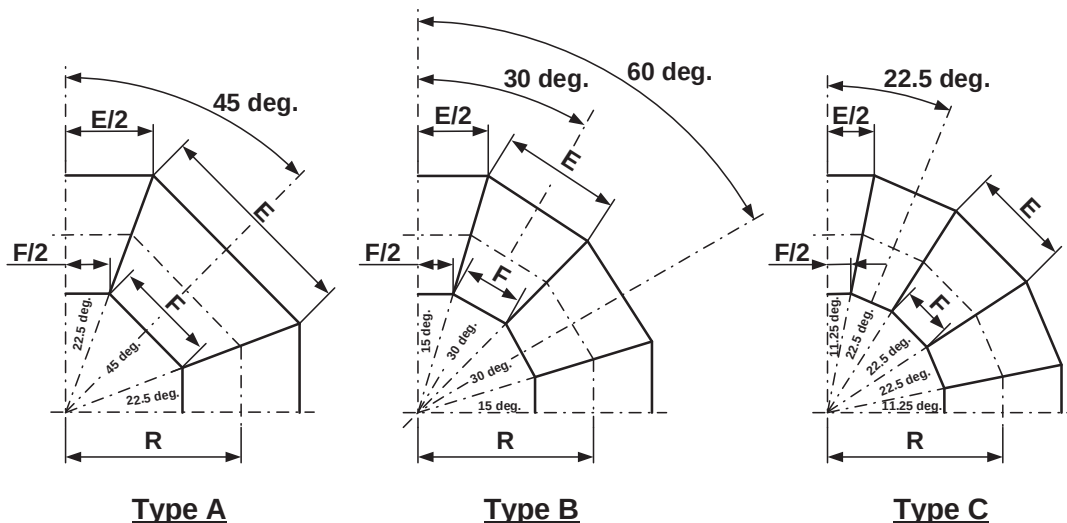


			84.00
			80.00
			76.00
		P	72.00
	P	P	70.00
P	P	P	68.00
P	P	P	66.00
P	P	P	64.00
P	P	P	62.00
P	P	P	60.00
P	P	P	58.00
P	P	P	56.00
P	P	P	54.00
P	P	P	52.00
P	P	P	50.00
P	P	P	48.00
P	P	P	46.00
P	P	P	44.00
P	P	P	42.00
P	P	P	40.00
P	P	P	38.00
P	P	P	36.00
P	P	P	34.00
P	P	P	32.00
P	P	P	30.00
P	P	P	28.00
P	P	P	26.00
P	P	P	24.00
P	P	P	22.00
P	P	P	20.00
P	P	P	18.00
P	P	P	16.00
P	P	P	14.00
P	P	P	12.00
P	P	P	10.00
P	P	P	8.00
P	P	P	6.00
			5.00
P	P	P	4.00
			3.50
P	P	P	3.00
			2.50
P	P	P	2.00
H	H	H	1.50
			1.25
H	H	H	1.00
H	H	H	0.75
H	H	H	0.50
68.00			
70.00			
72.00			

BRANCH PIPE (SIZE IN INCHES)

Mitre Bends

$$R = 1.5 \times DN$$



Dimensions of Mitre Bends (mm) DN 200 - 2500 / 8" - 100"												
DN (mm/in)	OD (mm/in)	Bend Radius R (mm)	Type of Bend				Type A		Type B		Type C	
			22.5°	30° 60°	45°	90°	E (mm)	F (mm)	E (mm)	F (mm)	E (mm)	F (mm)
200 / 8	219	305	C	B	A	A	343	162	222	105	165	78
250 / 10	273	380	C	B	A	A	428	202	277	130	205	97
300 / 12	324	460	C	B	A	A	515	247	333	160	247	119
350 / 14	356	530	C	B	A	A	587	292	379	189	282	140
400 / 16	406	610	C	B	A	A	674	337	436	218	323	162
450 / 18	457	690	C	B	A	A	761	382	492	247	365	184
500 / 20	508	760	C	B	A	A	840	419	543	271	403	201
600 / 24	610	910	C	B	A	A	1007	501	651	324	483	241
700 / 28	711	1070	C	B	A	A	1181	592	764	383	567	284
800 / 32	813	1220	C	B	A	A	1347	674	872	436	647	324
900 / 36	914	1370	C	B	A	A	1514	756	979	489	727	363
1000 / 40	1020	1520	C	B	A	A	1682	837	1088	541	808	402
1100 / 44	1120	1680	C	B	A	A	1856	928	1200	600	891	446
1200 / 48	1220	1830	C	B	A	A	2021	1011	1308	654	971	485
1300 / 52	1320	1980	C	B	A	A	2187	1094	1415	707	1050	525
1400 / 56	1420	2130	C	B	A	A	2353	1176	1522	761	1130	565
1500 / 60	1520	2290	C	B	A	A	2527	1267	1634	820	1213	609
1600 / 64	1620	2440	C	B	A	A	2692	1350	1742	874	1293	648
1700 / 68	1720	2590	C	B	A	A	2858	1433	1849	927	1372	688
1800 / 72	1820	2740	C	B	A	A	3024	1516	1956	981	1452	728
1900 / 76	1920	2900	C	B	A	A	3198	1607	2069	1040	1536	772
2000 / 80	2020	3050	C	B	A	A	3363	1690	2176	1093	1615	812
2100 / 84	2120	3200	C	B	A	A	3529	1773	2283	1147	1695	851
2200 / 88	2220	3350	C	B	A	A	3695	1856	2390	1200	1774	891
2300 / 92	2320	3510	C	B	A	A	3869	1947	2503	1259	1858	935
2400 / 96	2420	3660	C	B	A	A	4034	2030	2610	1313	1937	975
2500 / 100	2520	3810	C	B	A	A	4200	2112	2717	1367	2017	1014

Notes:

- 1) Standard tube bends can be used when applicable.
- 2) Wall thickness of mitre bends to be the same as duct/pipe.

1 General

This specification specifies the general tolerances, which apply for the fabrication of steel parts in case tolerances have not been indicated on the drawings.

1.1

The fabrication of steel parts is divided into two main groups:

- **Worked Steel Parts**
Any steel part, which has been machined, cut, grinded or otherwise, worked to a specified shape.
- **Steel Constructions**
Any construction of steel parts connected by welding or bolting. The tolerances apply for nominal dimensions related to connected parts.

1.2

In cases where worked steel parts are pre-fabricated to be used in a construction, where the dimensions and shapes of the loose parts are not critical; the tolerances to apply for these parts can be taken from the main group "Steel Constructions".

The tolerances must in such cases be measured in relation to the finished construction.

2 Worked Steel Parts

2.1 Linear Dimensions and Diameters

Tolerances (mm) within Nominal Dimensions (mm)											
0.5 to 3	Above 3 to 6	Above 6 to 30	Above 30 to 120	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000	Above 2000 to 4000	Above 4000 to 8000	Above 8000 to 12000	Above 12000 to 16000	Above 16000 to 20000
± 0.15	±0.2	±0.5	± 0.8	± 1.2	± 2	± 3	± 4	± 5	± 6	± 7	± 8

2.2 Rounding Dimensions (Radii)

Tolerances (mm) within Nominal Dimensions (mm)							
0.5 to 3	Above 3 to 6	Above 6 to 30	Above 30 to 120	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000	Above 2000 to 4000
± 0.2	± 0.5	± 1	± 2	± 4	± 6	± 8	± 10

2.3 Angular Dimension

Tolerances (deg./min. of arc) within Nominal Dimensions of the Shortest Angle Side (mm), 1)				
Above 0 to 10	Above 10 to 50	Above 50 to 120	Above 120 to 400	Above 400
$\pm 1^{\circ} 30'$	$\pm 50'$	$\pm 25'$	$\pm 15'$	$\pm 10'$

Note 1)

The shortest angle side is defined as the dimension "1" indicated in Figure 1 - 2, Appendix A

2.4 Straightness/Shape Conformity (Two-Dimensional)

Tolerances (mm) within Nominal Dimensions of Length (mm), 2)								
	Above 6 to 6	Above 30 to 120	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000	Above 2000 to 4000	Above 4000 to 8000	Above 8000
0.1	0.25	0.5	1	1.5	2.5	3.5	5	7

Note 2)

The tolerance on straightness is defined as the maximum distance between a straight line and the actual line.

The tolerance on shape conformity is defined as the maximum distance between the specified line shape and the actual line shape.

2.5 Planeness/Shape Conformity (Three-Dimensional)

Tolerances (mm) within Nominal Dimensions of Length (mm), 3)								
	Above 6 to 6	Above 30 to 120	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000	Above 2000 to 4000	Above 4000 to 8000	Above 8000
0.1	0.25	0.5	1	1.5	2.5	3.5	5	7

Note 3)

The nominal dimensions refer to the longest nominal side length or the nominal diameter of the surface.

The tolerance on planeness is defined as the maximum distance between a plane surface and the actual surface.

The tolerance on shape conformity is defined as the maximum distance between the specified surface shape and the actual surface shape.

2.6 Rectangularity

Tolerances (mm) within Nominal Dimensions of Length (mm), 4)											
	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000	Above 2000 to 3000	Above 3000 to 4000	Above 4000 to 5000	Above 5000 to 6000	Above 6000 to 7000	Above 7000 to 8000	Above 8000 to 9000	Above 9000 to 10000
2	3	4	7	10	14	18	21	24	28	31	35

Note 4)

The nominal dimensions refer to the shortest nominal side length for a rectangular surface shape.

