

CALCULATION SHEET FOR
COMPRESSED AIR STORAGE TANK

(JOB NO.: **SP09-U-001**)
(DRAWING NO.: **SP09-001-1**, REV. 1)

3				
2				
1	2010.01.14	1st		
0	2009.10.31.	FIRST ISSUE		
REVISION	DATE	DESCRIPTION	DESIGNED BY ENGINEER	TECHNOLOGY DEPT. MANAGER

SUZHOU PFAUDLER GLASS-LINED EQUIPMENT CO., LTD
苏州法德尔搪玻璃设备有限公司

TABLE OF CONTENTS

1	DESIGN DATA	3
2	THICKNESS OF CYLINDRICAL SHELL UNDER INTERNAL PRESSURE	6
3	THICKNESS OF ELLIPSOIDAL HEADS, PRESSURE ON CONCAVE SIDE	8
4	THICKNESS OF NOZZLE NECK UNDER INTERNAL PRESSURE	11
5	MAX. ALLOWABLE WORKING PRESSURE	21
6	HYDROSTATIC TEST PRESSURE AND TEMPERATURE	22
7	REINFORCEMENT FOR OPENINGS	23
8	STRENGTH CALCULATIONS FOR NOZZLE ATTACHMENT WELDS FOR PRESSURE LOADING	26
9	CHECK THE ADEQUACY OF THE ATTACHMENT WELDS AT OPENINGS	27
10	CHECK FLANGE TO NOZZLE NECK WELDS	29
11	DESIGN OF SUPPORTING LEGS	30
12	THE CALCULATION OF LIFTING LUG	32
13	PRESSURE-TEMPERATURE RATING FOR ASME FLANGE	34
14	CHECK FOR POST WELD HEAT TREATMENT	35
15	EVALUATION OF IMPACT TEST REQUIREMENT	36

1. DESIGN DATA:

	APPLICABLE CODE	ASME SEC. VIII DIV. 1 2007 EDITION AND 2009 ADDENDA.
(1)	CUSTOMER SPECIFICATION	DOC. NO. DC-09-1/Rev 0
(2)	DESIGN PRESSURE	INTERNAL 1.3MPa
(3)	DESIGN TEMPERATURE	50°C
(4)	TYPE OF JOINTS OF CATEGORIES A AND B	TYPE NO.1
(5)	RADIOGRAPHY	SPOT per UW-11(b)
(6)	JOINT EFFICIENCY	SHELL: 0.85, HEAD: 0.85, SHEEL to HEAD: 0.85
(7)	CORROSION ALLOWANCE	1 mm.
(8)	MATERIAL	SHELL & HEAD :SA-516M Gr.485 NOZZLE: SA-106Gr.B FLANGE: SA-105M SUPPORT LEGS:20(GB/T8163-2008) SUPPORT PLATE: SA-285M Gr.C LUG:SA-516M Gr.485
(9)	MAX. ALLOWABLE STRESS AT DESIGN TEMPERATURE	SA-285M Gr.C:108MPa at 50°C SA-105M: 138MPa at 50°C SA-106Gr.B: 118MPa at 50°C SA-516M Gr.485: 138MPa at 50°C
(10)	HEAD TYPE	2:1 Standard Ellipsoidal Head
(11)	TANK CAPACITY	1.5 m ³
(12)	SERVICE FLUID	COMPRESSED AIR (no lethal)
(13)	MIN. SERVICE TEMPERATURE	-10°C
(14)	THE LOADING CONSIDERED IN DESIGNING	SEE TABLE 1-1
(15)	TANK DIMENSIONS	SEE FIG 1-1

