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56000 VANNES

Written by :
D. JOST

Attention to M. PORHIEL

V/Réf : B403/6256 Saint Herblain, le 03/07/14

N/Réf : 14N126 - 14317672

DELIVERY ORDER

SUBJECT : Mechanical calculation report

Nbre	Référence du document	Désignation - Observation
1	14N126 - 14317672	Mechanical calculation report Of piping elements on drawings 317111-JLA-702-012, 702-013, 702-028 and 702-029 Following ASME VIII division 1

Ingénieur au service " Calculs "

Donatien JOST

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Rue des Frères Montgolfier – ZI du Prat

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Attention to M. PORHIEL

V/Réf : B403/6256

N/Réf : 14N126 - 14317672

CALCULATION DEPARTMENT

CALCULATION REPORT

Of piping elements on drawings 317111-JLA-702-012, 702-013, 702-028 and 702-029

Following ASME VIII division 1

C			
B			
A	03/07/14	D. JOST	J. P. LUCIANI
Rév.	Date	Name Signature	Name Signature
		Written by	Checked up by

REVISION RECORD

REV	DATE	PAGE / PARAGRAPHE CONCERNED	REVISION DECRIPION
A	03/07/14	All	First edition

Pages	*Révision Index*		
0	**A**		
à			
6	**A**		
APPENDIX A			
A0 à A2	**A**		
APPENDIX B			
B0	**A**		

TABLE OF CONTENTS

1. OBJECT

The goal of this calculation note is to review the mechanical strength under static pressure of piping elements of the anti-radiation screen following the assembly drawing 317111-JLA-702-001 Rév H.

The design is done according to ASME VIII division 1.

2. REFERENCES

2.1. Drawings

- 317111-JLA-702-001 Rév H (Assembly drawing)
- 317111-JLA-702-012 Rév G (Detail drawing of output circuit)
- 317111-JLA-702-013 Rév F (Detail drawing of input circuit)
- 317111-JLA-702-028 Rév E (Detail drawing of pipe #28)
- 317111-JLA-702-029 Rév F (Detail drawing of pipe #29)

Above listed drawings are jointed in appendix A.

2.2. Codes standards used

- ASME VIII division 1
- ASME II Part D (nuance SA312 grade 304L, SA249 grade 304L)
- ASME B16.9

2.3. Calculation software

- Microprotol V33.0.6.0 sofware is used for analytical calculations under static pressure.

3. DESIGN SPECIFICATION

3.1. Calculation conditions

- Fluid: liquid and/or gaseous nitrogen
  - → Calculations with : Density of 1

- Operating temperature: -196°C (77K)
  - → Calculations with : Temperature in service condition : 20°C (conservative)

- Operating pressure : Internal pressure of 6 bar and external pressure of 1 bar
  - → Calculations with : Internal pressure of 7 bar

- Hydraulic test conditions:
  - → Pressure : Internal pressure of 10 bar
    (According to §3.6 of calculation report 14N088 Rev A)
  - → Temperature : 20°C

- Corrosion allowance : 0 mm
- Welding joint efficiency : 1
- Nominal stress : According to ASME II Part D (see §3.5)

- Wind : Not applicable
- Seisme : Not applicable
- Fatigue : Not applicable
- Loads and moments : Not applicable

3.2. Piping description

Piping of output circuit following drawing 317111-JLA-702-**012** Rév G is composed of the following components :

- Straight and bended pipes Ø26,9x3,9 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)
- Straight and bended pipes Ø21,3x3,7 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)
- Long radius elbows Ø26,9x3,9 (schedule 80S) in SA403 grade 304L
- Straight tee Ø26,9x3,9 (schedule 80S) in SA403 grade 304L
- Reducing tees Ø26,9x3,9 / Ø21,3x3,7 (schedule 80S) in SA403 grade 304L
- Concentric reducers Ø26,9x3,9 / Ø21,3x3,7 (schedule 80S) in SA403 grade 304L

Piping of input circuit following drawing 317111-JLA-702-**013** Rév F is composed of the following components :

- Straight and bended pipes Ø26,9x3,9 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)
- Straight and bended pipes Ø21,3x3,7 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)
- Long radius elbow Ø26,9x3,9 (schedule 80S) in SA403 grade 304L
- Straight tees Ø26,9x3,9 (schedule 80S) in SA403 grade 304L
- Reducing tees Ø26,9x3,9 / Ø21,3x3,7 (schedule 80S) in SA403 grade 304L
- Concentric reducers Ø26,9x3,9 / Ø21,3x3,7 (schedule 80S) in SA403 grade 304L

Piping #28 following drawing 317111-JLA-702-**028** Rév E is composed of the following components :

- Straight and bended pipes Ø26,9x3,9 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)
- Long radius elbow Ø26,9x3,9 (schedule 80S) in SA403 grade 304L

Piping #29 following drawing 317111-JLA-702-**029** Rév F is composed of the following components :

- Straight and bended pipes Ø26,9x3,9 (schedule 80S) in SA312 grade 304L (ou SA249 grade 304L)

- Long radius elbow Ø26,9x3,9 (schedule 80S) in SA403 grade 304L

3.3. Materials and allowable stresses

				Units: MPa				
Element	**Material**	**Standard**	**Température**	**R_P**	**R_m**	**σ_R**	**f operating**	**f test**
Seamless pipes Welded pipes Buttwelding fittings (elbows, Reducers, tees) following B16.9	304L (ou 316L)	ASME SA312 ASME SA403	20°C	172	483	/	**115**	**155**
			20°C	172	483	/	**115**	/
	304L (ou 316L)	ASME SA249	20°C	172	483	/	**97.8**	**155**
			20°C	172	483	/	**97.8**	/

Nominal stresses are issued of l'ASME II Part D.

4. RESULTS

4.1. Pipes calculation

Two sizes of pipes are used on the 4 drawings (following §3.2 "Piping description") :

- Ø26,9x3,9 mm
- Ø21,3x3,7 mm

Elément	Epaisseur nominale *(en mm)*	Tolérance + corrosion *(en mm)*	Epaisseur utile *(en mm)*	Vérification de la conception
Pipes Ø26,9 schedule 80S	3.9	0,6	3,3	OK
Pipes Ø21,3 schedule 80S	3.7	0,6	3,1	OK

Calculations of these 2 sizes of pipes are joined in appendix B.

These pipes are compliant to ASME VIII division 1 for calculation condition described on paragraph 3.1.

4.2. Fittings calculation

Factory-made wrought buttwelding fittings according to ASME B16.9 are calculated as for seamless pipes of equivalent material, pipe size and wall thickness.

Long radius elbows, straight and reducing tees and reducers are calculated by the calculation of a tube of same diameter, wall thickness and material.

Tees are also calculated as nozzles following openings rules of ASME VIII division 1 (conservative for a standard fittings purchased following ASME B16.9).

Elément	Epaisseur nominale *(en mm)*	Tolérance + corrosion *(en mm)*	Epaisseur utile *(en mm)*	Vérification de la conception
Fittings *(Long radius elbows, straight and reducing tees and reducers)* Ø26,9 schedule 80S	3.9	0,6	3,3	OK
Fittings *(Long radius elbows, straight and reducing tees and reducers)* Ø21,3 schedule 80S	3.7	0,6	3,1	OK

Calculations of fittings (equivalent tubes calculation) and openings are joined in appendix B.

All fittings described in §3.2 are compliant to ASME VIII division 1 for calculation condition described on paragraph 3.1.

5. CONCLUSION

This calculation report shows that the design of piping elements on drawings 317111-JLA-702-012, 317111-JLA-702-013, 317111-JLA-702-028 and 317111-JLA-702-029 is compliant to ASME VIII division 1 rules for design conditions defined in paragraph §3.1.

Remarks :

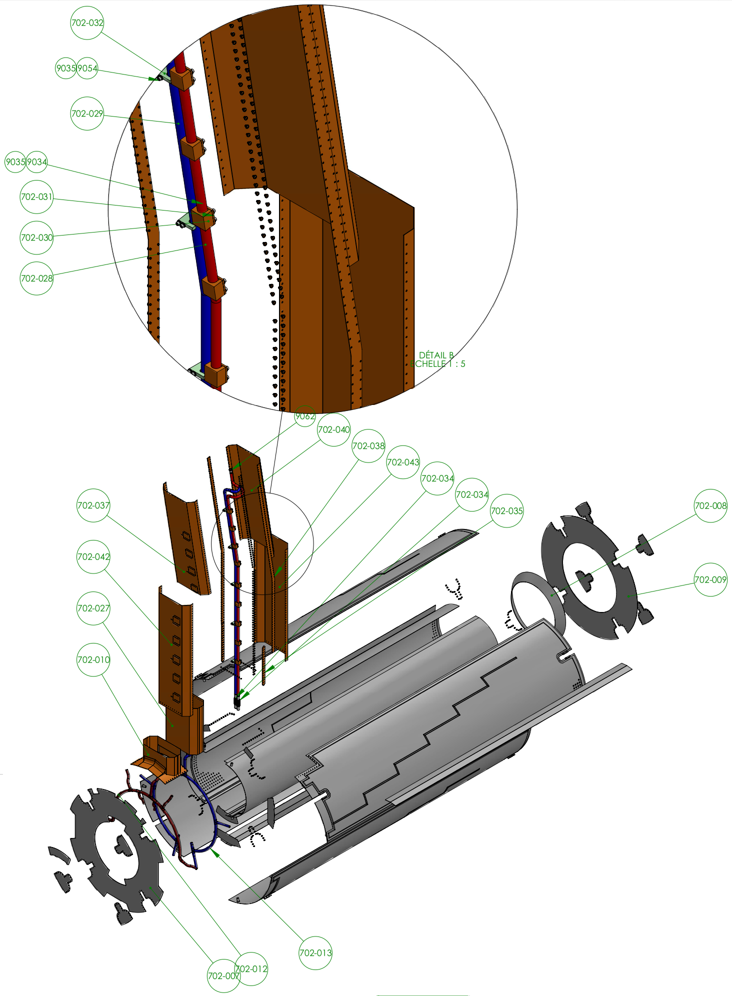
- Pipes and fittings shall be purchased with respect of material grades (304L) and standards (ASME B16.9, …) indicated in paragraphe 3.2.