The tolerance on rectangularity is defined as the maximum difference in length between the actual measured diagonals for a rectangular surface shape.

WSC FOR PIPING CLASSES: B1D, K34D				
MATERIAL SPECIFICATIONS	PIPES	ASTM A 335GR.P11, ASTM A 691 GR.1.25CR CL.42		
	FITTINGS	ASTM A 182GR.F11 CL.2, ASTM A 234 GR.WP11 CL.1, ASTM A 234GR.WP11-W CL.1		
	FLANGES	ASTM A 182GR.F11 CL.2.		
	OTHERS	-		
BASE METAL 'P' NO	4			
WELDING PROCESS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: GTAW	FILLERPASS: GTAW/SAW (NOTE-1)	ROOTPASS: GTAW	FILLER PASS: GTAW/SAW
	FILLET JOINTS/ SOCKET JOINTS: SAW			
WELDING MATERIALS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: ER70S-B2L/ ER80S-B2	FILLER PASS: ER70S-B2L / ER80S-B2/ E7016-B2L/ E7018-B2L	ROOT PASS: ER70S-B2L/ ER80S-B2	FILLER PASS: ER70S-B2L/ ER80S-B2/ E7016-B2L/ E7018-B2L
	FILLET JOINT/SOCKET JOINT: E7016-B2L/E7018-B2L			
	BACKING RING: -		CONSUMABLE INSERT: -	
JOINT PREPARATION	ASME B31.3			
GASES	PURGING: -		SHIELDING: ARGON	
GAS COMPOSITION	PURGING: -		SHIELDING: 99.995%	
PREHEATING	PREHEAT TEMP: 150°C MIN		INTERPASS TEMP.: ---	
POST HEATING: AS PER WELDING SPECIFCAITON FOR PIPING				
POST WELD HEAT TREATMENT (NOTE-2)	HOLDING TEMP: 650-705°C		HOLDING TIME: 1HOUR PER INCH THK	
	RATE OF HEATING: 200°C/HR MAX		MIN. HOLDING TIME: 2HRS	
	METHOD OF COOLING: CONTROLLED		RATE OF COOLING: 200°C/HR MAX	
MECHANICAL PROPERTY REQUIREMENTS	CHARPY 'V' NOTCH VALUE:		MIN: -	AVERAGE: -
	AT TEMPERATURE:		-	
	HARDNESS: 225 BHN MAX (NOTE-2)			
CODE OF FABRICATION	ASME B31.3			

TECHNICAL NOTES

- FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.
- PWHT SHALL BE DONE FOR ALL WALL THICKNESSES AND POST HEAT TRATED HARDNESS OF WELD SHALL NOT EXCEED 225 BHN. ANY KIND OF ATTACHMENTS ON SUCH PIPING SHALL BE STRESS RELIEVED AND SHALL ALSO MEET THE HARDNESS LIMIT.

WSC FOR PIPING CLASSES: A1N, B1N, K42N			
MATERIAL SPECIFICATIONS	PIPES	ASTM A 312 TP316L, ASTM A 358 TP316L CL.1	
	FITTINGS	ASTM A 182 GR.F316L, ASTM A 403 GR.WP316L-S, ASTM A 403 GR.WP316L-WX	
	FLANGES	ASTM A 182 GR.F316L	
	OTHERS	-	
BASE METAL 'P' NO	8		
WELDING PROCESS	GROOVE JOINTS		
	BUTT		OTHER THAN BUTT
	ROOT PASS: GTAW	FILLERPASS: GTAW/SMAW	ROOTPASS: GTAW FILLER PASS: GTAW/SMAW
	FILLET JOINTS/ SOCKET JOINTS: SMAW		
WELDING MATERIALS	GROOVE JOINTS		
	BUTT		OTHER THAN BUTT
	ROOT PASS: ER316L	FILLER PASS: ER316L / E316L-15/16	ROOT PASS: ER316L FILLER PASS: ER316L / E316L-15/16
	FILLET JOINT/SOCKET JOINT: E316L-15/16		
	BACKING RING: -		CONSUMABLE INSERT: -
JOINT PREPARATION	AS PER ASME B31.3		
GASES	PURGING: ARGON		SHIELDING: ARGON
GAS COMPOSITION	PURGING: 99.995%		SHIELDING: 99.995 %
PREHEATING	PREHEAT TEMP: 10 °C		INTER PASS TEMP.: 175°C MAX
POST HEATING: ---			
POST WELD HEAT TREATMENT	HOLDING TEMP: -		HOLDING TIME: -
	RATE OF HEATING: -		MIN. HOLDING TIME: -
	METHOD OF COOLING: -		RATE OF COOLING: -
MECHANICAL PROPERTY REQUIREMENTS	CHARPY 'V' NOTCH VALUE:		MIN: - AVERAGE: -
	AT TEMPERATURE:		-
	HARDNESS: -		
CODE OF FABRICATION	AS PER ASME 31.3		

TECHNICAL NOTES:

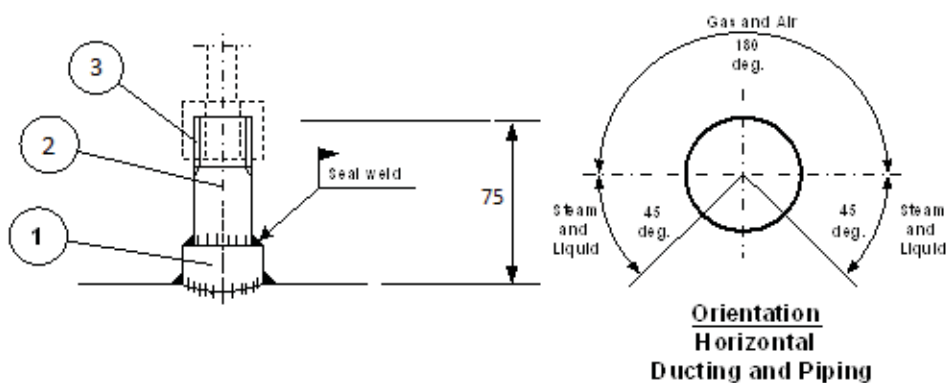
- FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.

WSC FOR PIPING CLASSES: A1A, B1A, D1A, E1A, F1A, A7A, A9A, B9A, D9A, A10A, A13A, B13A, A15A, A20A, A32A, K22A, K24A, K28A, B26				
MATERIAL SPECIFICATIONS	PIPES	ASTM A106 GR.B, ASTM A 672 GR.B60 CL.12, ASTM A 672 GR.B60 CL.22, API 5L GR.B PSL1, IS-1239, IS-3589 GR.410, ASTM A 53 GR.B TYPE S		
	FITTINGS	ASTM A105, ASTM A 234 GR.WPB, ASTM A 234 GR.WPB-W, ASTM A 105 LINED WITH PTFE, API 5L GR.BPSL1		
	FLANGES	ASTM A105, ASTM A105 WITH INTERNAL LINING		
	OTHERS	-		
BASE METAL 'P' NO	1			
WELDING PROCESS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: GTAW/SAW (NOTE-1)	FILLER PASS: GTAW / SMAW	ROOT PASS: GTAW / SMAW	FILLER PASS: GTAW / SMAW
	FILLET JOINTS/ SOCKET JOINTS: SMAW			
WELDING MATERIALS	GROOVE JOINTS			
	BUTT		OTHER THAN BUTT	
	ROOT PASS: ER70S-2 / E6010	FILLER PASS: ER70S-2 / E7016 / E7018	ROOT PASS: ER70S-2 / E6010	FILLER PASS: ER70S-2 / E7016 / E7018
	FILLET JOINT/SOCKET JOINT: E7016 / E7018			
	BACKING RING: -		CONSUMABLE INSERT: -	
JOINT PREPARATION	ASME B31.3			
GASES	PURGING: -		SHIELDING: ARGON	
GAS COMPOSITION	PURGING: -		SHIELDING: 99.995%	
PREHEATING (NOTE-3)	PREHEAT TEMP: 10°C MIN/ 100°C FOR THK >25 mm		INTERPASS TEMP.: ----	
POST HEATING: --				
POST WELD HEAT TREATMENT	HOLDING TEMP: ---		HOLDING TIME: ---	
	RATE OF HEATING: ---		MIN. HOLDING TIME: ---	
	METHOD OF COOLING: ---		RATE OF COOLING: ---	
MECHANICAL PROPERTY REQUIREMENTS	CHARPY 'V' NOTCH VALUE:		MIN: -	AVERAGE: -
	AT TEMPERATURE:		-	
	HARDNESS: 200 BHN MAX (NOTE-4)			
CODE OF FABRICATION	ASME B31.3			

TECHNICAL NOTES:

- 1 THE ROOT PASS FOR SINGLE SIDE WELDING SHALL BE DONE BY GTAW PROCESS.
- 2 FOR PIPING SIZES 2" OD AND BELOW SHALL BE ENTIRELY WELDED BY GTAW PROCESS.
- 3 PRE-HEAT TEMPERATURE OF ATLEAST 50°C SHALL BE PROVIDED FOR THE FIRST TWO PASSES FOR THK>=12.5 mm & ≤25 mm.