TABLE 1-1 LOADING CONSIDERED IN DESIGNING

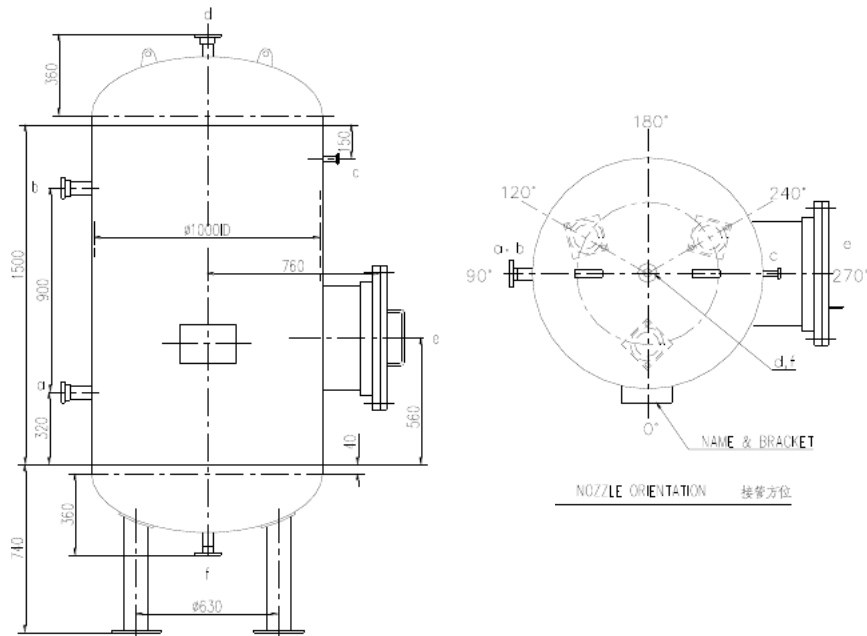
Item	Description	Yes	No
1	Internal pressure	[☒]	[☐]
2	External pressure	[☐]	[☒]
3	Weight of vessel	[☒]	[☐]
4	Weight of normal contents under operation conditions	[☐]	[☒]
5	Weight of normal contents under test conditions	[☒]	[☐]
6	Superimposed static reactions from weight of attached equipment	[☐]	[☒]
7	The attachments of internals	[☐]	[☒]
8	The attachments of vessel supports (skirt, legs, saddles etc.)	[☒]	[☐]
9	The attachments of lifting lugs	[☒]	[☐]
10	Cyclic and dynamic reactions due to pressure	[☐]	[☒]
11	Cyclic and dynamic reactions due to thermal variations	[☐]	[☒]
12	Cyclic and dynamic reactions due to equipment mounted on the vessel	[☐]	[☒]
13	Cyclic and dynamic reactions due to mechanical loadings	[☐]	[☒]
14	Wind reactions	[☐]	[☒]
15	Snow reactions	[☐]	[☒]
16	Seismic reactions	[☐]	[☒]
17	Impact reactions, such as those due to fluid shock	[☐]	[☒]
18	Temperature gradients	[☐]	[☒]
19	Differential thermal expansion	[☐]	[☒]
20	Abnormal pressure, such as those caused by deflagration	[☐]	[☒]
21	Test pressure and coincident static head acting during the test (See UG-99)	[☒]	[☐]

LIST OF NOZZLES

f	1	DN40	Class150 S.O. RF	DRAIN	SA-106Gr.B
e	1	DN450	Class150 S.O. RF	MANHOLE	SA-516M Gr.485
d	1	DN40	Class150 S.O. RF	SAFETY VALVE	SA-106Gr.B
c	1	DN15	Class150 S.O. RF	PRESSURE GAUGE	SA-106Gr.B
b	1	DN50	Class150 S.O. RF	AIR OUTLET	SA-106Gr.B
a	1	DN50	Class150 S.O. RF	AIR INLET	SA-106Gr.B
NOZZLE NO.	Q'TY	SIZE	TYPE	DESCRIPTION	REMARKS

Note: Bolt holes of flanges shall straddle center line of the tank.

FIG.1-1 Brief Drawing of Shell



2. THICKNESS OF CYLINDRICAL SHELL UNDER INTERNAL PRESSURE

ASME SEC. VIII DIV.1 UG-27

● Part	:	Shell
● Design pressure	P (MPa) :	1.3
● Design temperature	(°C) :	50
● Material	:	SA-516M Gr.485
● Maximum allowable stress value at design temperature	S _d (MPa) :	138
● Maximum allowable stress value at test temperature	S _t (MPa) :	138
● Height to point under consideration	H (m) :	1.900
● Density of test medium (water) at test temperature	ρ (kg/m ³) :	1000
● Type of welded joints in TABLE UW-12	:	Type No. (1)
● Radiographic examination	:	SPOT
		Per UW-11(b)
● Joint efficiency (specified in UW-12)	E :	0.85
● Corrosion allowance (designated by customer)	C (mm) :	1.0
● Nominal shell thickness	t _n (mm)	10
● Inside radius corroded	R (mm) :	501
● Final center line radius	R _f (mm) :	505
● Original center line radius (specified in UCS-79)	R _o (mm) :	∞ (Infinity)

(1) Required minimum shell thickness excluding allowance (circumferential stress)

$$0.385SE = 0.385 \times 138 \times 0.85 = 45.16 > P \quad \text{according to UG-27(b)\&(c)}$$

(a) For design condition

$$t_{\min 1} = \frac{PR}{S_d E - 0.6P} = \frac{1.3 \times 501}{138 \times 0.85 - 0.6 \times 1.3} = 5.59 \text{ mm}$$

