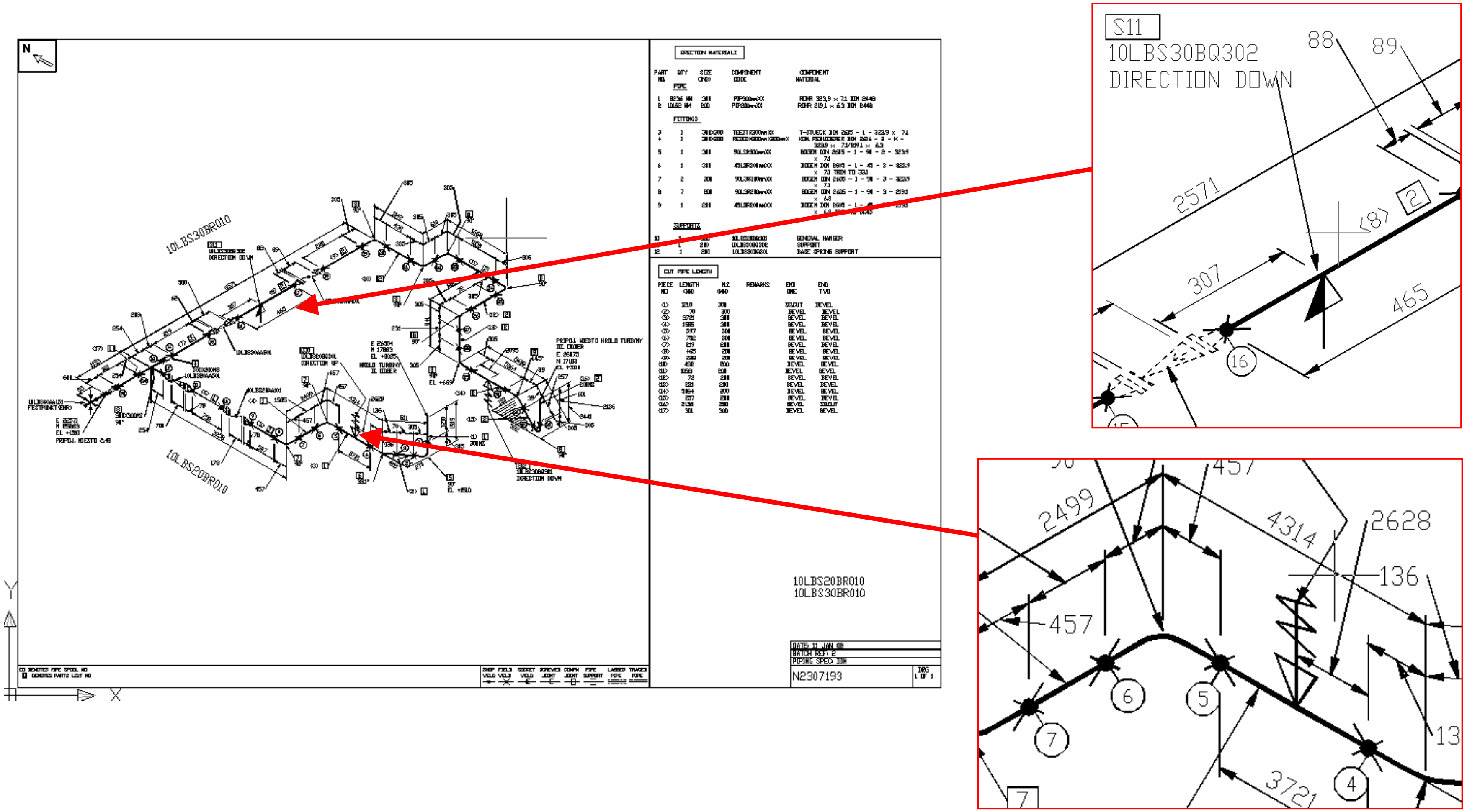


Isometric drawing.

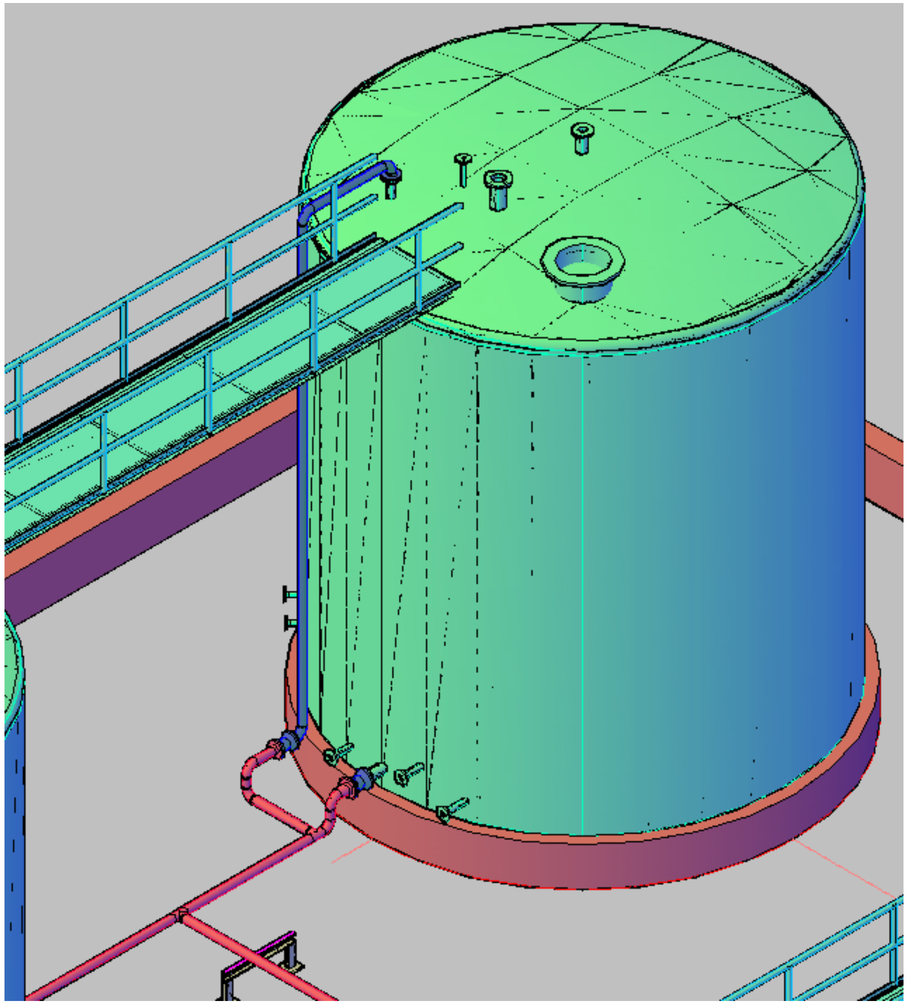


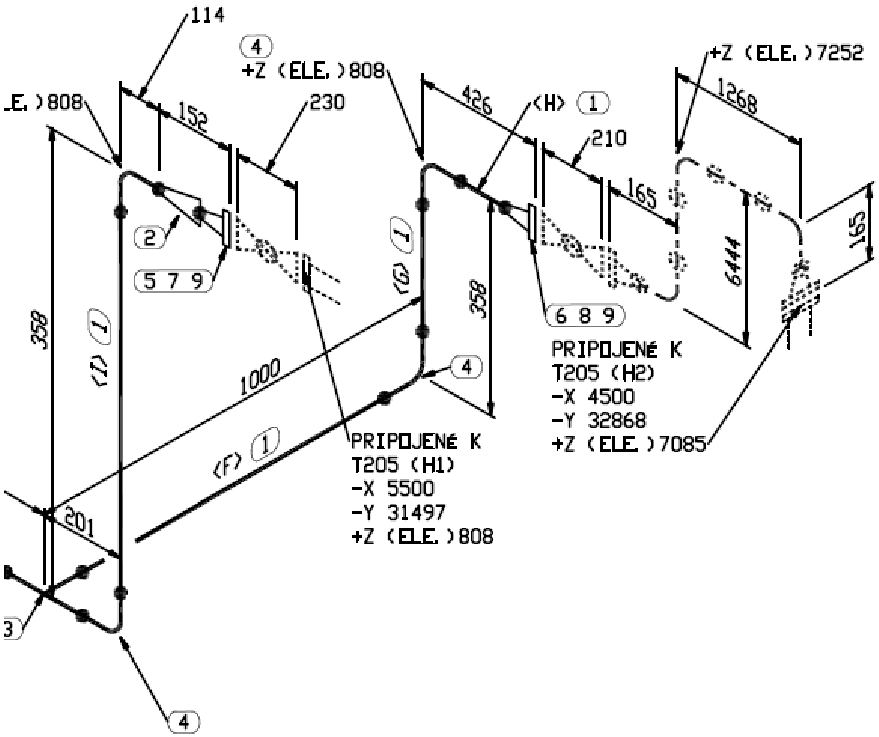


Isometric drawing.

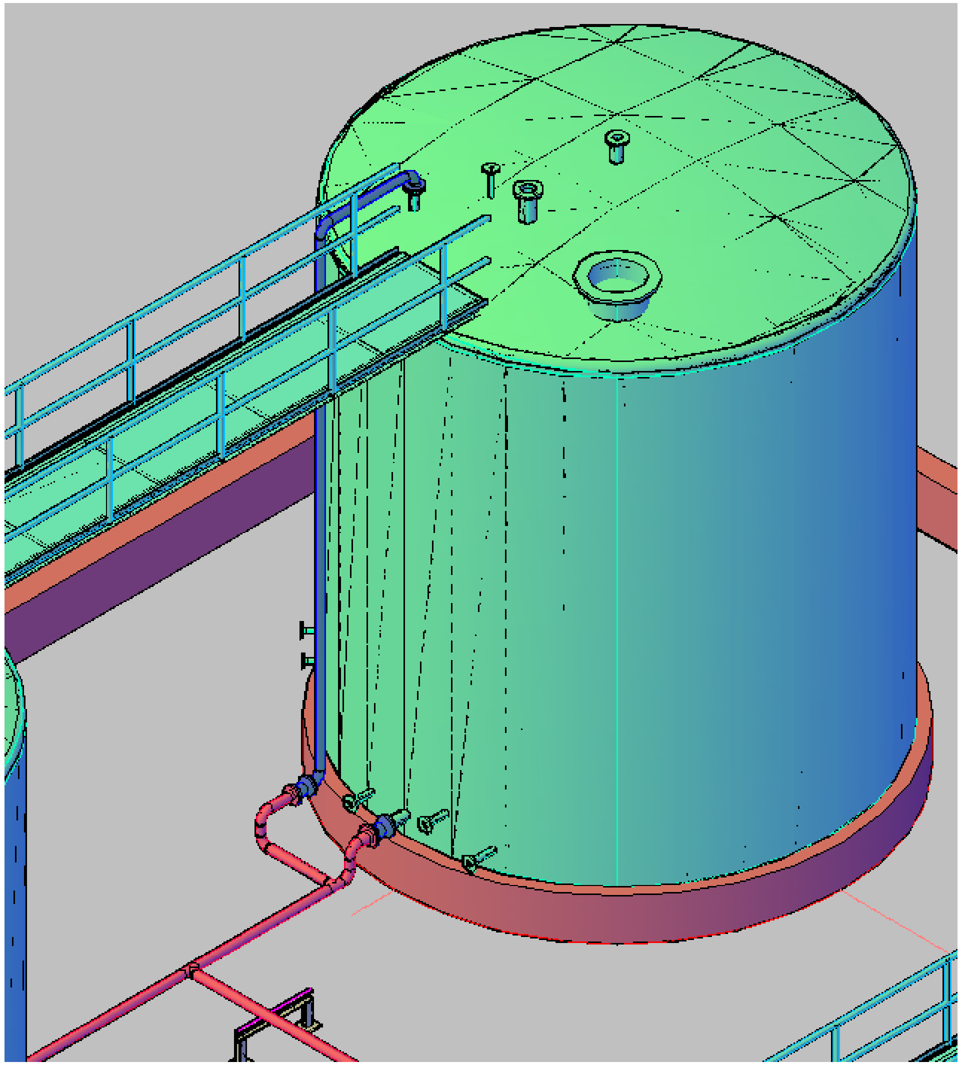


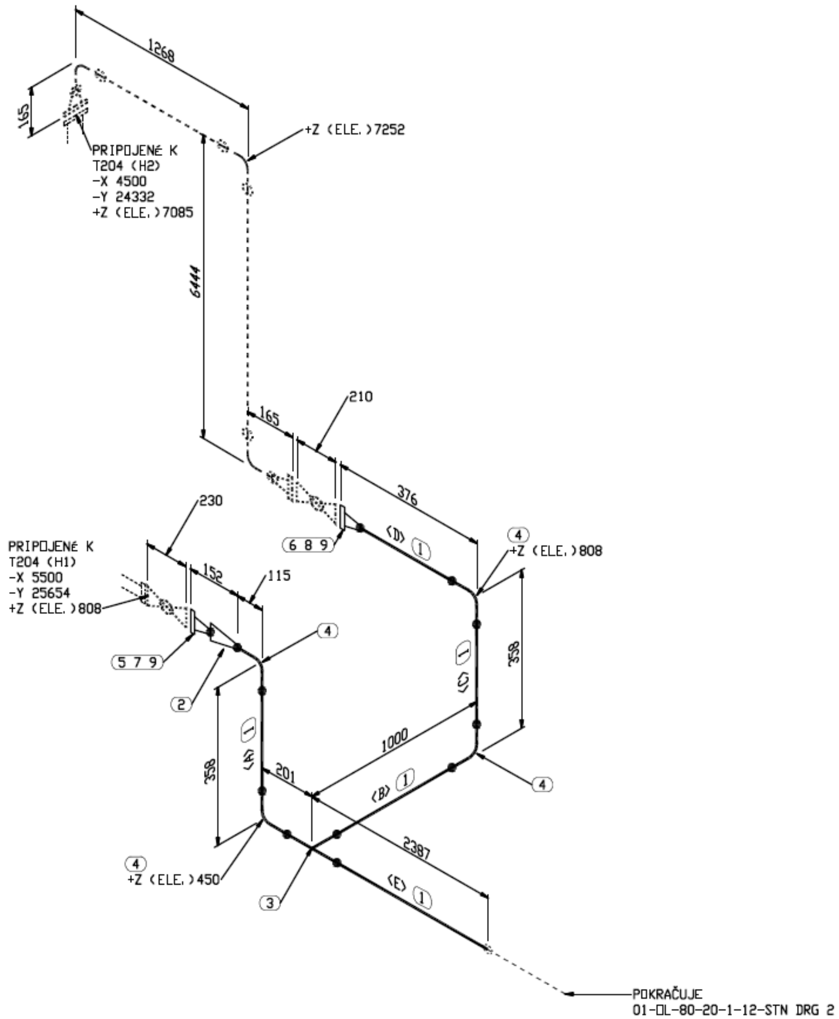
Isometric drawing.



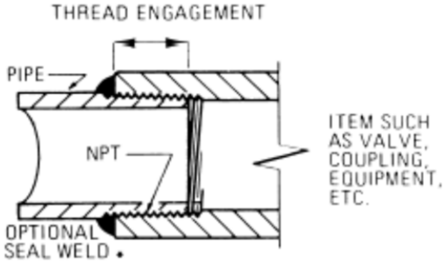


Isometric drawing.

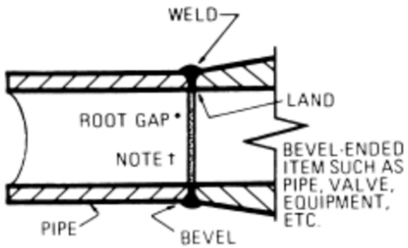




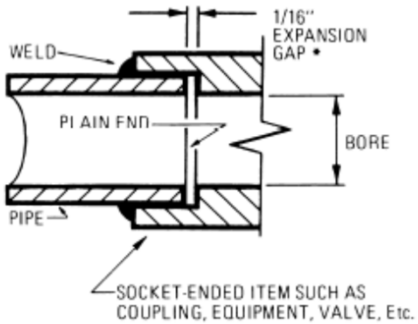
Piping system.



Screwed Piping S
(THD Thread)

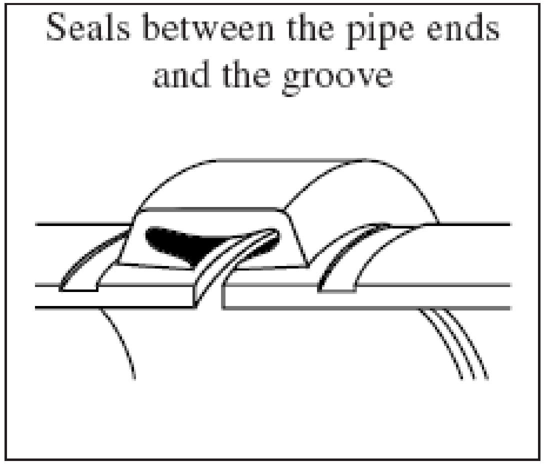


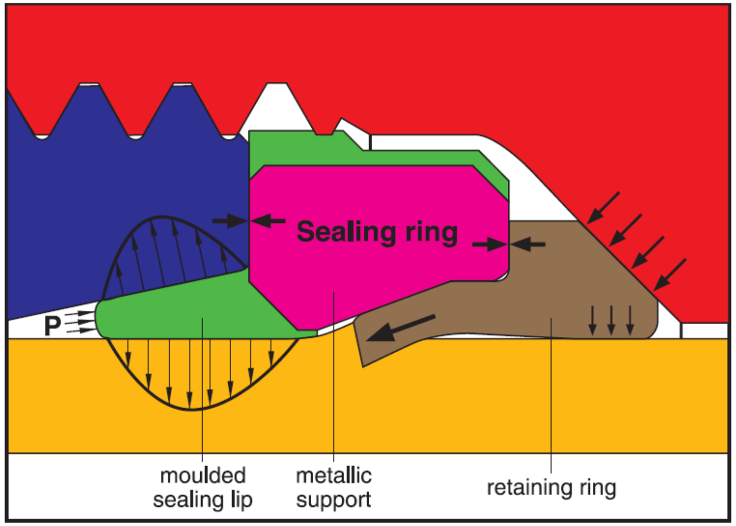
Butt-Welded Piping BW



Socket-Welded Piping
SW

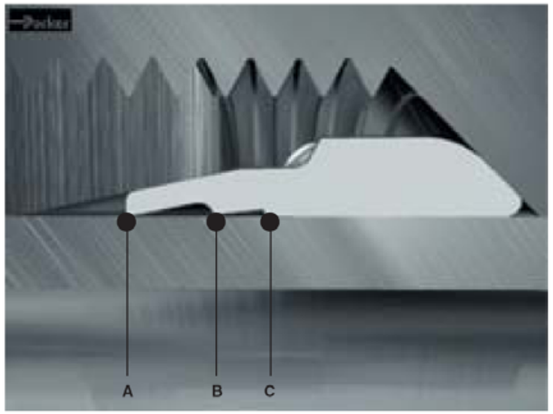
Piping system. Základné spôsoby spájania potrubí.



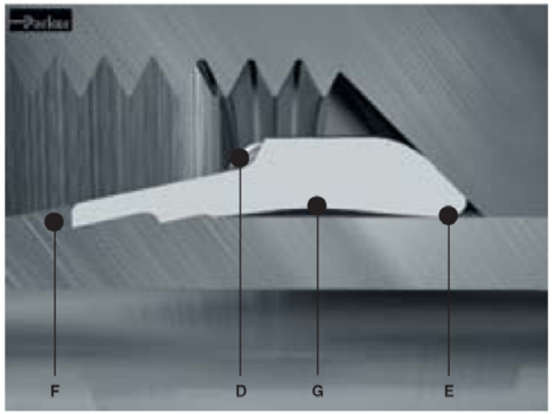


The metallic support of the sealing ring acts just like an integrated pre-assembly tool.

Other type of connection.

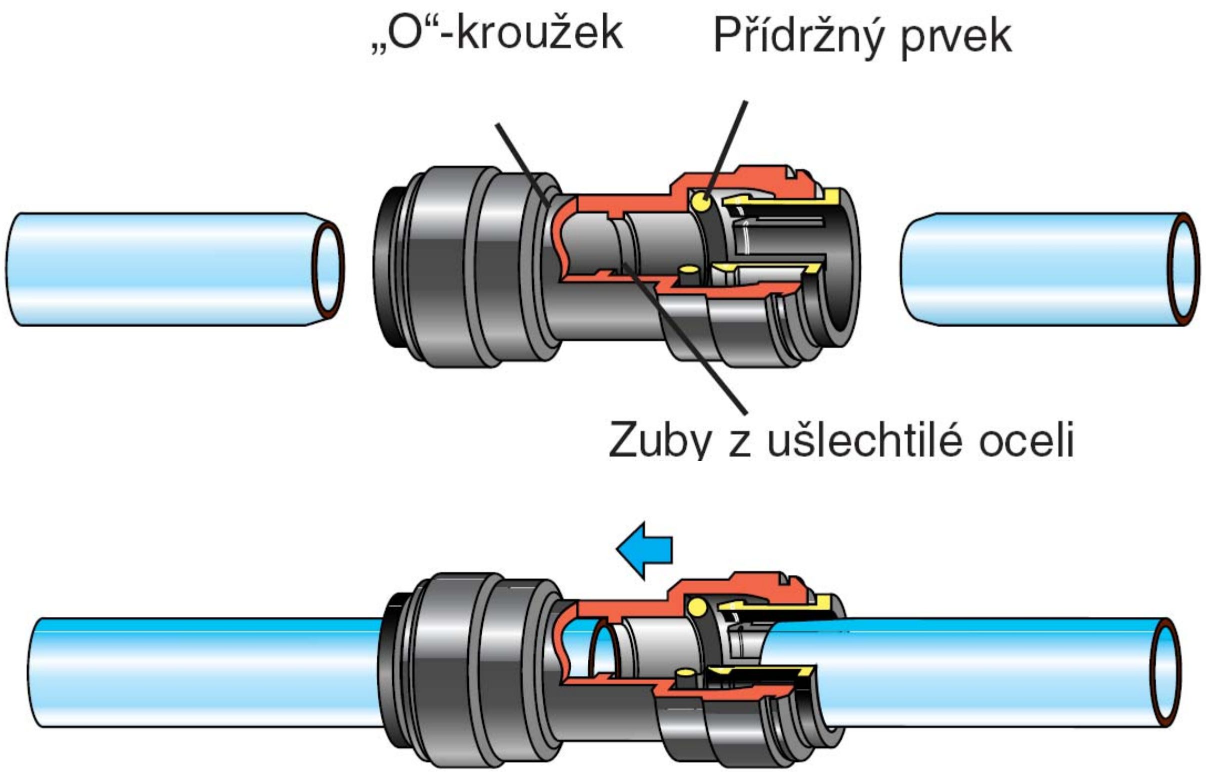


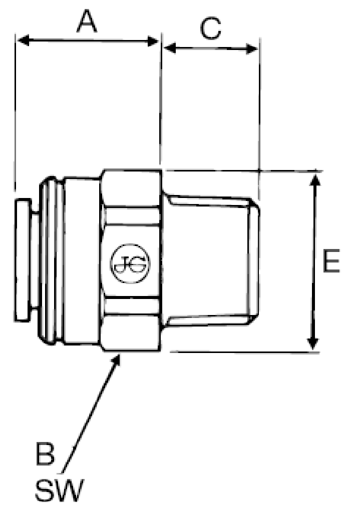
Before tightening the nut

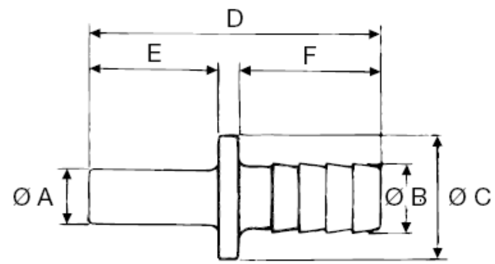


After tightening the nut

John Guest

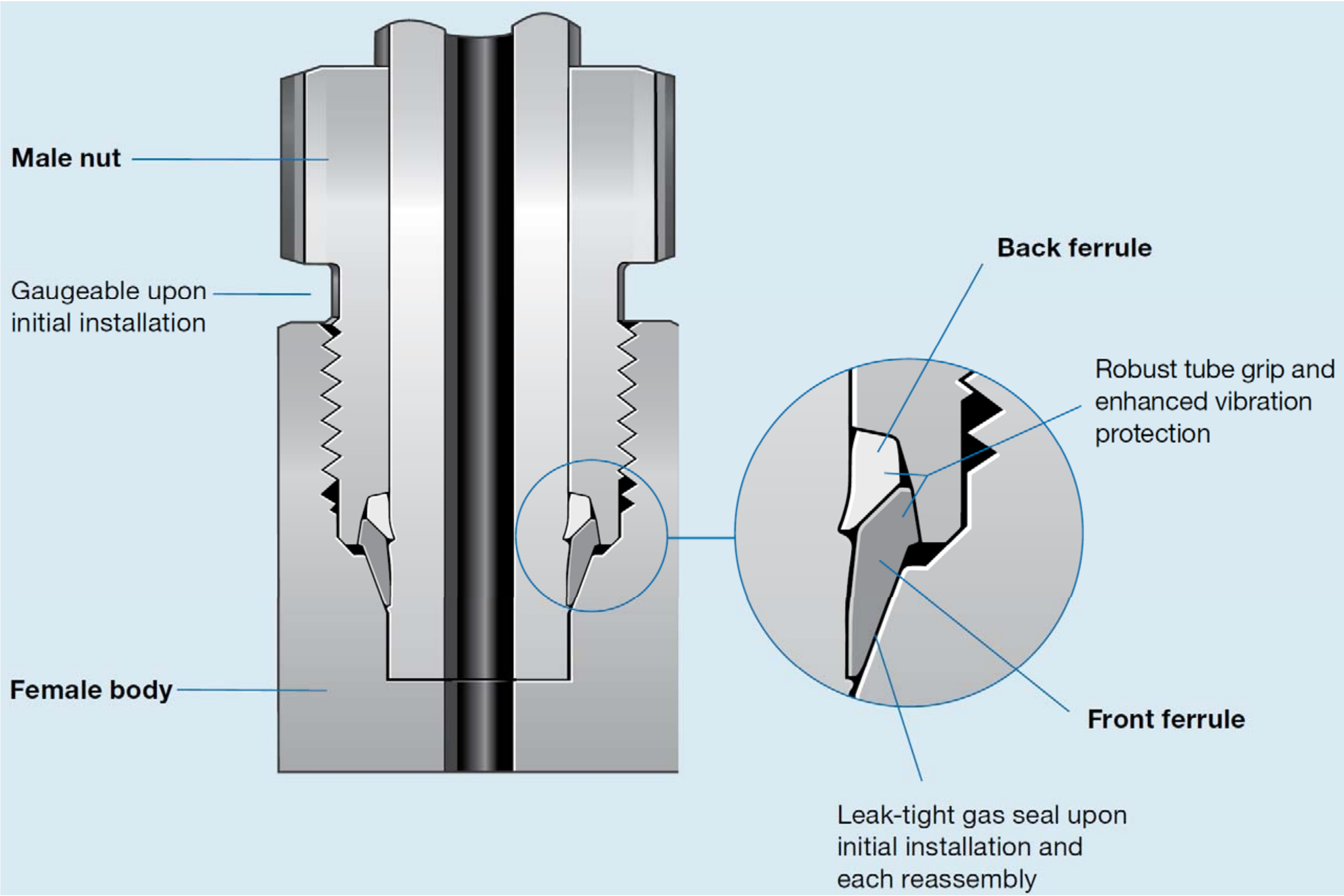






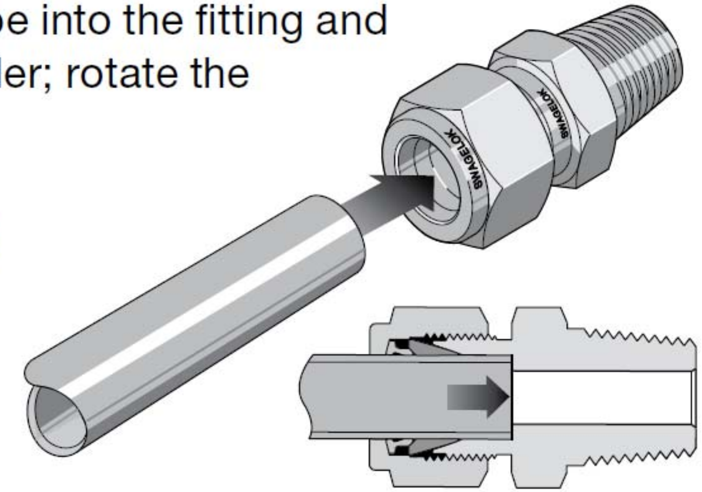
Patented method of connecting pipes.
System connecting with other connections