Pressure Point Type 1 **Process Gas and Air Service**

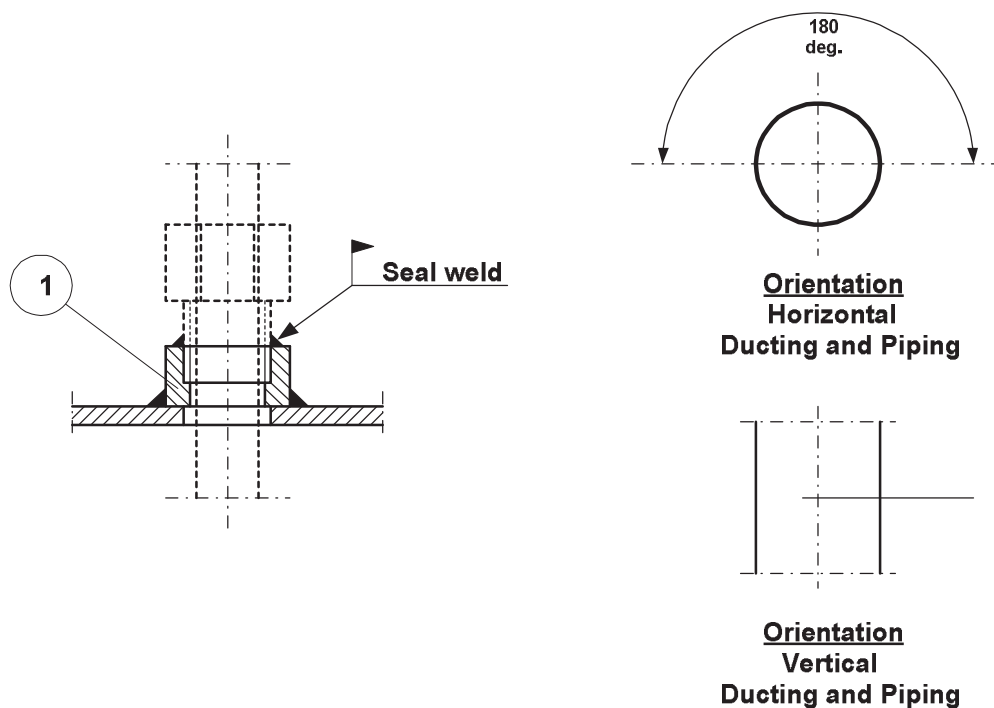


Applicable for Duct Class	Max. Design Pressure (Bar g)	Max. Design Temp. (deg.C)	Details			
			Pos. No.	Description	Dimensions	Material
K22A	0.3	300	1	Half-coupling SW	1/2"	Acc. to Duct Class
K24A	0.3	450	2	Half-nipple NPT-M, plain / bevel end	1/2"	Acc. to Duct Class
K34D	0.2	500	3	Cap NPT-F, Note 1)	1/2"	Acc. to Duct Class
K42N	0.2	300				

Notes:

- 1) Each connection to be provided with a cap to be replaced with the instrument line connection fitting.

Temperature Point Type 1 Process Gas and Air Service

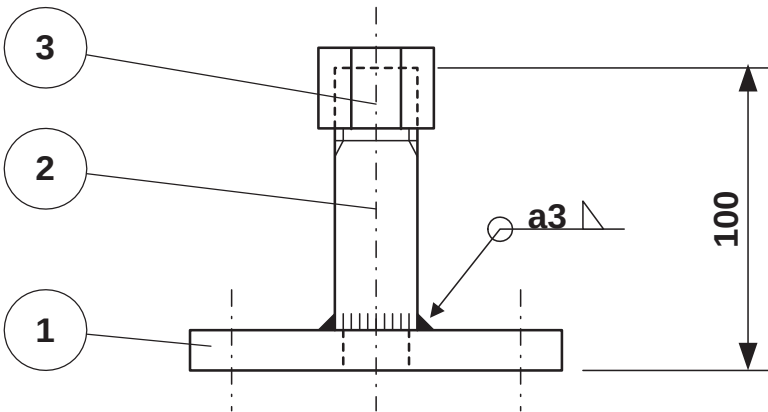


Applicable for Duct Class	Max. Design Pressure (Bar g)	Max. Design Temp. (deg.C)	Details			
			Pos. No.	Description	Dimensions	Material
K22A	0.3	300	1	Half-coupling NPT-F	1"	Acc. to Duct Class
K24A	0.3	450	2	Plug NPT-M, Note 1)	1"	Acc. to Duct Class
K34D	0.2	500				
K42N	0.2	300				

Notes:

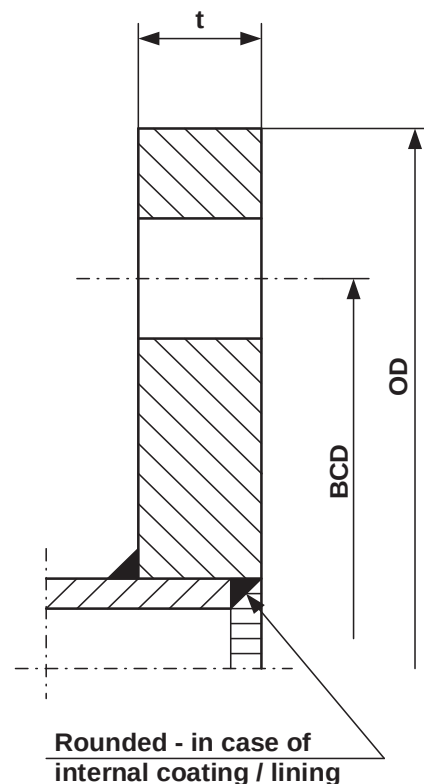
- 1) Each connection to be provided with a plug to be replaced with the thermowell after cleaning of the duct.

Flanged Nozzle with Cap

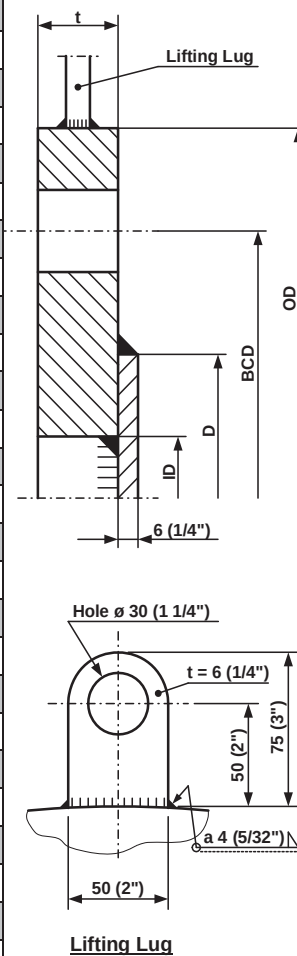


Pos. No.	Description	Dimensions		Material
		Flange	Hole	
1	Blind flange with hole	1/2"	ø15	AISI 316L
		3/4"	ø20	
		1"	ø25	
		1 1/2"	ø40	
		2"	ø50	
2	Pipe, threaded NPT-M	1/2" - 2"		AISI 316L
3	Cap NPT-F	1/2" - 2"		AISI 316L

Dimensions of Duct Flanges - Steel						
DN (mm/inch)	OD (mm)	t (mm/inch)	BCD (mm)	No. of Holes	Hole dia. (mm)	Bolts UNC
400 / 16	597	20 / 3/4	540	16	19	5/8"
450 / 18	635	20 / 3/4	578	16	19	5/8"
500 / 20	699	20 / 3/4	635	20	19	5/8"
600 / 24	780	20 / 3/4	725	20	19	5/8"
700 / 28	895	20 / 3/4	840	24	19	5/8"
800 / 32	1015	20 / 3/4	950	24	19	5/8"
900 / 36	1115	20 / 3/4	1050	28	19	5/8"
1000 / 40	1170	20 / 3/4	1120	32	19	5/8"
1100 / 44	1270	20 / 3/4	1220	36	19	5/8"
1200 / 48	1370	20 / 3/4	1320	40	19	5/8"
1300 / 52	1470	20 / 3/4	1420	44	19	5/8"
1400 / 56	1570	20 / 3/4	1520	48	19	5/8"
1500 / 60	1670	20 / 3/4	1620	48	19	5/8"
1600 / 64	1770	20 / 3/4	1720	52	19	5/8"
1700 / 68	1870	20 / 3/4	1820	56	19	5/8"
1800 / 72	1970	25 / 1	1920	60	24	3/4"
1900 / 76	2070	25 / 1	2020	64	24	3/4"
2000 / 80	2170	25 / 1	2120	68	24	3/4"
2100 / 84	2270	25 / 1	2220	68	24	3/4"
2200 / 88	2370	25 / 1	2320	72	24	3/4"
2300 / 92	2470	25 / 1	2420	76	24	3/4"
2400 / 96	2570	25 / 1	2520	80	24	3/4"
2500 / 100	2670	25 / 1	2620	84	24	3/4"
2600 / 104	2770	25 / 1	2720	88	24	3/4"
2700 / 108	2870	25 / 1	2820	92	24	3/4"
2800 / 112	2970	25 / 1	2920	92	24	3/4"
2900 / 116	3070	25 / 1	3020	96	24	3/4"
3000 / 120	3170	30 / 1 1/4	3120	100	24	3/4"
3100 / 124	3270	30 / 1 1/4	3220	104	24	3/4"
3200 / 128	3370	30 / 1 1/4	3320	108	24	3/4"
3300 / 132	3470	30 / 1 1/4	3420	108	24	3/4"
3400 / 136	3570	30 / 1 1/4	3520	112	24	3/4"
3500 / 140	3670	30 / 1 1/4	3620	116	24	3/4"