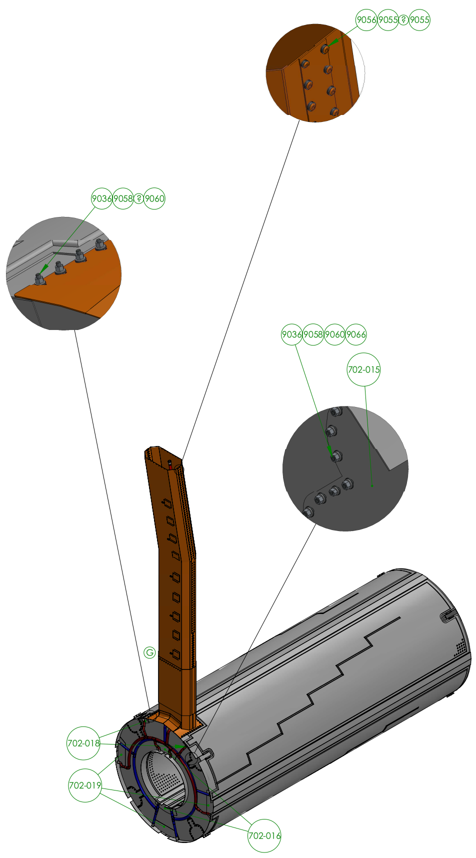
* * *

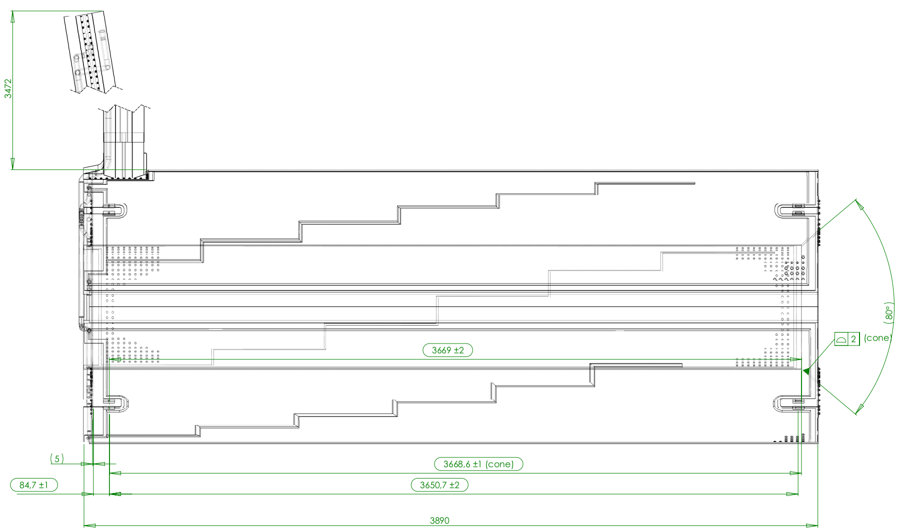
ANNEXE A

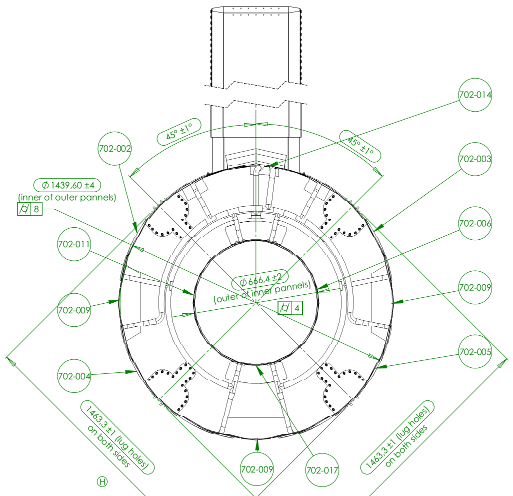
Documents de référence

- Plan,
- Nomenclature,









REP	REFERENCE	DESIGNATION	QTY	REV	MATERIAL	MASS (Kg)
702-002	317111-JLA-702-002	LEFT-TOP PANNEL	1	G	304L (X2CrNi18-9)	121.00
702-003	317111-JLA-702-003	RIGHT-TOP PANNEL	1	G	304L (X2CrNi18-9)	216.94
702-004	317111-JLA-702-004	LEFT-DOWN PANNEL	1	G	304L (X2CrNi18-9)	121.00
702-005	317111-JLA-702-005	RIGHT-DOWN PANNEL	1	G	304L (X2CrNi18-9)	219.11
702-006	317111-JLA-702-006	INNER RIGHT PANNEL	1	E	304L (X2CrNi18-9)	118.00
702-007	317111-JLA-702-007	Flange 1	1	E	304L (X2CrNi18-9)	40.03
702-008	317111-JLA-702-008	Cone	1	D	304L (X2CrNi18-9)	10.59
702-009	317111-JLA-702-009	Flange 2	1	D	304L (X2CrNi18-9)	39.36
702-010	317111-JLA-702-010	Copper neck	1	H	Cuivre/Copper	4.11
702-011	317111-JLA-702-011	INNER LEFT PANNEL	1	E	304L (X2CrNi18-9)	58.00
702-012	317111-JLA-702-012	output circuit	1	G	Inox/Stainless steel 304L	6.68
702-013	317111-JLA-702-013	input circuit	1	F	Inox/Stainless steel 304L	8.49
702-014	317111-JLA-702-014	bar connection 1	1	E	304L (X2CrNi18-9)	8.82
702-015	317111-JLA-702-015	Closing panel	8	D	304L (X2CrNi18-9)	0.60
702-016	317111-JLA-702-016	Closing welded panel 1	2	D	304L (X2CrNi18-9)	0.23
702-017	317111-JLA-702-017	bar connection 2	2	D	304L (X2CrNi18-9)	3.23
702-018	317111-JLA-702-018	Closing welded panel 2	2	D	304L (X2CrNi18-9)	0.07
702-019	317111-JLA-702-019	Closing welded panel 3	3	D	304L (X2CrNi18-9)	0.28
702-020	317111-JLA-702-020	bar connection 3	3	D	304L (X2CrNi18-9)	9.59
702-027	317111-JLA-702-027	Manchon	1	E	Cuivre/Copper	8.86
702-028	317111-JLA-702-028	Pipe #28	1	E	304L (X2CrNi18-9)	7.21
702-029	317111-JLA-702-029	Pipe #29	1	F	Inox/Stainless steel 304L	6.17
702-030	317111-JLA-702-030	Na Return pipe support	9	D	Cuivre/Copper	0.34
702-031	317111-JLA-702-031	Na return pipe support closing	9	C	Cuivre/Copper	0.09
702-032	317111-JLA-702-032	Nitrogen supply pipe support	5	E	FR4	0.04
702-034	317111-JLA-702-034	Bellow for Na pipes	2	D	See assembly	0.30
702-035	317111-JLA-702-035	Copper neck part #35	2	C	Cuivre/Copper	0.23
702-037	317111-JLA-702-037	Copper neck part #37	1	E	Cuivre/Copper	9.24
702-038	317111-JLA-702-038	Copper neck part #38	2	C	Cuivre/Copper	1.04
702-040	317111-JLA-702-040	Copper neck part #40	1	E	Cuivre/Copper	9.39
702-042	317111-JLA-702-042	Copper neck part #42	1	F	Cuivre/Copper	10.03
702-043	317111-JLA-702-043	Copper neck part #43	1	E	Cuivre/Copper	10.19
9034	VIS 304L CHc M 6 X 10	NVI9000	36		STAINLESS STEEL	5.41
9035	Rondelle Ø 6 M inox304L	Rondelle Inox/Washer Stainless Steel	46		304L (X2CrNi18-9)	1.19
9036	Thread rod M5 x Lg15	Stainless Steel Threated Rod	178		Inox/Stainless steel 304L	0.00
9054	VIS 304L CHc M 6 X 12	NVI9000	10		STAINLESS STEEL	5.86
9055	Rondelle Ø 4 M inox304L	NVIRP0011	752			
9056	rivet_iso_16585_4_x_8_0		376		Cuivre/Copper	1.34
9058	Ecrou H M 5 Inox 304L	Ecrou Inox / Nut Stainless Steel	178		Inox/Stainless steel 304L	0.00
9060	Rondelle Ø 5 M inox304L	Rondelle Inox/Washer Stainless Steel	178		Inox/Stainless steel 304L	0.68
9062	Reduction 1inch-0,75inch-ANSI-80S		1		304L (X2CrNi18-9)	0.14
9065	Spring-washer-DIN6796-INOX	spring washer	10		stainless steel-A2(304L)	0.00
9066	Spring Washer Ø5	spring washer	178		stainless steel-A2(304L)	0.00
9067	Spring Washer Ø4	spring washer	376		stainless steel-A2(304L)	0.00
9068	idium sheet	Indium sheet 0.1mm thickness	1		Matériau <non spécifié>	0.00

NOTE:
- Content liquid nitrogen at 70°K.
- Design pressure: 6atm absolute from 60°K to 300°K.
- Design and manufacturing according to AMSE BPV.
- thermical junction beetwen non-welded parts shall be made with indium joint

REP 702-030 shall be brazed on 702-038 702-040

threaded rods 9036 shall be brazed on the panels

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROUVE
	E	change of components	12/11/2012	
	G	change of components (added Ø5 for 027 part fastening)	21/11/2013	
	H	change of components and added cotations	10/03/2014	

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	Name	Date
Drawing	M. Delbecq	10/03/2014
Checked		
Approved		
MATERIAL:	Matériau <non spécifié>	
Trait.:		
Roughness :		
Tol Gen		
Supplier:		
Weight:	1084.16 Kg	