Swagelok


Male nut
Gaugeable upon initial installation
Female body
Back ferrule
Robust tube grip and enhanced vibration protection
Front ferrule
Leak-tight gas seal upon initial installation and each reassembly

Swagelok

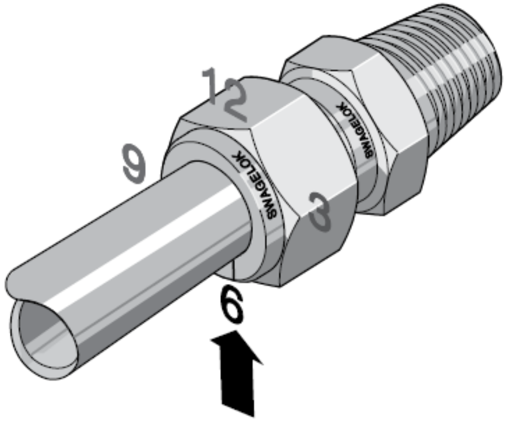
Fully insert the tube into the fitting and against the shoulder; rotate the nut finger-tight.

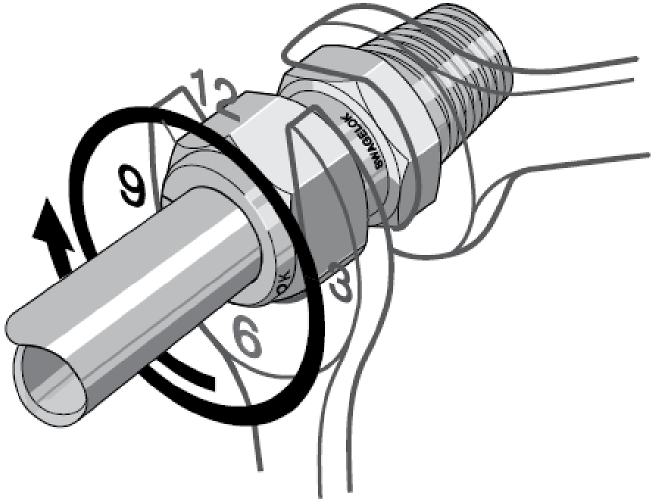


High-pressure applications and high safety-factor systems: *Further tighten the nut until the tube will not turn by hand or move axially in the fitting.*

While holding the fitting body steady, tighten the nut one and one-quarter turns to the 9 o'clock position.

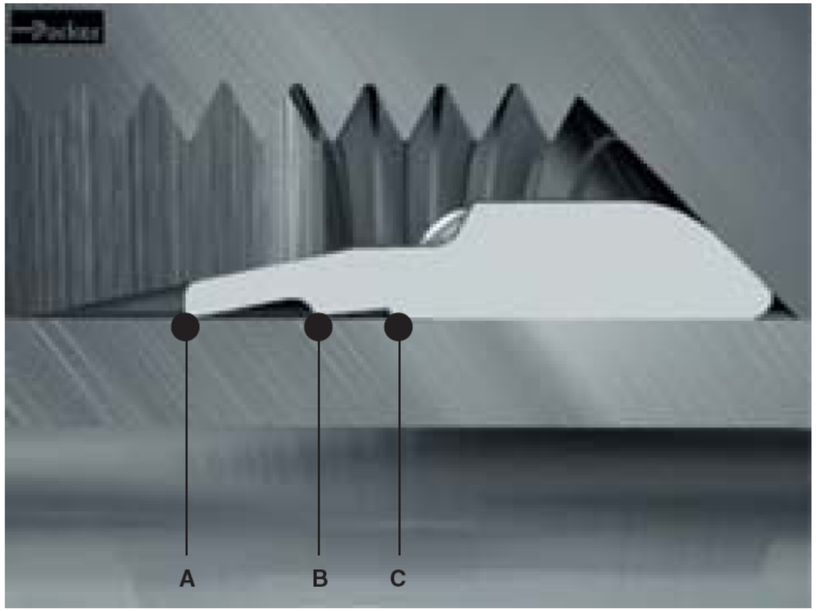
Mark the nut at the 6 o'clock position.



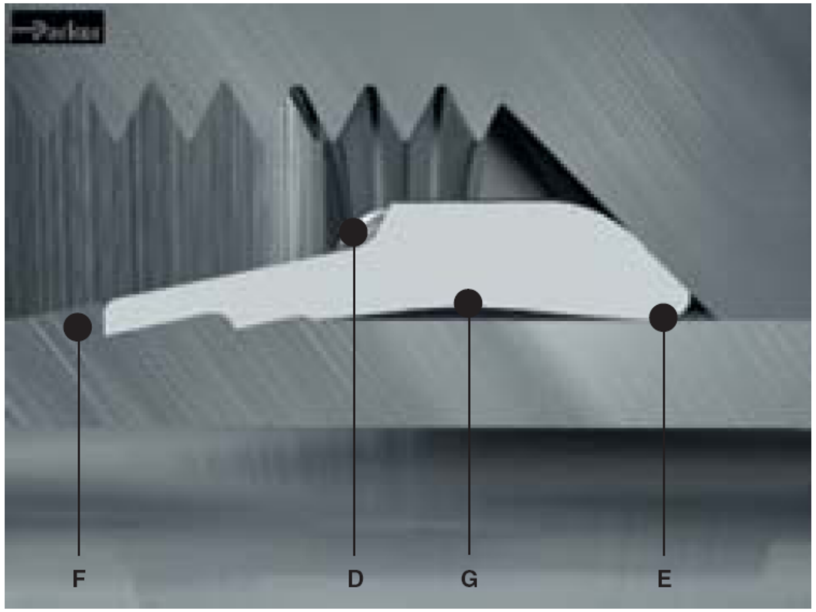


Parker

High pressure – Due to the application of even better materials combined with the special processing of individual components, EO-PSR can be used in applications of up to 800 bar (S series) and 500 bar (L series).



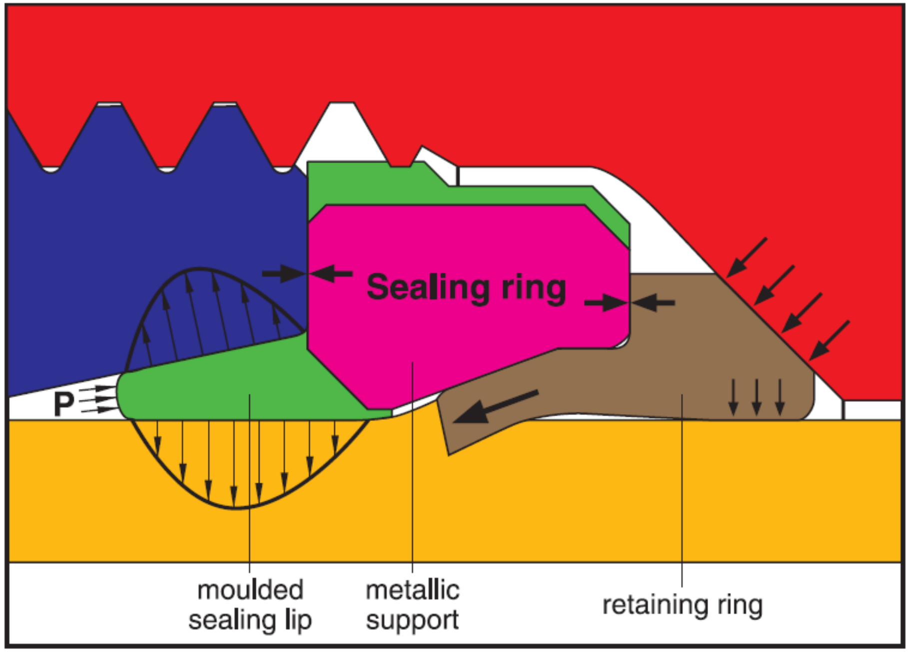
Before tightening the nut



After tightening the nut

Parker

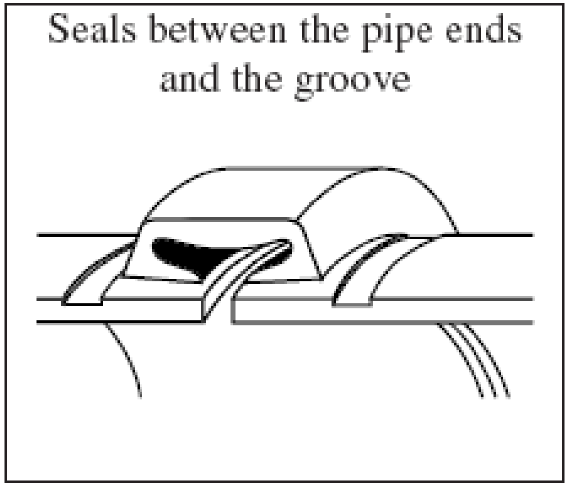
EO-2: Safe dry – clean – leakfree



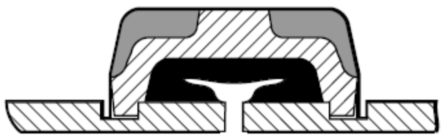
The metallic support of the sealing ring acts just like an integrated pre-assembly tool.

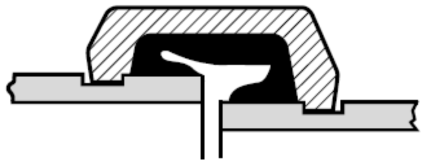
Increased pressure – Due to the application of even better materials combined with the special processing of individual components, EO-2 can be used in applications of up to 800 bar (S series) and 500 bar (L series).

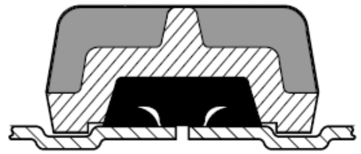
Victaulic

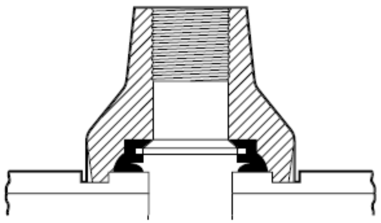


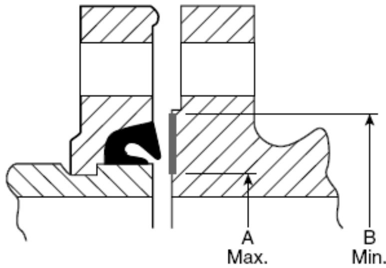
Victaulic


Standard

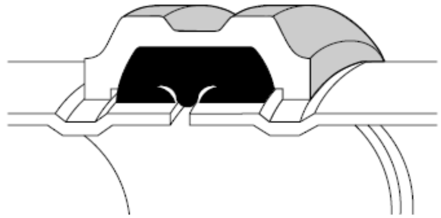

Reducing

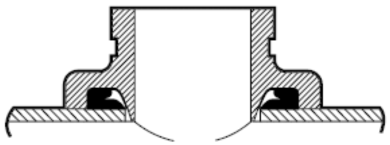

FlushSeal®

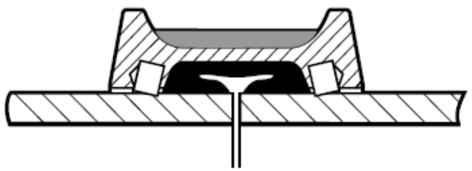

Outlet

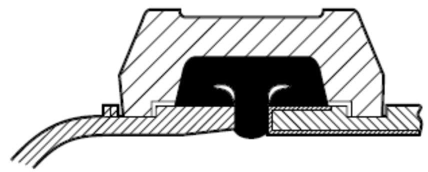


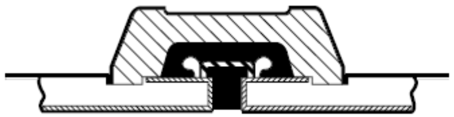
Vic-Flange®

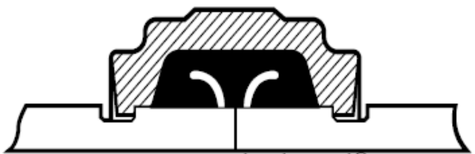

Grooved Copper Tubing with FlushSeal Gasket

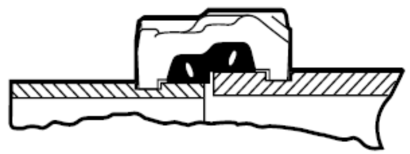

Mechanical-T®


Plain End


EndSeal®


EndSeal® Fire-R™


AWWA FlushSeal®


IPS to AWWA Transition

Piping system. Pipe

Wall thickness = mm **Weight –kg/m (Plain end mass)**

Pipe Size (Inches)	Pipe OD (mm)	5S	10S	10	20	30	STD	40S	40	XS	80S	80	XXS
3/8	17.10		1.65 **0.64**				2.31 **0.84**	2.31 **0.86**	2.31 **0.84**	3.20 **1.10**	3.20 **1.12**	3.20 **1.10**	
1/2	21.30	1.65 **0.82**	2.11 **1.01**				2.77 **1.27**	2.77 **1.30**	2.77 **1.27**	3.73 **1.62**	3.73 **1.65**	3.73 **1.62**	7.47 **1.95**
3/4	26.70	1.65 **1.04**	2.11 **1.31**				2.87 **1.69**	2.87 **1.71**	2.87 **1.69**	3.91 **2.20**	3.91 **2.24**	3.91 **2.20**	7.82 **3.64**
1	33.40	1.65 **1.33**	2.77 **2.13**				3.38 **2.50**	3.38 **2.55**	3.38 **2.50**	4.55 **3.24**	4.55 **3.29**	4.55 **3.24**	9.09 **5.45**
1 1/4	42.20	1.65 **1.68**	2.77 **2.76**				3.56 **3.39**	3.56 **3.46**	3.56 **3.39**	4.85 **4.47**	4.85 **4.56**	4.85 **4.47**	9.70 **7.77**
1 1/2	48.30	1.65 **1.95**	2.77 **3.17**				3.68 **4.05**	3.68 **4.13**	3.68 **4.05**	5.08 **5.41**	5.08 **5.51**	5.08 **5.41**	10.15 **9.56**
2	60.30	1.65 **2.44**	2.77 **4.01**				3.91 **5.44**	3.91 **5.54**	3.91 **5.44**	5.54 **7.48**	5.54 **7.63**	5.54 **7.48**	11.07 **13.44**
2 1/2	73.00	2.11 **3.77**	3.05 **5.36**				5.16 **8.63**	5.16 **8.81**	5.16 **8.63**	7.01 **11.41**	7.01 **11.64**	7.01 **11.41**	14.02 **20.39**
3	88.90	2.11 **4.60**	3.05 **5.59**				5.49 **11.29**	5.49 **11.52**	5.49 **11.29**	7.62 **15.27**	7.62 **15.59**	7.62 **15.27**	15.24 **27.68**
3 1/2	101.6	2.11 **5.29**	3.05 **7.99**				5.74 **13.57**	5.74 **13.84**	5.74 **13.57**	8.08 **18.63**	8.08 **19.01**	8.08 **18.63**	
4	114.3	2.11 **5.96**	3.05 **8.52**				6.02 **16.07**	6.02 **16.40**	6.02 **16.07**	8.56 **22.32**	8.56 **22.77**	8.56 **22.32**	17.12 **41.03**
5	141.3	2.77 **9.67**	3.40 **11.82**				6.55 **21.77**	6.55 **22.20**	6.55 **21.77**	9.53 **30.97**	9.53 **31.59**	9.53 **30.97**	19.05 **57.43**
6	168.3	2.77 **11.55**	3.40 **14.13**				7.11 **28.26**	7.11 **28.83**	7.11 **28.26**	10.97 **42.56**	10.97 **43.42**	10.97 **42.56**	21.95 **79.22**
8	219.1	2.77 **15.09**	3.76 **20.37**		6.35 **33.31**	7.04 **36.81**	8.18 **42.55**	8.18 **43.39**	8.18 **42.55**	12.70 **64.64**	12.70 **65.95**	12.70 **64.64**	22.23 **107.92**
10	273.1	3.40 **23.08**	4.19 **28.34**		6.35 **41.77**	7.80 **51.03**	9.27 **60.31**	9.27 **61.52**	9.27 **60.31**	12.70 **81.55**	12.70 **83.19**	15.90 **96.01**	25.40 **155.15**
12	323.9	3.96 **31.89**	4.57 **36.73**		6.35 **49.73**	8.35 **65.20**	9.53 **73.88**	9.27 **75.32**	10.31 **79.73**	12.70 **97.46**	12.70 **99.43**	17.48 **132.08**	25.40 **186.97**
14	355.6	3.96 **35.06**	4.78 **42.14**	6.35 **54.69**	7.92 **67.90**	9.53 **81.33**	9.53 **93.27**		11.13 **94.55**	12.70 **107.39**		19.05 **158.10**	
16	406.4	4.19 **42.41**	4.78 **48.26**	6.35 **62.64**	7.92 **77.83**	9.53 **93.27**	9.53 **81.33**		12.70 **123.30**	12.70 **123.30**		21.44 **203.53**	
18	457.0	4.19 **47.77**	4.78 **54.36**	6.35 **70.57**	7.92 **87.71**	11.13 **122.38**	9.53 **105.16**		14.27 **155.80**	12.70 **139.15**		23.38 **254.55**	
20	508.0	4.78 **60.46**	5.54 **70.00**	6.35 **78.55**	9.35 **117.15**	12.70 **155.12**	9.53 **117.15**		15.09 **183.42**	12.70 **155.12**		25.19 **311.17**	
22	559.0	4.78 **66.57**	5.54 **77.06**	6.35 **86.54**	9.35 **129.13**	12.70 **171.09**	9.53 **129.13**			12.70 **171.09**		28.58 **373.83**	
24	610.0	5.54 **84.16**	6.35 **96.37**	6.35 **94.53**	9.35 **141.12**	14.27 **209.64**	9.53 **141.12**		17.48 **255.41**	12.70 **187.06**		30.96 **442.08**	