Dimensions of Duct Blind flanges - Steel								
DN (mm/inch)	OD (mm)	ID (mm)	t (mm/inch)	BCD (mm)	No. of Holes	Hole dia. (mm) Note 1	Bolts UNC Note 1	D (mm)
400 / 16	597	410	20 / 3/4	540	16	19	5/8"	450
450 / 18	635	460	20 / 3/4	578	16	19	5/8"	500
500 / 20	699	510	20 / 3/4	635	20	19	5/8"	550
600 / 24	780	610	20 / 3/4	725	20	19	5/8"	650
700 / 28	895	710	20 / 3/4	840	24	19	5/8"	750
800 / 32	1015	810	20 / 3/4	950	24	19	5/8"	850
900 / 36	1115	910	20 / 3/4	1050	28	19	5/8"	950
1000 / 40	1170	1020	20 / 3/4	1120	32	19	5/8"	1060
1100 / 44	1270	1120	20 / 3/4	1220	36	19	5/8"	1160
1200 / 48	1370	1220	20 / 3/4	1320	40	19	5/8"	1260
1300 / 52	1470	1320	20 / 3/4	1420	44	19	5/8"	1360
1400 / 56	1570	1420	20 / 3/4	1520	48	19	5/8"	1460
1500 / 60	1670	1520	20 / 3/4	1620	48	19	5/8"	1560
1600 / 64	1770	1620	20 / 3/4	1720	52	19	5/8"	1660
1700 / 68	1870	1720	20 / 3/4	1820	56	19	5/8"	1760
1800 / 72	1970	1820	25 / 1	1920	60	24	3/4"	1860
1900 / 76	2070	1920	25 / 1	2020	64	24	3/4"	1960
2000 / 80	2170	2020	25 / 1	2120	68	24	3/4"	2060
2100 / 84	2270	2120	25 / 1	2220	68	24	3/4"	2160
2200 / 88	2370	2220	25 / 1	2320	72	24	3/4"	2260
2300 / 92	2470	2320	25 / 1	2420	76	24	3/4"	2360
2400 / 96	2570	2420	25 / 1	2520	80	24	3/4"	2460
2500 / 100	2670	2520	25 / 1	2620	84	24	3/4"	2560
2600 / 104	2770	2620	25 / 1	2720	88	24	3/4"	2660
2700 / 108	2870	2720	25 / 1	2820	92	24	3/4"	2760
2800 / 112	2970	2820	25 / 1	2920	92	24	3/4"	2860
2900 / 116	3070	2920	25 / 1	3020	96	24	3/4"	2960
3000 / 120	3170	3020	30 / 1 1/4	3120	100	24	3/4"	3060
3100 / 124	3270	3120	30 / 1 1/4	3220	104	24	3/4"	3160
3200 / 128	3370	3220	30 / 1 1/4	3320	108	24	3/4"	3260
3300 / 132	3470	3320	30 / 1 1/4	3420	108	24	3/4"	3360
3400 / 136	3570	3420	30 / 1 1/4	3520	112	24	3/4"	3460
3500 / 140	3670	3520	30 / 1 1/4	3620	116	24	3/4"	3560

**Note**

- 1) Cover to be reinforced for DN >100

Dimensions of Ducting											
DN	OD	Carbon / Un-alloyed Steel			Stainless Steel			GRP			
		t		Max. Dist. between Supports Note 2)	t		Max. Dist. between Supports Note 2)	ID	OD	t	Max. Dist. between Supports
(mm/inch)	(mm)	(mm)	(inch)	(m)	(mm)	(inch)	(m)	(mm)	(mm)	(mm)	(m)
400 / 16	406	6	1/4	7	4	5/32	8	400	According to manufacturer	According to manufacturer	According to manufacturer
450 / 18	457	6	1/4	8	4	5/32	8	450			
500 / 20	508	6	1/4	8	4	5/32	9	500			
600 / 24	610	6	1/4	9	4	5/32	10	600			
700 / 28	711	6	1/4	10	4	5/32	11	700			
800 / 32	813	8	5/16	12	4	5/32	11	800			
900 / 36	914	8	5/16	12	4	5/32	12	900			
1000 / 40	1020	8	5/16	13	4	5/32	13	1000			
1100 / 44	1120	8	5/16	14	4	5/32	14	1100			
1200 / 48	1220	8	5/16	15	4	5/32	14	1200			
1300 / 52	1320	8	5/16	15	4	5/32	15	1300			
1400 / 56	1420	8	5/16	16	4	5/32	16	1400			
1500 / 60	1520	8	5/16	16	4	5/32	16	1500			
1600 / 64	1620	8	5/16	17	4	5/32	17	1600			
1700 / 68	1720	8	5/16	18	4	5/32	17	1700			
1800 / 72	1820	8	5/16	18	4	5/32	18	1800			
1900 / 76	1920	8	5/16	19	4	5/32	18	1900			
2000 / 80	2020	8	5/16	19	4	5/32	19	2000			
2100 / 84	2120	8	5/16	20	4	5/32	19	2100			
2200 / 88	2220	10	3/8	21	6	1/4	21	2200			
2300 / 92	2320	10	3/8	22	6	1/4	22	2300			
2400 / 96	2420	10	3/8	22	6	1/4	22	2400			
2500 / 100	2520	10	3/8	23	6	1/4	23	2500			
2600 / 104	2620	10	3/8	23	6	1/4	23	2600			
2700 / 108	2720	10	3/8	24	6	1/4	24	2700			
2800 / 112	2820	10	3/8	24	6	1/4	24	2800			
2900 / 116	2920	10	3/8	24	6	1/4	24	2900			
3000 / 120	3020	12	1/2	26	8	5/16	26	3000			
3100 / 124	3120	12	1/2	26	8	5/16	26	3100			
3200 / 128	3220	12	1/2	27	8	5/16	27	3200			
3300 / 132	3320	12	1/2	27	8	5/16	27	3300			
3400 / 136	3420	12	1/2	27	8	5/16	27	3400			
3500 / 140	3520	12	1/2	28	8	5/16	28	3500			

Notes:

- 1) Corrosion Allowance - Max. 3.2 mm for Carbon / Un-alloyed Steel. Corrosion Allowance - 0 mm for Stainless Steel and GRP
- 2) Does not apply for concentrated loads between supports such as flanges valves etc. (shall be considered separately if any)

13.1 General

This section covers basic design requirements for square ducts, including basic design requirements for flanges, bellows and dampers installed in square ducts.

The basic design requirements for ducts cover also special transition pieces, etc., typically fabricated from plate with external reinforcement.

The basic design requirements outlined in this section must be regarded as indicative only. The detailed design of square ducts must in each case be verified with regard to plate thickness, type and distance between external reinforcement, bends with/without guide vanes, etc.

13.2 Wall thickness and duct reinforcement

13.2.1 In this section recommendations for selection of profiles for external reinforcement are given. The tables given in this section are based on the following:

- An internal design pressure of 200 mbarg has been used for calculating/evaluating maximum deflections and stresses.
- The general maximum allowable stress used is 100 N/mm², which is applicable for all duct classes at the specified design temperatures.
- The maximum length of the reinforcement profiles has been based on a maximum allowable deflection of 2.5 mm/m (1/400) and a maximum allowable stress of 100 N/mm² (static load).
- The reinforcement profiles are calculated as fixed ends, which presuppose that the reinforcement profiles are fully welded at the duct corners.
- The distance between the reinforcement profiles has been evaluated against a maximum deflection of the plate field between the profiles of 4 mm/m (1/250) and a maximum allowable stress of 100 N/mm² (static load).
- The plate fields are evaluated as all edges fixed.
- The reinforcement profiles are foreseen to reinforce the entire span between two duct corners, i.e. intermediate reinforcement profiles positioned parallel to the duct have not been considered. The implementation of such intermediate reinforcement profiles positioned parallel to the duct can be considered in specific cases, typically in connection with designing reinforcement of ducts with maximum dimensions larger than about 5500 mm.
- The height of the reinforcement profiles should not exceed 140 mm, on process gas ducts in particular, in order to minimise the risk of cold spots caused by insufficient insulation thickness on the reinforcement profiles

13.2.1 As alternative to or in addition to external reinforcement profiles, internal bracing can be used as reinforcement.

The advantages of internal bracing are that the risk of cold spots will be minimised, and the amount of reinforcing steel can in some cases be reduced.

The disadvantage of internal bracing is that the flow in the duct will be disturbed, which for some applications should be avoided. Furthermore, the extent of internal bracing required may in some cases restrict the possibilities for internal inspections, repairs etc. of the ducting.

The design of internal bracing is not covered by this specification, as external reinforcement profiles will be used in most cases. However, it should for each specific project be decided whether external reinforcement profiles or internal bracing will be used.

13.2.2 Materials for reinforcement profiles and/or internal bracing must be selected according to the relevant duct class.