DIPOLE

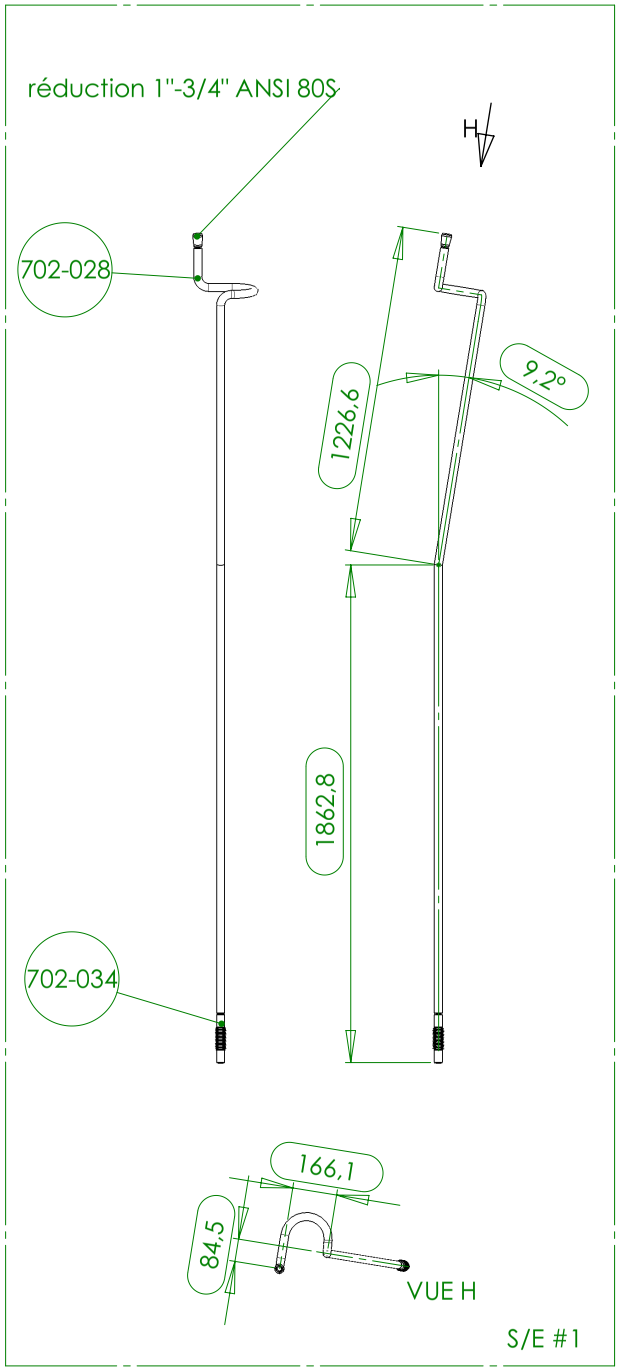
Anti-Radation screen

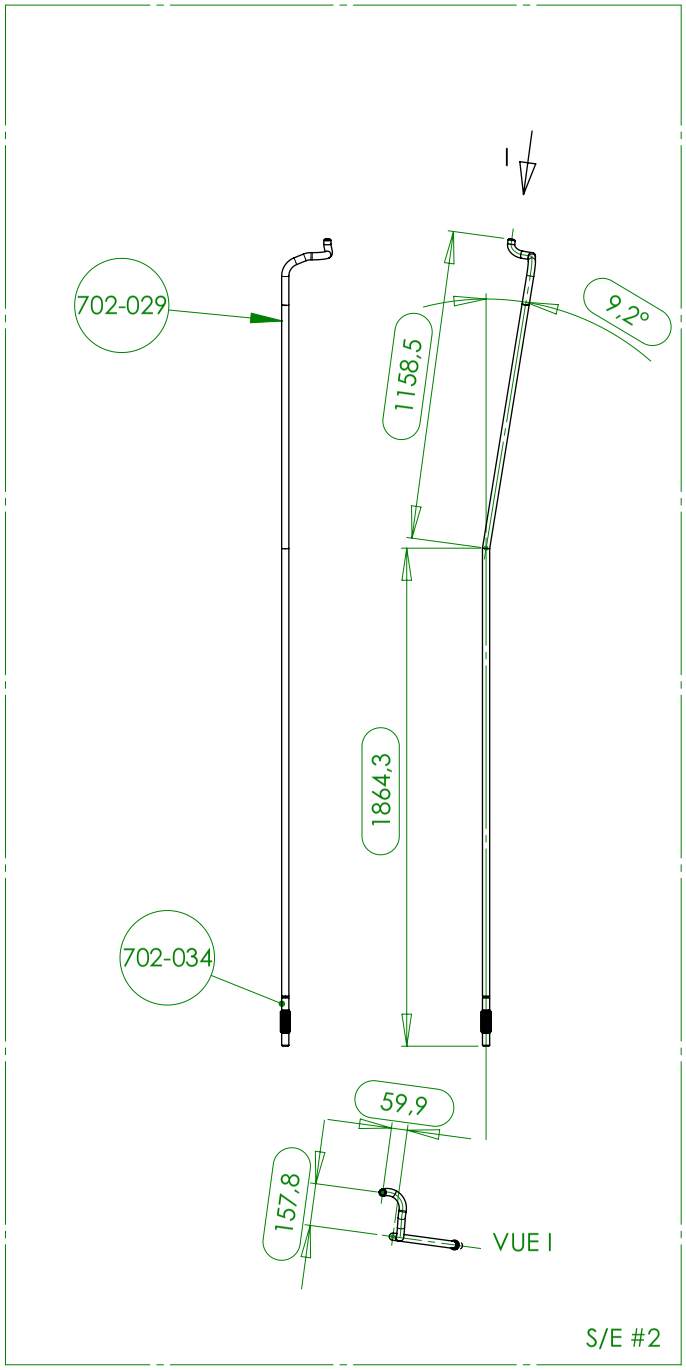
File name:317111-JLA-702-001

DWG NO. **317111-JLA-702-001**

Rev: **H**

A0 SCALE:1:20 SHEET 1 OF 2





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	Name	Date
Drawing	M. Delbecq	10/03/2014
Checked		
Approved		
MATERIAL:	Matériau <non spécifié>	
Trait.:		
Roughness :		
Tol Gen		
Supplier:		
Weight:	1084.16 Kg	

DIPOLE

Anti-Radation screen

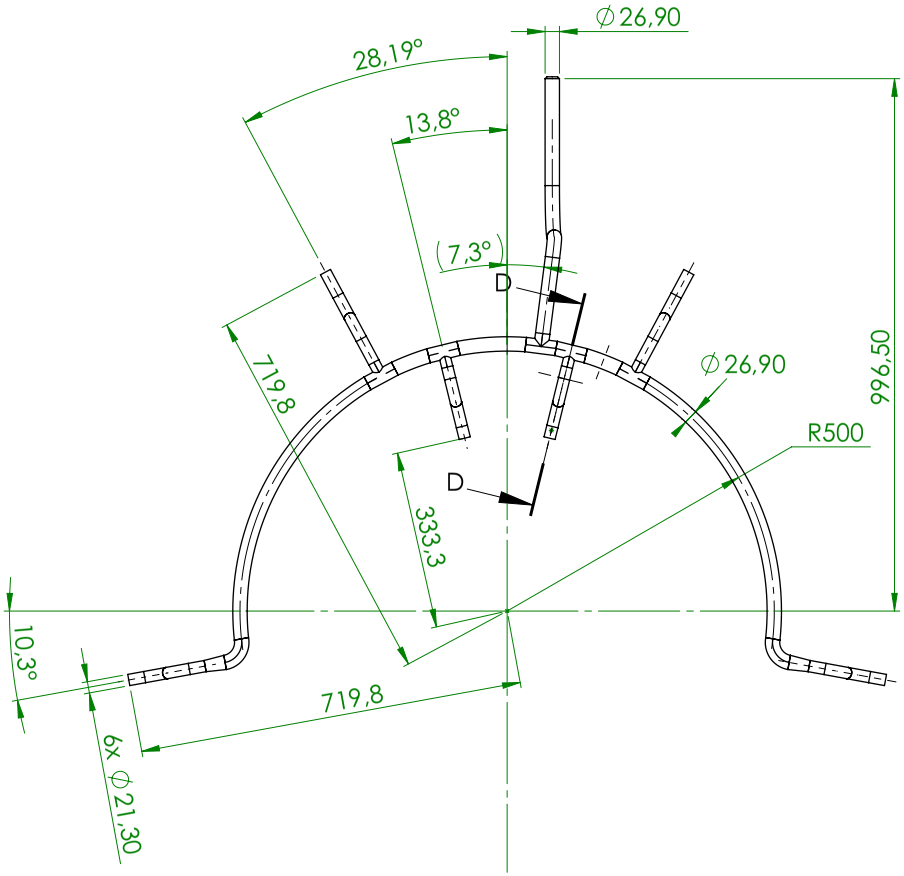
File name:317111-JLA-702-001

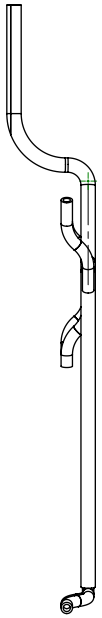
DWG NO. **317111-JLA-702-001**

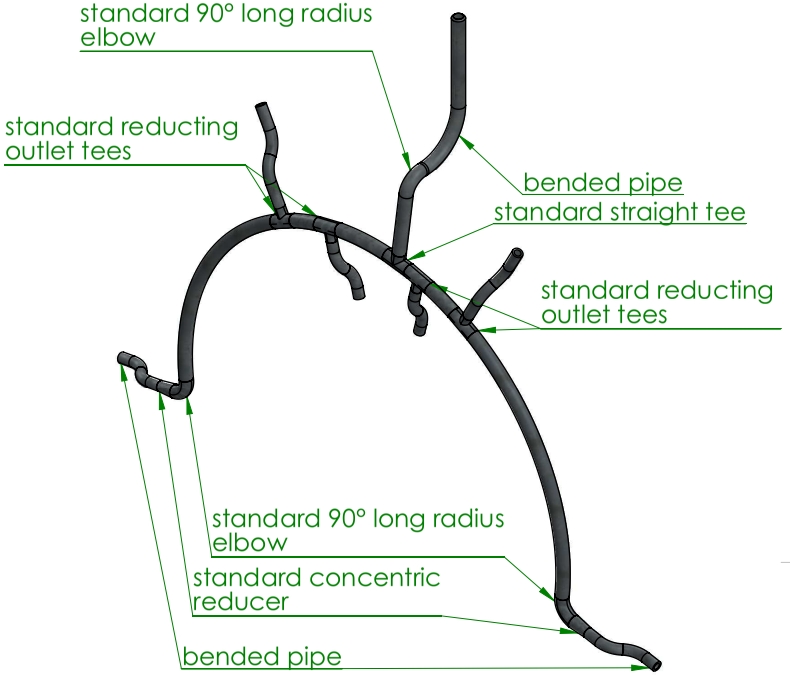
Rev: **H**

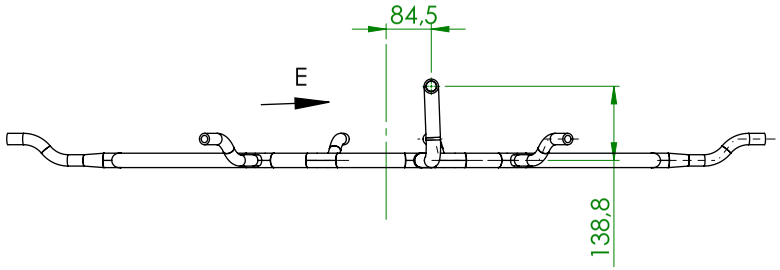
A3 SCALE:1:20 SHEET 2 OF 2

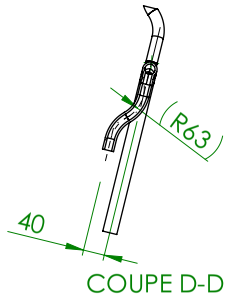
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROUVE
	D	changed bending angles, radius and added notes	27/06/2012	
	E	changed final heigh	15/04/2013	
	F	changed pipe-to-pipe welding by standard fitting	12/09/2013	MD
	G	changed exit dimension	10/03/2014	