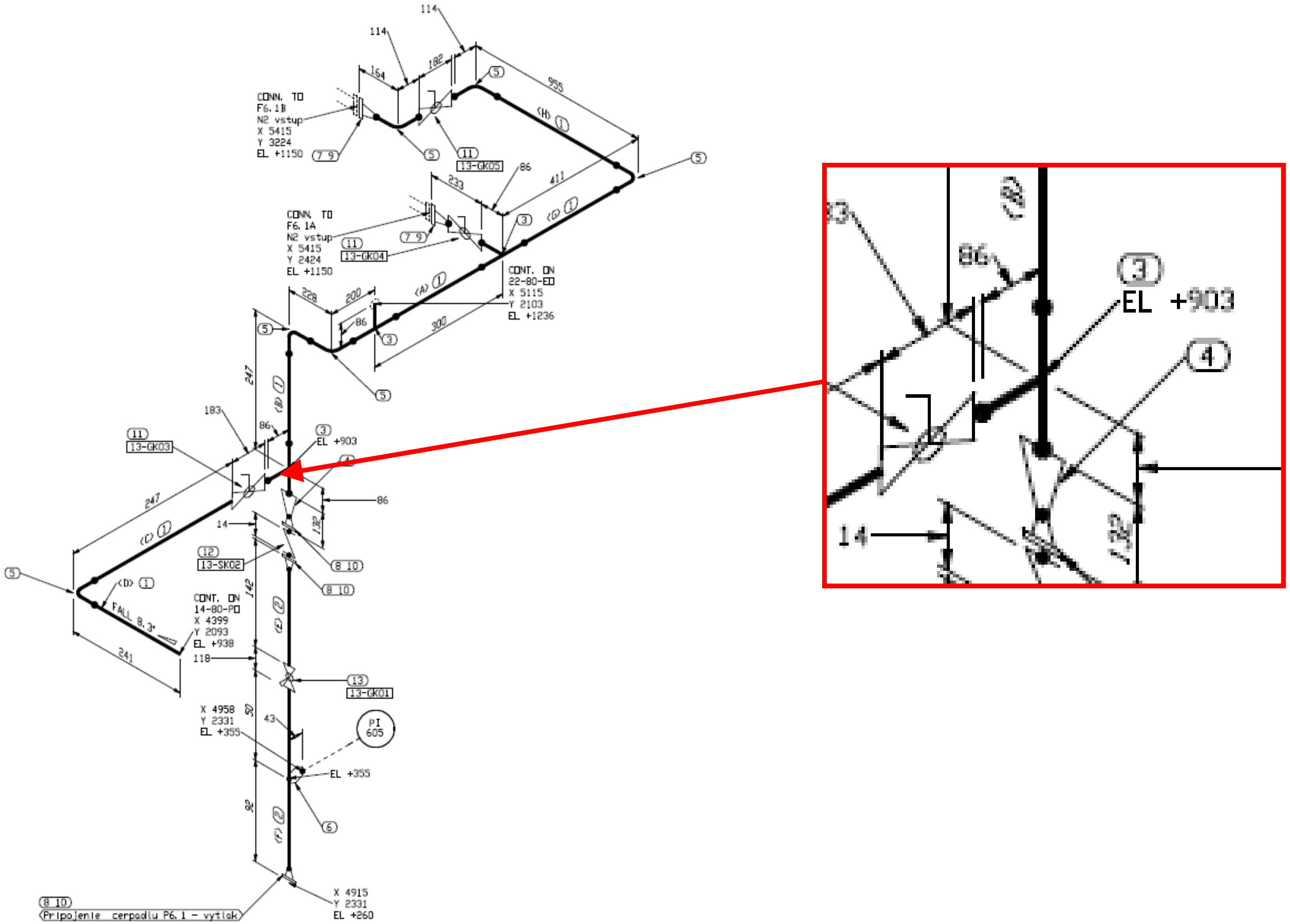
Schedule

STD- standard

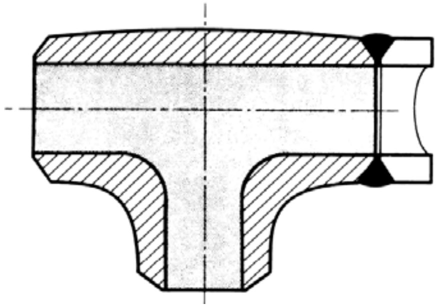
XS- extra strong

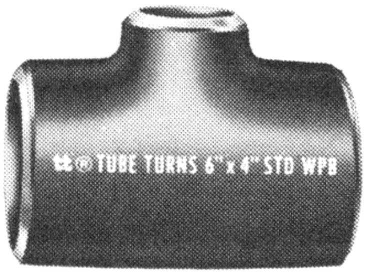
XXS – extra extra strong

Piping system. Tee, Cross



Piping system. Tee, Cross





ASME B16.9-2001

FACTORY-MADE WROUGHT BUTTWELDING FITTINGS

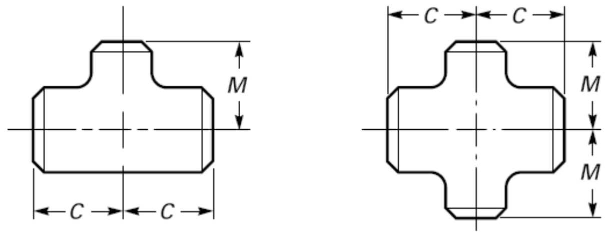
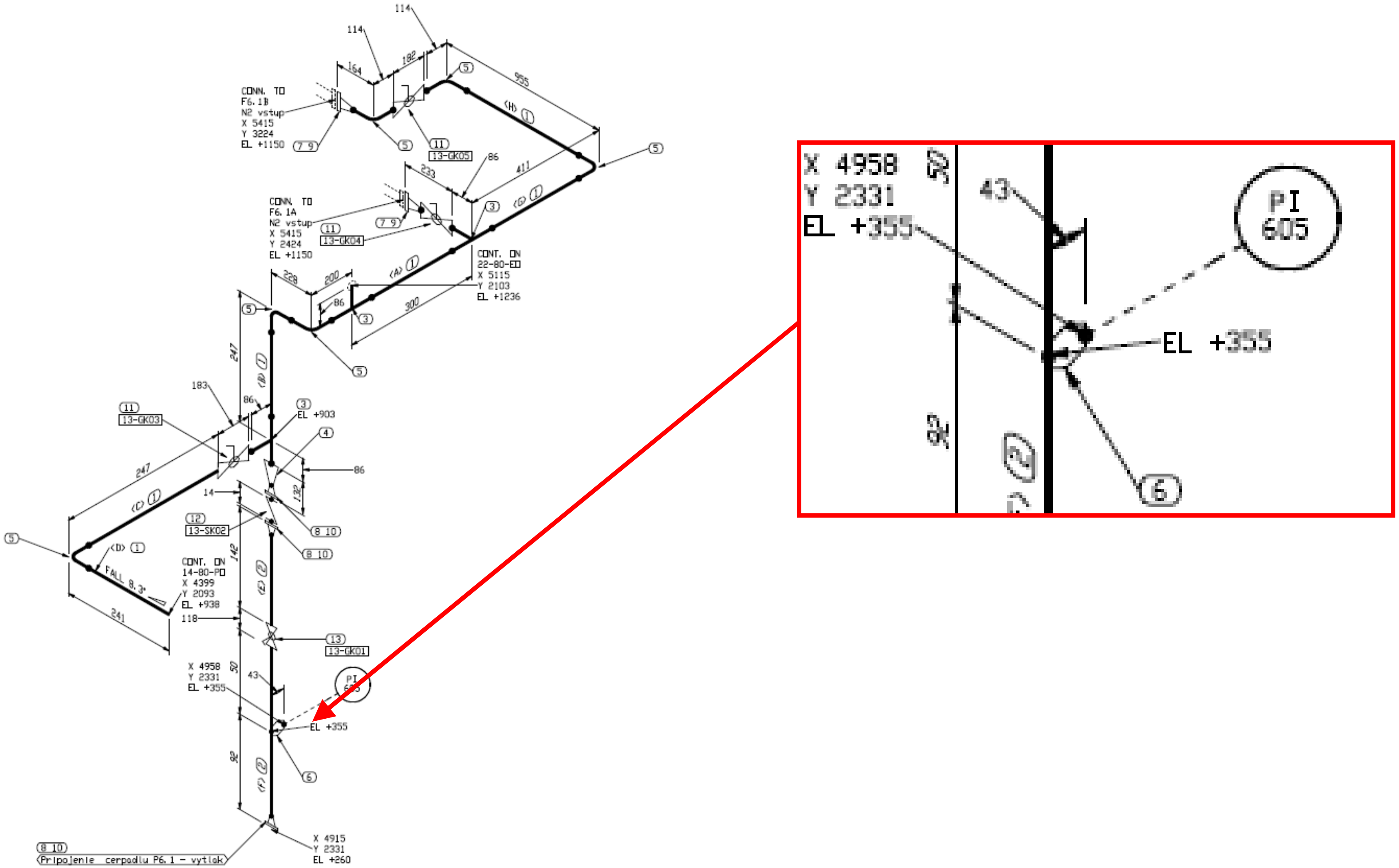


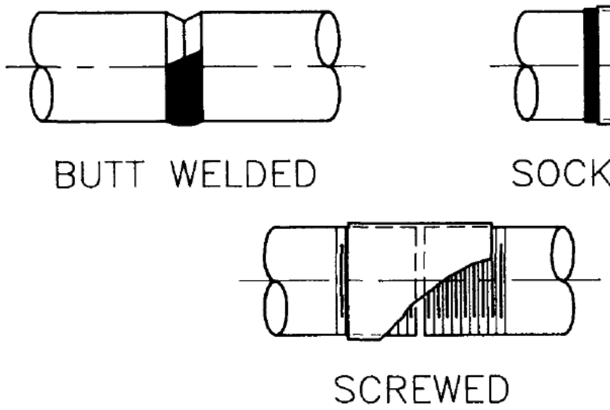
TABLE 9 DIMENSIONS OF REDUCING OUTLET TEES AND REDUCING OUTLET CROSSES

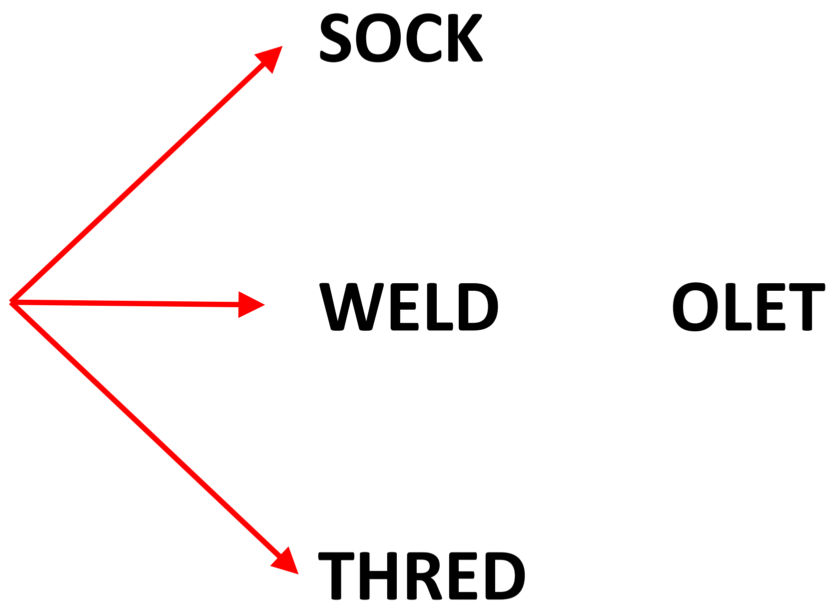
Nominal Pipe Size (NPS)	DN	Outside Diameter at Bevel		Center-to-End	
		Run	Outlet	Run, C	Outlet, M [Note (1)]
$\frac{1}{2} \times \frac{1}{2} \times \frac{3}{8}$	15 × 15 × 10	21.3	17.3	25	25
$\frac{1}{2} \times \frac{1}{2} \times \frac{1}{4}$	15 × 15 × 8	21.3	13.7	25	25
$\frac{3}{4} \times \frac{3}{4} \times \frac{1}{2}$	20 × 20 × 15	26.7	21.3	29	29
$\frac{3}{4} \times \frac{3}{4} \times \frac{3}{8}$	20 × 20 × 10	26.7	17.3	29	29
$1 \times 1 \times \frac{3}{4}$	25 × 25 × 20	33.4	26.7	38	38
$1 \times 1 \times \frac{1}{2}$	25 × 25 × 15	33.4	21.3	38	38
$1\frac{1}{4} \times 1\frac{1}{4} \times 1$	32 × 32 × 25	42.2	33.4	48	48
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{3}{4}$	32 × 32 × 20	42.2	26.7	48	48
$1\frac{1}{4} \times 1\frac{1}{4} \times \frac{1}{2}$	32 × 32 × 15	42.2	21.3	48	48
$1\frac{1}{2} \times 1\frac{1}{2} \times 1\frac{1}{4}$	40 × 40 × 32	48.3	42.2	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times 1$	40 × 40 × 25	48.3	33.4	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{3}{4}$	40 × 40 × 20	48.3	26.7	57	57
$1\frac{1}{2} \times 1\frac{1}{2} \times \frac{1}{2}$	40 × 40 × 15	48.3	21.3	57	57
$2 \times 2 \times 1\frac{1}{2}$	50 × 50 × 40	60.3	48.3	64	60
$2 \times 2 \times 1\frac{1}{4}$	50 × 50 × 32	60.3	42.2	64	57
$2 \times 2 \times 1$	50 × 50 × 25	60.3	33.4	64	51
$2 \times 2 \times \frac{3}{4}$	50 × 50 × 20	60.3	26.7	64	44

Piping system. Outlet, Olet

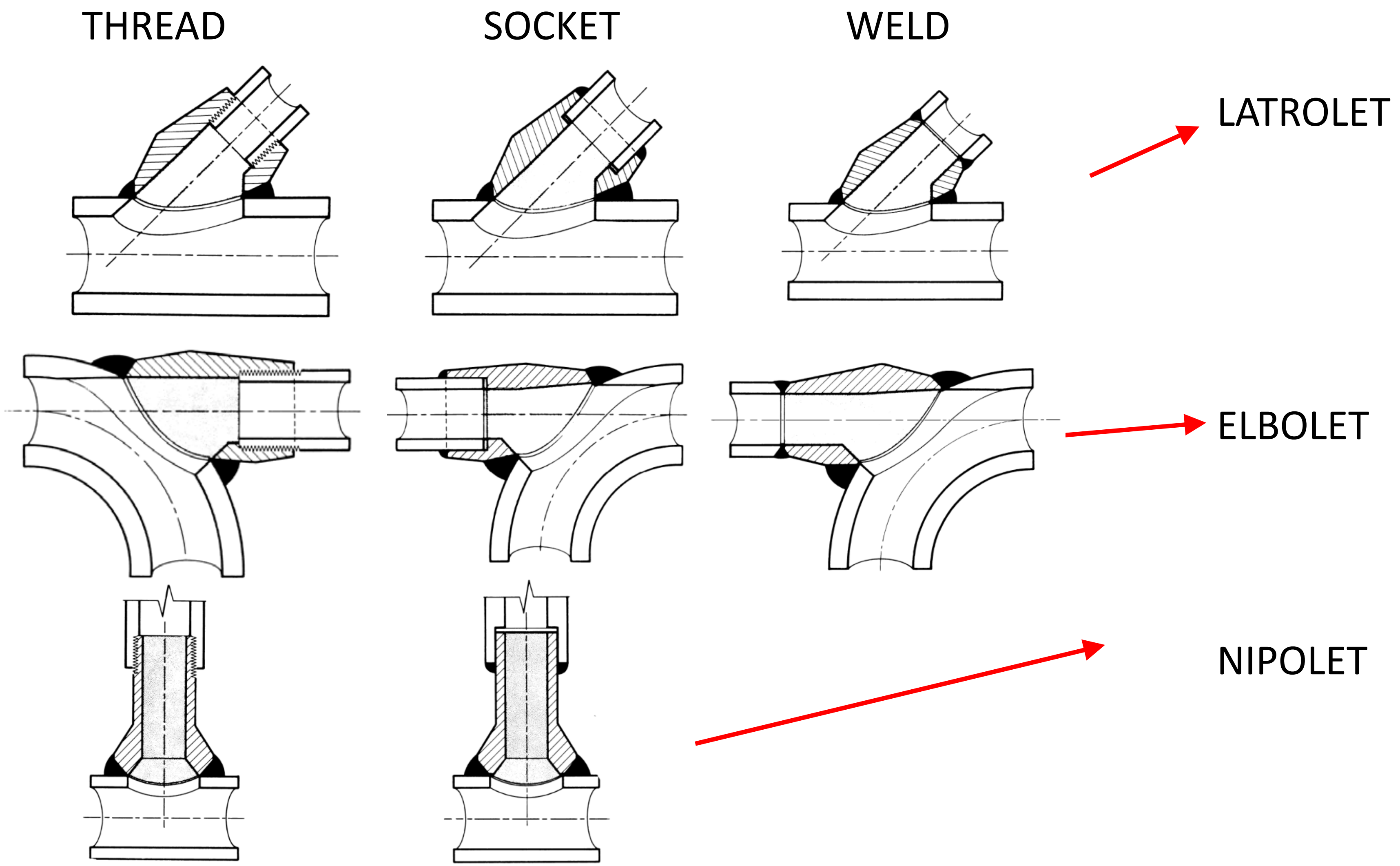


Piping system. Outlet, Olet

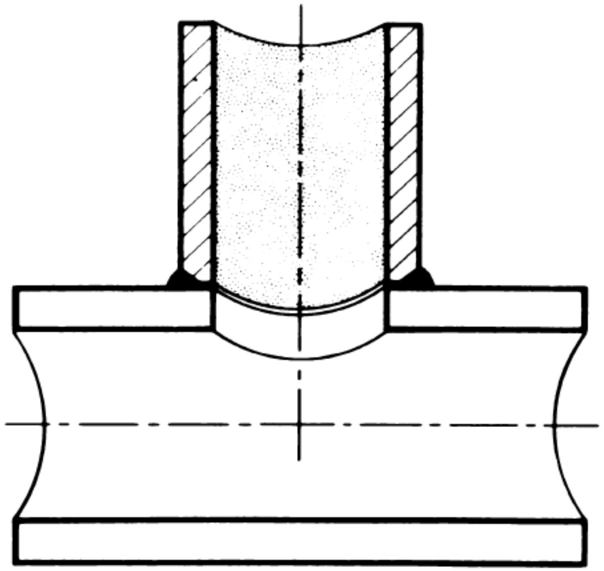




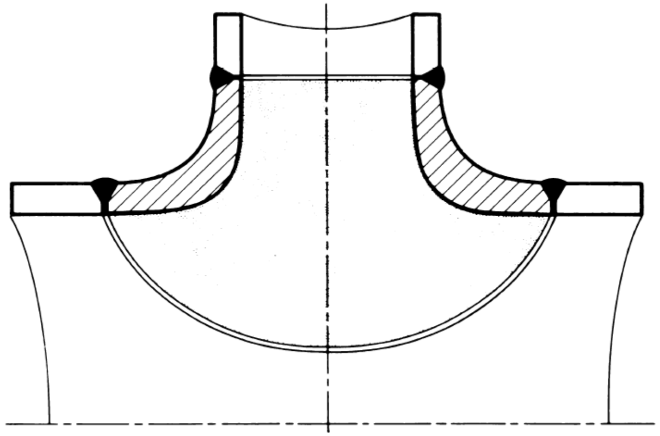
Piping system. Outlet, Olet



Piping system. Outlet, Olet



STUB-IN

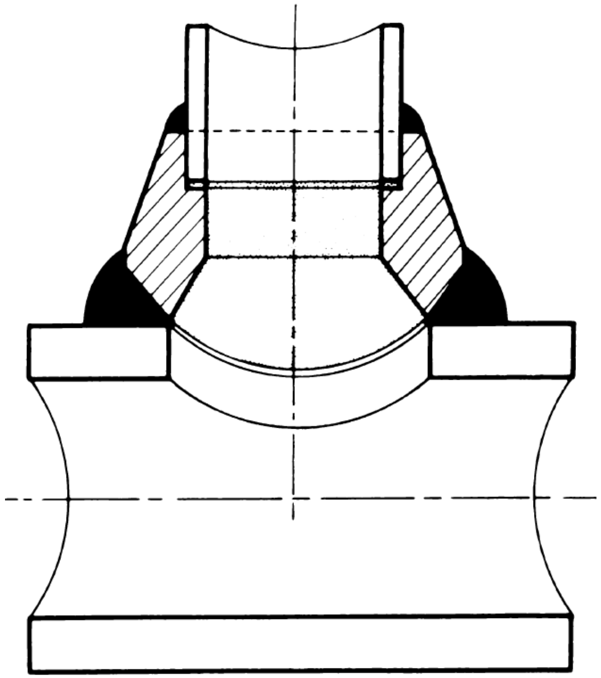


SWEEPOLET

WELDOLET

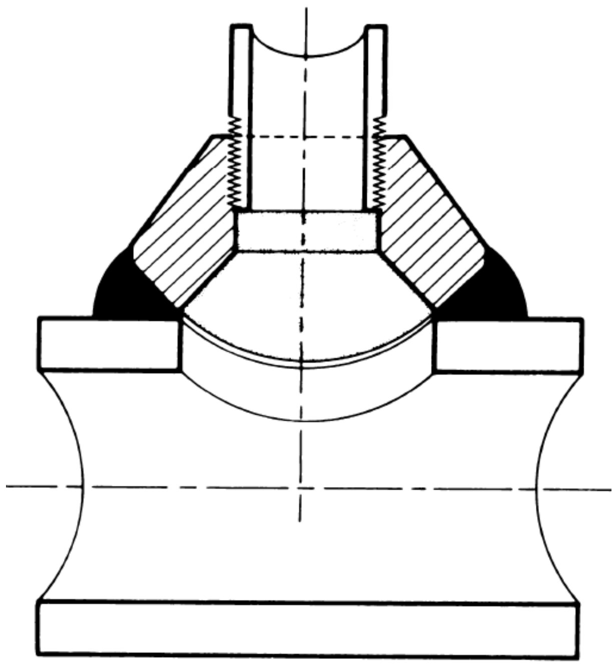
Piping system. Outlet, Olet

SOCKET



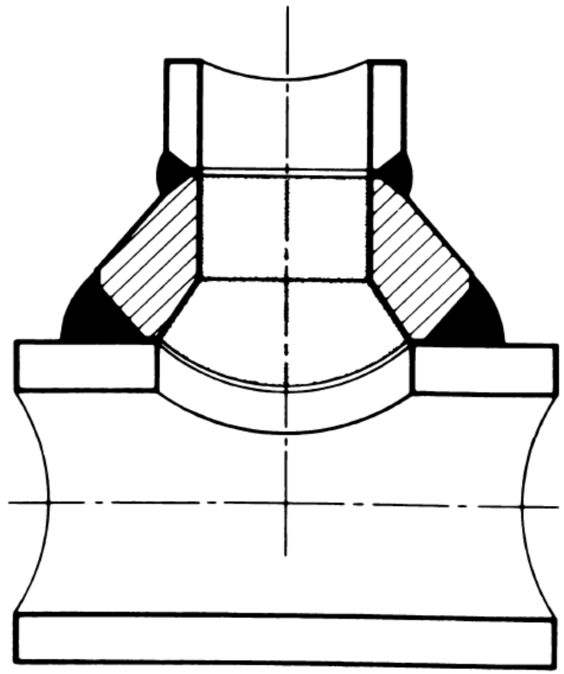
SOCKOLET

THREAD



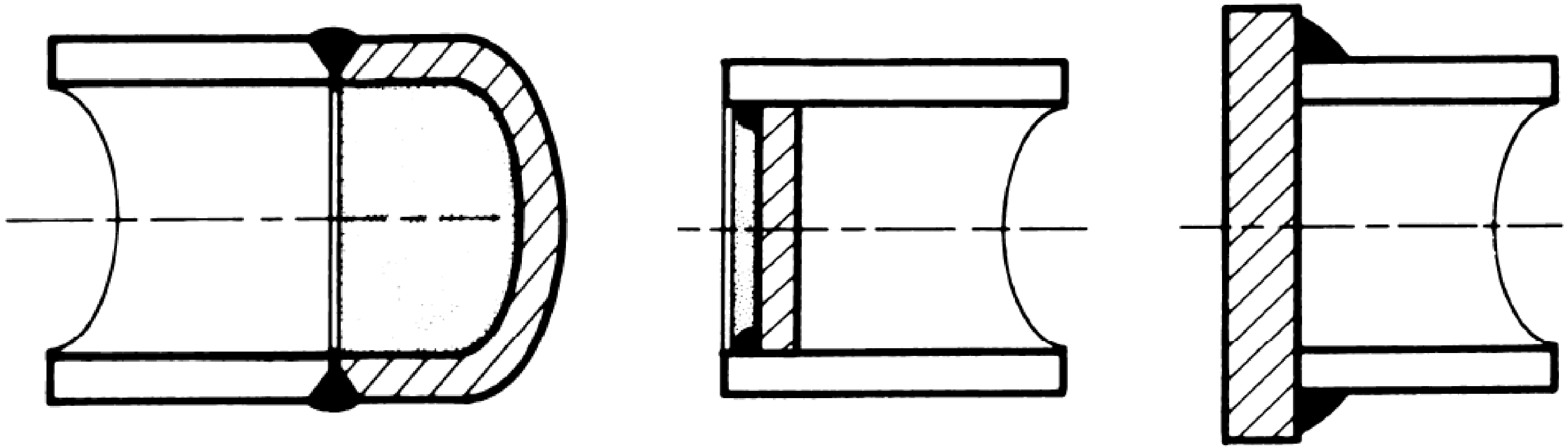
THREADOLET

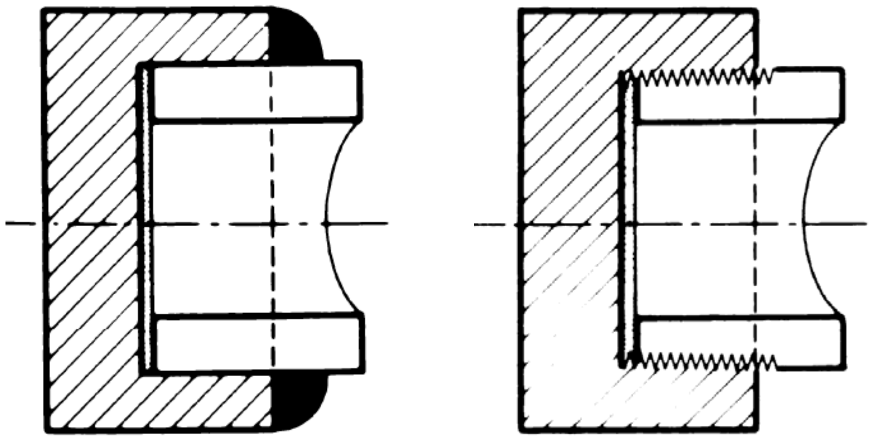
WELD



WELDOLET

Piping system. Cap

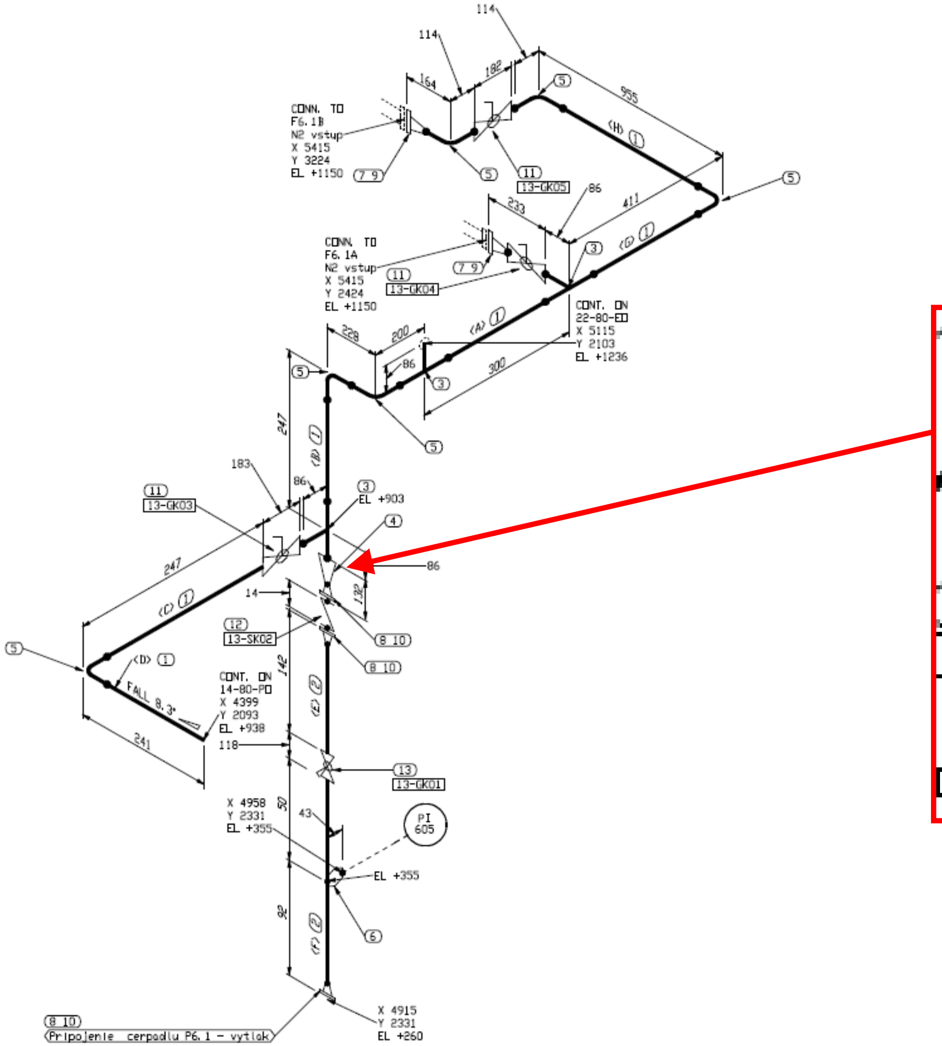


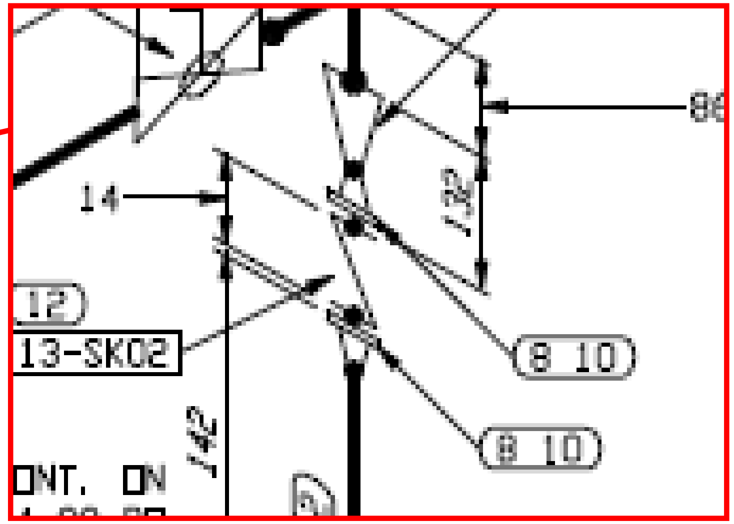


Torispherical, straight, elliptical ... Etc.