Type	Thickness Duct Plate (mm)	Combinations of Max. Length (L) and Distance (B) between Profiles					
		L _{max.} (mm)	B _{max.} (mm)	L _{max.} (mm)	B _{max.} (mm)	L _{max.} (mm)	B _{max.} (mm)
60 x 6	6	1,700	500	1,600	550	1,500	600
80 x 8	6	2,100	500	2,000	550	1,900	600
100 x 10	6	2,500	500	2,400	550	2,300	600
L100x50x8	6	2,500	500	2,400	550	2,300	600
L100x65x9	6	2,600	500	2,500	550	2,300	600
UNP 100	6	3,000	500	2,900	550	2,700	600
UNP 120	6	3,500	500	3,300	550	3,200	600
UNP 140	6	4,000	500	3,800	550	3,700	600
IPE 100	6	2,900	500	2,700	550	2,600	600
IPE 120	6	3,400	500	3,200	550	3,100	600
IPE 140	6	3,900	500	3,700	550	3,500	600
HEA 100	6	3,600	500	3,400	550	3,300	600
HEA 120	6	4,200	500	4,000	550	3,800	600
HEA 140	6	4,900	500	4,700	550	4,500	600
HEB 100	6	3,800	500	3,700	550	3,500	600
HEB 120	6	4,700	500	4,500	550	4,300	600
HEB 140	6	5,600	500	5,400	550	5,100	600

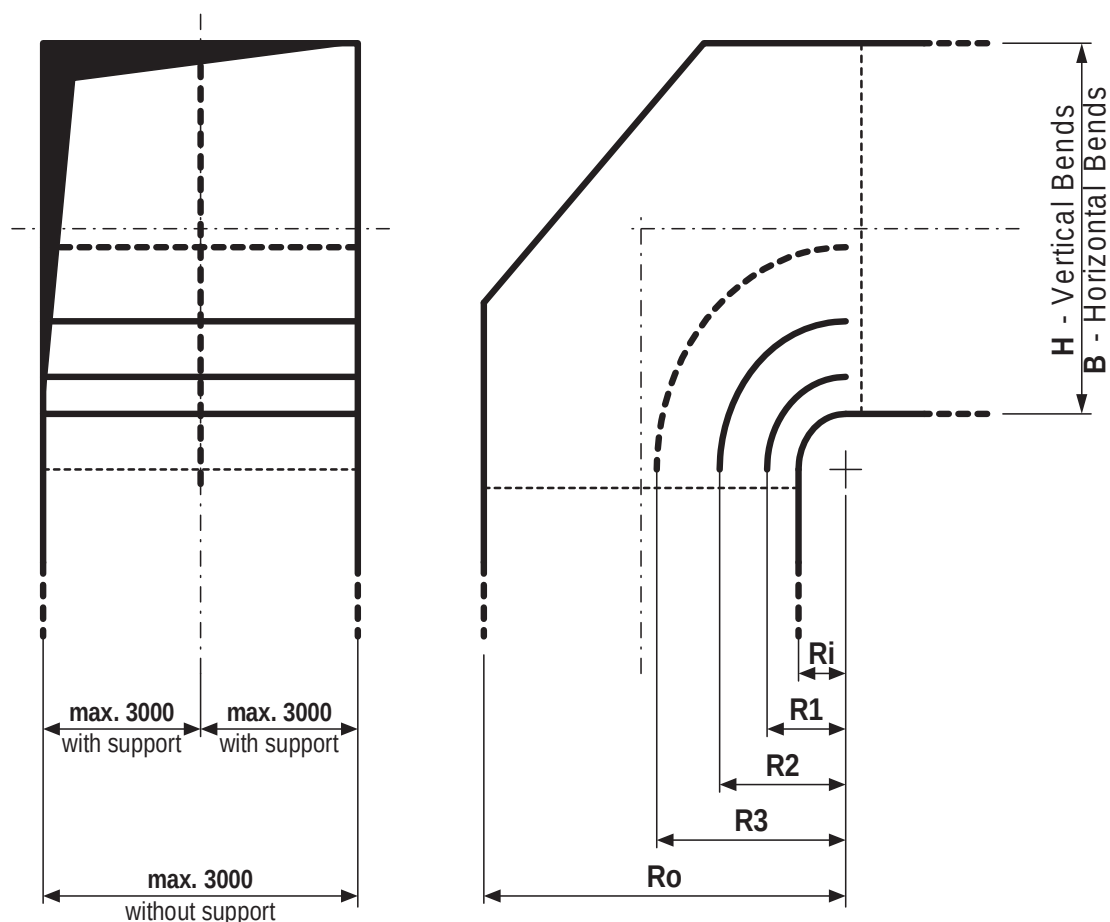
Selection of Reinforcement Profiles based on Max. Duct Dimension								
L _{max.} (mm)	Recommended Profile	B _{max.} (mm)	L _{max.} (mm)	Recommended Profile	B _{max.} (mm)	L _{max.} (mm)	Recommended Profile	B _{max.} (mm)
1,500	60 x 6	600	3,000	IPE 120	600	4,500	HEA 140	600
1,600	60 x 6	550	3,100	IPE 120	600	4,600	HEA 140	550
1,700	60 x 6	500	3,200	IPE 120	550	4,700	HEA 140	550
1,800	80 x 8	600	3,300	IPE 120	500	4,800	HEA 140	500
1,900	80 x 8	600	3,400	IPE 120	500	4,900	HEA 140	500
2,000	80 x 8	550	3,500	IPE 140	600	5,000	HEB 140	600
2,100	80 x 8	500	3,600	IPE 140	550	5,100	HEB 140	600
2,200	100 x 10	600	3,700	IPE 140	550	5,200	HEB 140	550
2,300	100 x 10	600	3,800	IPE 140	500	5,300	HEB 140	550
2,400	100 x 10	550	3,900	IPE 140	500	5,400	HEB 140	550
2,500	IPE 100	600	4,000	UNP 140	500	5,500	HEB 140	500
2,600	IPE 100	600	4,100	HEA 120	500	5,600	HEB 140	500
2,700	IPE 100	550	4,200	HEA 120	500			
2,800	IPE 100	500	4,300	HEA 140	600			
2,900	IPE 100	500	4,400	HEA 140	600			

13.3 Bends/guide vanes

In general, all bends in square ducts should be provided with internal guide vanes, in order to reduce the pressure loss in the bends.

In most cases installation of guide vanes (maximum 3 pcs.) will be sufficient to obtain a feasible reduction in pressure loss. However, in some cases more sophisticated guide systems may be required. In such cases, the design must be considered/calculated as part of the detailed engineering activities, and specified on the relevant detailed duct drawings.

General guidelines for design of internal guide vanes are given on the next two pages.



H or B (mm)	R_i (mm)	X
< 2000	300	2
2000 - 4000	300	3
> 4000	500	3

Guide Vane Factor:

$$f = (R_i / R_0)^{1/(X+1)}$$

X = Number of guide vanes

$$R_1 = R_i / f$$

$$R_2 = R_1 / f$$

$$R_3 = R_2 / f$$

Notes:

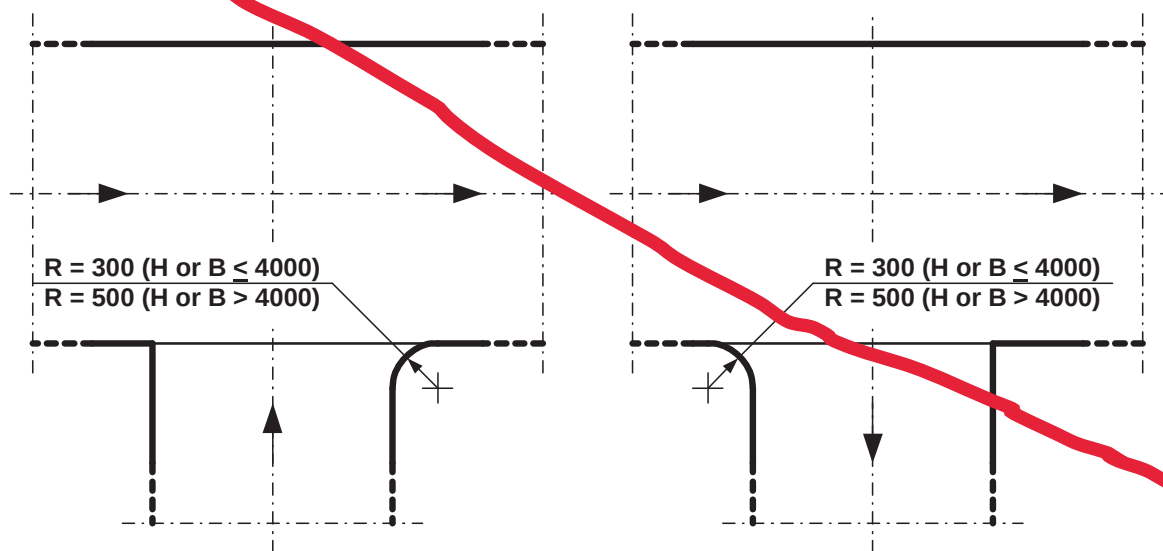
- 1) In some cases guide vanes may not be required, however, an internal radius of $R_i = 300$ mm should always be implemented, in order to reduce the pressure loss in the bend. Intermediate support(s) is/are in general required for duct widths larger than 3000 mm.
- 2) Thickness of guide vanes and intermediate support(s) (if required) - 6 mm.
- 3) Material for guide vanes and intermediate support(s) to be selected according to the relevant Duct Class.