(b) For hydrostatic test condition

$$\begin{aligned}
 t_{\min 2} &= \frac{PR}{S_t E - 0.6P} + \frac{(9.81H\rho/10^6)R}{S_t E - 0.6(9.81H\rho/10^6)} \\
 &= \frac{1.3 \times 501}{138 \times 0.85 - 0.6 \times 1.3} + \frac{9.81 \times 1.900 \times 1000/10^6 \times 501}{138 \times 0.85 - 0.6 \times (9.81 \times 1.900 \times 1000/10^6)} \\
 &= 5.59 + 0.08 = 5.67 \text{ mm}
 \end{aligned}$$

(2) Design thickness

Required minimum shell thickness including allowance

$$t = \max(t_{\min 1}, t_{\min 2}) + C = 5.67 + 1.0 = 6.67 \text{ mm}$$

(3) Provided thickness

Nominal thickness (mm) $10 > t$ OK

(4) Check minimum required thickness for paragraph **UG-16 (b) (4)**

Minimum thickness required (including corrosion allowance) : $2.5 + 1 = 3.5 \text{ mm}$,
nominal thickness is $10 \text{ mm} > 3.5 \text{ mm}$, OK

(5) Check extreme fiber elongation for paragraph **UCS-79**

Maximum allowable fiber elongation without post weld heat treatment is based on the following formula: For single curvature

$$r = \frac{50t}{R_f} \left(1 - \frac{R_f}{R_0} \right) \% = \frac{50 \times 10}{505} \times \left(1 - \frac{505}{\infty} \right) \% = 0.99\% < 5\%$$

None of the conditions in UCS-79 (1~5) apply, so no heat treatment after cold forming need to apply.

3. THICKNESS OF ELLIPSOIDAL HEAD, PRESSURE ON CONCAVE SIDE

ASME SEC. VIII DIV.1 UG-32

●Part		:	heads
●Design pressure	P (MPa)	:	1.3
●Design temperature	(°C)	:	50
●Material		:	SA-516M Gr.485
●Maximum allowable stress value at design temperature	S _d (MPa)	:	138
●Maximum allowable stress value at test temperature	S _t (MPa)	:	138
●Height to point under consideration (bottom head)	H (m)	:	2.190
●Height to point under consideration (top head)	H (m)	:	0.400
●Density of test medium at test temperature	ρ (kg/m ³)	:	1000
●Type of welded joints in TABLE UW-12		:	Seamless
●Radiographic examination (A)		:	N.A
●Weld joining heads to shell		:	Type No. (1), SPOT Per UW-11(b)
●Joint efficiency (specified in UW-12(d))	E	:	0.85
●Corrosion allowance (designated by customer)	C (mm)	:	1
●Inside diameter of ellipsoidal head (corroded)	D	:	1002
●Inside spherical radius of hemispherical head	L (mm)	:	501
●Crown final centerline radius (specified in UG-32(d) and UCS-79)	R _f (mm)	:	905
●Knuckle final centerline radius (specified in UG-32(d) and UCS-79)	r _f (mm)	:	174.25
●Original center line radius (specified in UCS-79)	R ₀ (mm)	:	∞ (Infinity)

(1) Required minimum head thickness

Without joint, according to **UW-12(d)**, $E=0.85, L=0.9D=0.9 \times 1002=901.8\text{mm}$

$$t_s/L = 8.5/901.8=0.0094 > 0.002 \quad \text{according to } \mathbf{UG-32(d)}$$

(a) For the top head according to **UG-32(d)**

(a-1) for design condition

Required minimum head thickness excluding allowance $t_{\min}$

$$t_{\min 1} = \frac{PD}{2S_d E - 0.2P} = \frac{1.3 \times 1002}{2 \times 138 \times 0.85 - 0.2 \times 1.3} = 5.56 \text{ mm}$$

(b) For the bottom head

(b-1) for design condition

Required minimum head thickness excluding allowance $t_{\min}$

$$t_{\min 2} = \frac{PD}{2S_d E - 0.2P} = \frac{1.3 \times 1002}{2 \times 138 \times 0.85 - 0.2 \times 1.3} = 5.56 \text{ mm}$$

(b-2) for hydrostatic test condition

(Due to same dimension for ellipsoidal heads, the bottom head will be applied for calculation)

$$\begin{aligned} t_{\min 3} &= \frac{PD}{2S_d E - 0.2P} + \frac{(9.81H\rho/10^6)D}{2S_d E - 0.2(9.81H\rho/10^6)} \\ &= \frac{1.3 \times 1002}{2 \times 138 \times 0.85 - 0.2 \times 1.3} + \frac{9.81 \times 2.190 \times 1000/10^6 \times 1002}{2 \times 138 \times 0.85 - 0.2 \times (9.81 \times 2.190 \times 1000/10^6)} \\ &= 5.56 + 0.09 = 5.65 \text{ mm} \end{aligned}$$