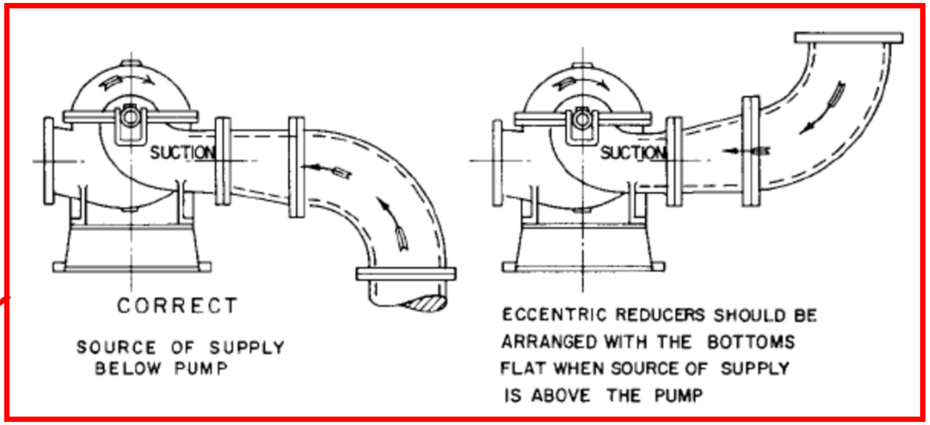
Design:
Weld, Socket, Thread

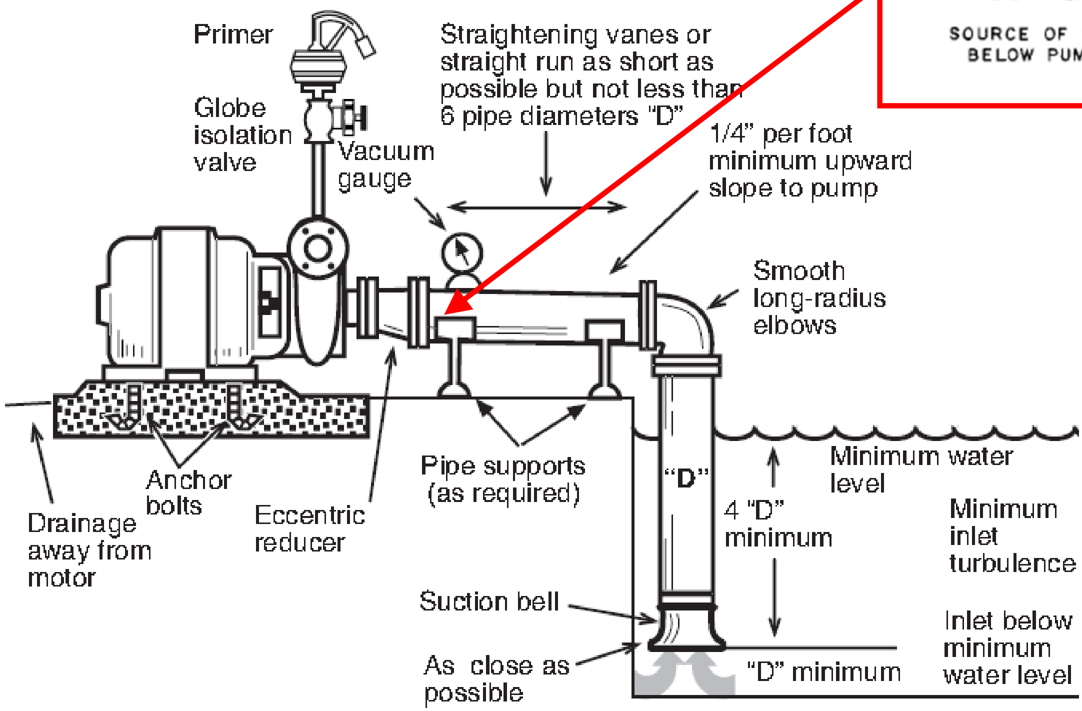
Piping system. Reducer CON, ECC

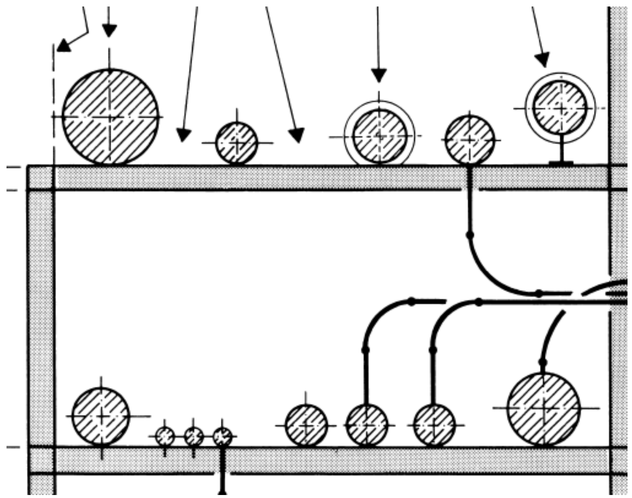




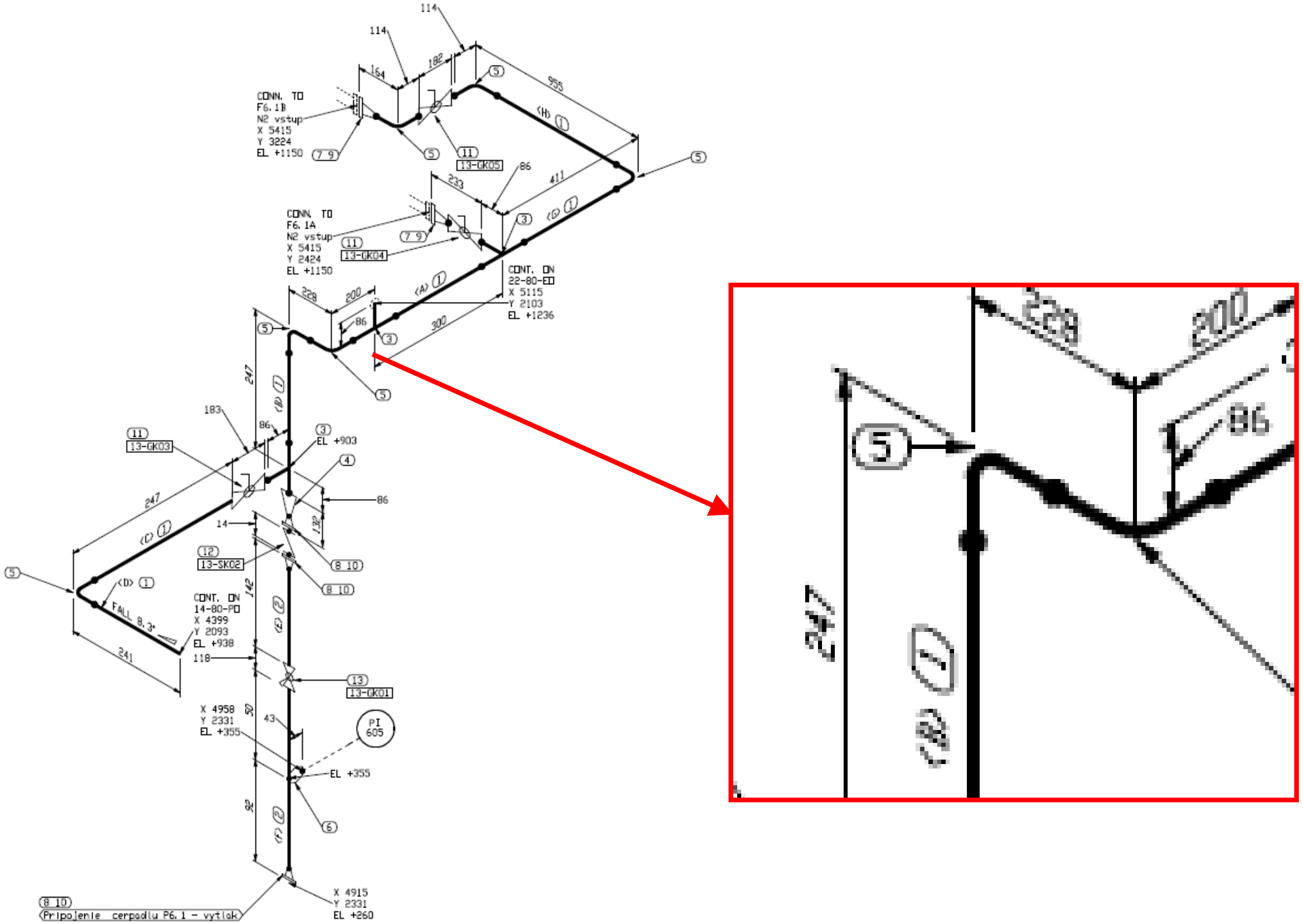
Piping system. Reducer CON, ECC



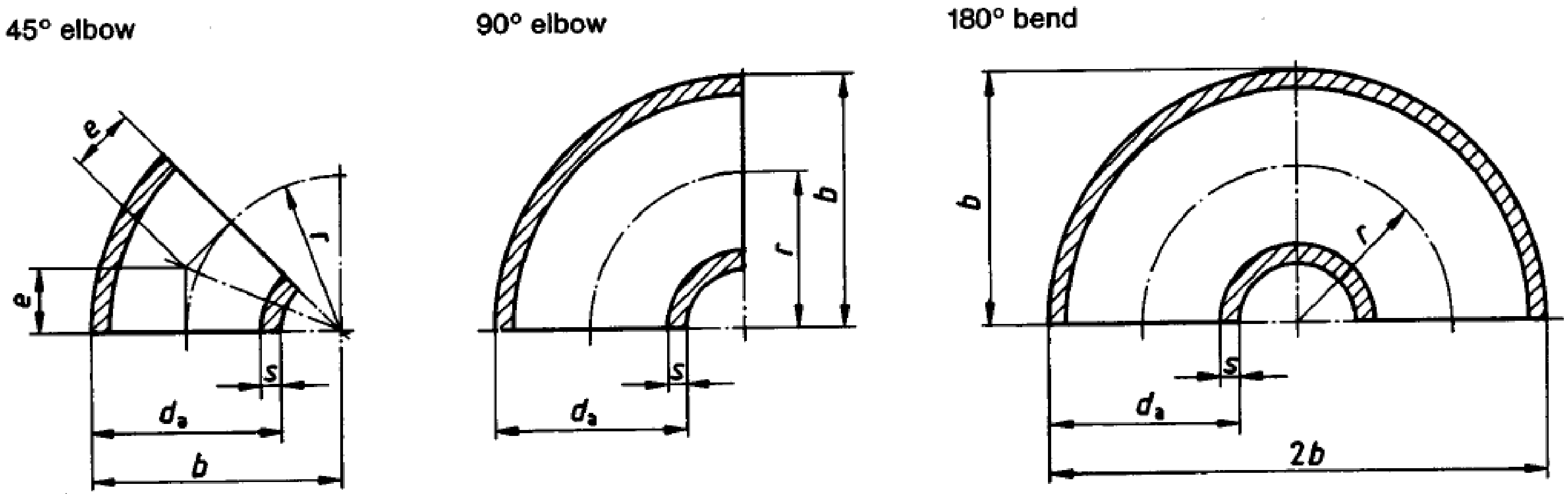




Piping system. Elbow, R=1D, R=1,5D



Piping system. Elbow, R=1D, R=1,5D



r is to be calculated as follows:

type 2: $r \approx 1{,}0 \cdot d_a$

type 3: $r \approx 1{,}5 \cdot d_a$

type 5: $r \approx 2{,}5 \cdot d_a$

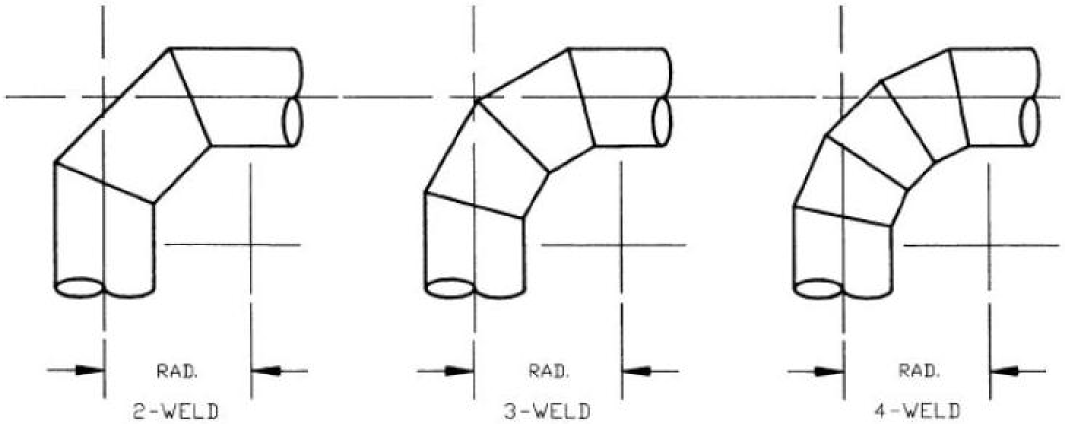
type 10: $r \approx 5{,}0 \cdot d_a$

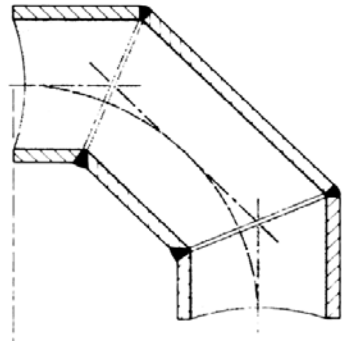
type 20: $r \approx 10{,}0 \cdot d_a$

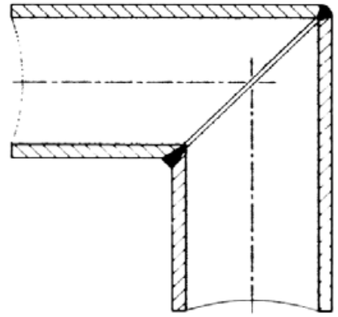
Steel butt-welding pipe fittings
Elbows and bends with reduced pressure factor

DIN 2605 Part 1

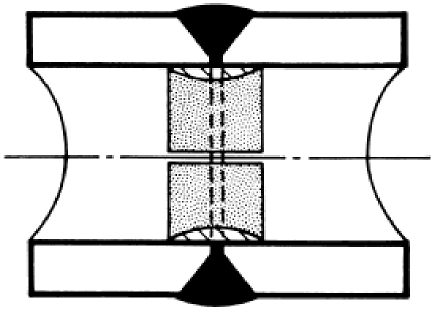
Piping system. Mitter Elbow



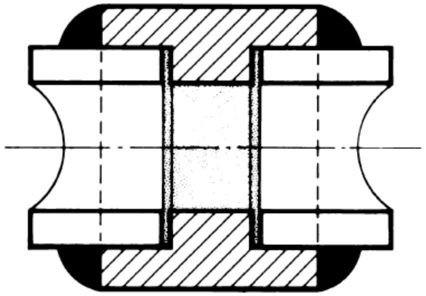




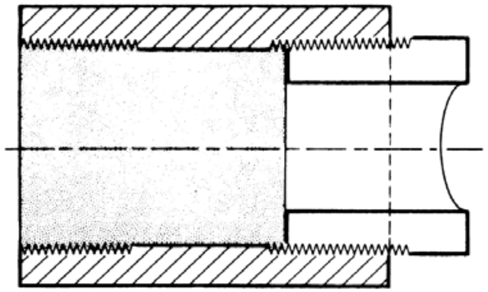
Piping system. Coupling, Connector



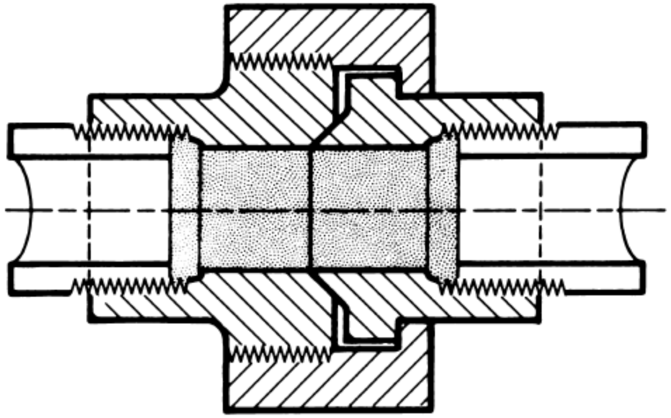
Butt-Welded
Piping BW

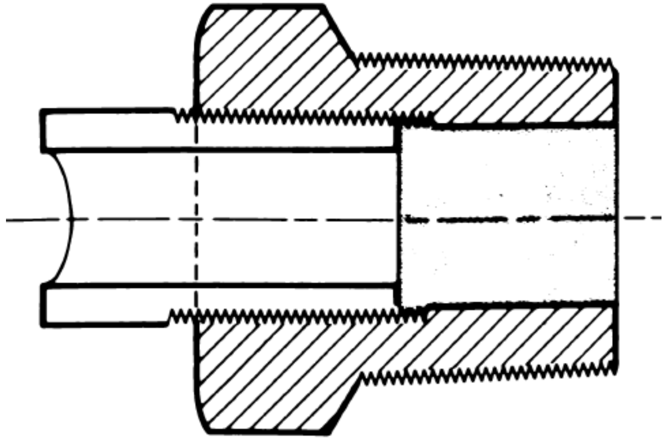


Socket-Welded
Piping SW

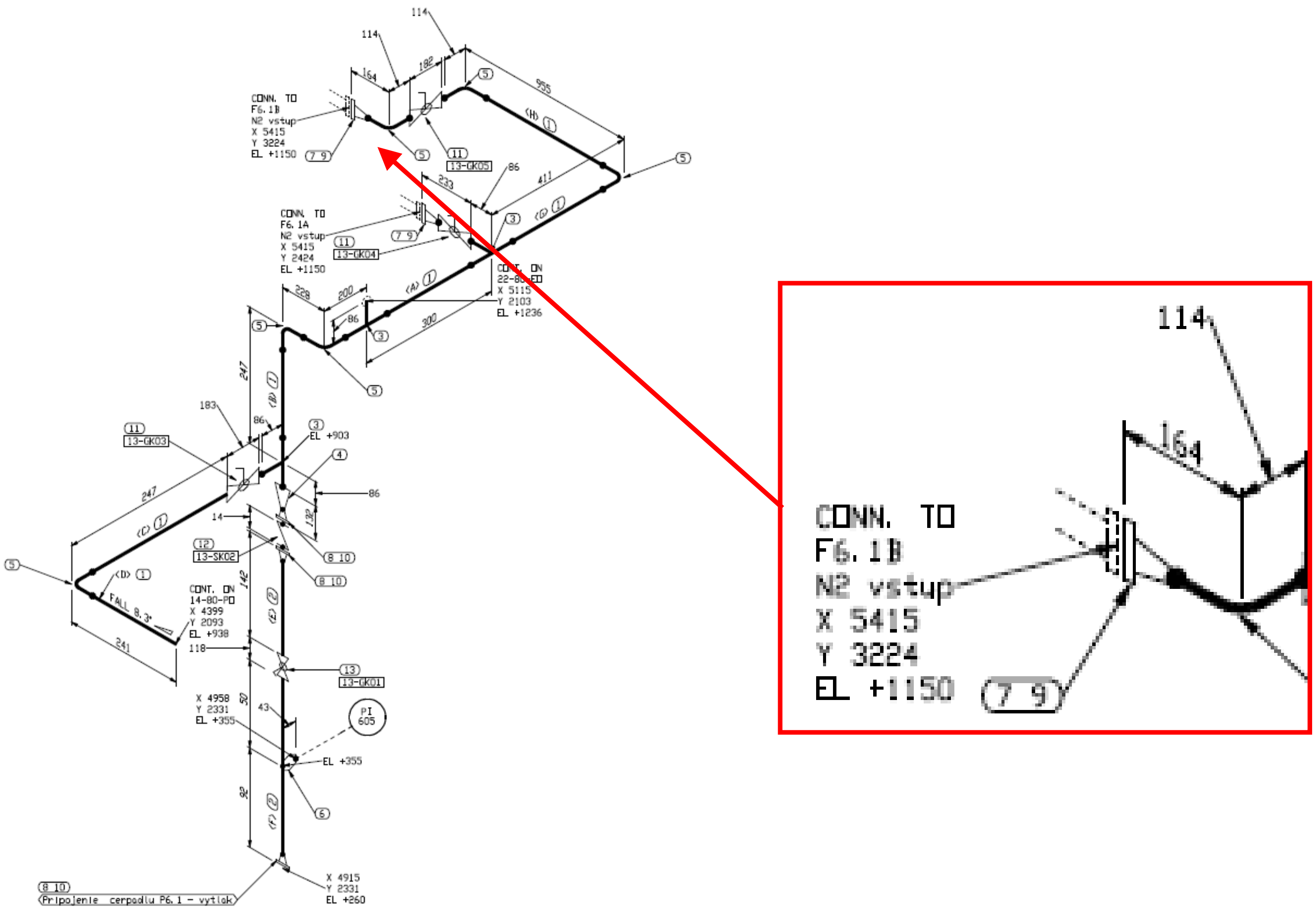


Screwed Piping S
(THD Thread)

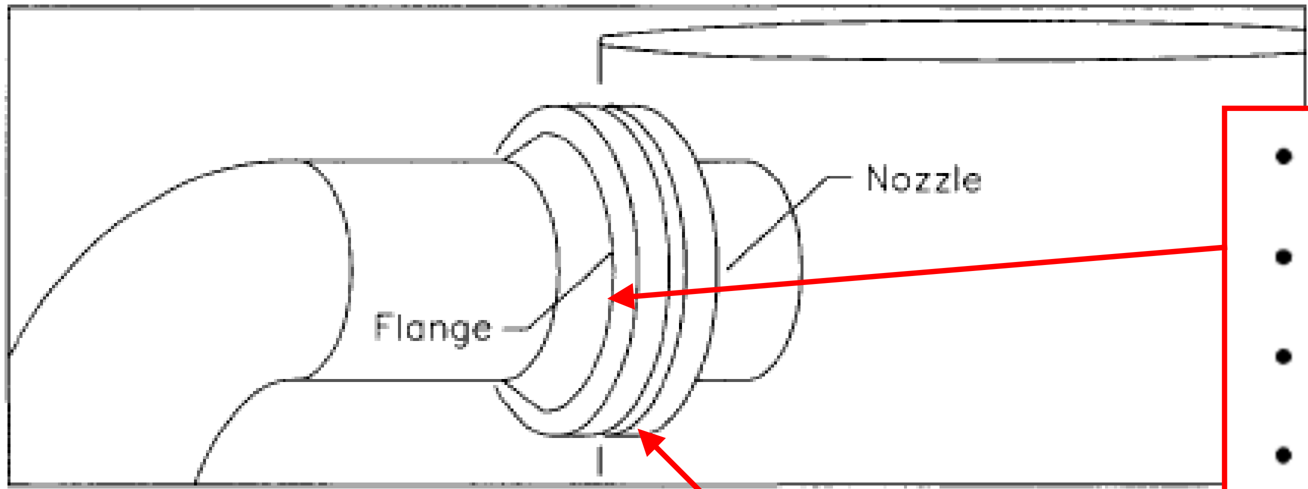




Piping system. Flange



Piping system. Flange

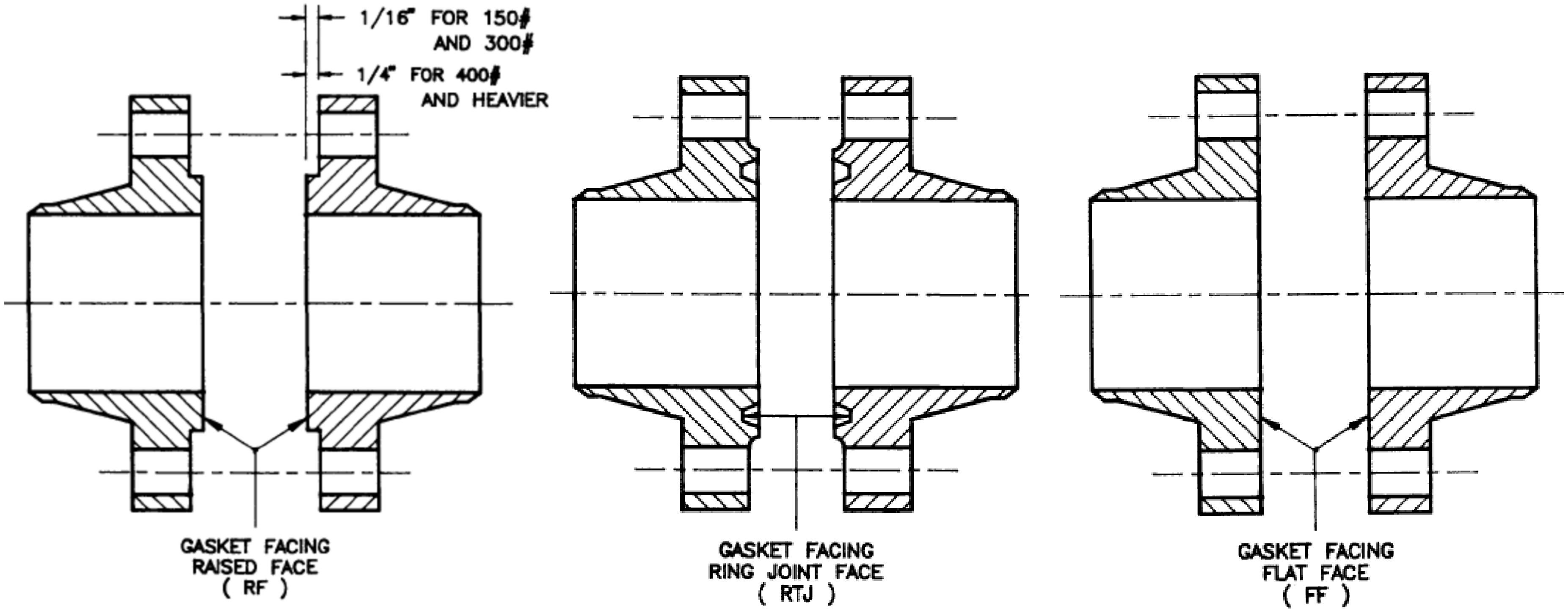


- weld neck
- threaded
- socket weld
- slip-on
- lap-joint
- reducing
- blind
- orifice