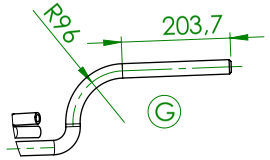








COUPE D-D



VUE E

NOTE:
- Content liquid nitrogen at 70°K.
- Design pressure: 6atm absolute from 60°K to 300°K.
- Design and manufacturing according to AMSE BPV.
- All pipes and fittings are schedule 80S

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	Name	Date
Drawing	M.Delbecq	10/03/2014
Checked		
Approved		
MATERIAL:	Inox/Stainless steel 304L	
Trait.:		
Roughness :		
Tol Gen	+/-1	
Supplier:		
Weight:	6.68 Kg	
	0.00	

ANTI-RADIATION SCREEN

output circuit

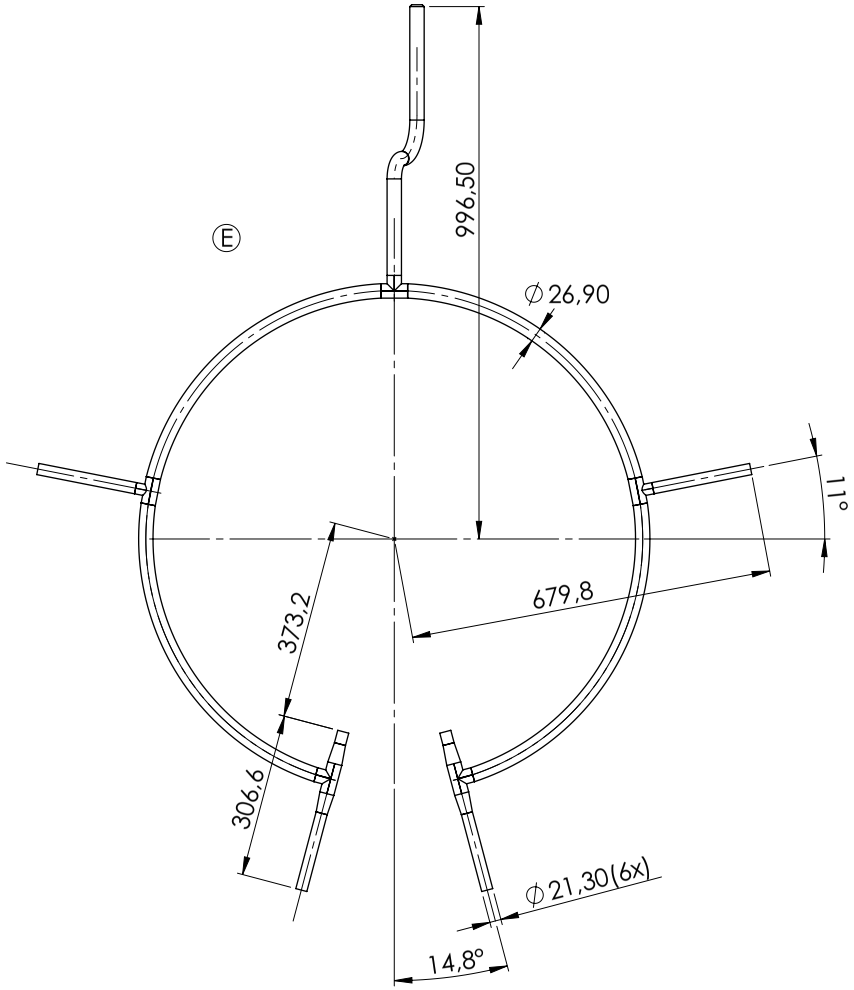
File name:317111-JLA-702-012

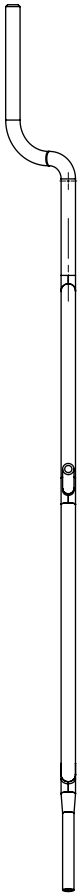
DWG NO. **317111-JLA-702-012**

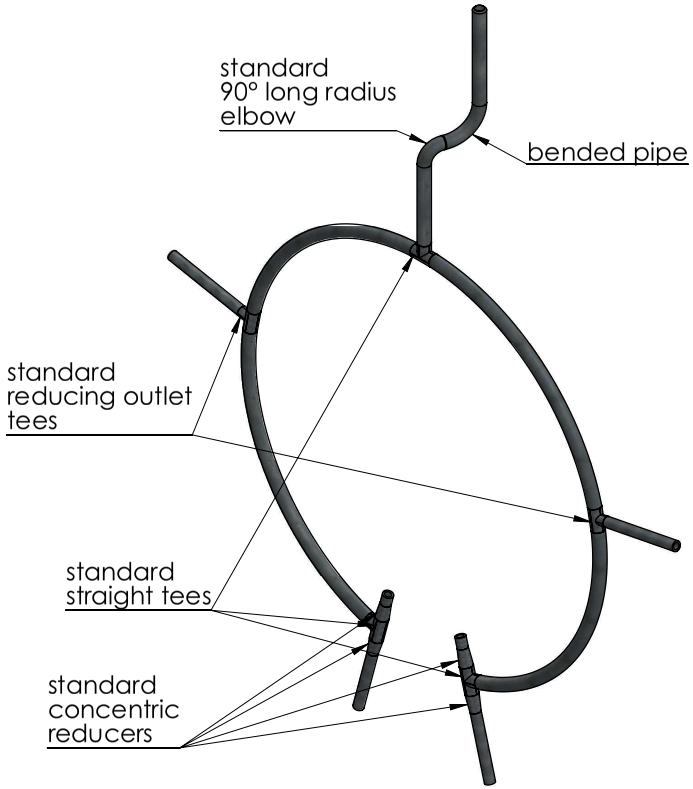
Rev: **G**

A3 SCALE:1:10 SHEET 1 OF 1

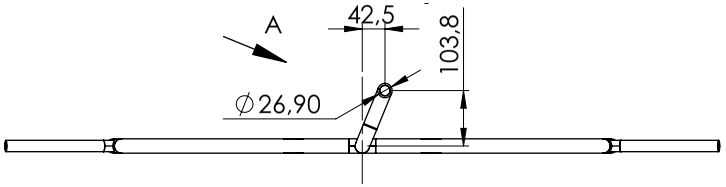
REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROUVE
	D	changed bending radius and added notes	27/06/2012	
	E	changed final height	15/04/2013	
	F	changed pipe-to-pipe welding by standard fittings	12/09/2013	MD

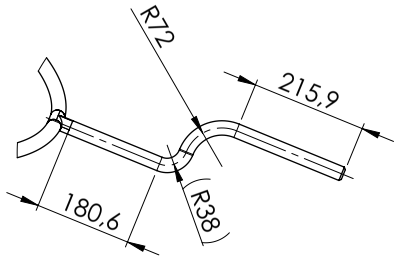






NOTE:
- Content liquid nitrogen at 70°K.
- Design pressure: 6atm absolute from 60°K to 300°K.
- Design and manufacturing according to AMSE BPV.
- All pipes and fittings are schedule 80S





VUE A

SIGMAPHI
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F-56000 Vannes
Tel(33) 02.97.01.08.80 Fax (33)02.97.01.08.81 EMAIL Contact@sigmaphi.fr

	Name	Date
Drawing	M.Delbecq	04/03/2014
Checked		
Approved		
MATERIAL:	Inox/Stainless steel 304L	
Trait.:		
Roughness :		
Tol Gen	+/-1	
Supplier:		
Weight:	8.49 Kg	
	0.00	

File name:317111-JLA-702-013

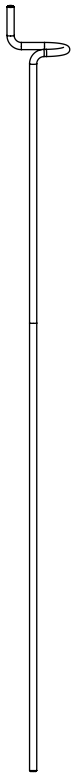
ANTI-RADIATION SCREEN

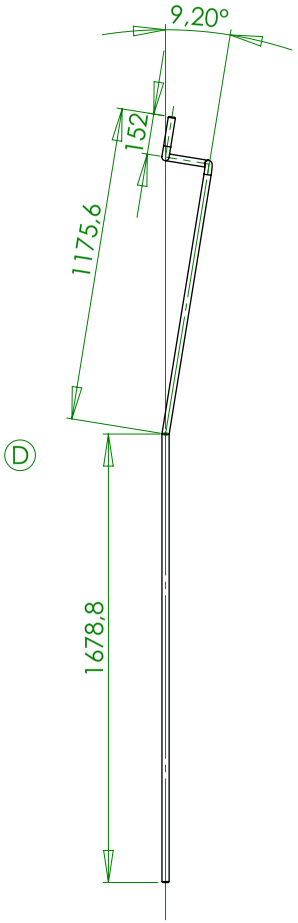
input circuit

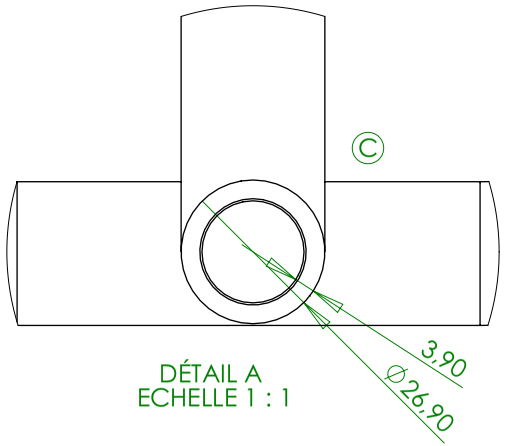
DWG NO. **317111-JLA-702-013**

Rev: **F**

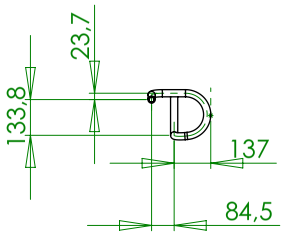
A3 SCALE:1:10 SHEET 1 OF 1







DÉTAIL A
ECHELLE 1 : 1



for intermediary bending positions see CAD file

F

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROUVE
	C	changed Ø and other dimensions	06/07/2012	
	D	changed height	15/04/2013	
	F	added note and cotations	03/03/2014	

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	Name	Date
Drawing	M. Delbecq	04/03/2014
Checked		
Approved		

MATERIAL:	304L (X2CrNi18-9)
Trait.:	
Roughness :	
Tol Gen	±1
Supplier:	
Weight:	7.21 Kg
	0.00