(2) Design thickness

Required minimum head thickness including allowance

$$t = \max(t_{\min 1}, t_{\min 2}, t_{\min 3}) + C = 5.65 + 1.0 = 6.65 \text{ mm}$$

(3) Provided thickness

Nominal thickness (mm) 10

Minimum thickness after forming (mm) $8.5 \geq t$ OK

(4) Check minimum head thickness for hemispherical head from paragraph **UG-32 (b) & (f)**

$$0.665SE = 0.665 \times 138 \times 1 = 91.77 \text{ MPa} > P$$

Required minimum hemispherical head thickness

$$t_{\min h} = \frac{PL}{2SE - 0.2P} = \frac{1.3 \times 501}{2 \times 138 \times 1 - 0.2 \times 1.3} = 2.36 \text{ mm}$$

$$tr = t_{\min h} / E = 2.36 / 0.85 = 2.78 \text{ mm} < 8.5 \text{ mm} \quad \text{OK}$$

(5) Check minimum required thickness for paragraph UG-16(b)(4)

Minimum thickness required (including corrosion allowance) : $2.5 + 1 = 3.5 \text{ mm}$,

minimum thickness after forming is $8.5 \text{ mm} > 3.5 \text{ mm} \quad \text{OK}$

(6) Check extreme fiber elongation for paragraph UCS-79

Maximum allowable fiber elongation without heat treatment is based on the following

formula: For double curvature

Crown radius elongation

$$r = \frac{75t}{R_f} \left(1 - \frac{R_f}{R_0} \right) \% = \frac{75 \times 10}{905} \times \left(1 - \frac{905}{\infty} \right) \% = 0.83 \% < 5 \%$$

Knuckle radius elongation

$$r = \frac{75t}{r_f} \left(1 - \frac{r_f}{R_0} \right) \% = \frac{75 \times 10}{174.25} \times \left(1 - \frac{174.25}{\infty} \right) \% = 4.3 \% < 5 \%$$

None of the conditions listed in UCS-79(d)(1) through (5) exist, so no heat treatment of

heads after cold forming need to apply for SA-516M Gr.485 (P-NO.1 Group NO.2).

4. THICKNESS OF NOZZLE NECK INTERNAL PRESSURE

4-1 FOR NOZZLE a

ASME SEC. VIII DIV.1 UG-45

●Design pressure	P (MPa)	:	1.3
●Design temperature	T (°C)	:	50
●Material of nozzle neck		:	SA-106Gr.B
●Allowable stress of nozzle neck material at design temperature	S _d (MPa)	:	118
● Allowable stress of nozzle neck material at test temperature	S _t (MPa)	:	118
●Material of shell		:	SA-516M Gr.485
● Allowable stress of shell (or head) at design temperature	S _s (MPa)	:	138
●Height to point under consideration	H (m)	:	1.580
●Density of test medium at test temperature (water)	ρ (kg/m ³)	:	1000
●Type of welded joints of nozzle neck in TABLE UW-12		:	Seamless
●Joint efficiency of nozzle neck	E	:	1.0
●Corrosion allowance (designated by customer)	C (mm)	:	1
●Outside radius of nozzle neck	R _o (mm)	:	30.15
●Nominal thickness of the standard wall pipe(B36.10M)	t _{std} (mm)	:	3.91
●Inside radius of shell corroded	R _s (mm)	:	501

(1) Minimum required thickness of nozzle neck for par. **UG-45 (a)**

$$0.385SE = 0.385 \times 118 \times 1.00 = 45.43 > P$$

(a) under design condition **Appendix 1-1**

Required minimum thickness including allowance

$$t_{\min 1} = \frac{PR_o}{S_d E + 0.4P} + C = \frac{1.3 \times 30.15}{118 \times 1 + 0.4 \times 1.3} + 1 = 1.33 \text{ mm}$$

(b)under hydrostatic test condition

Required minimum thickness including allowance

$$\begin{aligned}
 t_{\min 2} &= \frac{PR_o}{S_s E + 0.4P} + \frac{(9.81H\rho/10^6)R_o}{S_s E + 0.4(9.81H\rho/10^6)} + C \\
 &= \frac{1.3 \times 30.15}{118 \times 1 + 0.4 \times 1.3} + \frac{9.81 \times 1.580 \times 1000 / 10^6 \times 30.15}{118 \times 1 + 0.4 \times (9.81 \times 1.580 \times 1000 / 10^6)} + 1 \\
 &= 0.33 + 0.004 + 1 = 1.334 \text{ mm}
 \end{aligned}$$