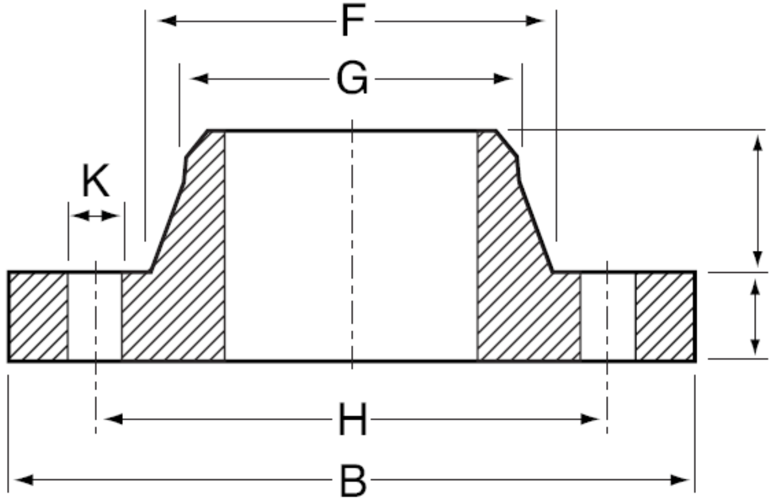
- flat face
- raised face
- ring-type joint

-Type
-Size
-Rating
-Sealing surface

Piping system. Flange



Piping system. Flange



WELDING NECK

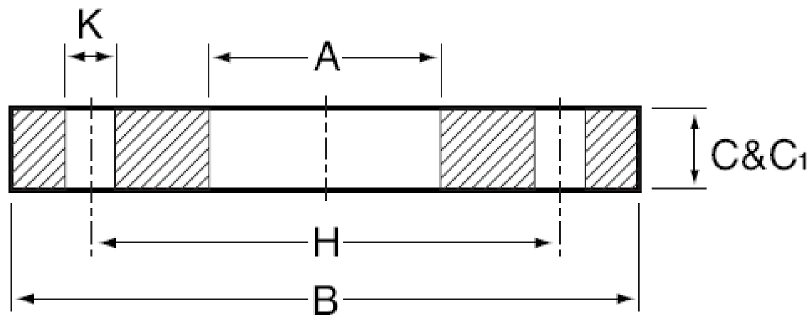
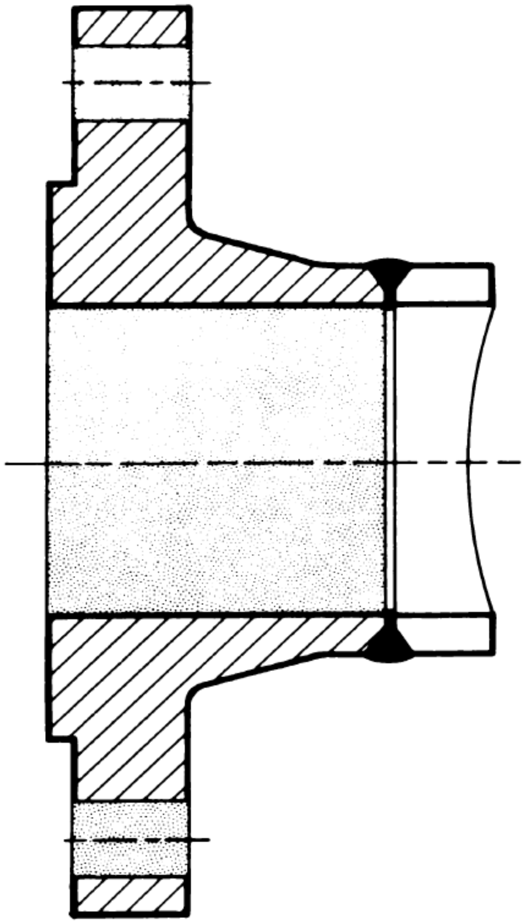


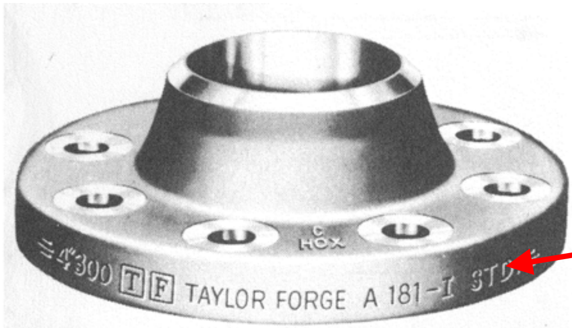
PLATE SLIP-ON WELDING

Main dimensions:

- Bolt circle
- Number of Bolts
- Outside dimension

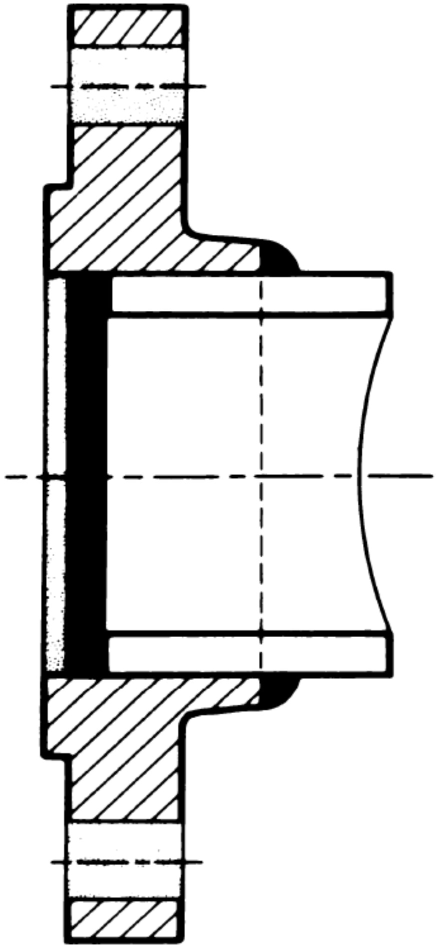
Piping system. Flange Welding Neck

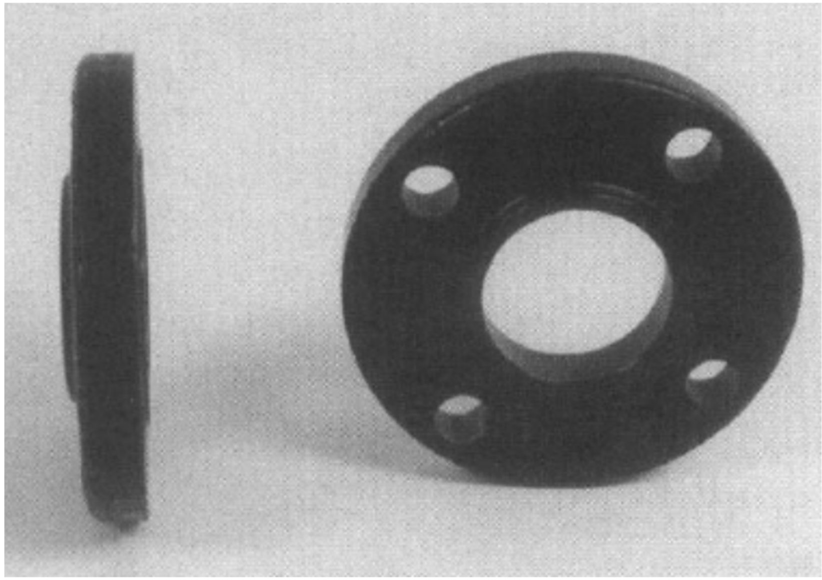


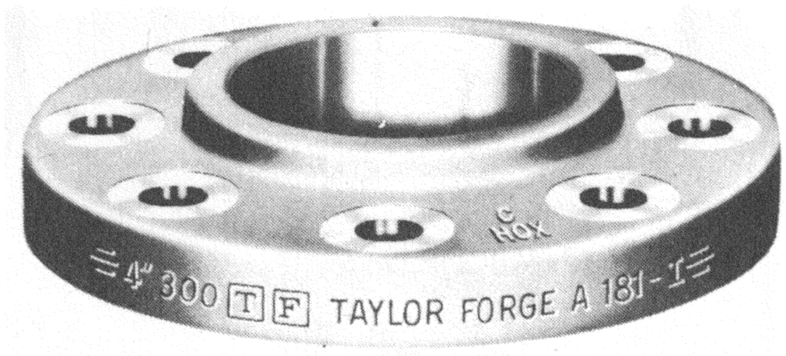


Identification

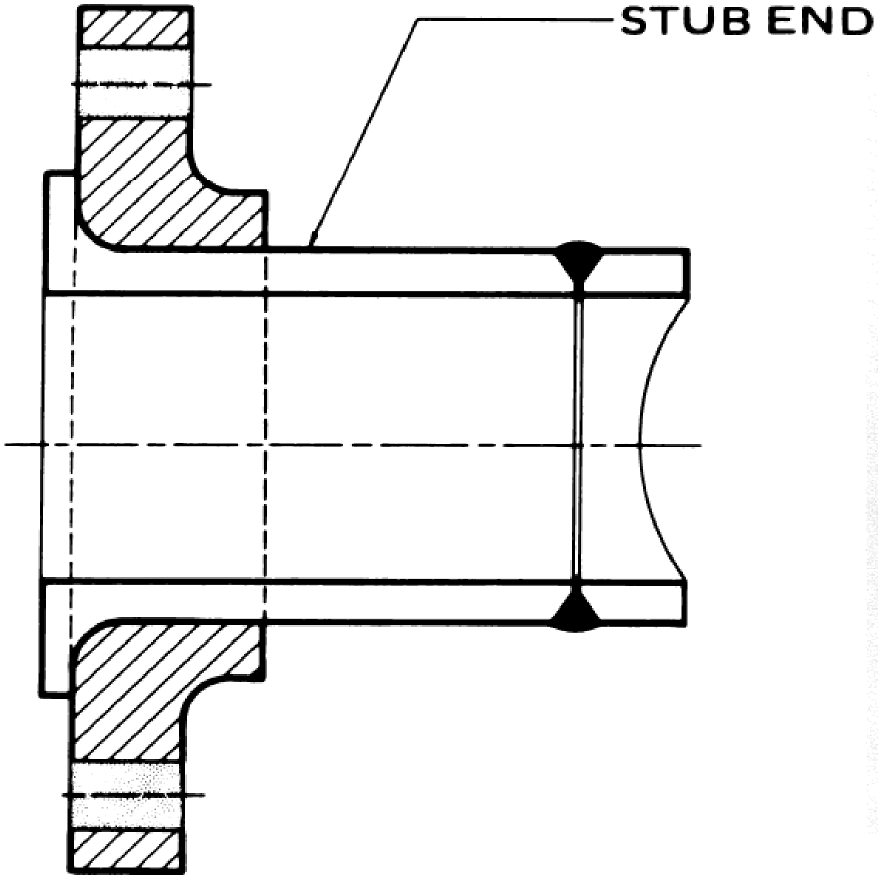
Piping system. Slip-on flange

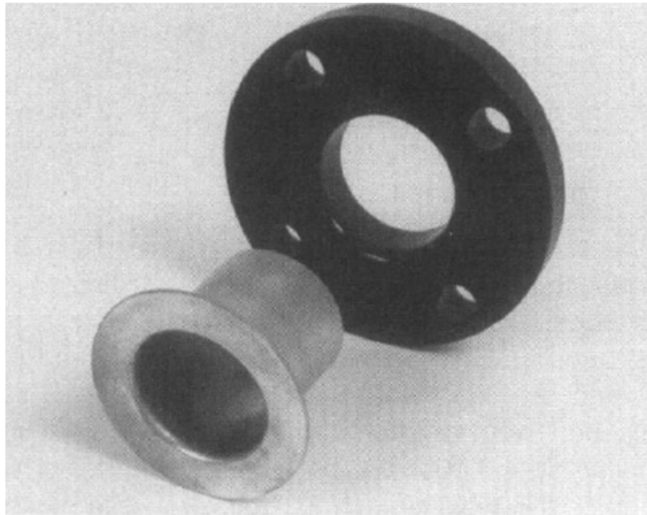




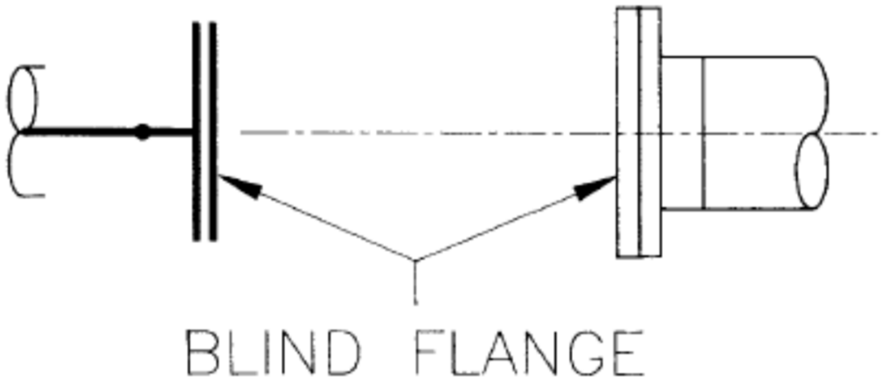


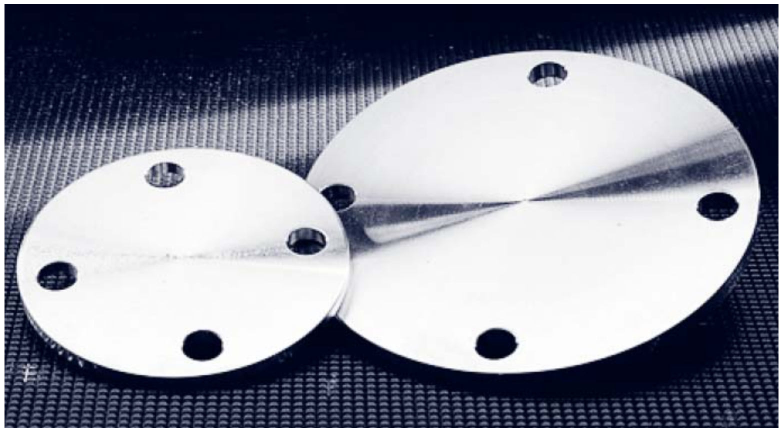
Piping system. Lap-joint flange

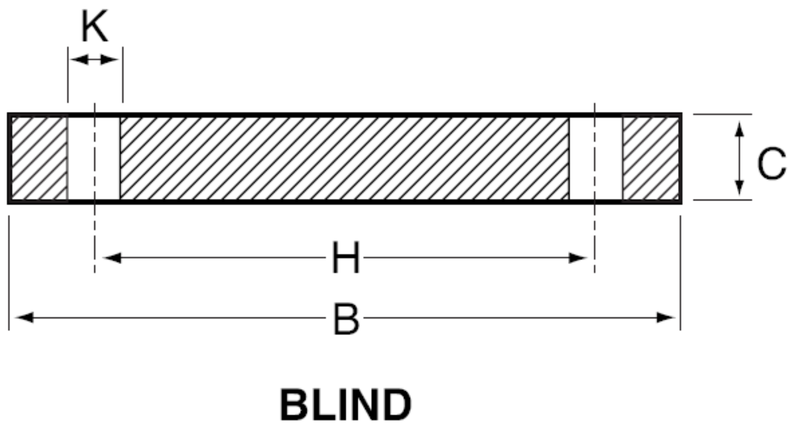




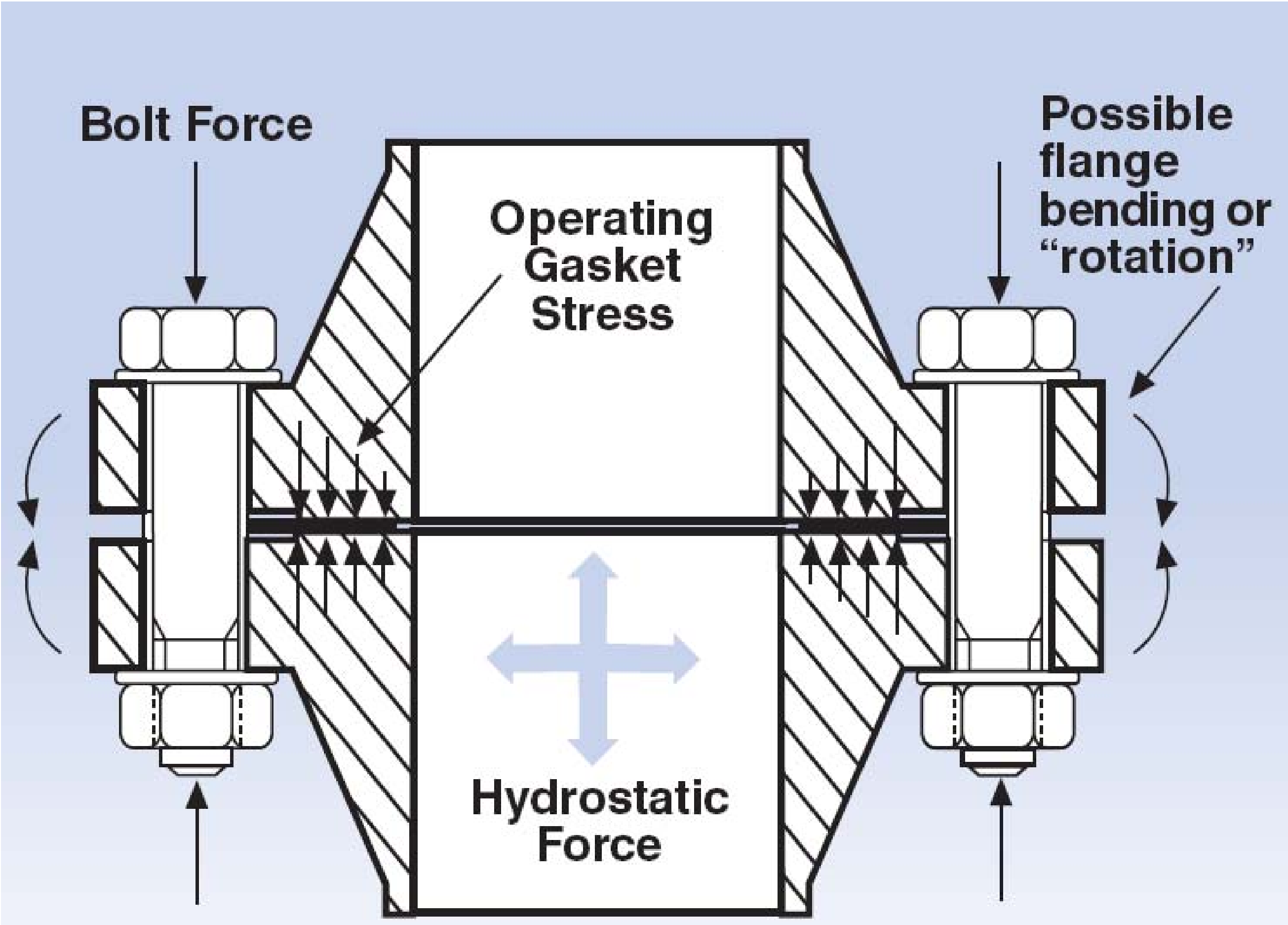
Piping system. Blind flange







Piping system. Gasket

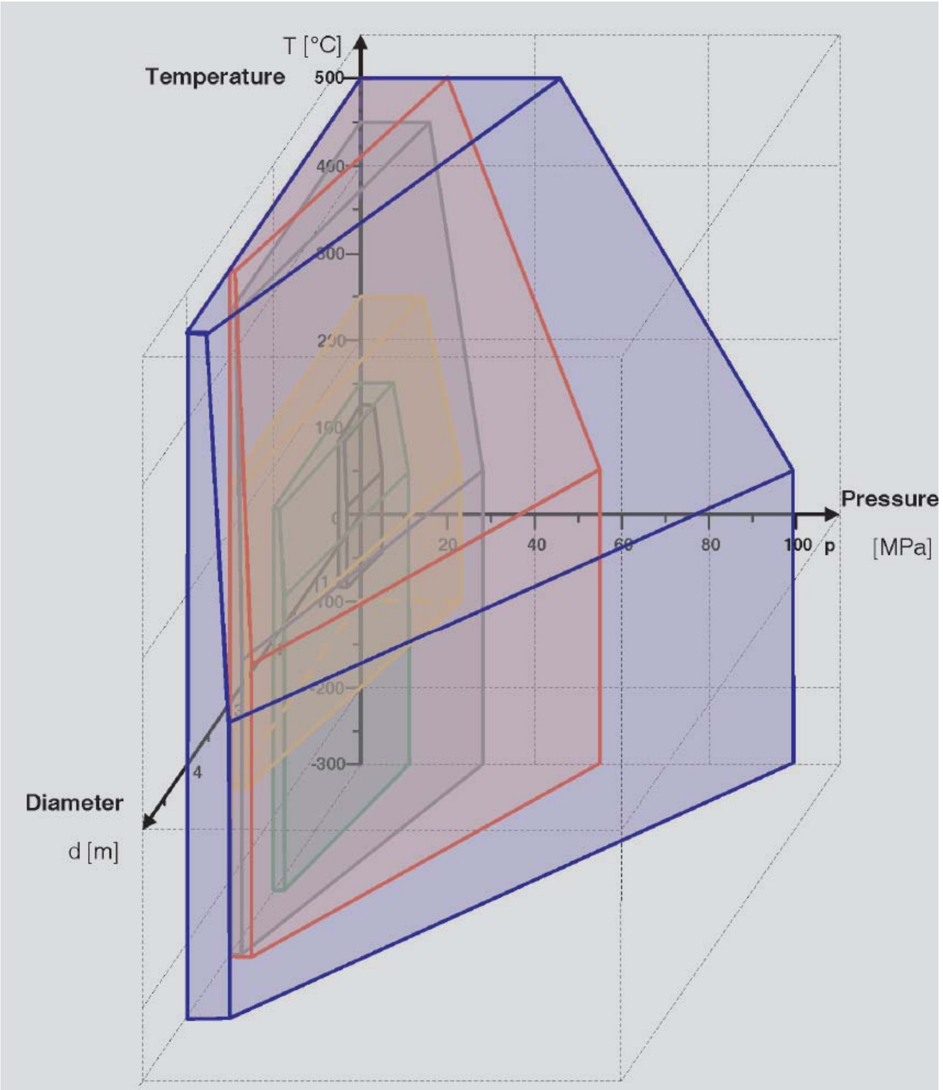


A seal is a component ensuring the tightness of two surfaces, using the stored energy between them.