ANTI-RADIATION SCREEN

Pipe #28

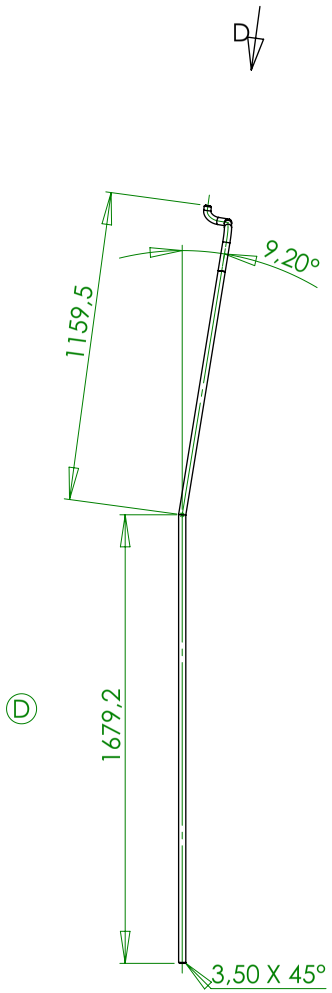
File name:317111-JLA-702-028

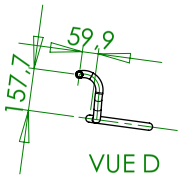
DWG NO. **317111-JLA-702-028**

Rev: **E**

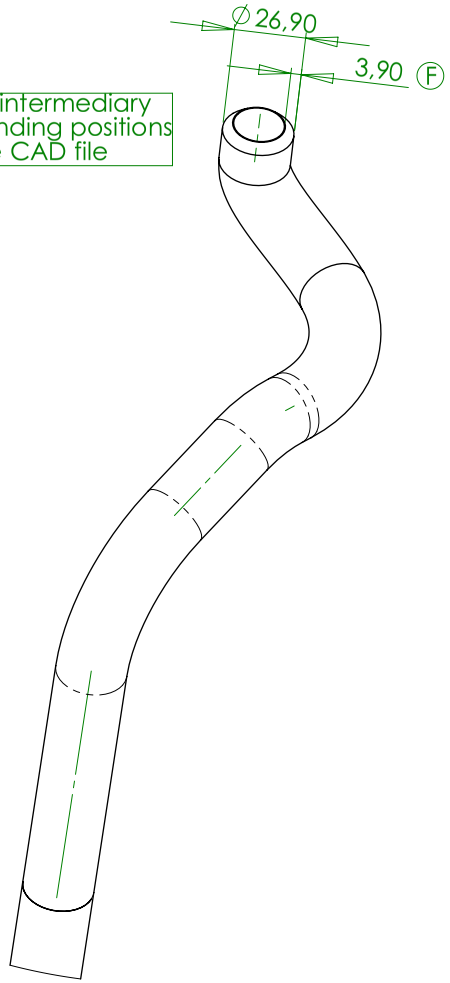
A3 SCALE:1:20 SHEET 1 OF 1

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROUVE
	D	changed height	15/04/2013	
	F	changed thickness	03/03/2014	





for intermediary bending positions see CAD file



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	Name	Date
Drawing	M. Delbecq	04/03/2014
Checked		
Approved		
MATERIAL:	Inox/Stainless steel 304L	
Trait.:		
Roughness :		
Tol Gen	±1	
Supplier:		
Weight:	6.17 Kg	
	0.00	

File name:317111-JLA-702-029

ANTI-RADIATION SCREEN

Pipe #29

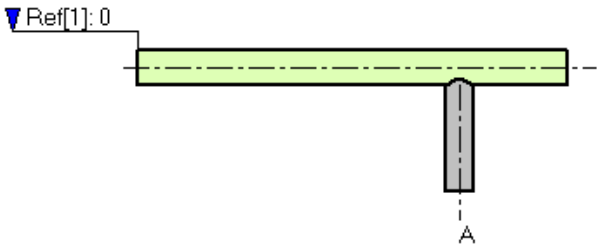
DWG NO. **317111-JLA-702-029**

Rev: **F**

A3 SCALE:1:20 SHEET 1 OF 1

ANNEXE B

Note de calcul détaillée



Job Tag :	Description :
Job Name :	Drawing No :
Vessel Tag :	

Element(s) of geometry in internal pressure

Cylindrical shell under internal pressure.

ASME VIII DIV.1 2010 - 2011a

t = minimum required thickness	t_n = nominal thickness	E = Joint efficiency
P = internal pressure	S = Allowable stress	T = Temperature
R = Internal Radius	Ca = corrosion + tolerance	σ = circular stress
R_o = outside radius	$Tol_{\%}$ = tolerance for pipes	P_a = maximum allowable pressure
$t_{n,min} = (t+Ca)/Tol_{\%}$ shall be $\leq t_n$	$t_u = (t_n \times Tol_{\%})-Ca$ shall be $\geq t$	P_h = Hydrostatic pressure

UG-27 (c)	$t = P(R+Ca)/(SE-0.6P)$	$\sigma = (P(R+Ca) / t_u + 0.6P) / E$	$P_a = S\,E\,t_u / ((R+Ca)+ 0.6\,t_u)$
Appendix 1-1.(a)(1)	$t = PR_o/(SE+0.4P)$	$\sigma = (PR_o / t_u - 0.4P) / E$	$P_a = S\,E\,t_u / (R_o - 0.4\,t_u)$

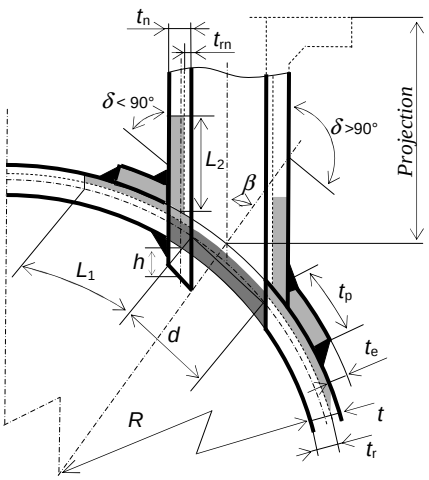
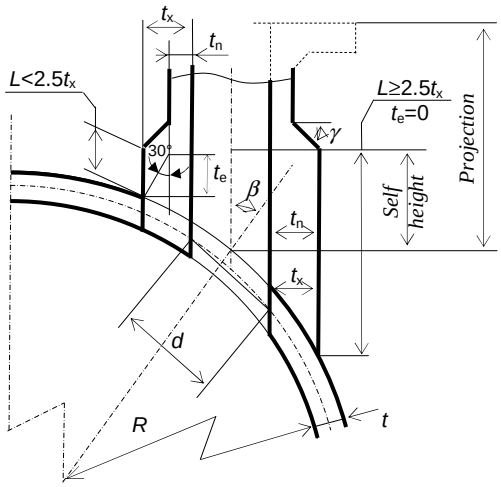
Shell (01) : 31.05 (Virole)

SA249TP304L			Welded Tube					Schedule : /	DN : /
t_n = 3,900 mm	R = 9,55 mm		$Tol_{\%}$ = /			PWHT : No		Radiography : Full	
	R_o = 13,45 mm		Cor. = 0 mm		Tol. = 0,6 mm	UG-16(b) = 1,5 mm			
	P (MPa)	P_h (MPa)	T (°C)	S (MPa)	E	t_u (mm)	σ (MPa)	P_a (MPa)	t (mm)	$t_{n,min}$ (mm)
Operation N	0,7	0	20	97,8	1	3,300	2,57	26,61	0,096	0,696
Horizontal test X	1,0002	0,0002	20	154,8	1	3,300	3,68	42,11	0,087	0,687
MAWP (20 °C, Corroded) = 26,61 MPa					MAWP (20 °C, new) = 26,61 MPa					

Isolated Opening(s)

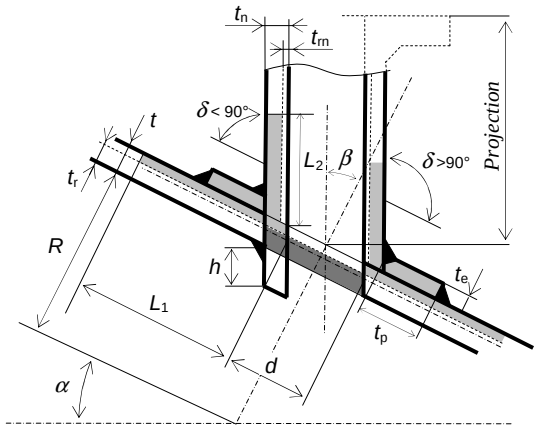
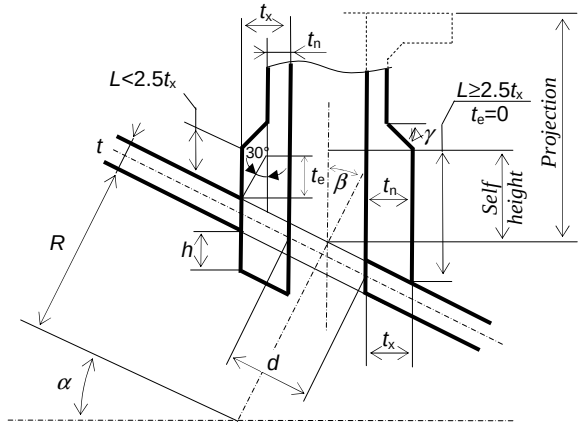
Figures for all configurations, from FIG. UG-37.1 And FIG UG-40.

Shell ($\alpha = 0$) or Cone ($\alpha > 0$) : in longitudinal plane.

Nozzle with or without pad, set-in or set-on	Selfreinforcing nozzle, set-in or set-on
	

Cylindrical or conical shell : circumferential plane

Head : in the plane that contains the axis of the nozzle and the longitudinal axis of vessel.

Nozzle with or without pad, set-in or set-on	Selfreinforcing nozzle, set-in or set-on
	

Opening A [in operation Int.P.] *(Process)*

ASME VIII DIV.1

Nozzle without pad on Shell (No. 1)		Set In
Pressure : P = 0,7 MPa	Temperature : 20 °C	
Shell	Material :SA249TP304L	Allowable stress : S_v = 97,8 MPa
Joint efficiency : 1 E_1 = 1	Corrosion + tolerance : Ca_v = 0,6 mm	Allowable stress : S = 97,8 MPa
Ext. Diameter : D_o = 26,9 mm	Nominal thickness : 3,9 mm	Tolerance for seamless pipe : /
Nozzle	Material : SA249TP304L	Allowable stress : S_n = 97,8 MPa
Joint efficiency : 1	Corrosion + tolerance : Ca_n = 0,6 mm	Tolerance for seamless pipe : /
Ext. Diameter : D_{on} = 26,9 mm	Nominal thickness : 3,9 mm	
External Projection : 100 mm	Internal Projection : 0 mm	
Inclination : 0 °	Eccentricity : 0 mm	
Flange	Material : /	Type : /
Rating : /	Height : /	/
Pad	Material : /	Allowable stress : S_p = /
Height : /	Width : /	Ext. Diameter : D_{op} = /
Weld Outside : leg_{41}= 4 mm	outer reinforcement : leg_{42}= /	Inside : leg_{43}= /

fr_1 =min(1,S_n/S_v) = 1 fr_2 = min(1,S_n/S_v) = 1 fr_3 = min(1,min(S_n, S_p)/S_v) = 1 fr_4 = min(1,S_p/S_v) = 1

Required thickness of the nozzle neck Appendix 1-1

$t_{rn} = P\,R_{on} / (S_nE+0.4P)$ = 0,096 mm R_{on} = 13,45 mm E = 1

The nozzle neck thickness is adequate per Appendix 1-1.