Specification of Guide Vanes for Square Ducts

Duct Size H or B (mm)	No. of vanes	Ri (mm)	R1 (mm)	R2 (mm)	R3 (mm)
1,000	2	300	490	800	
1,200	2	300	515	875	
1,400	2	300	535	955	
1,600	2	300	555	1,025	
1,800	2	300	575	1,100	
2,000	3	300	500	830	1,380
2,200	3	300	510	865	1,470
2,400	3	300	520	900	1,560
2,600	3	300	530	935	1,645
2,800	3	300	540	965	1,730
3,000	3	300	545	995	1,810
3,200	3	300	555	1,025	1,895
3,400	3	300	560	1,055	1,975
3,600	3	300	570	1,080	2,055
3,800	3	300	575	1,110	2,130
4,000	3	300	585	1,135	2,210
4,200	3	500	875	1,535	2,685
4,400	3	500	885	1,565	2,770
4,600	3	500	895	1,595	2,855
4,800	3	500	900	1,630	2,935
5,000	3	500	910	1,660	3,020
5,200	3	500	920	1,670	3,100
5,400	3	500	925	1,720	3,185
5,600	3	500	935	1,745	3,265
5,800	3	500	940	1,775	3,345
6,000	3	500	950	1,805	3,425

13.4 Branch connections

Branch connections should be designed as shown below, in order to reduce the pressure loss in the connection.



13.5 Flanges

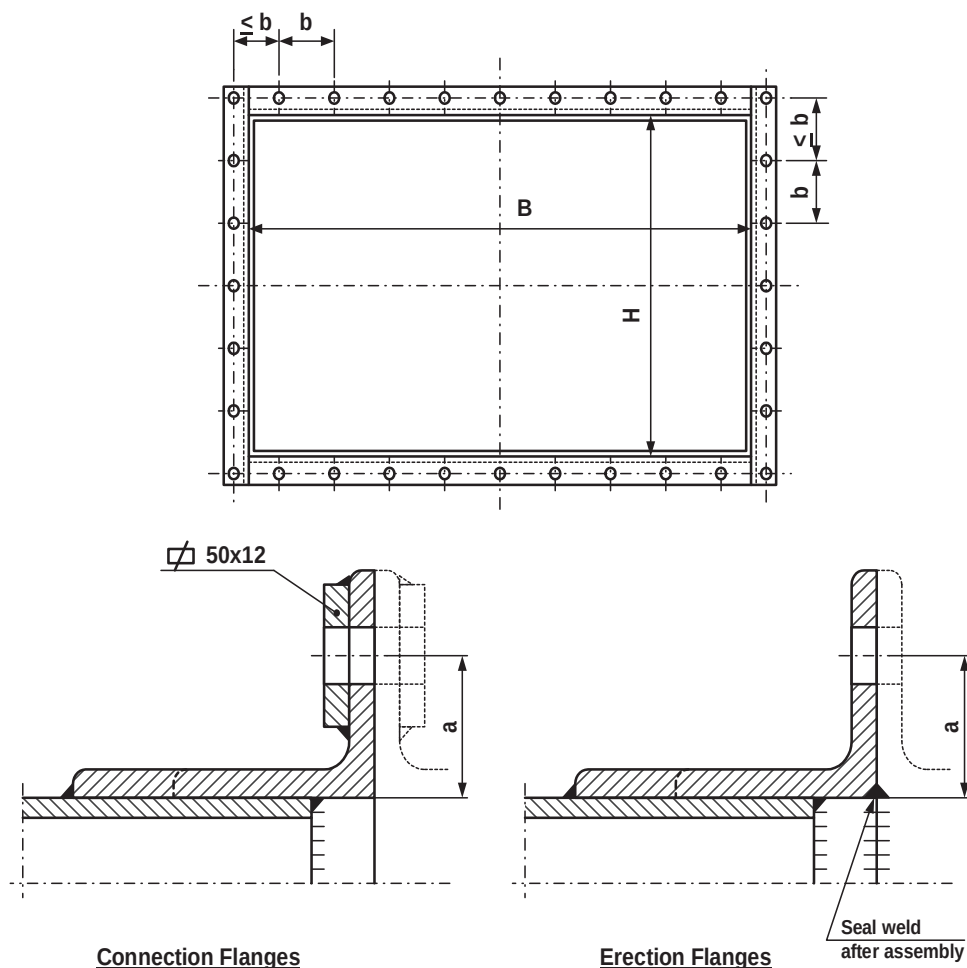
Two types of flanges are specified in this section, i.e. connection flanges and erection flanges.

Connection flanges are used for disconnectable flange connections, typically required for fabric type bellows, dampers, etc.

Erection flanges can be used for connection of two ducts or connection of ducts to equipment during erection. Erection flanges are internally seal welded after they have been connected. Erection flanges should, in general, only be used when deemed feasible, i.e. erection flanges should only be used when this provides an advantage during erection, including cost savings, which are higher than the cost of the erection flanges.

Basic design guidelines for connection and erection flanges are given on the next page.

Square Flanges



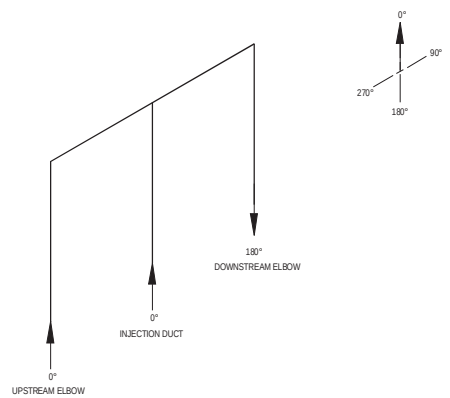
Duct Size H or B (mm)	Flange Profile	Boltholes $\varnothing$ (mm)	Bolts (mm)	a (mm)	b	
					Connection Fl. (mm)	Erection Fl. (mm)
≤ 1500	L 80x10	19	5/8"UNC	50	100 - 120	400 - 500
$1500 \leq 4000$	L 120x80x10	19	5/8"UNC	50	100 - 120	400 - 500
> 4000	L 150x100x12	23	3/4"UNC	60	100 - 120	400 - 500

Notes:

- 1) Material for flanges to be selected according to the relevant Duct Class.

B

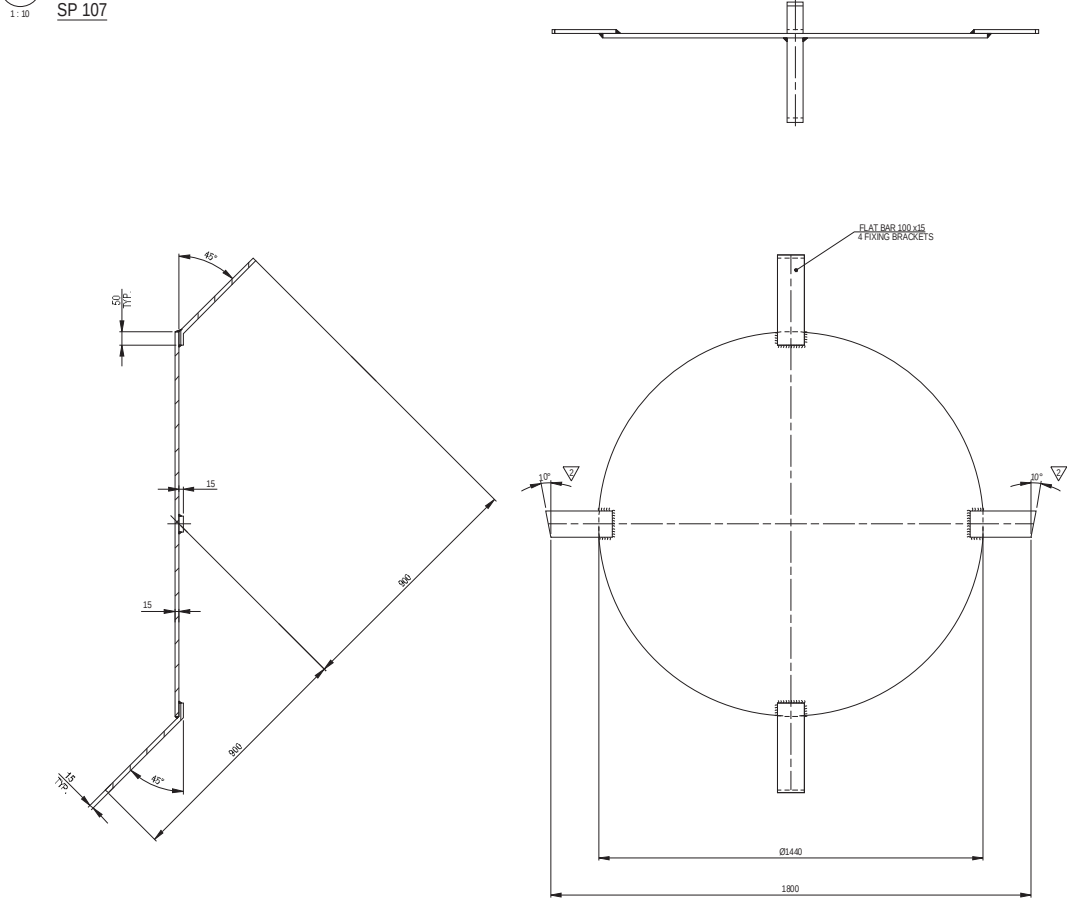
ORIENTATION OF ELBOWS AND INJECTION DUCT