- (2) Minimum required thickness of shell for par. **UG-45 (b) (1)**, and **UG-16 (b) (4)**, $E_s = 1.00$

$$t_s = \frac{PR_s}{S_s E_s - 0.6P} + C = \frac{1.3 \times 501}{138 \times 1 - 0.6 \times 1.3} + 1 = 4.75 + 1 = 5.75 \text{ mm} > 2.5 + 1 = 3.5 \text{ mm}$$

- (3) Minimum thickness of standard wall pipe including allowance for par. **UG-45 (b) (4)**

$$t_p = 0.875 t_{\text{std}} + C = 0.875 \times 3.91 + 1 = 4.42 \text{ mm}$$

$$t = (\text{the smaller value of } t_s \text{ or } t_p) \quad \text{per } \mathbf{UG-45(b)}$$

$$= 4.42 \text{ mm} > t_{\min 1}, t_{\min 2}$$

- (4) Provided thickness

Nominal thickness (mm) 5.54

Minimum thickness (mm) $5.54 \times 0.875 = 4.8475 \geq t$ OK

4-2 FOR NOZZLE **b**

ASME SEC. VIII DIV.1 UG-45

●Design pressure	P (MPa)	: 1.3
●Design temperature	T (°C)	: 50
●Material of nozzle neck		: SA-106Gr.B
●Allowable stress of nozzle neck material at design temperature	S_d (MPa)	: 118
● Allowable stress of nozzle neck material at test temperature	S_t (MPa)	: 118
●Material of shell		: SA-516M Gr.485
● Allowable stress of shell (or head) at design temperature	S_s (MPa)	: 138
●Height to point under consideration	H (m)	: 0.680
●Density of test medium at test temperature (water)	ρ (kg/m ³)	: 1000

- Type of welded joints of nozzle neck in TABLE

UW-12 : Seamless

- Joint efficiency of nozzle neck E : 1.0
- Corrosion allowance (designated by customer) C (mm) : 1
- Outside radius of nozzle neck R_o (mm) : 30.15
- Nominal thickness of the standard wall pipe(B36.10M) t_{std} (mm) : 3.91
- Inside radius of shell corroded R_s (mm) : 501

- (1) Minimum required thickness of nozzle neck for par. **UG-45 (a)**

$$0.385SE = 0.385 \times 118 \times 1.00 = 45.43 > P$$

(a) under design condition **Appendix 1-1**

Required minimum thickness including allowance

$$t_{min1} = \frac{PR_o}{S_d E + 0.4P} + C = \frac{1.3 \times 30.15}{118 \times 1 + 0.4 \times 1.3} + 1 = 1.33mm$$

(b)under hydrostatic test condition

Required minimum thickness including allowance

$$\begin{aligned} t_{min2} &= \frac{PR_o}{S_t E + 0.4P} + \frac{(9.81H\rho/10^6)R_o}{S_t E + 0.4(9.81H\rho/10^6)} + C \\ &= \frac{1.3 \times 30.15}{118 \times 1 + 0.4 \times 1.3} + \frac{9.81 \times 0.680 \times 1000/10^6 \times 30.15}{118 \times 1 + 0.4 \times (9.81 \times 0.680 \times 1000/10^6)} + 1 \\ &= 0.33 + 0.002 + 1 = 1.332mm \end{aligned}$$

- (2) Minimum required thickness of shell for par. **UG-45 (b) (1)**,and **UG-16 (b) (4)**, $E_s = 1.00$

$$t_s = \frac{PR_s}{S_s E_s - 0.6P} + C = \frac{1.3 \times 501}{138 \times 1 - 0.6 \times 1.3} + 1 = 4.75 + 1 = 5.75mm > 2.5 + 1 = 3.5 mm$$

- (3) Minimum thickness of standard wall pipe including allowance for par. **UG-45 (b) (4)**