Required thickness of the nozzle neck UG-45

$t_a = t_{rn}+Ca_n$= 0,7 mm ; t_{b1} = max[t_{UG-27} , UG-16(b)]+Ca_v= 2,1 mm ; t_{b3} = Table UG-45+Ca_n= 3,72 mm

t_{UG-45} = max [t_a , min [t_{b3} , t_{b1}]] = 2,1 mm

The nozzle neck thickness is adequate per UG-45.

Dimensions FIG. UG-40

angle of plane with longitudinal axis : angle of each side / vessel wall :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
β = deflection angle / normal line	0 °	
d = diameter of the finished opening	20,3 mm	
R_n = radius of the finished opening	10,15 mm	
t_i = thickness of internal projection	/	
t_p = width of reinforcing pad	/	
t_x = thickness of selfreinforcing	/	
L = height of selfreinforcing	/ /	
Configuration of the reinforcement :	/ /	
t_e = thickness or height of the reinforcement	0 mm 0 mm	
t_n = thickness of nozzle	3,3 mm 3,3 mm	
h = height of the internal projection	0 mm 0 mm	

Reinforcement checking UG-37 *opening A [in operation Int.P.]*

Required thicknesses UG-37(a)		
t_r = 0,096 mm [UG-27(c)]	t = 3,3 mm	E = 1
$t_{rn} = P\,R_{on} / (S_nE+0.4P)$ = 0,096 mm	R_{on} = 13,45 mm	E = 1

Limits of reinforcement UG-40 :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
UG-40 (b) : max [d , R_n+t_n+t] =	20,3 mm 20,3 mm	
UG-40 (c) : min [2.5t , 2.5t_n+t_e] =	8,25 mm 8,25 mm	

Area required UG-37 (c) :	Longitudinal plane : θ = 0°	Circumferential plane : θ = 90°
F = Correction factor FIG.UG-37	1	
$A = d\,t_r\,F + 2\,t_n/\cos(\beta)\,t_r\,F\,(1-f_{r1})$	1,9 mm^2	

Lengths and heights of calculation of the areas :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
L_1 = min [UG-40(b)-Radius , length available]	10,15 mm 10,15 mm	
L_2 = min [UG-40(c) , height available]	8,25 mm 8,25 mm	
L_3 = min [h , 2.5t , 2.5t_i] =	0 mm 0 mm	
L_5 = min [UG-40 (b)-R_{on} , t_p , length available]	0 mm 0 mm	

Area available (mm^2) :	Longitudinal plane : θ = 0° δ = 90 °	δ = 90 °	Circumferential plane : θ = 90° δ = /	δ = /
$A_1 = L_1 (E_1\ t\text{-}t_r\ F) - t_n/\cos(\beta) (E_1\ t\text{-}t_r\ F) (1\text{-}f_{r1})$	32,5	32,5		
$A_2 = L_2 (t_n\text{-}t_{rn})\ fr_2$	26,4	26,4		
$A_3 = L_3\ t_i\ f_{r2}$	0	0		
$A_{41} = leg_{41}^2 /2\ f_{r2}$	8	8		
$A_{42} = leg_{42}^2 /2\ f_{r4}$	0	0		
$A_{43} = leg_{43}^2 /2\ f_{r2}$	0	0		
$A_5 = L_5\ t_e\ f_{r4}$	0	0		
$A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5$ =	67	67		
	small opening UG-36(c)(3)			

The opening is adequately reinforced per UG-37.

Weld sizes check UW-16(c). *opening A [in operation Int.P.]*

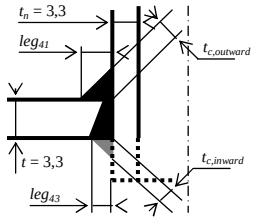


Fig. UW-16.1(d) full penetration weld

	Minimum throat required	actual
$t_{c,outward}$	min[¼ in.(6 mm);0.7×t_{min}]= 2,31 mm t_{min} = min[¾ in.(19 mm) ; t , t_n]	0.7×leg_{41} = 2,8 mm
$t_{c,inward}$	min[¼ in.(6 mm);0.7×t_{min}]= / t_{min} = min[¾ in.(19 mm) ; t , t_n]	0.7×leg_{43} – Ca_n = /
Weld sizes are adequate		

Weld loads check UG-41(b).

Strength calculations for attachments welds are not required for this opening in accordance with UW-15(b).

Opening A [in test Int.P.] *(Process)*

ASME VIII DIV.1

Nozzle without pad on Shell (No. 1)		Set In
Pressure : P = 1,0002 MPa	Temperature : 20 °C	
Shell	Material :SA249TP304L	Allowable stress : S_v = 154,8 MPa
Joint efficiency : 1 E_1 = 1	Corrosion + tolerance : Ca_v = 0,6 mm	Allowable stress : S = 154,8 MPa
Ext. Diameter : D_o = 26,9 mm	Nominal thickness : 3,9 mm	Tolerance for seamless pipe : /
Nozzle	Material : SA249TP304L	Allowable stress : S_n = 154,8 MPa
Joint efficiency : 1	Corrosion + tolerance : Ca_n = 0,6 mm	Tolerance for seamless pipe : /
Ext. Diameter : D_{on} = 26,9 mm	Nominal thickness : 3,9 mm	
External Projection : 100 mm	Internal Projection : 0 mm	
Inclination : 0 °	Eccentricity : 0 mm	
Flange	Material : /	Type : /
Rating : /	Height : /	/
Pad	Material : /	Allowable stress : S_p = /
Height : /	Width : /	Ext. Diameter : D_{op} = /
Weld Outside : leg_{41}= 4 mm	outer reinforcement : leg_{42}= /	Inside : leg_{43}= /

fr_1 =min(1,S_n/S_v) = 1 fr_2 = min(1,S_n/S_v) = 1 fr_3 = min(1,min(S_n, S_p)/S_v) = 1 fr_4 = min(1,S_p/S_v) = 1

Required thickness of the nozzle neck Appendix 1-1

$t_{rn} = P\ R_{on} / (S_nE+0.4P)$ = 0,087 mm R_{on} = 13,45 mm E = 1

The nozzle neck thickness is adequate per Appendix 1-1.

Required thickness of the nozzle neck UG-45

$t_a = t_{rn}+Ca_n$= 0,69 mm ; t_{b1} = max[t_{UG-27} , UG-16(b)]+Ca_v= 2,1 mm ; t_{b3} = Table UG-45+Ca_n= 3,72 mm

t_{UG-45} = max [t_a , min [t_{b3} , t_{b1}]] = 2,1 mm

The nozzle neck thickness is adequate per UG-45.

Dimensions FIG. UG-40

angle of plane with longitudinal axis : angle of each side / vessel wall :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
β = deflection angle / normal line	0 °	
d = diameter of the finished opening	20,3 mm	
R_n = radius of the finished opening	10,15 mm	
t_i = thickness of internal projection	/	
t_p = width of reinforcing pad	/	
t_x = thickness of selfreinforcing	/	
L = height of selfreinforcing	/ /	
Configuration of the reinforcement :	/ /	
t_e = thickness or height of the reinforcement	0 mm 0 mm	
t_n = thickness of nozzle	3,3 mm 3,3 mm	
h = height of the internal projection	0 mm 0 mm	

Reinforcement checking UG-37 *opening A [in test Int.P.]*

Required thicknesses UG-37(a)		
t_r = 0,087 mm [UG-27(c)]	t = 3,3 mm	E = 1
$t_{rn} = P\ R_{on} / (S_nE+0.4P)$ = 0,087 mm	R_{on} = 13,45 mm	E = 1

Limits of reinforcement UG-40 :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
UG-40 (b) : max [d , R_n+t_n+t] =	20,3 mm 20,3 mm	
UG-40 (c) : min [2.5t , 2.5t_n+t_e] =	8,25 mm 8,25 mm	

Area required UG-37 (c) :	Longitudinal plane : θ = 0°	Circumferential plane : θ = 90°
F = Correction factor FIG.UG-37	1	
$A = d\ t_r\ F + 2\ t_n/\cos(\beta)\ t_r\ F\ (1-f_{r1})$	1,8 mm^2	

Lengths and heights of calculation of the areas :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
L_1 = min [UG-40(b)-Radius , length available]	10,15 mm 10,15 mm	
L_2 = min [UG-40(c) , height available]	8,25 mm 8,25 mm	
L_3 = min [h , 2.5t , 2.5t_i] =	0 mm 0 mm	
L_5 = min [UG-40 (b)-R_{on} , t_p , length available]	0 mm 0 mm	

Area available (mm^2) :	Longitudinal plane : θ = 0° δ = 90 °	 δ = 90 °	Circumferential plane : θ = 90° δ = /	 δ = /
$A_1 = L_1 (E_1 t\text{-}t_r F) - t_n/\cos(\beta) (E_1 t\text{-}t_r F) (1\text{-}f_{r1})$	32,6	32,6		
$A_2 = L_2 (t_n\text{-}t_{rn}) fr_2$	26,5	26,5		
$A_3 = L_3 t_i f_{r2}$	0	0		
$A_{41} = leg_{41}^2 /2 f_{r2}$	8	8		
$A_{42} = leg_{42}^2 /2 f_{r4}$	0	0		
$A_{43} = leg_{43}^2 /2 f_{r2}$	0	0		
$A_5 = L_5 t_e f_{r4}$	0	0		
$A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 =$	67,1	67,1		
	small opening UG-36(c)(3)			

The opening is adequately reinforced per UG-37.

Summary

Summary of nozzles [Location and Dimensions].