We divide materials for seals into:

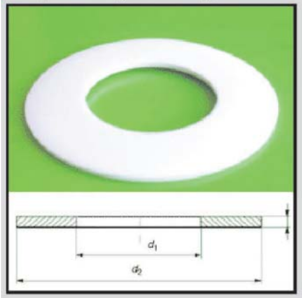
Non-metallic types
Semi-metallic types
Metallic types

Piping system. Gasket

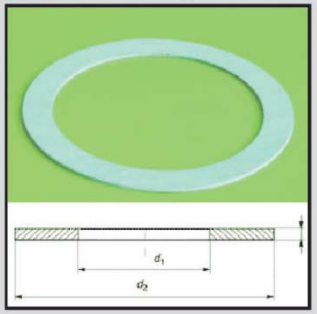


Rubber gasket

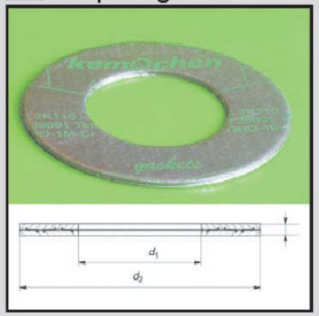
PTFE-, ePTFE-gasket



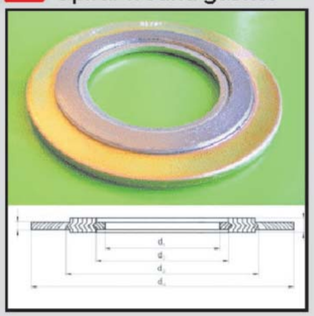
Fibre sheet gasket



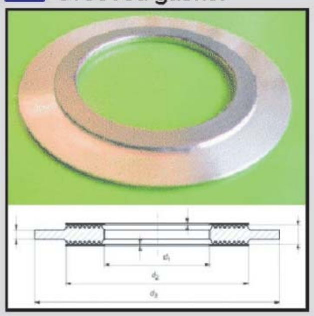
Graphite gasket



Spiral-wound gasket



Grooved gasket



Piping system. Bolt-Nut

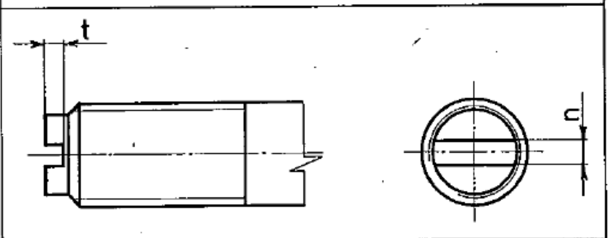
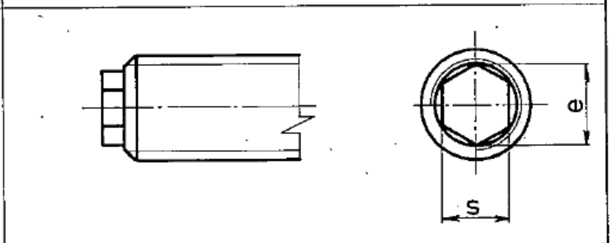
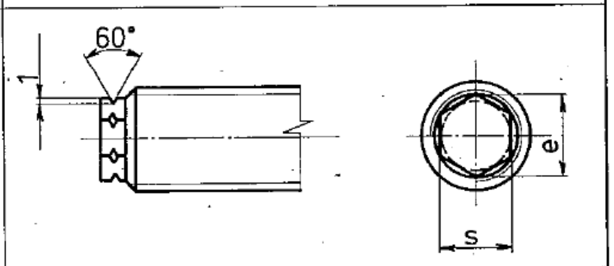
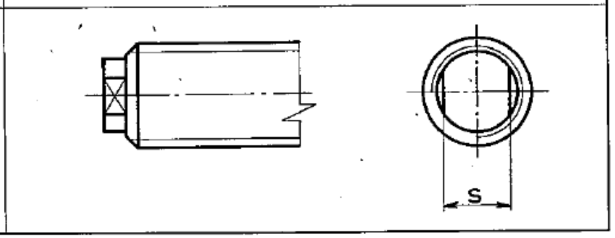
Sub-clause number	Mechanical and physical property		Property class 3.6	4.6	4.8	5.6	5.8	6.8	8.8[1] $d \le$ 16mm[3]	8.8[1] $d >$ 16mm[3]	9.8[2]	10.9	12.9
5.1 und 5.2	Tensile strength Rm in N/mm² [4), 5)]	nominal value	300	400		500		600	800	800	900	1000	1200
		min.	330	400	420	500	520	600	800	830	900	1040	1220
5.3	Vickers hardness HV $F \ge 98$ N	min.	95	120	130	155	160	190	250	255	290	320	385
		max.	220[6)					250	320	335	360	380	435
5.4	Brinell hardness HB $F = 30\,D^2$	min.	90	114	124	147	152	181	238	242	276	304	366
		max.	209[6)]					238	304	318	342	361	414
5.5	Rockwell hardness HR	min. HRB	52	67	71	79	82	89	—	—	—	—	—
		HRC	—	—	—	—	—	—	22	23	28	32	39
		max. HRB	95[6)]					99,5	—	—	—	—	—
		max. HRC	—					—	32	34	37	39	44
5.6	Surface hardness HV 0,3	max.	—						[7)]				
5.7	lower yield stress R_{eL}[8)] in N/mm²	nominal value	180	240	320	300	400	480	—	—	—	—	—
		min.	190	240	340	300	420	480	—	—	—	—	—
5.8	Stress at 0,2% non-proportional elongation $R_{p0,2}$[9)] in N/mm²	nominal value	—					—	640	640	720	900	1080
		min.	—					—	640	660	720	940	1100
5.9	Stress under proofing load S_p	S_p / R_{eL} or $S_p / R_{p0,2}$	0,94	0,94	0,91	0,93	0,9	0,92	0,91	0,91	0,9	0,88	0,88
		N/mm²	180	225	310	280	380	440	580	600	650	830	970
5.10	Breaking torque, M_B Nm min.		—						see ISO 898-7				
5.11	Percent elongation after fracture *A* in %	min.	25	22	—	20	—	—	12	12	10	9	8
5.12	Reduction area after fracture Z	% min.	—						52		48	48	44
5.13	Strength under wedge loading[5)]		The values for full size bolts and screws (not studs) shall not be smaller than the minimum values for tensile strength shown in 5.2										
5.14	Impact strength, *KU* in J	J min.	—			25	—		30	30	25	20	15
5.15	Head soudness		no fracture										
5.16	Minimum height of non-decarburized thread zone, *E*		—						½ H_1			⅔ H_1	¾ H_1
	Maximum depth of complete decarburization, *G*	mm	—						0,015				
5.17	Hardness after retempering		—						Reduction of hardness 20 HV max.				
5.18	Surface integrity		In accordance with ISO 6157-1 or ISO 6157-3 as appropriate										

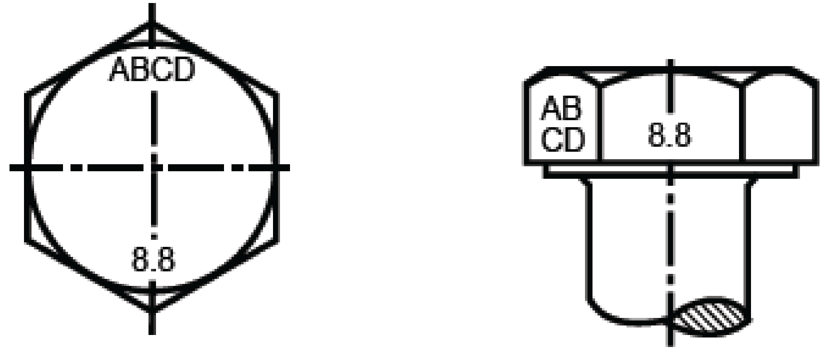
Screw connection

Selection of suitable material

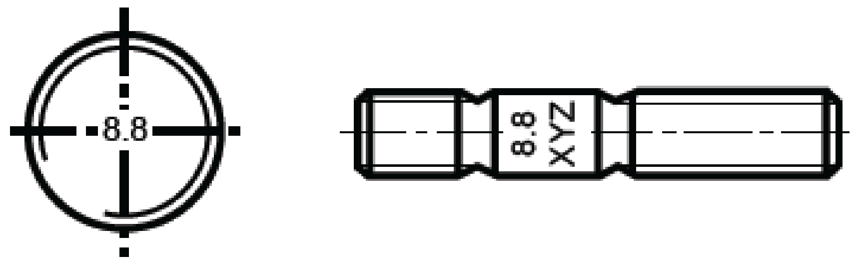
Mechanical properties
High temperatures
Low temperatures
Corrosive environment

Piping system. Bolt

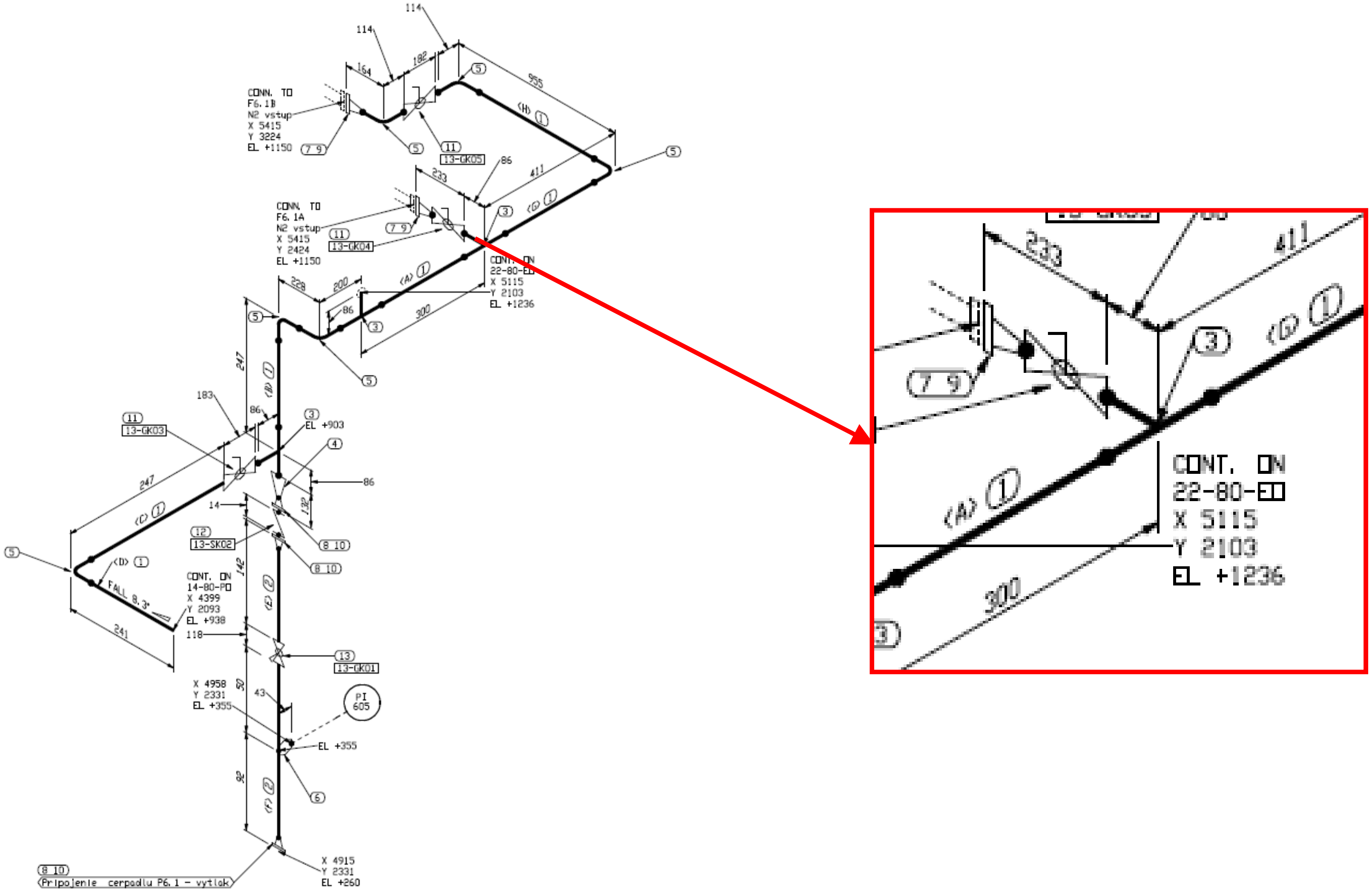
Materiál	Doplňková číslice za číslem normy	Tvar konce šroubu
12 050.6 nebo 12 056.6	13 1520.1	
15 320.5	13 1520.2	
15 320.5 ¹)	13 1520.3	
17 248.4	13 1520.4	



Examples of marking on hexagon screws



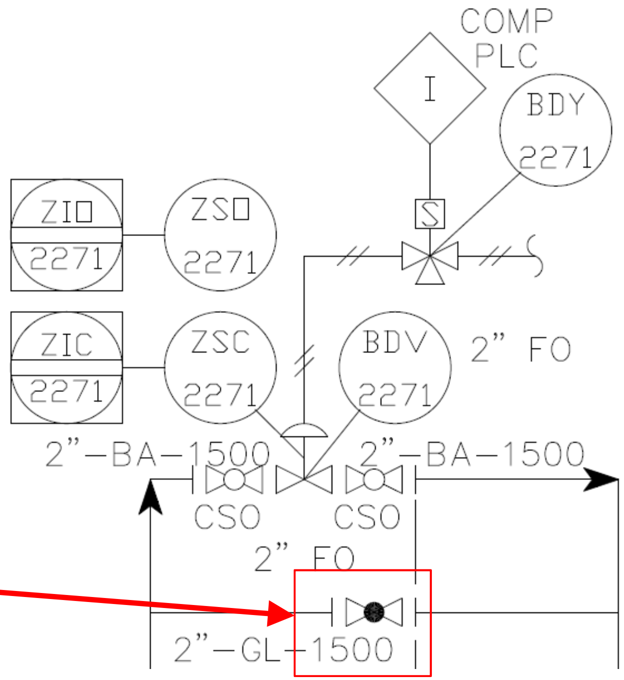
Piping system. Valves



Piping system. Valves

What influences the correct choice of fittings?

- function
- material design
- T/p
- security
- lifespan
- connection
- operation
- weight
- maintenance
- the price



Multiple alternatives for one position
Compromise

Piping system. Valves

Table 5: Loss coefficients ζ for various types of valves and fittings (referred to the velocity of flow in the line connection nominal diameter DN)

	Type of valve / fitting		Design	15	20	25	32	40	50	65	80	100	125	150	200	250	300	400	500	600	800	1000	Comment
Shut-off valves	Slide disc valves	min	1	0.1	←																→	0.1	
	(d_E = DN)	max		0.65	0.6	0.55	0.5	0.5	0.45	0.4	0.35	0.3	←								→	0.3	For d_E < DN cf. footnote 1)
	Round-body gate valves	min	2						0.25	0.24	0.23	0.22	0.21	0.19	0.18	0.17	0.16	0.15	0.13	0.12	0.11	0.11	
	(d_E = DN)	max							0.32	0.31	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.19	0.18	0.16	0.15	0.14	
	Ball and plug valves	min	3	0.10	0.10	0.09	0.09	0.08	0.08	0.07	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.02					For d_E < DN
	(d_E = DN)	max		0.15	←												→	0.15					ζ = 0.4 to 1.1
	Butterfly valves PN 2.5 10	min	4					0.90	0.59	0.38	0.26	0.20	0.14	0.12	0.09	0.06	←				→	0.06	
		max						1.20	1.00	0.80	0.70	0.62	0.56	0.50	0.42	0.40	0.37	0.33	0.33	0.33	0.30	0.28	
	Butterfly valves PN 16 25	min	4						2.04	1.80	1.55	1.30	1.08	0.84	0.75	0.56	0.48	0.40	←		→	0.40	
		max							2.50*	2.30*	2.10*	1.90*	1.70*	1.50*	1.30	1.10	0.90	0.83	0.76	0.71	0.67*	0.63*	* Also for PN 40
	Globe valves, forged	min	5			6.0	←	→	6.0														
		max				6.8	←	→	6.8														
	Globe valves, cast	min	6	3.0	←											→	3.0						ζ = 2 to 3 can be achieved
		max		6.0	←											→	6.0						for optimized valve
	Compact valves	min	7	0.3	0.4	0.6	0.6	1.0	1.1	←				→	1.1								
		max		0.3	0.9	1.9	←		→	1.9	2.2	2.2	2.3	2.5	2.5								
	Angle valves	min	8	2.0	←												→	2.0					
		max		3.1	←	→	3.1	3.4	3.8	4.1	4.4	4.7	5.0	5.3	5.7	6.0	6.3	6.6					
	Y-valves	min	9	1.5	←											→	1.5						
		max		2.6	←											→	2.6						
	Straight-through valves	min	10	0.6	←												→	0.6					
		max		1.6	←												→	1.6					
	Diaphragm valves	min	11	0.8	←								→	0.8									
		max		2.7	←								→	2.7									
Non-return valves	Non-return valves, straight seat	min	12	3.0	←									→	3.0								
		max		6.0	←									→	6.0								
	Non-return valves, axial	min	13	3.2	←			→	3.2	3.7	5.0	7.3	4.3	←		→	4.3						Axially expanded as from
		max		3.4	3.4	3.5	3.6	3.8	4.2	5.0	6.4	8.2	4.6	←		→	4.6						DN 125
	Non-return valves, slanted seat	min	14	2.5	2.4	2.2	2.1	2.0	1.9	1.7	1.6	1.5	←			→	1.5						
		max		3.0	←											→	3.0						
	Foot valves	min	15						1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.4	0.4	(7.0)	(6.1)	(5.5)	(4.5)	(4.0)	( ) In groups
		max							3.0	←						→	3.0						
	Swing check valves	min	16	0.5	←		→	0.5	0.4	←						→	0.4	0.3	←		→	0.3	Swing check valves with-
		max		3.0	←																→	3.0	out levers and weights 2)
	Hydrostops v = 4 m/s		17						0.9			3.0		3.0	2.5	2.5	1.2	2.2					
	v = 3 m/s								1.8			4.0		4.5	4.0	4.0	1.8	3.4					
	v = 2 m/s								5.0			6.0		8.0	7.5	6.5	6.0	7.0					
	Filters		18					2.8	←							→	2.8						In clean condition
	Strainers		19					1.0	←							→	1.0						

1) If the narrowest shut-off diameter d_E is smaller than the line connection nominal diameter DN, the loss coefficient ζ must be increased by $(DN/d_E)^x$ with x = 5 to 6.
2) When the valve is partially open, i.e. low flow velocities, the loss coefficients increase to the "max" values. With increasing flow velocities v (in m/s) the loss coefficients decrease roughly as ζ 3/v.
See Fig. 13 for designs.

Procesné parametre:

Tlaková strata ξ

Pre regulačné Valves Prietokový súčiniteľ Kv, Cv.

$$Kv = \frac{1}{100} \cdot Q \cdot \sqrt{\frac{\rho_1}{\Delta p}} \qquad [m^3.h^{-1}]$$

kde

Q	je objemový prietok	$[m^3.h^{-1}]$
ρ	je objemová hmotnosť	$[kg.m^{-3}]$
Δp	je tlaková strata armatúry	[MPa]

Handwheel rotation	Kv-value (m^3/h)
0.5	1.1
1.0	2.2
1.5	3.2
2.0	4.3
2.5	5.4
3.0	6.45
3.4	7.2

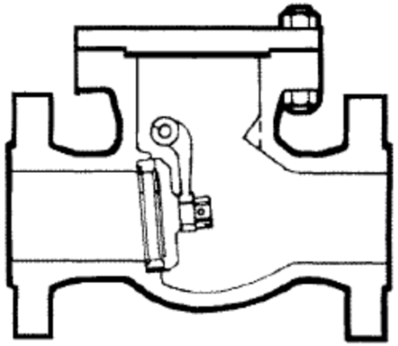
Prietokový súčiniteľ - charakteristický prietok danou armatúrou za presne definovaných
podmienok pri menovitom
Kv – m3/hod.
Cv- US gal/min.

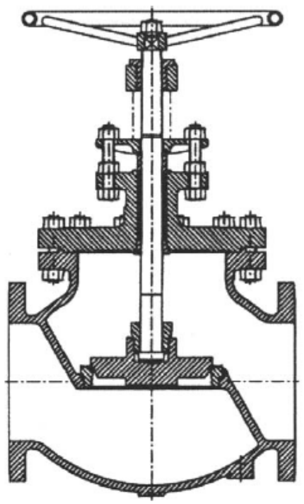
Piping system. Valves

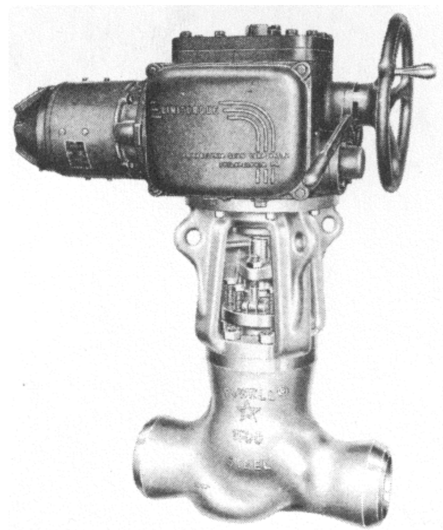
Basic functions of valves

VALVE ACTION	EXPLANATION
ON/OFF	STOPPING OR STARTING FLOW
REGULATING	VARYING THE RATE OF FLOW
CHECKING	PERMITTING FLOW IN ONE DIRECTION ONLY
SWITCHING	SWITCHING FLOW ALONG DIFFERENT ROUTES
DISCHARGING	DISCHARGING FLUID FROM A SYSTEM