$$t_p = 0.875t_{std} + C = 0.875 \times 3.91 + 1 = 4.42mm$$

$t =$ (the smaller value of t_s or t_p) per **UG-45(b)**

$$= 4.42mm. > t_{min1}, t_{min2}$$

- (4) Provided thickness

Nominal thickness (mm) 5.54

Minimum thickness (mm) $5.54 \times 0.875 = 4.8475 \geq t$ OK

4-3 FOR NOZZLE **d**

ASME SEC. VIII DIV.1 UG-45

●Design pressure	P (MPa)	:	1.3
●Design temperature	T (°C)	:	50
●Material of nozzle neck		:	SA-106Gr.B
●Allowable stress of nozzle neck material at design temperature	S _d (MPa)	:	118
● Allowable stress of nozzle neck material at test temperature	S _t (MPa)	:	118
●Material of shell		:	SA-516M Gr.485
● Allowable stress of shell (or head) at design temperature	S _s (MPa)	:	138
●Height to point under consideration	H (m)	:	0.11
●Density of test medium at test temperature (water)	ρ (k/m ³)	:	1000
●Type of welded joints of nozzle neck in TABLE UW-12		:	Seamless
●Joint efficiency of nozzle neck	E	:	1.0
●Corrosion allowance (designated by customer)	C (mm)	:	1
●Outside radius of nozzle neck	R _o (mm)	:	24.15
●Nominal thickness of the standard wall pipe(B36.10M)	t _{std} (mm)	:	3.68
●Inside diameter of ellipsoidal head (corroded)	D (mm)	:	1002

(1) Minimum required thickness of nozzle neck for par. **UG-45 (a)**

$$0.385SE = 0.385 \times 118 \times 1.00 = 45.43 > P$$

(a) under design condition **Appendix 1-1**

Required minimum thickness including allowance

$$t_{\min 1} = \frac{PR_o}{S_d E + 0.4P} + C = \frac{1.3 \times 24.15}{118 \times 1 + 0.4 \times 1.3} + 1 = 1.265 \text{ mm}$$

(b) under hydrostatic test condition

Required minimum thickness including allowance

$$\begin{aligned}
 t_{\min 2} &= \frac{PR_o}{S_i E + 0.4P} + \frac{(9.81H\rho/10^6)R_o}{S_i E + 0.4(9.81H\rho/10^6)} + C \\
 &= \frac{1.3 \times 24.15}{118 \times 1 + 0.4 \times 1.3} + \frac{9.81 \times 0.110 \times 1000/10^6 \times 24.15}{118 \times 1 + 0.4 \times (9.81 \times 0.110 \times 1000/10^6)} + 1 \\
 &= 0.275 + 0.0002 + 1 = 1.2752 \text{ mm}
 \end{aligned}$$

- (2) Minimum required thickness of head for par. **UG-45 (b) (1)**, and **UG-16 (b) (4)**, $E_s = 1.00$

$$t_s = \frac{PD}{2S_s E_s - 0.2P} + C = \frac{1.3 \times 1002}{2 \times 138 \times 1 - 0.2 \times 1.3} + 1 = 4.72 + 1 = 5.72 \text{ mm} > 2.5 + 1 = 3.5 \text{ mm}$$

- (3) Minimum thickness of standard wall pipe including allowance for par. **UG-45 (b) (4)**

$$t_p = 0.875 t_{\text{std}} + C = 0.875 \times 3.68 + 1 = 4.22 \text{ mm}$$

$t = (\text{the smaller value of } t_s \text{ or } t_p) \quad \text{per } \mathbf{UG-45(b)}$

$$= 4.22 \text{ mm} > t_{\min 1}, t_{\min 2}$$

- (4) Provided thickness

Nominal thickness (mm) 5.08

Minimum thickness (mm) $5.08 \times 0.875 = 4.445 \geq t \quad \text{OK}$

4-4 FOR NOZZLE **f**

ASME SEC. VIII DIV.1 UG-45

●Design pressure	P (MPa)	: 1.3
●Design temperature	T (°C)	: 50
●Material of nozzle neck		: SA-106Gr.B
●Allowable stress of nozzle neck material at design temperature	S_d (MPa)	: 118
● Allowable stress of nozzle neck material at test temperature	S_t (MPa)	: 118
●Material of shell		: SA-516M Gr.485
● Allowable stress of shell (or head) at design temperature	S_s (MPa)	: 138
●Height to point under consideration	H (m)	: 2.300
●Density of test medium at test temperature (water)	ρ (kg/m ³)	: 1000
●Type of welded joints of nozzle neck in TABLE		

UW-12		:	Seamless
●Joint efficiency of nozzle neck	E	:	1.0
●Corrosion allowance (designated by customer)	C (mm)	:	1
●Outside radius of nozzle neck	R _o (mm)	:	24.15
●Nominal thickness of the standard wall pipe(B36.10M)	t _{std} (mm)	:	3.68
●Inside diameter of ellipsoidal head (corroded)	D (mm)	:	1002