Tag	Location				Dimensions (mm)								Flange		
	Loc.	Ori.	Inc.	Exc.	Neck				Reinforcement			Projection	DN	Rating	Typ.
	(mm)	(°)	(°)	(mm)	Diam.	Thk.	Sch.	DN	Type	(a)	(b)				
A	300,0	90,00	0,00	0,00	26,90	3,900	/		/	/	/	100,00	/	/	/
(a),(b) : Pad = thickness, Width ; Self Reinforcing = Height, over thickness ; Internal Plate = thickness, Height															

NB : The external projection and the height of over thickness of a self is measured on axis of the nozzle.

Summary of nozzles [Type, Adjacent Openings, Goose and Material].

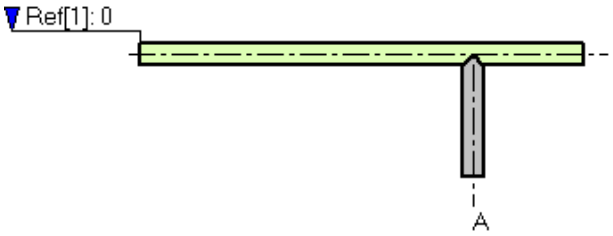
Tag	Set-in Set-on	Operating	Adjacent openings	Goose		hydrostatic height		Material		
				Radius (mm)	Loc. (mm)	Operating (mm)	Test (mm)	Neck	Pad	Flange
A	in	A	None	/	/	0,00	19,1	SA249TP304L	/	/
Nozzle Type			A = Process, H = manhole, E = With Blind Flange, L = Instrument, AP = Boot, XT = transition by head, CA = Shell Inlet, CS = Shell Outlet, TA = Channel Inlet, TS = Tubeside Outlet.							

Summary of nozzles [Type, Weight and Local Loads].

Tag	Loc.	Operating	Mass		Local Loads					
	Shell No.		Nozzle (kg)	Flange (kg)	Longitudinal Shear Load (daN)	Circumferential Shear Load (daN)	Radial Load (daN)	Longitudinal Moment (daN.m)	Circular Moment (daN.m)	Torsional moment (daN.m)
A	01[01]	A	0,3	0,0	0	0	0	0	0	0
Nozzle Type			A = Process, H = manhole, E = With Blind Flange, L = Instrument, AP = Boot, XT = transition by head, CA = Shell Inlet, CS = Shell Outlet, TA = Channel Inlet, TS = Tubeside Outlet.							
Flange Weight			With blind flange if present.							

Summary of Geometry.

Type Tag	Diameter outside (mm)	Length (mm)	Height / base (mm)	Thickness (mm)	Angle (°)	Mass (kg)	Flanges rating	Specific Gravity	Material
01[01] 31.05	26,9	400,0	400,0	3,900	0	0,9		8,00	SA249TP304L
Angle : half angle at apex for a concentric cone ; maximum angle between cone an cylinder for an eccentric cone. Material : (N) = normalized NB : Italic line indicates an element without pressure..									



Job Tag :	Description :
Job Name :	Drawing No :
Vessel Tag :	

Element(s) of geometry in internal pressure

Cylindrical shell under internal pressure.

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t = minimum required thickness	t_n = nominal thickness	E = Joint efficiency
P = internal pressure	S = Allowable stress	T = Temperature
R = Internal Radius	Ca = corrosion + tolerance	σ = circular stress
R_o = outside radius	$Tol_{\%}$ = tolerance for pipes	P_a = maximum allowable pressure
$t_{n,min} = (t+Ca)/Tol_{\%}$ shall be $\leq t_n$	$t_u = (t_n \times Tol_{\%})-Ca$ shall be $\geq t$	P_h = Hydrostatic pressure

UG-27 (c)	$t = P(R+Ca)/(SE-0.6P)$	$\sigma = (P(R+Ca) / t_u + 0.6P) / E$	$P_a = S\,E\,t_u / ((R+Ca)+ 0.6\,t_u)$
Appendix 1-1.(a)(1)	$t = PR_o/(SE+0.4P)$	$\sigma = (PR_o / t_u - 0.4P) / E$	$P_a = S\,E\,t_u / (R_o - 0.4\,t_u)$

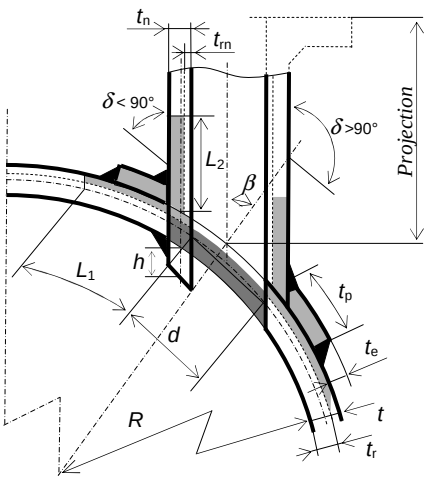
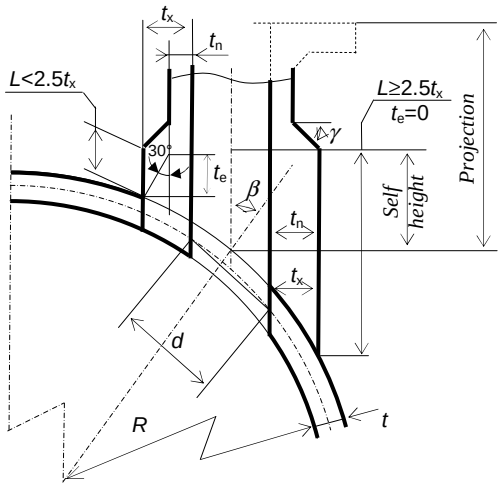
Shell (01) : 31.05 (Virole)

SA249TP304L			Welded Tube					Schedule : /	DN : /
t_n = 3,700 mm	R = 6,95 mm	$Tol_{\%}$ = /			PWHT : No	Radiography : Full			
	R_o = 10,65 mm	Cor. = 0 mm	Tol. = 0,6 mm		UG-16(b) = 1,5 mm				
	P (MPa)	P_h (MPa)	T (°C)	S (MPa)	E	t_u (mm)	σ (MPa)	P_a (MPa)	t (mm)	$t_{n,min}$ (mm)
Operation N	0,7	0	20	97,8	1	3,100	2,03	33,64	0,076	0,676
Horizontal test X	1,0001	0,0001	20	154,8	1	3,100	2,91	53,25	0,069	0,669
MAWP (20 °C, Corroded) = 33,64 MPa				MAWP (20 °C, new) = 33,64 MPa						

Isolated Opening(s)

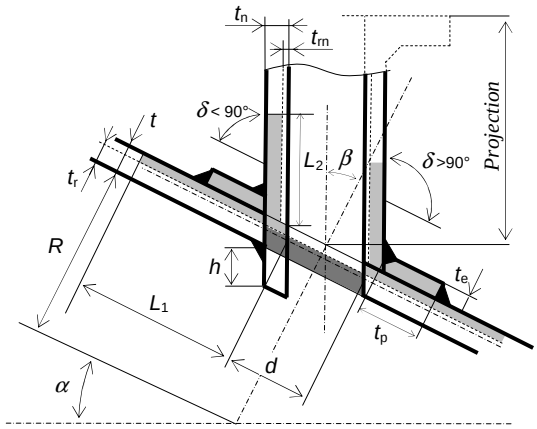
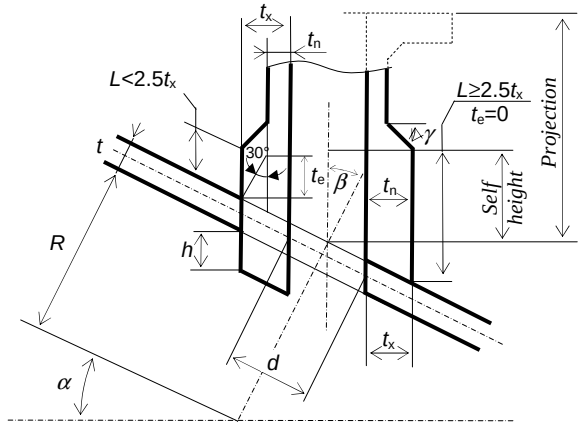
Figures for all configurations, from FIG. UG-37.1 And FIG UG-40.

Shell ($\alpha = 0$) or Cone ($\alpha > 0$) : in longitudinal plane.

Nozzle with or without pad, set-in or set-on	Selfreinforcing nozzle, set-in or set-on
	

Cylindrical or conical shell : circumferential plane

Head : in the plane that contains the axis of the nozzle and the longitudinal axis of vessel.

Nozzle with or without pad, set-in or set-on	Selfreinforcing nozzle, set-in or set-on
	

Opening A [in operation Int.P.] *(Process)*

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Nozzle without pad on Shell (No. 1)		Set In
Pressure : P = 0,7 MPa	Temperature : 20 °C	
Shell	Material :SA249TP304L	Allowable stress : S_v = 97,8 MPa
Joint efficiency : 1 E_1 = 1	Corrosion + tolerance : Ca_v = 0,6 mm	Allowable stress : S = 97,8 MPa
Ext. Diameter : D_o = 21,3 mm	Nominal thickness : 3,7 mm	Tolerance for seamless pipe : /
Nozzle	Material : SA249TP304L	Allowable stress : S_n = 97,8 MPa
Joint efficiency : 1	Corrosion + tolerance : Ca_n = 0,6 mm	Tolerance for seamless pipe : /
Ext. Diameter : D_{on} = 21,3 mm	Nominal thickness : 3,7 mm	
External Projection : 100 mm	Internal Projection : 0 mm	
Inclination : 0 °	Eccentricity : 0 mm	
Flange	Material : /	Type : /
Rating : /	Height : /	/
Pad	Material : /	Allowable stress : S_p = /
Height : /	Width : /	Ext. Diameter : D_{op} = /
Weld Outside : leg_{41}= 4 mm	outer reinforcement : leg_{42}= /	Inside : leg_{43}= /

fr_1 =min(1,S_n/S_v) = 1 fr_2 = min(1,S_n/S_v) = 1 fr_3 = min(1,min(S_n, S_p)/S_v) = 1 fr_4 = min(1,S_p/S_v) = 1

Required thickness of the nozzle neck Appendix 1-2

t_{rn} = R_{on} (1 - exp[P/SE]) = 0,076 mm R_{on} = 10,65 mm E = 1

The nozzle neck thickness is adequate per Appendix 1-2.

Required thickness of the nozzle neck UG-45

t_a = t_{rn}+Ca_n= 0,68 mm ; t_{b1} = max[t_{UG-27} , UG-16(b)]+Ca_v= 2,1 mm ; t_{b3} = Table UG-45+Ca_n= 3,56 mm

t_{UG-45} = max [t_a , min [t_{b3} , t_{b1}]] = 2,1 mm

The nozzle neck thickness is adequate per UG-45.