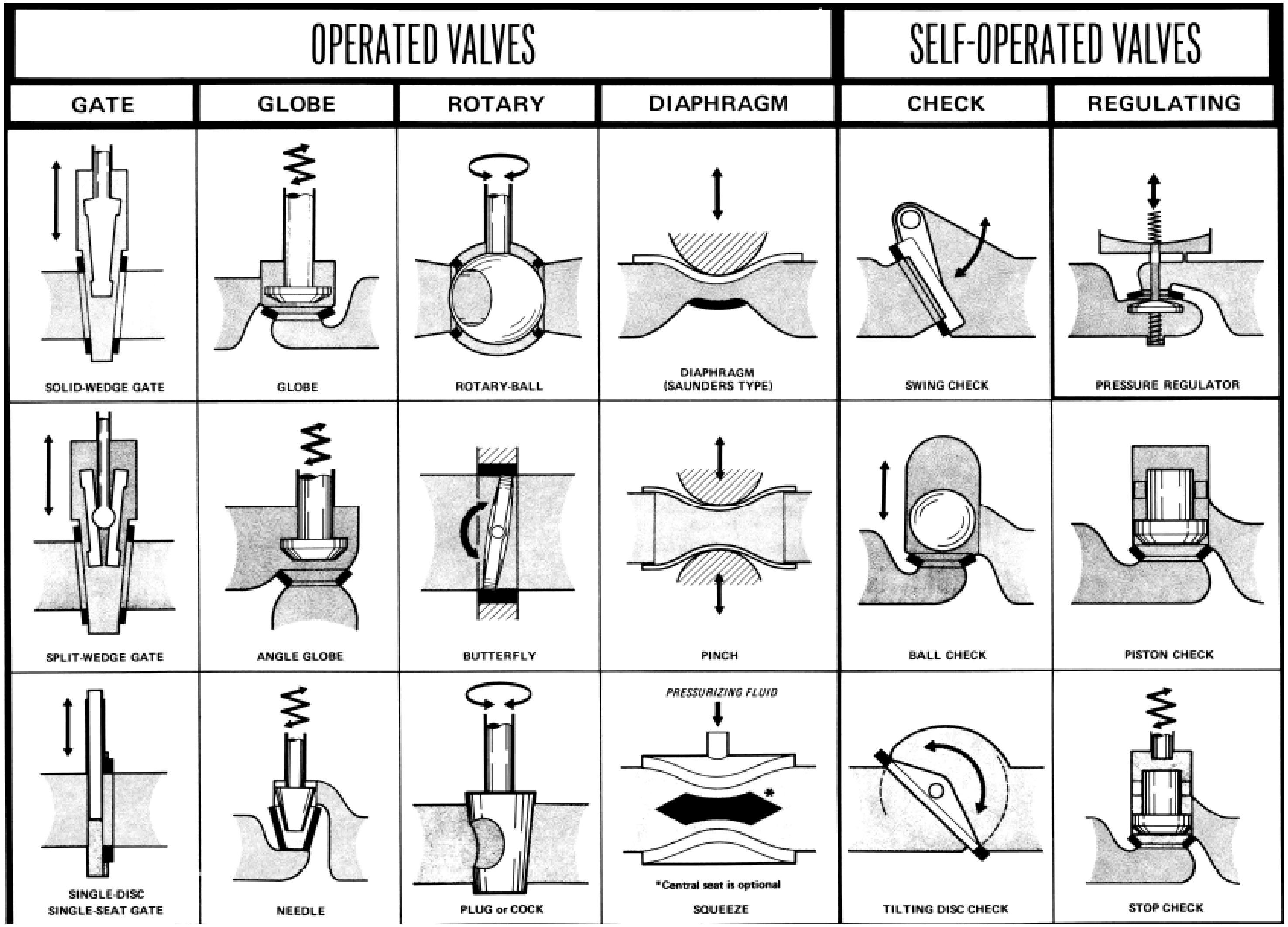
Basic ways of controlling valves



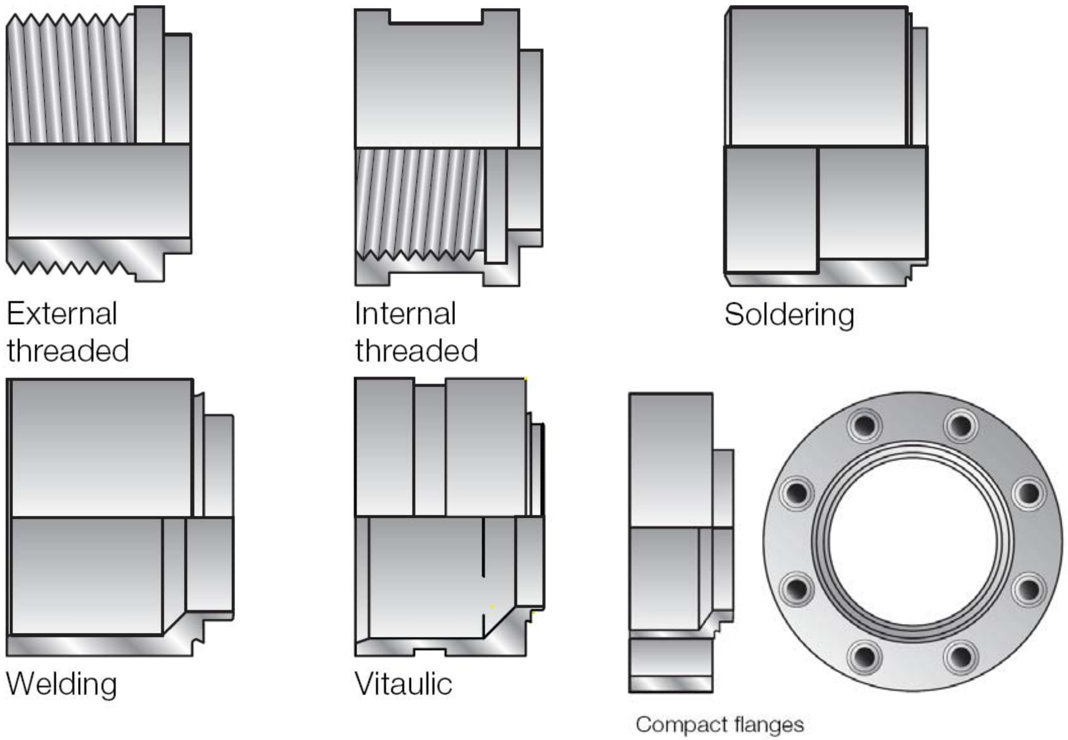




Piping system. Valves



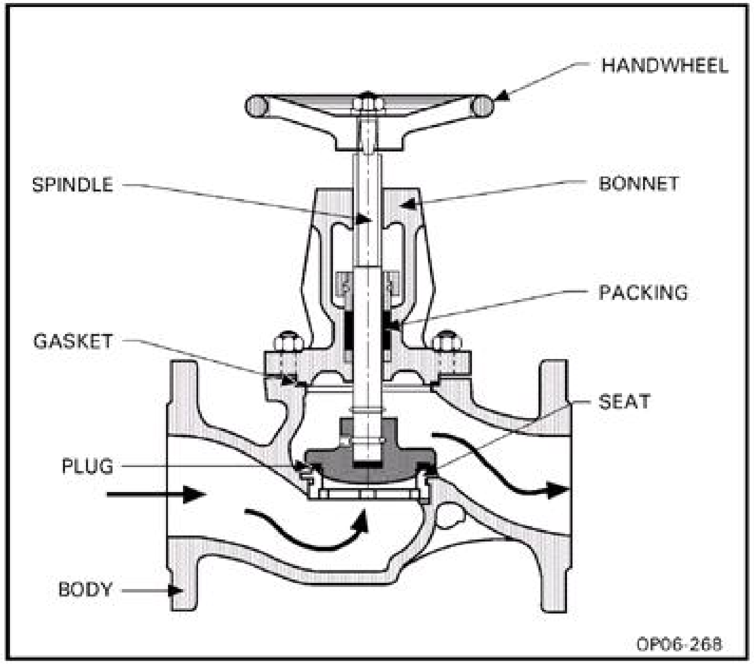
Piping system. Valves



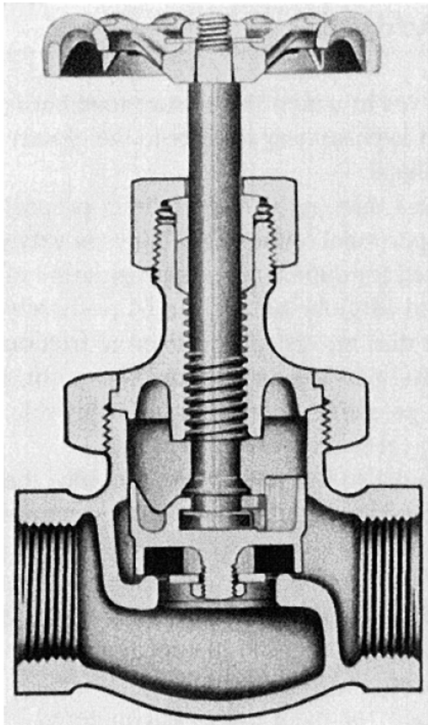
Connection dimension:

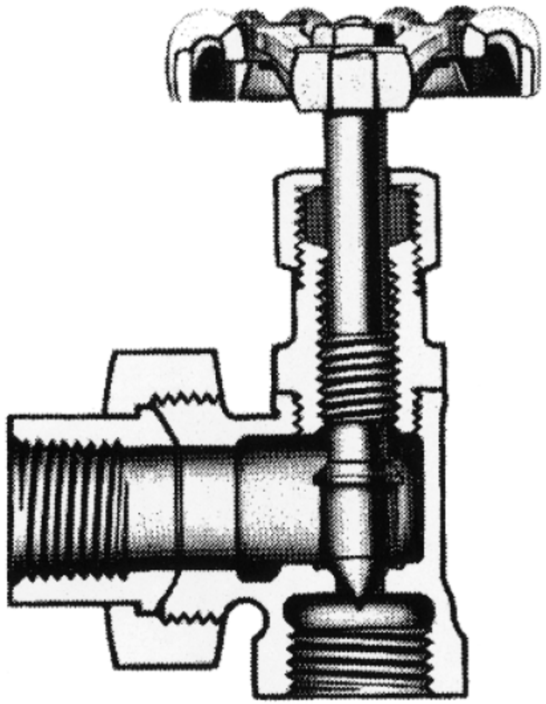
- Flange
- Thread
- Weld
- Other connections (Parker, Swagelock, Clamp, aseptic program...)

Valves. Globe Valve



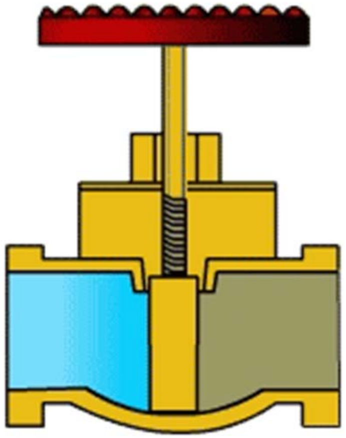
Valve Body Pattern:
-Standard
-Angle
-Oblique „Y“

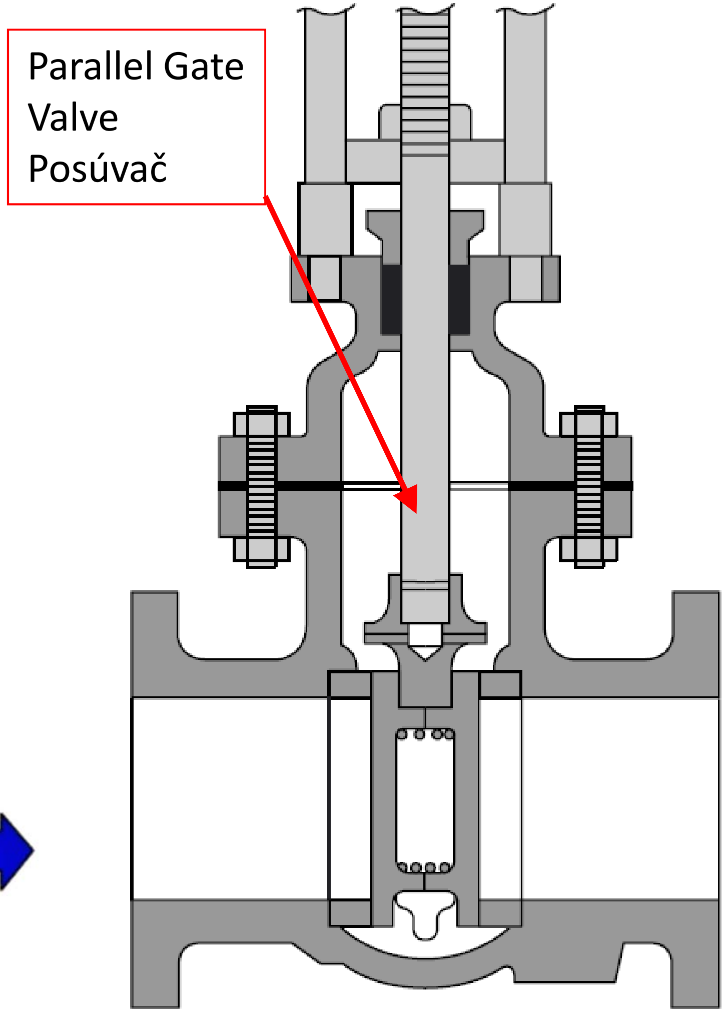




Function
-Control
-ON/OFF
-Časté otváranie a zatváranie
Application
(g) a (l)
Vacuum

Valves. Parallel Gate Valve





Advantages:

- low pressure loss at 100% opening.
- suitable for slurries, pastes, suspensions, and difficult-to-transport materials

Disadvantages:

- unsuitable for frequent opening. Seal damage.
- Not suitable for regulation. Effective regulation starts at 50% closure
- at high speeds the tendency to vibrate

Function

-ON/OFF

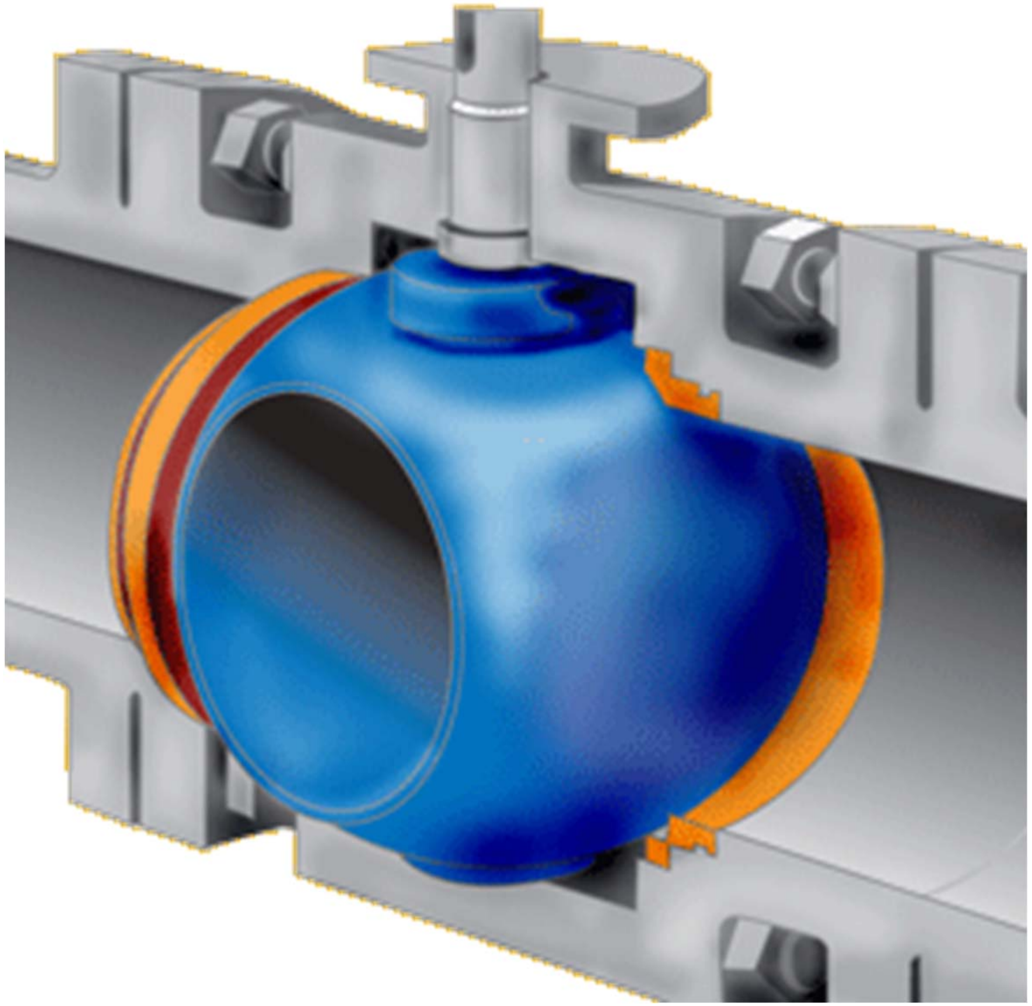
- Control, špeciálna konštrukcia

Application

-(g),(l) . Also suspensions, slurries, pastes

-Vacuum

Valves. Ball Valve



Advantages:
- quick opening/closing 90°-
- about higher pressures
- low pressure loss at 100% opening

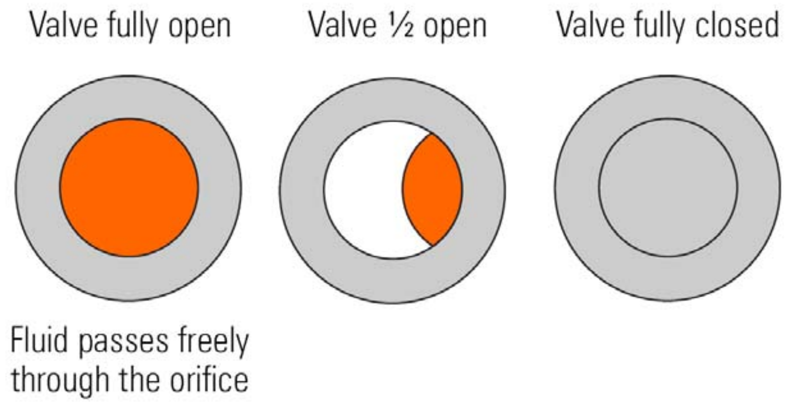
Disadvantages:
- mostly for lower temperatures
- unsuitable for regulation.

Function
-ON/OFF, Switching function
Application
-(g),(l),

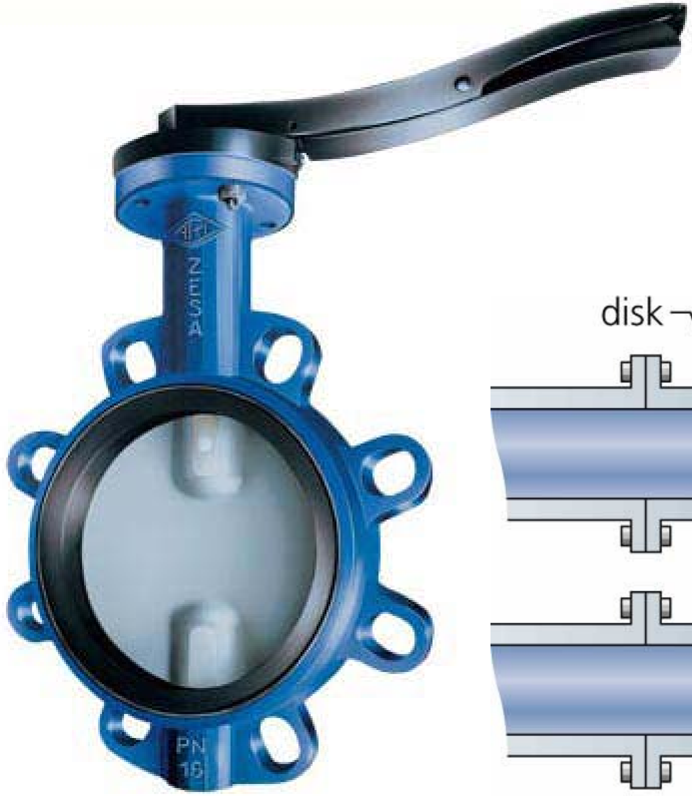
Valves. Ball Valve

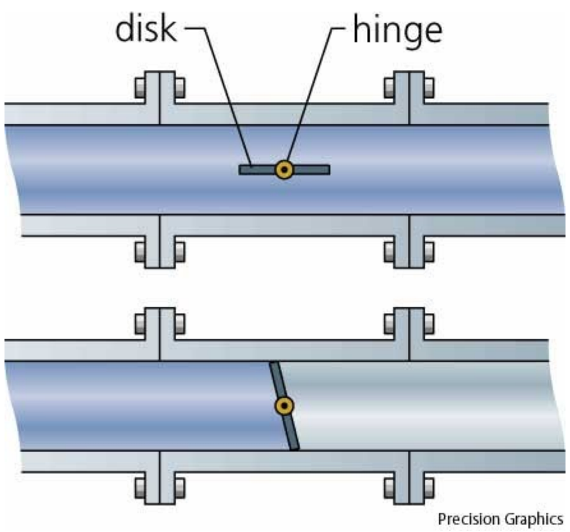
Design:

1-piece (e.g. flanged/ intermediate flanged)
2-part
3-part



Valves. Butterfly Valve



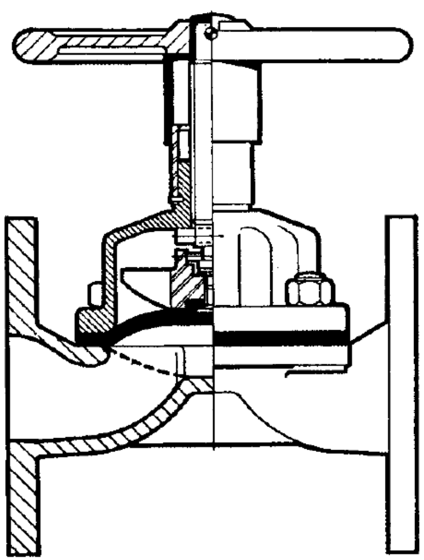


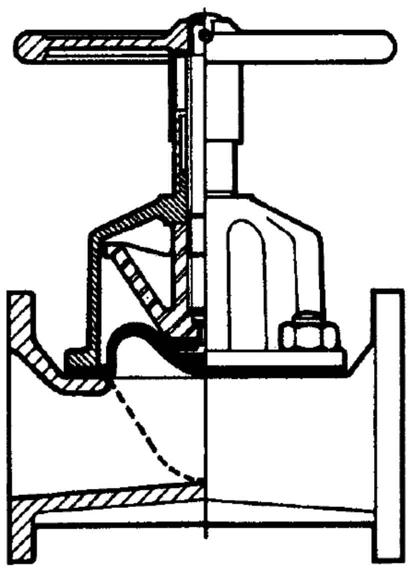
Advantages:
- simple, cheap
- low weight
- opening/closing 90°
- low pressure loss at 100% opening
- implemented seal
- also suitable for regulation

Disadvantages:
- mostly for lower temperatures/pressures
- "pigging", the middle part

Function
-ON/OFF, Control
Application
-(g),(l),

Valves. Diaphragm valve





Straight line movement.
Compression of the flexible membrane element

Advantages:

- for extremely corrosive and abrasive materials.
- low weight
- simple
- also suitable for regulation

Disadvantages:

-temperature restrictions, lower temperatures (up to 160 °C) - membrane

-pressurizing the system.

Inner liner

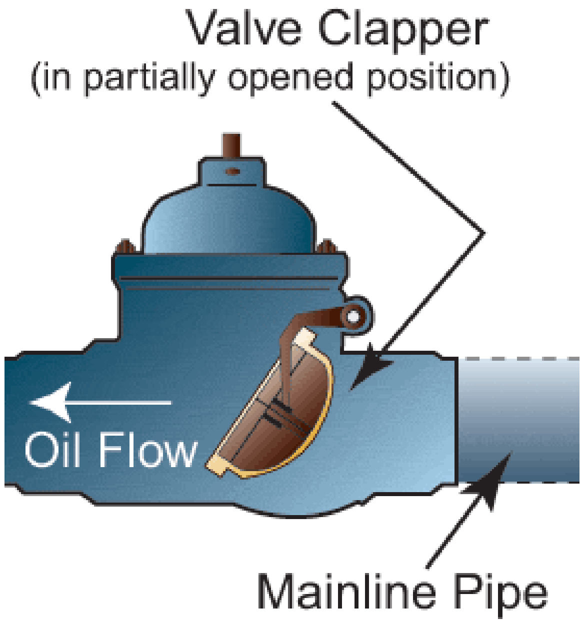
Function

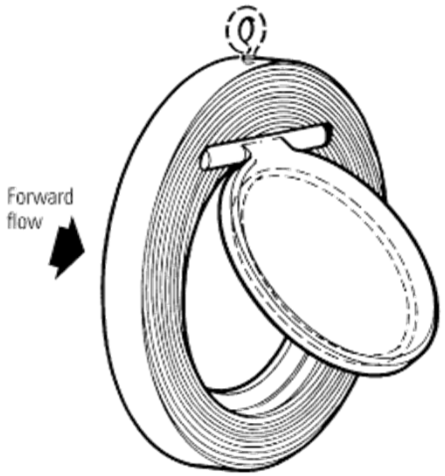
-ON/OFF, Control

Application

- (l),(g) + corrosion medium.

Valves. Swing Check Valve



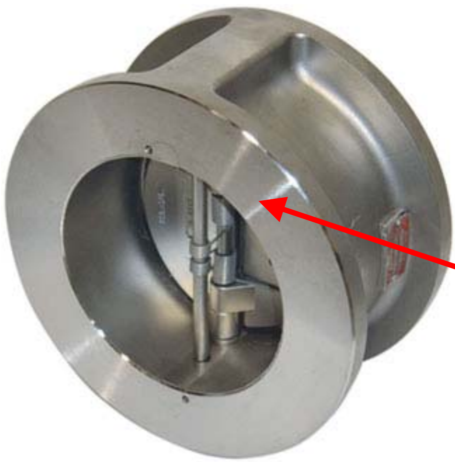


Swing Check Valve
The closing element is rotated by the flow of the medium, in reverse flow it is, on the contrary, pushed onto the contact surface.

Advantages:

- greater distance of movement of the closing element.
- little tendency to clogging

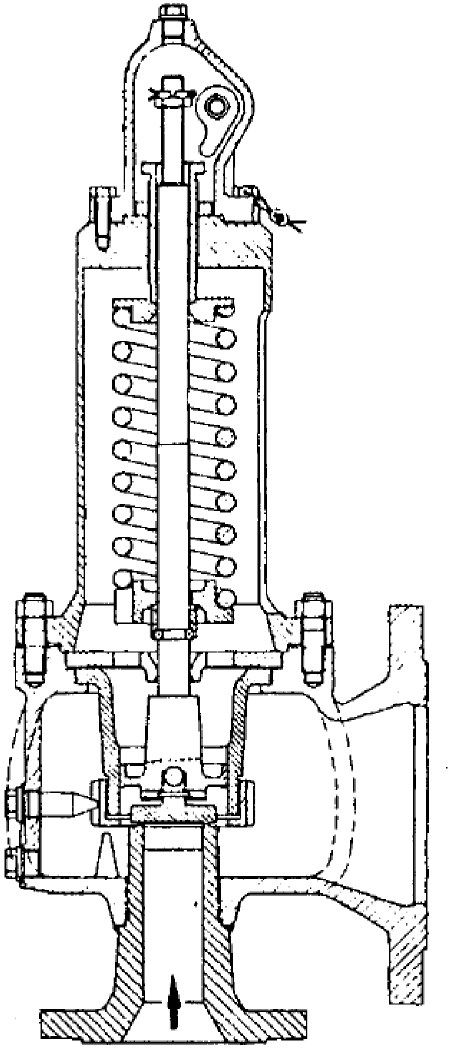
Disadvantages:
keep mounting position

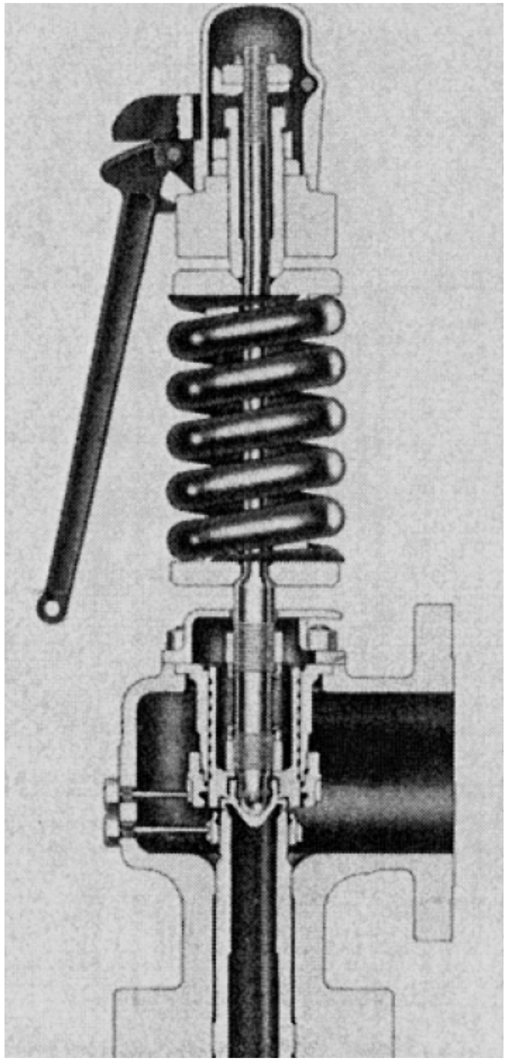


Double disk Swing Check valve

Function
Backflow prevention
Application
- (l),(g)

Valves. Pressure Relief Valve



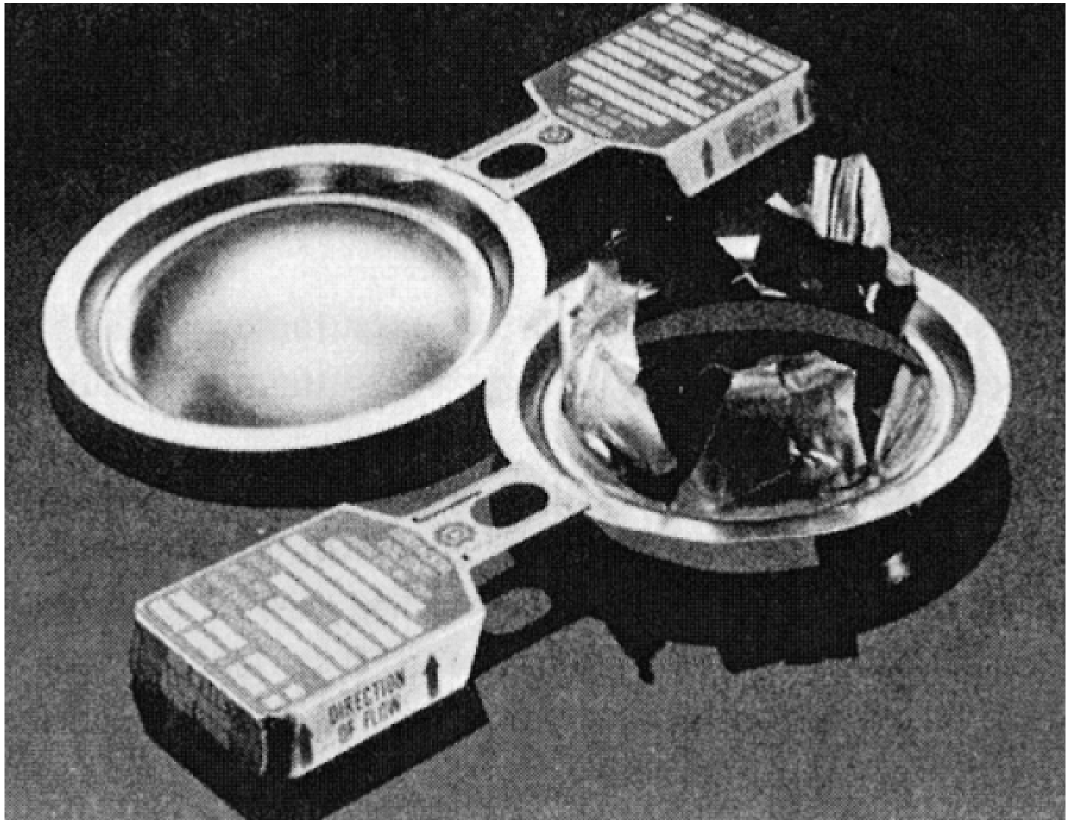


Pressure Relief Valve
Automatic valve, when the permissible pressure is exceeded, the valve opens and reduces the pressure.