(1) Minimum required thickness of nozzle neck for par. UG-45 (a)

$$0.385SE = 0.385 \times 118 \times 1.00 = 45.43 > P$$

(a) under design condition **Appendix 1-1**

Required minimum thickness including allowance

$$t_{\min 1} = \frac{PR_o}{S_d E + 0.4P} + C = \frac{1.3 \times 24.15}{118 \times 1 + 0.4 \times 1.3} + 1 = 1.265 \text{ mm}$$

(b) under hydrostatic test condition

Required minimum thickness including allowance

$$\begin{aligned} t_{\min 2} &= \frac{PR_o}{S_t E + 0.4P} + \frac{(9.81H\rho/10^6)R_o}{S_t E + 0.4(9.81H\rho/10^6)} + C \\ &= \frac{1.3 \times 24.15}{118 \times 1 + 0.4 \times 1.3} + \frac{9.81 \times 2.300 \times 1000/10^6 \times 24.15}{118 \times 1 + 0.4 \times (9.81 \times 2.300 \times 1000/10^6)} + 1 \\ &= 0.265 + 0.005 + 1 = 1.27 \text{ mm} \end{aligned}$$

(2) Minimum required thickness of head for par. UG-45 (b) (1), and UG-16 (b) (4), Es = 1.00

$$t_s = \frac{PD}{2S_s E_s - 0.2P} + C = \frac{1.3 \times 1002}{2 \times 138 \times 1 - 0.2 \times 1.3} + 1 = 4.72 + 1 = 5.72 \text{ mm} > 2.5 + 1 = 3.5 \text{ mm}$$

(3) Minimum thickness of standard wall pipe including allowance for par. UG-45 (b) (4)

$$t_p = 0.875 t_{\text{std}} + C = 0.875 \times 3.68 + 1 = 4.22 \text{ mm}$$

t = (the smaller value of t_s or t_p) per **UG-45(b)**

$$= 4.22 \text{ mm.} > t_{\min 1}, t_{\min 2}$$

(4) Provided thickness

Nominal thickness (mm) 5.08

Minimum thickness (mm) $5.08 \times 0.875 = 4.445 \geq t$ OK

4-5 FOR NOZZLE c

ASME SEC. VIII DIV.1 UG-45

●Design pressure	P (MPa)	:	1.3
●Design temperature	T (°C)	:	50
●Material of nozzle neck		:	SA-106Gr.B
●Allowable stress of nozzle neck material at design temperature	S _d (MPa)	:	118
● Allowable stress of nozzle neck material at test temperature	S _t (MPa)	:	118
●Material of shell		:	SA-516M Gr.485
● Allowable stress of shell (or head) at design temperature	S _s (MPa)	:	138
●Height to point under consideration	H (m)	:	0.55
●Density of test medium at test temperature (water)	ρ (kg/m ³)	:	1000
●Type of welded joints of nozzle neck in TABLE UW-12		:	Seamless
●Joint efficiency of nozzle neck	E	:	1.0
●Corrosion allowance (designated by customer)	C (mm)	:	1
●Outside radius of nozzle neck	R _o (mm)	:	10.65
●Nominal thickness of the standard wall pipe(B36.10M)	t _{std} (mm)	:	2.77
Per UG45(b)(4) note26 OD38 next larger pipe size OD42.2			
●Inside radius of shell corroded	R _s (mm)	:	501

(1) Minimum required thickness of nozzle neck for par. **UG-45 (a)**

$$0.385SE = 0.385 \times 118 \times 1.00 = 45.43 > P$$

(a) under design condition **Appendix 1-1**

Required minimum thickness including allowance

$$t_{min1} = \frac{PR_o}{S_d E + 0.4P} + C = \frac{1.3 \times 10.65}{118 \times 1 + 0.4 \times 1.3} + 1 = 1.12 \text{ mm}$$

(b)under hydrostatic test condition

Required minimum thickness including allowance

$$t_{\min 2} = \frac{PR_o}{S_i E + 0.4P} + \frac{(9.81H\rho/10^6)R_o}{S_i E + 0.4(9.81H\rho/10^6)} + C$$

$$= \frac{1.3 \times 10.65}{118 \times 1 + 0.4 \times 1.3} + \frac{9.81 \times 0.550 \times 1000 / 10^6 \times 10.65}{118 \times 1 + 0.4 \times (9.81 \times 0.550 \times 1000 / 10^6)} + 1$$

$$= 0.12 + 0.0005 + 1 = 1.1205 \text{ mm}$$

- (2) Minimum required thickness of shell for par. **UG-45 (b) (1)**, and **UG-16 (b) (4)**, $E_s = 1.00$

$$t_s = \frac{PR_s}{S_s E_s - 0.6P} + C = \frac{1.3 \times 501}{138 \times 1 - 0.6 \times 1.3} + 1 = 4.75 + 1 = 5.75 \text{ mm} > 2.5 + 1 = 3.5 \text{ mm}$$