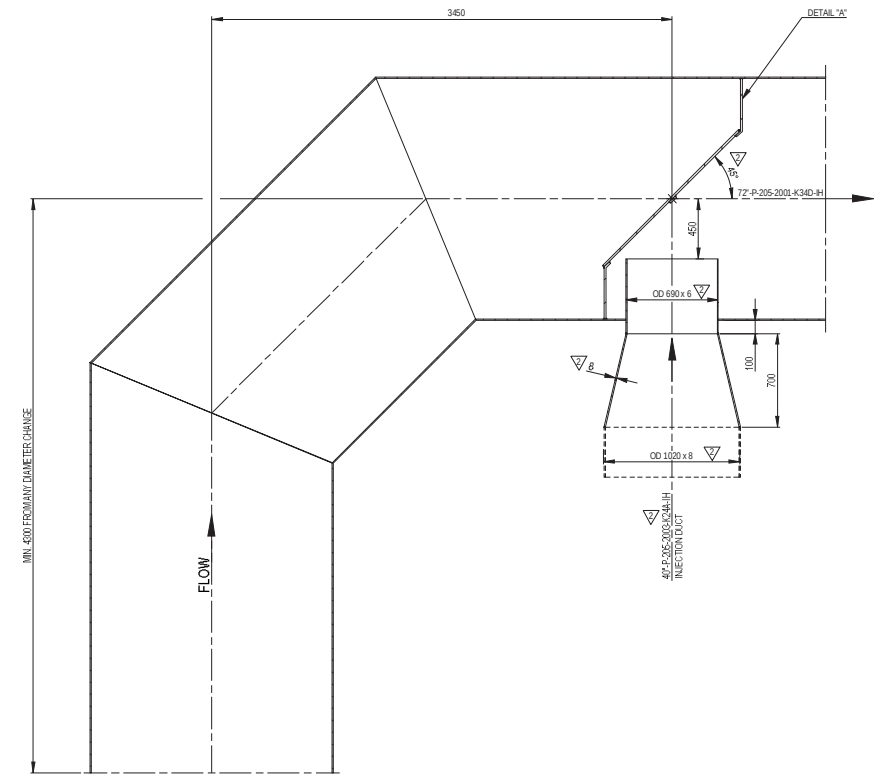
ORIENTATION OF MIXER PLATE SHALL FOLLOW
ORIENTATION OF INJECTION DUCT

A

MIXER PLATE
SP 107

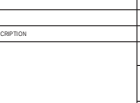


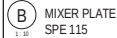
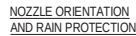
ANNEXURE-IX



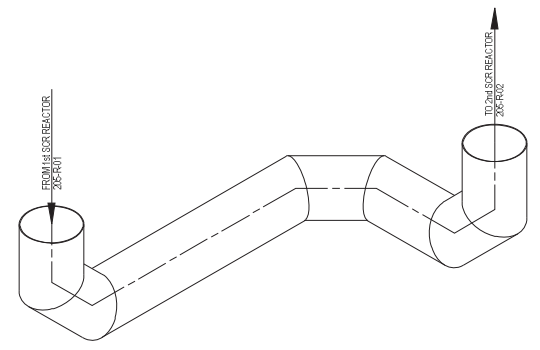
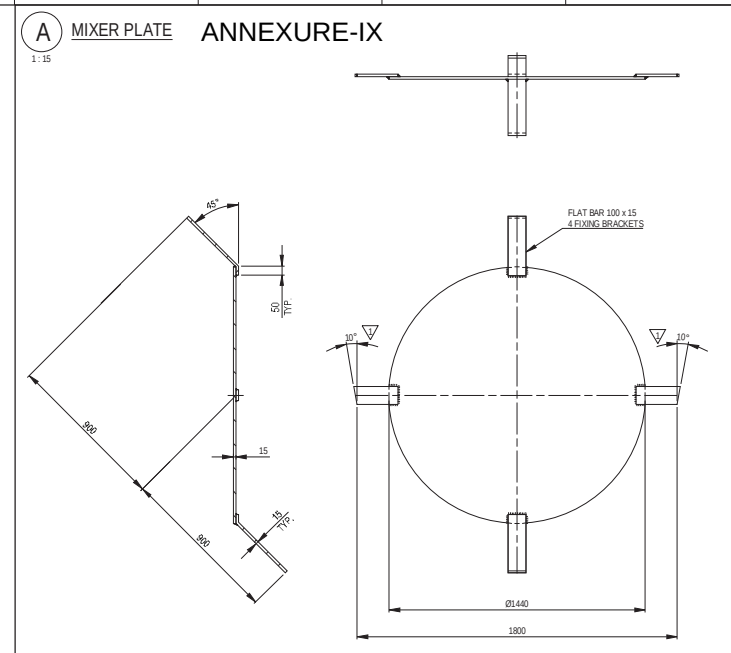
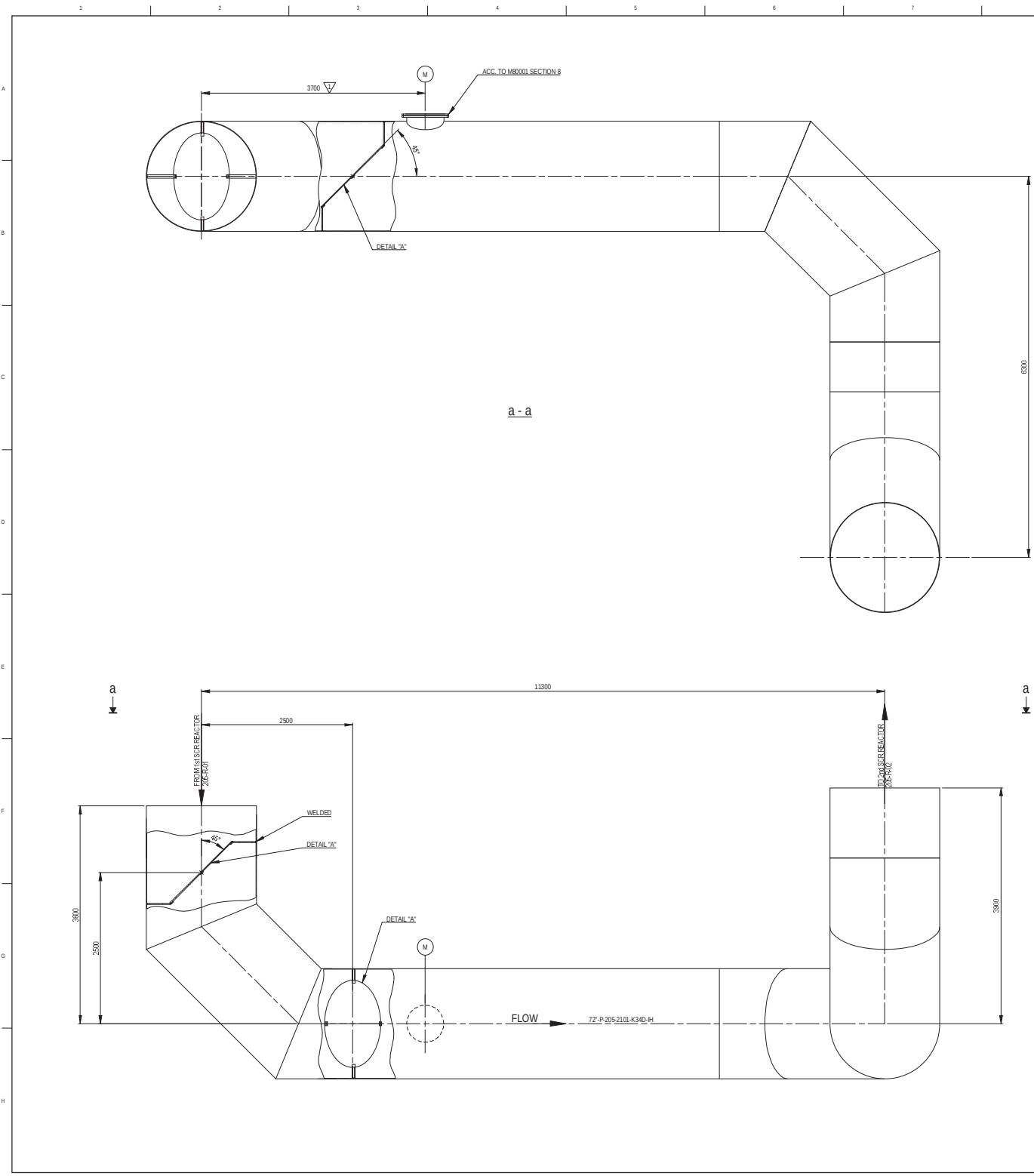
NOTES :

- 1) MATERIALS ACC. TO MAIN DUCT CLASS
- 2) MINIMUM DISTANCE FROM INJECTION DUCT CENTER TO DOWNSTREAM ELBOW 5 x ID
- 3) MINIMUM DISTANCE FROM INJECTION DUCT CENTER TO DOWNSTREAM EQUIPMENT INLET 8 x ID
- 4) ORIENTATION ACC. TO DETAIL "B"

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2	Revised as indicated	Jan 09, 2018	SKYAJAMKU	ABKU	ABKJ
1	Injection duct size updated	Nov 27, 2017	SKYAJABMA	ABKU	ABKJ
0	First issue	Nov 17, 2017	ARAJIRAVM	SKYA	ABKJ
REV.	DESCRIPTION	DATE	DRAWN	CHKD.	APPD.
Sulphuric Acid Plant Haldia Refinery					
SWS gas / Air mixing system Type 1			SP 107		
DOCUMENT ID S-06841			2		
JOB NO. 1			M81005		
			TVP-DOC-NO-M81005-REV-1		