Types:
-directly controlled PV (pressure usually opens through a spring or a counterweight)
- indirectly controlled PV (Valve so-called "pilot", which controls the cone of the main valve.

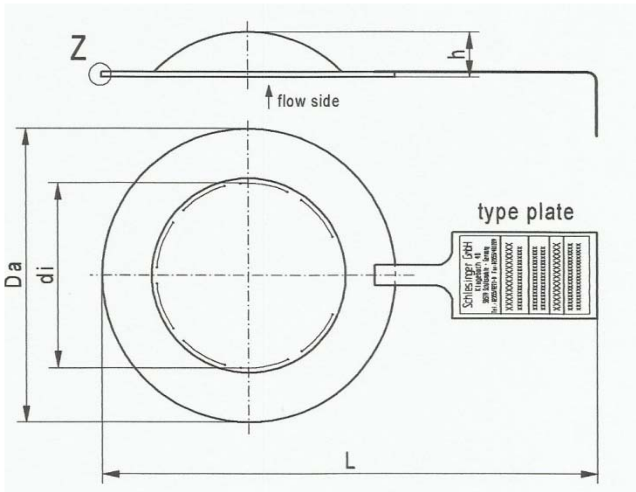
Function
Safe function.
Application
(g), (l)

Valves. Rapture disk

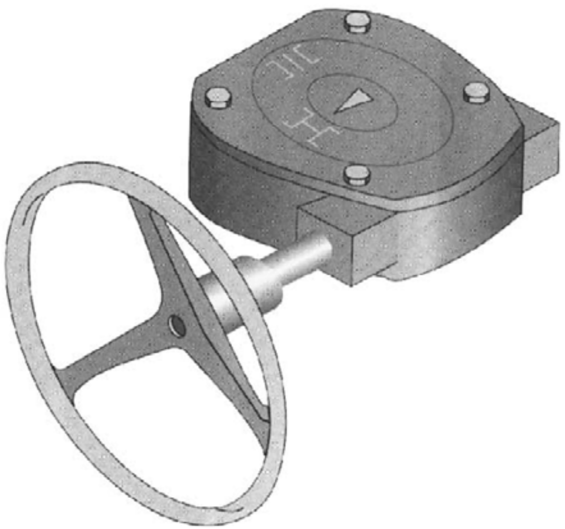


If the safety valve is not enough:

- A ruptured membrane
- Huge capacity.
- Extremely fast.
- Even in a vacuum
- At extremely low temperatures
- As another level of protection
- Mechanical damage. Replacement required.



Valves. Actuator

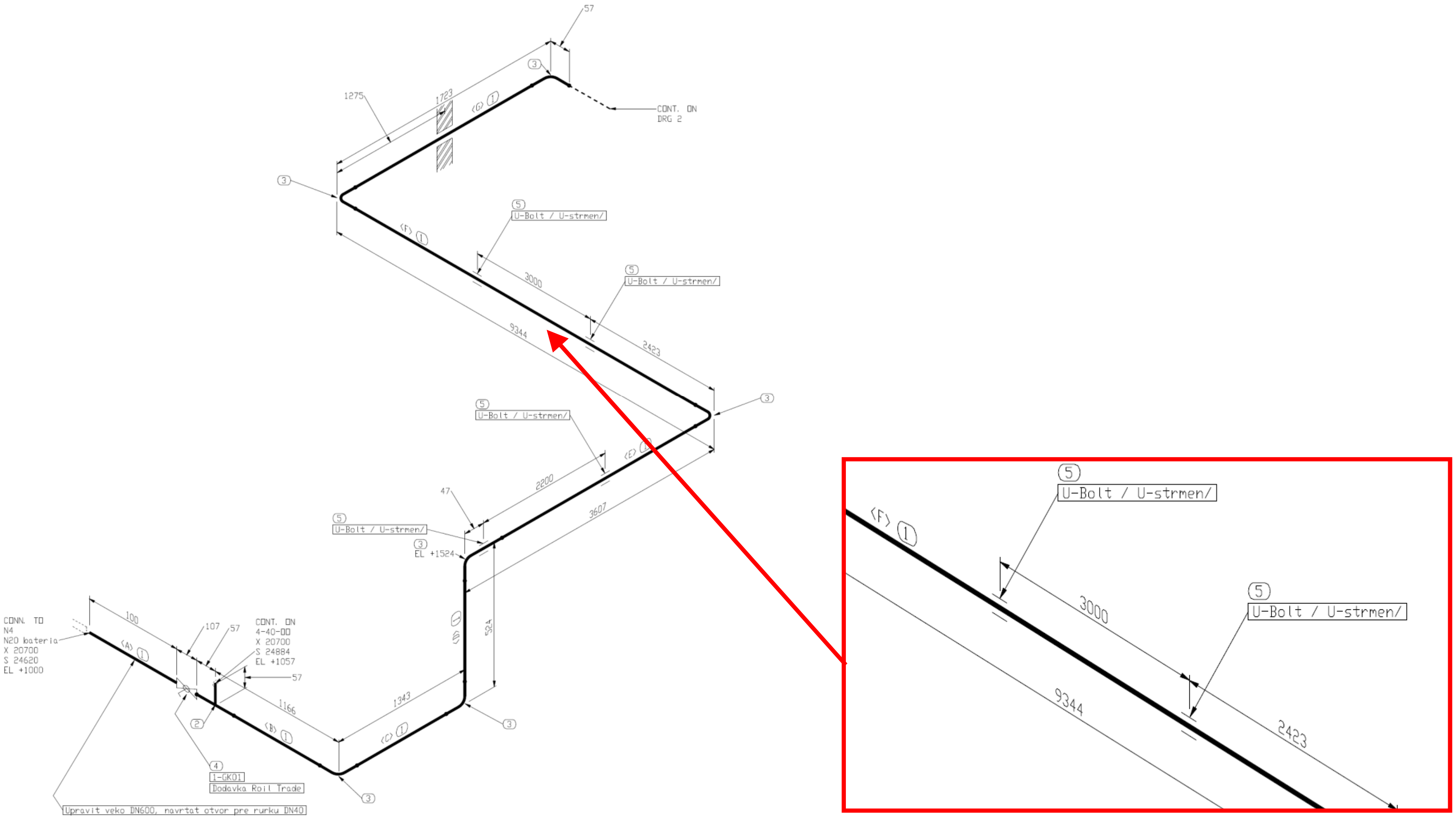


Basic division

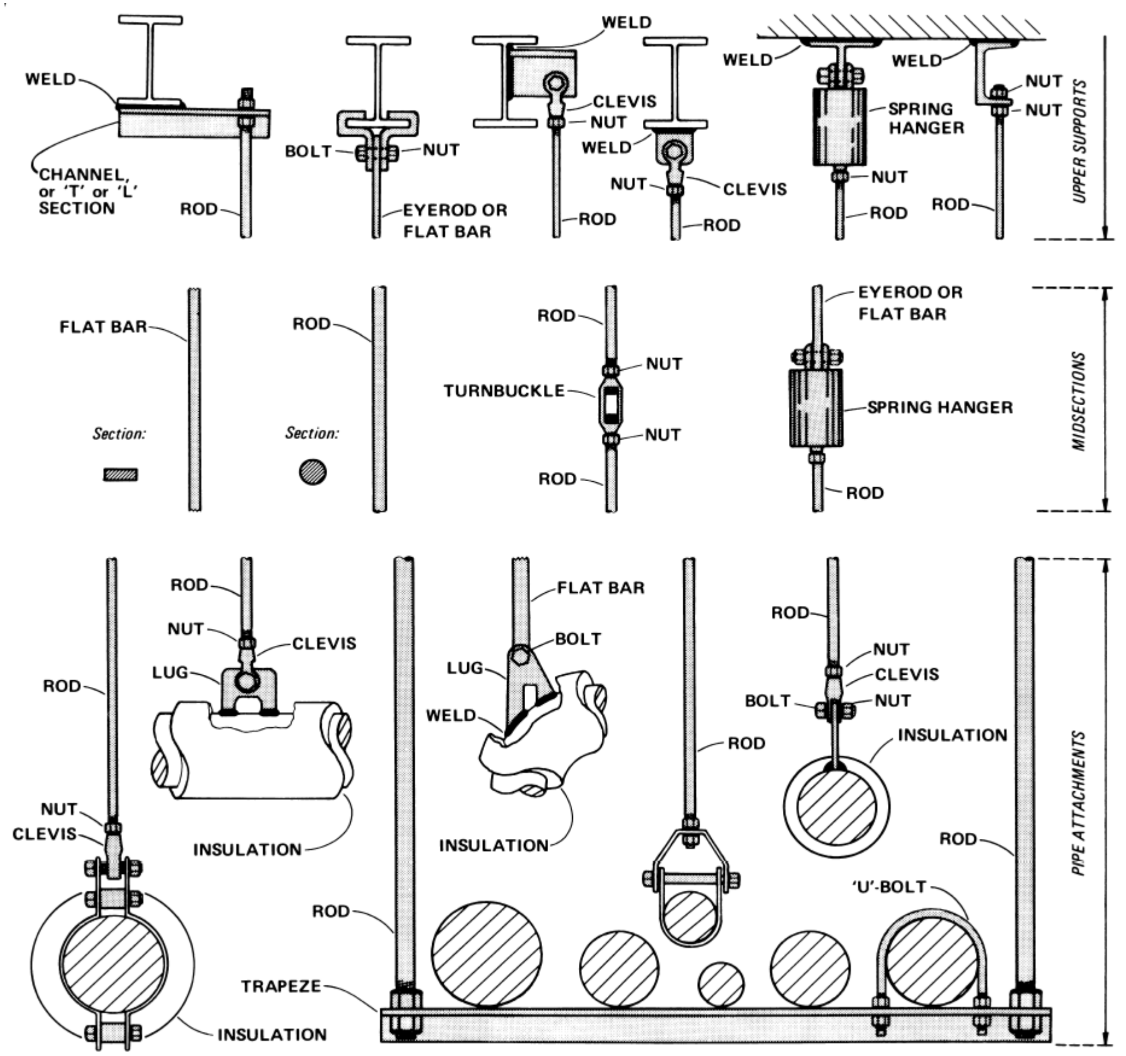
Manual drive:
It requires human power and a mechanical element connected to the armature (e.g. lever, handle, wheel)

Controlled drive.
It requires an energy source (e.g. electrical energy, compressed air) a mechanical element connected to the fitting. A control system is required for control.

Pipe Support



Pipe Support



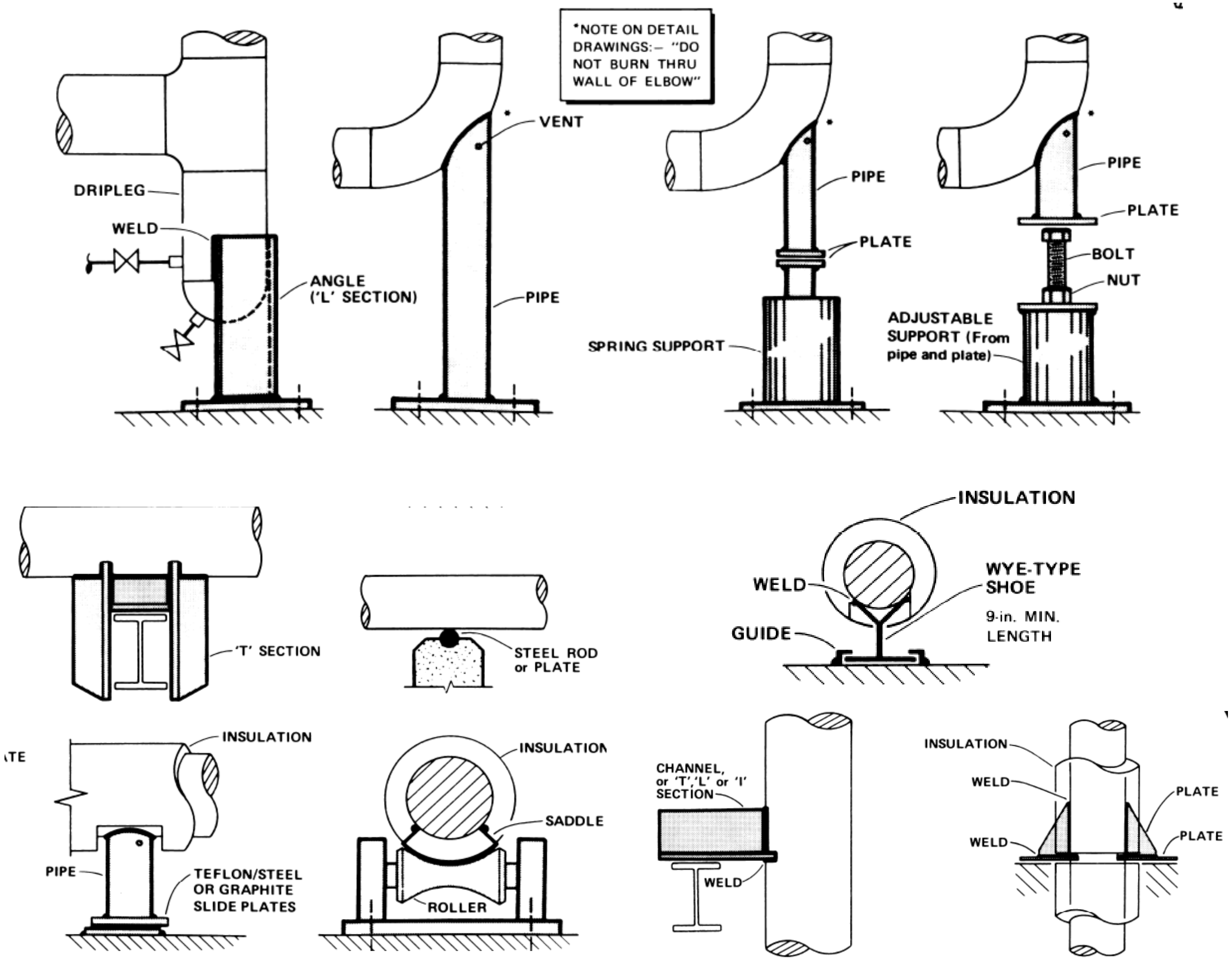
Pipe support

- capturing the weight of the pipeline (+ weight of medium, insulation, all other loads)

The calculation model will determine the exact location of attachment as well as the removed degree of freedom

Supports
Hanger
Flexible (Spring support and hangers)

Pipe Support



Dummy Leg

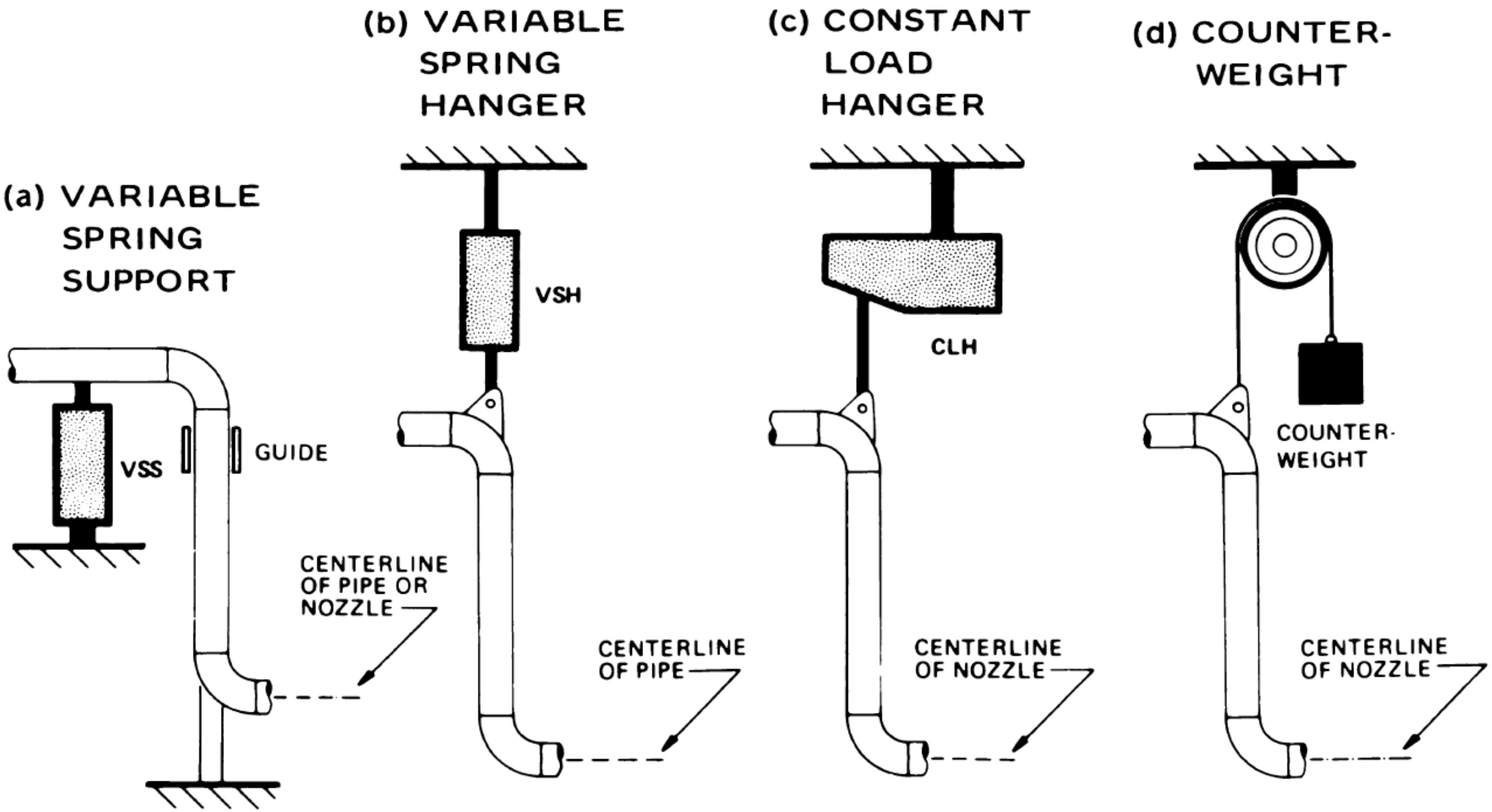
/Dummy leg with spring support/

Sliding bearings

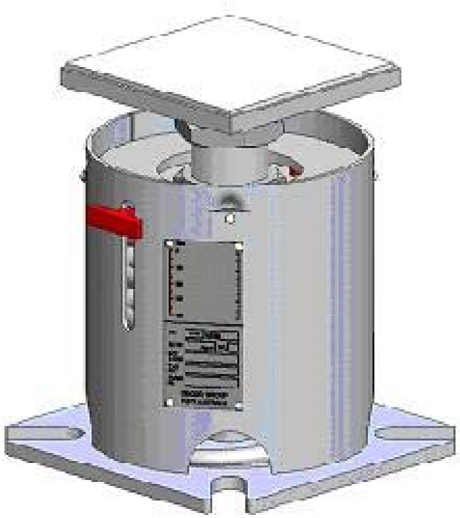
Gap

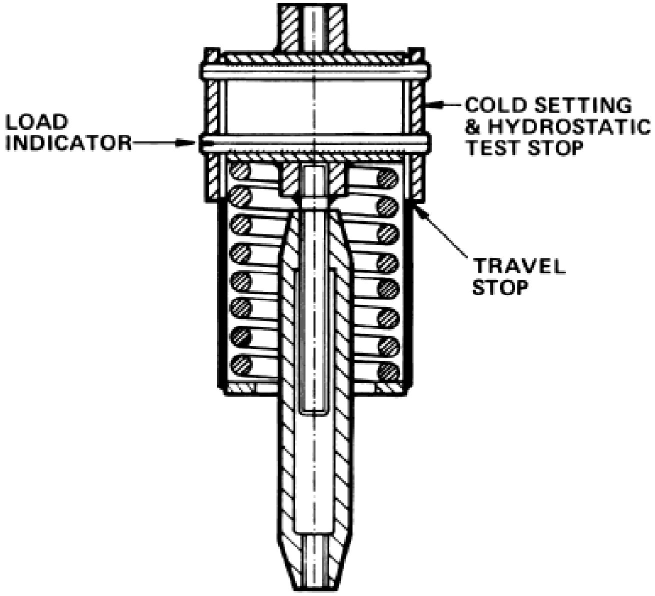
Guide

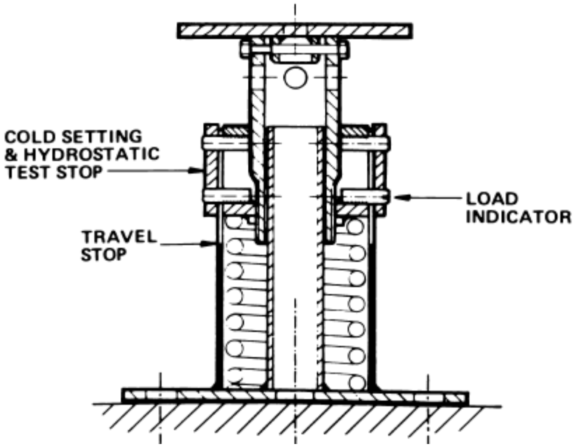
Pipe Support



Pipe Support



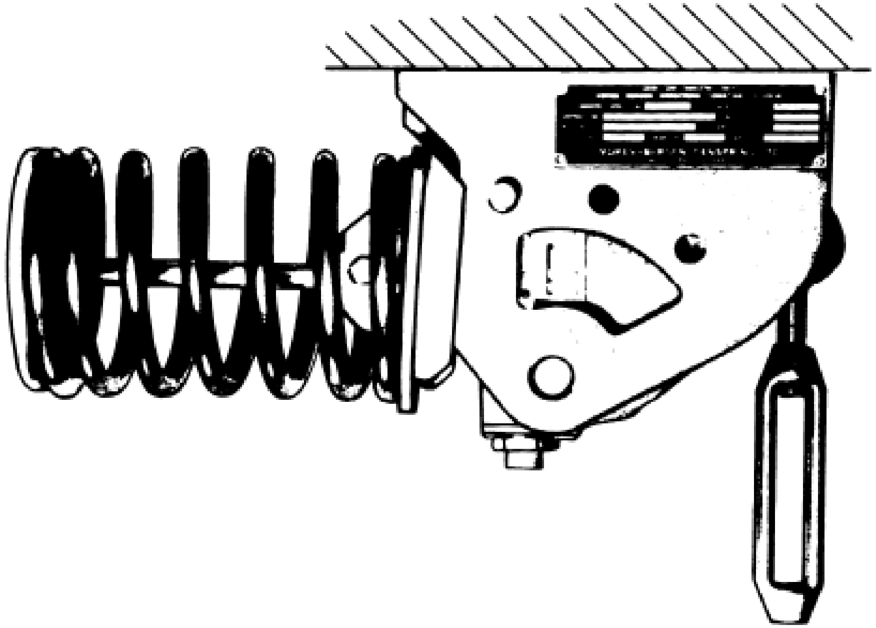




VSH - Variable Spring Hanger

- The most common
- Limitation, 25%-30% of the spring range.

Pipe Support



CSH – Constant Load Hanger

- Expensive
- Wide range

Pipe Support