- (3) Minimum thickness of standard wall pipe including allowance for par. **UG-45 (b) (4)**

$$t_p = 0.875 t_{\text{std}} + C = 0.875 \times 2.77 + 1 = 3.42 \text{ mm}$$

$t = (\text{the smaller value of } t_s \text{ or } t_p) \quad \text{per } \mathbf{UG-45(b)}$

$$= 3.42 \text{ mm} > t_{\min 1}, t_{\min 2}$$

- (4) Provided thickness

Nominal thickness (mm) 4.78

Minimum thickness (mm) $4.78 \times 0.875 = 4.1825 \geq t$ OK

4-6 FOR MANHOLE NOZZLE • e

ASME SEC.VIII DIV.1 UG-45

● Design pressure	P (MPa)	: 1.3
● Design temperature	T (°C)	: 50
● Material of nozzle neck		: SA-516M Gr.485
● Allowable stress of nozzle neck material at design temperature	S_d (MPa)	: 138
● Allowable stress of nozzle neck material at test temperature	S_t (MPa)	: 138
● Height to point under consideration	H (m)	: 1.57
● Density of test medium at test temperature (water)	ρ (kg/m ³)	: 1000
● Type of welded joints of nozzle neck in TABLE UW-12		: Type No. (1)
● Radiographic examination of nozzle neck		: SPOT Per UW-11(b)
● Joint efficiency of nozzle neck (specified in UW-12)	E	: 0.85
● Corrosion allowance (designated by customer)	C (mm)	: 1
● Outside radius of nozzle neck	R_o (mm)	: 228.5

●Inside radius of nozzle corroded	R (mm)	: 219.5
●Inside radius of shell corroded	R _s (mm)	: 501
●Final center line radius of nozzle	R _f (mm)	: 223.5
●Original center line radius of nozzle	R ₀ (mm)	: ∞ (Infinity)

(1) Minimum required thickness of nozzle par. **UG-45 (a) and UG-27 (c) (1)**

$$0.385SE = 0.385 \times 138 \times 0.85 = 45.16 > P$$

(a) under design condition

Required minimum thickness including allowance

$$t_{\min 1} = \frac{PR}{S_d E - 0.6P} + C = \frac{1.3 \times 219.5}{138 \times 0.85 - 0.6 \times 1.3} + 1 = 2.25 + 1 = 3.25 \text{ mm}$$

(b) under hydrostatic test condition

Required minimum thickness including allowance

$$\begin{aligned} t_{\min 2} &= \frac{PR}{S_d E - 0.6P} + \frac{(9.81H\rho/10^6)R}{S_d E - 0.6(9.81H\rho/10^6)} + C \\ &= \frac{1.3 \times 219.5}{138 \times 0.85 - 0.6 \times 1.3} + \frac{9.81 \times 1.590 \times 1000/10^6 \times 219.5}{138 \times 0.85 - 0.6 \times (9.81 \times 1.590 \times 1000/10^6)} + 1 \\ &= 2.25 + 0.03 + 1 = 3.28 \text{ mm} \end{aligned}$$

(c) With supplemental loading by flange and cover

- Weight of flange and cover W = 170kg
- Bending moment due to supplemental loading

$$\text{Under operating condition} \quad M_1 = 170 \times 9.81 \times 0.260 = 433.6 \text{ N} \cdot \text{m}$$

$$\text{Under cover opened condition} \quad M_2 = 170 \times 9.81 \times 0.560 = 933.9 \text{ N} \cdot \text{m}$$

Per **UG-27(c) and Appendix L**, Use S = 138 × 1.5 = 207MPa (see **UG-23(c)**)

$$\begin{aligned} t_3 &= \frac{PR}{2SE + 0.4P} + \frac{M_1}{\pi R^2 SE} + C \\ &= \frac{1.3 \times 228.5}{2 \times 207 \times 0.85 + 0.4 \times 1.3} + \frac{433.6}{\pi \times 228.5^2 \times 207 \times 0.85} + 1 \\ &= 0.843 + 0.000015 + 1 \approx 1.843015 \text{ mm} \approx 1.84 \text{ mm} \end{aligned}$$

$$t_4 = \frac{M_2}{\pi R^2 SE} + C = \frac{933.9}{\pi \times 228.5^2 \times 207 \times 0.85} + 1 = 0.000032 + 1 \approx 1.0 \text{ mm}$$

以上内容仅为本文档的试下载部分，为可阅读页数的一半内容。如要下载或阅读全文，请访问：<https://d.book118.com/948062004112006060>