NOTES							
(1) DESIGN DETAILS-ADD TO TOPSOE SPEC NO. 06900							
(2) WA TERIALS-ADD TO TOPSOE SPEC NO. 06900, DUCT CLASS-KEN							
(3) INSULATION THICKNESS : 300 mm							
(4) DIMENSIONS IN [] ARE FOR PRACTICAL PURPOSES							
(5) STEEL WEIGHT : 2.85 N/m							
REFERENCE DOCUMENTS							
TEST							DQC NO.
DUCTING SPECIFICATION							MBS001
GENERAL SPEC FOR SUPPORTS ON PROCESS GAS DUCTING AND PIPING							SP-384
C/S SPEC IMPLACAT, INSPECTION AND TEST FOR PRESSURE EQUIPMENT & DUCTING							SP-318
GENERAL TOLERANCES FOR SHEET METAL							SP-275
GENERAL SPECIFICATION FOR WALLS, WINDOWS AND LIFTING LOOPS							SP-389
PRESCRIPTION FOR HAZARDOUS WASTE HANDLING							SP-033
PROCESS GAS WATER ASSEMBLY							MBS111
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1	Revised as indicated				July 25, 1981	SA-PARAMO	RANDI JENSEN
2	First issue				May 25, 2017	SA-PARAMO	RANDI JENSEN
AUTH	DESCRIPTION		DATE	BYNAME	DATE	APPROV	
Sulfuric Acid Plant Volula Refinery							
					REVISION NO.	SCALE	
Process gas heater outlet duct for 2nd Volula Reactor					SHEET	1 / 5	
PROJECT NO:		M81007		DRAWN BY:		1	

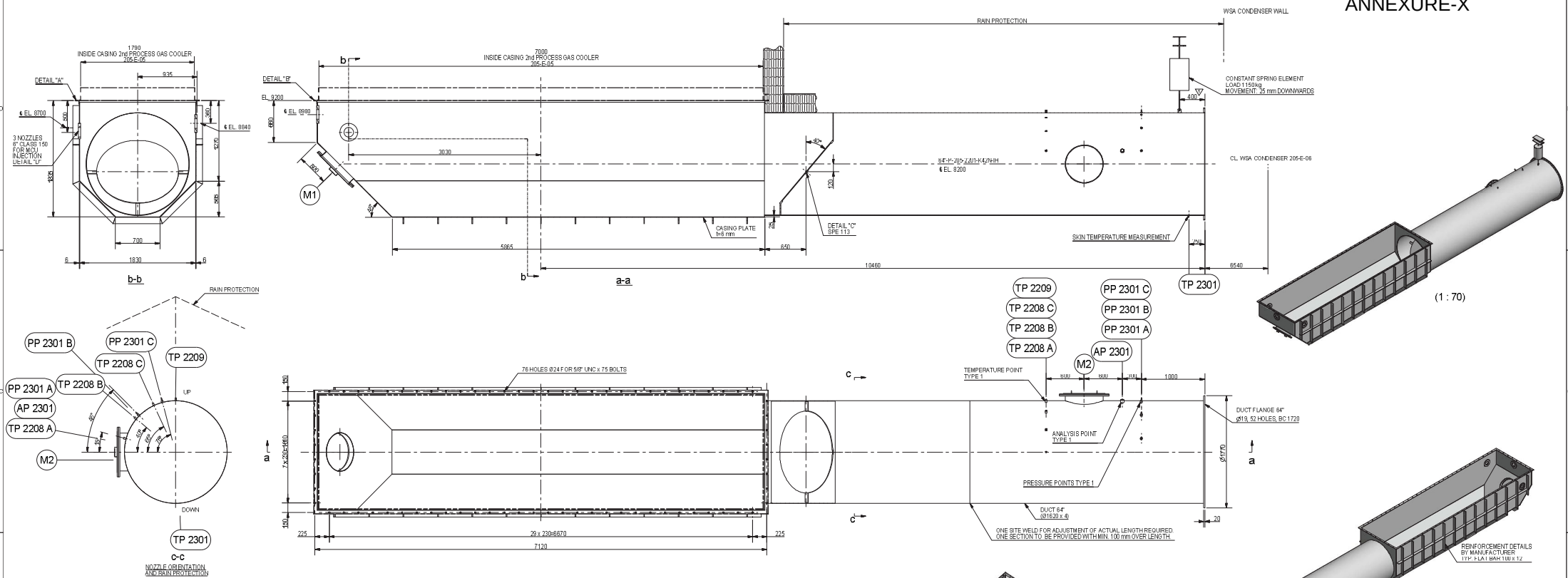


NOTES :

1) MATERIAL ACCORDING TO MAIN DUCT CLASS.

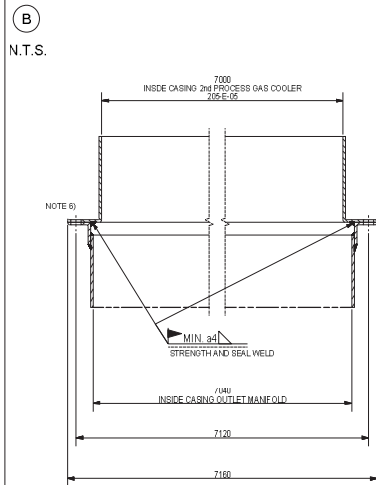
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1	Revised as indicated	Jan 09, 2018	SKYAJAMKU	ABKU	ABKJ
0	First Issue	Nov 17, 2017	ARAJARAVM	SKYA	ABKJ
REV.	DESCRIPTION	DATE	DRAWN	CHKD.	APPD.
Sulphuric Acid Plant Haldia Refinery			OWN: SIZE A1 SCALE 1 : 33.33		
Mixing plates between 1st and 2nd SCR reactor SP type 11			IT DA NO. SP 114		
DOCUMENT ID S-06841			DOCUMENT NUMBER M81030		
JOB NO.			REV.		

ANNEXURE-X

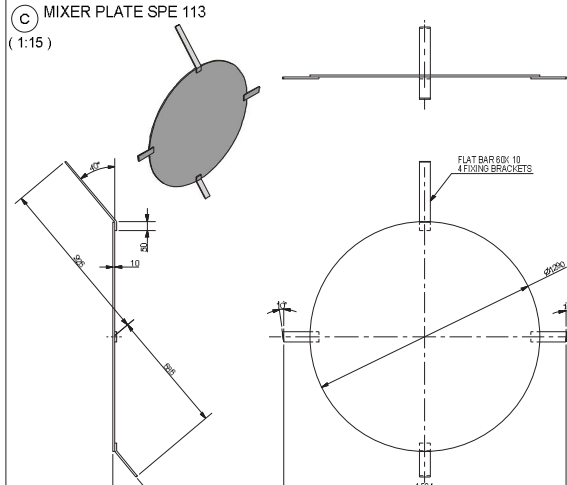


NOZZLE	PROJECTION FROM CENTERLINE OF DUCT (mm)
PP	875 mm
TP	850 mm
AP	850 mm
M	900 mm

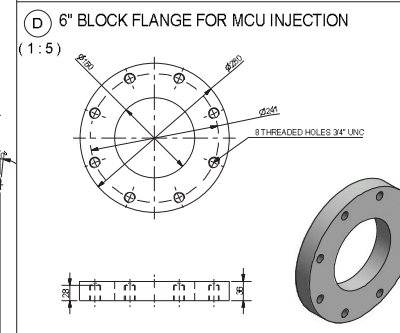
(A)
N.T.S.



(C) MIXER PLATE SPE 113
(1:15)



(D) 6" BLOCK FLANGE FOR MCU INJECTION
(1:5)



NOTES		
1) DESIGN DETAILS ACCORDING TO TOPPO SPEC NO. M80001		
2) MATERIALS CALL TO TOPPO SPEC NO. M80001 DOCT CLASS K42N		
3) TEXT WEIGHT = 2900g		
4) INSULATING THICKNESS = 200 mm		
5) DIMENSIONS IN A REFR FOR PRACTICAL PURPOSES		
6) FINISHES OF COULET MUST CONFORM TO M80001 INDEX BY BEARING THE PLATES		
REFERENCE DOCUMENTS		
TEXT	DOC. NO.	
OUTPUT SPECIFICATION	M80001	
GENERAL SPECIFICATION FOR MANUFACTURE, INSPECTION AND TEST OF LOW PRESSURE EQUIPMENT AND DUCTING	SP-374	
GENERAL SPECIFICATIONS FOR STEEL PARTS	SP-375	
GENERAL SPECIFICATION FOR LIFTING DEVICES AND LIFTING LUGS	SP-393	
SECTION ON INSULATION	SP-394	
GENERAL SPECIFICATION FOR SUPPORTS ON PROCESS GAS DUCTING AND PIPING	SP-394	
DO NOT PROCESS DUCT COVER ASSEMBLY	M831010	

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[illegible]

Sulphuric Acid Plant Haldia Refinery	
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	DWG SIZE A1	ITEM
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	SCALE
--	-------

2nd Process gas cooler outlet duct	1 : 30	
------------------------------------	--------	--

DOCUMENT ID: S-06841 M81002 1

JOB NO.	DOCUMENT NUMBER	REV.
L1	M81002-INVENTOR rev.0	Y801 rev.0 TT-347 EN (M)