Dimensions FIG. UG-40

angle of plane with longitudinal axis : angle of each side / vessel wall :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
β = deflection angle / normal line	0 °	
d = diameter of the finished opening	15,1 mm	
R_n = radius of the finished opening	7,55 mm	
t_i = thickness of internal projection	/	
t_p = width of reinforcing pad	/	
t_x = thickness of selfreinforcing	/	
L = height of selfreinforcing	/ /	
Configuration of the reinforcement :	/ /	
t_e = thickness or height of the reinforcement	0 mm 0 mm	
t_n = thickness of nozzle	3,1 mm 3,1 mm	
h = height of the internal projection	0 mm 0 mm	

Reinforcement checking UG-37 *opening A [in operation Int.P.]*

Required thicknesses UG-37(a)		
t_r = 0,076 mm [UG-27(c)]	t = 3,1 mm	E = 1
t_{rn} = P R_{on} / (S_nE+0.4P) = 0,076 mm	R_{on} = 10,65 mm	E = 1

Limits of reinforcement UG-40 :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
UG-40 (b) : max [d , R_n+t_n+t] =	15,1 mm 15,1 mm	
UG-40 (c) : min [2.5t , 2.5t_n+t_e] =	7,75 mm 7,75 mm	

Area required UG-37 (c) :	Longitudinal plane : θ = 0°	Circumferential plane : θ = 90°
F = Correction factor FIG.UG-37	1	
A = d t_r F + 2 t_n/cos(β) t_r F (1-f_{r1})	1,1 mm^2	

Lengths and heights of calculation of the areas :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
L_1 = min [UG-40(b)-Radius , length available]	7,55 mm 7,55 mm	
L_2 = min [UG-40(c) , height available]	7,75 mm 7,75 mm	
L_3 = min [h , 2.5t , 2.5t_i] =	0 mm 0 mm	
L_5 = min [UG-40 (b)-R_{on} , t_p , length available]	0 mm 0 mm	

Area available (mm^2) :	Longitudinal plane : $\theta = 0°$ $\delta = 90°$	$\delta = 90°$	Circumferential plane : $\theta = 90°$ $\delta = /$	$\delta = /$
$A_1 = L_1 (E_1 t - t_r F) - t_n/\cos(\beta) (E_1 t - t_r F) (1 - f_{r1})$	22,8	22,8		
$A_2 = L_2 (t_n - t_{rn}) fr_2$	23,4	23,4		
$A_3 = L_3 t_i f_{r2}$	0	0		
$A_{41} = leg_{41}^2 /2 f_{r2}$	8	8		
$A_{42} = leg_{42}^2 /2 f_{r4}$	0	0		
$A_{43} = leg_{43}^2 /2 f_{r2}$	0	0		
$A_5 = L_5 t_e f_{r4}$	0	0		
$A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 =$	54,3	54,3		
	small opening UG-36(c)(3)			

The opening is adequately reinforced per UG-37.

Weld sizes check UW-16(c). *opening A [in operation Int.P.]*

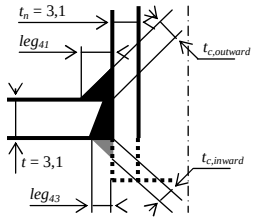

Fig. UW-16.1(d) full penetration weld		
	Minimum throat required	actual
$t_{c,outward}$	min[¼ in.(6 mm);0.7×t_{min}]= 2,17 mm t_{min} = min[¾ in.(19 mm) ; t , t_n]	0.7×leg_{41} = 2,8 mm
$t_{c,inward}$	min[¼ in.(6 mm);0.7×t_{min}]= / t_{min} = min[¾ in.(19 mm) ; t , t_n]	0.7×leg_{43} – Ca_n = /
Weld sizes are adequate		

Weld loads check UG-41(b).

Strength calculations for attachments welds are not required for this opening in accordance with UW-15(b).

Opening A [in test Int.P.] *(Process)*

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Nozzle without pad on Shell (No. 1)		Set In
Pressure : P = 1,0001 MPa	Temperature : 20 °C	
Shell	Material :SA249TP304L	Allowable stress : S_v = 154,8 MPa
Joint efficiency : 1 E_1 = 1	Corrosion + tolerance : Ca_v = 0,6 mm	Allowable stress : S = 154,8 MPa
Ext. Diameter : D_o = 21,3 mm	Nominal thickness : 3,7 mm	Tolerance for seamless pipe : /
Nozzle	Material : SA249TP304L	Allowable stress : S_n = 154,8 MPa
Joint efficiency : 1	Corrosion + tolerance : Ca_n = 0,6 mm	Tolerance for seamless pipe : /
Ext. Diameter : D_{on} = 21,3 mm	Nominal thickness : 3,7 mm	
External Projection : 100 mm	Internal Projection : 0 mm	
Inclination : 0 °	Eccentricity : 0 mm	
Flange	Material : /	Type : /
Rating : /	Height : /	/
Pad	Material : /	Allowable stress : S_p = /
Height : /	Width : /	Ext. Diameter : D_{op} = /
Weld Outside : leg_{41}= 4 mm	outer reinforcement : leg_{42}= /	Inside : leg_{43}= /

fr_1 =min(1,S_n/S_v) = 1 fr_2 = min(1,S_n/S_v) = 1 fr_3 = min(1,min(S_n, S_p)/S_v) = 1 fr_4 = min(1,S_p/S_v) = 1

Required thickness of the nozzle neck Appendix 1-2

t_{rn} = R_{on} (1 - exp[P/SE]) = 0,069 mm R_{on} = 10,65 mm E = 1

The nozzle neck thickness is adequate per Appendix 1-2.

Required thickness of the nozzle neck UG-45

$t_a = t_{rn}+Ca_n$= 0,67 mm ; t_{b1} = max[t_{UG-27} , UG-16(b)]+Ca_v= 2,1 mm ; t_{b3} = Table UG-45+Ca_n= 3,56 mm

t_{UG-45} = max [t_a , min [t_{b3} , t_{b1}]] = 2,1 mm

The nozzle neck thickness is adequate per UG-45.

Dimensions FIG. UG-40

angle of plane with longitudinal axis : angle of each side / vessel wall :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
β = deflection angle / normal line	0 °	
d = diameter of the finished opening	15,1 mm	
R_n = radius of the finished opening	7,55 mm	
t_i = thickness of internal projection	/	
t_p = width of reinforcing pad	/	
t_x = thickness of selfreinforcing	/	
L = height of selfreinforcing	/ /	
Configuration of the reinforcement :	/ /	
t_e = thickness or height of the reinforcement	0 mm 0 mm	
t_n = thickness of nozzle	3,1 mm 3,1 mm	
h = height of the internal projection	0 mm 0 mm	

Reinforcement checking UG-37 *opening A [in test Int.P.]*

Required thicknesses UG-37(a)		
t_r = 0,069 mm [UG-27(c)]	t = 3,1 mm	E = 1
$t_{rn} = P\ R_{on} / (S_nE+0.4P)$ = 0,069 mm	R_{on} = 10,65 mm	E = 1

Limits of reinforcement UG-40 :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
UG-40 (b) : max [d , R_n+t_n+t] =	15,1 mm 15,1 mm	
UG-40 (c) : min [2.5t , 2.5t_n+t_e] =	7,75 mm 7,75 mm	

Area required UG-37 (c) :	Longitudinal plane : θ = 0°	Circumferential plane : θ = 90°
F = Correction factor FIG.UG-37	1	
$A = d\ t_r\ F + 2\ t_n/\cos(\beta)\ t_r\ F\ (1-f_{r1})$	1 mm^2	

Lengths and heights of calculation of the areas :	Longitudinal plane : θ = 0° δ = 90 ° δ = 90 °	Circumferential plane : θ = 90° δ = / δ = /
L_1 = min [UG-40(b)-Radius , length available]	7,55 mm 7,55 mm	
L_2 = min [UG-40(c) , height available]	7,75 mm 7,75 mm	
L_3 = min [h , 2.5t , 2.5t_i] =	0 mm 0 mm	
L_5 = min [UG-40 (b)-R_{on} , t_p , length available]	0 mm 0 mm	

Area available (mm^2) :	Longitudinal plane : θ = 0° δ = 90 °	 δ = 90 °	Circumferential plane : θ = 90° δ = /	 δ = /
$A_1 = L_1 (E_1 t\text{-}t_r F) - t_n/\cos(\beta) (E_1 t\text{-}t_r F) (1\text{-}f_{r1})$	22,9	22,9		
$A_2 = L_2 (t_n\text{-}t_{rn}) fr_2$	23,5	23,5		
$A_3 = L_3 t_i f_{r2}$	0	0		
$A_{41} = leg_{41}^2 /2 f_{r2}$	8	8		
$A_{42} = leg_{42}^2 /2 f_{r4}$	0	0		
$A_{43} = leg_{43}^2 /2 f_{r2}$	0	0		
$A_5 = L_5 t_e f_{r4}$	0	0		
$A_1 + A_2 + A_3 + A_{41} + A_{42} + A_{43} + A_5 =$	54,4	54,4		
	small opening UG-36(c)(3)			

The opening is adequately reinforced per UG-37.

Summary

Summary of nozzles [Location and Dimensions].

Tag	Location				Dimensions (mm)								Flange		
	Loc. (mm)	Ori. (°)	Inc. (°)	Exc. (mm)	Neck				Reinforcement			Projection	DN	Rating	Typ.
					Diam.	Thk.	Sch.	DN	Type	(a)	(b)				
A	300,0	90,00	0,00	0,00	21,30	3,700	/		/	/	/	100,00	/	/	/
(a),(b) : Pad = thickness, Width ; Self Reinforcing = Height, over thickness ; Internal Plate = thickness, Height															

NB : The external projection and the height of over thickness of a self is measured on axis of the nozzle.

Summary of nozzles [Type, Adjacent Openings, Goose and Material].

Tag	Set-in Set-on	Operating	Adjacent openings	Goose		hydrostatic height		Material		
				Radius (mm)	Loc. (mm)	Operating (mm)	Test (mm)	Neck	Pad	Flange
A	in	A	None	/	/	0,00	13,9	SA249TP304L	/	/
Nozzle Type	A = Process, H = manhole, E = With Blind Flange, L = Instrument, AP = Boot, XT = transition by head, CA = Shell Inlet, CS = Shell Outlet, TA = Channel Inlet, TS = Tubeside Outlet.									

Summary of nozzles [Type, Weight and Local Loads].

Tag	Loc.	Operating	Mass		Local Loads					
	Shell No.		Nozzle (kg)	Flange (kg)	Longitudinal Shear Load (daN)	Circumferential Shear Load (daN)	Radial Load (daN)	Longitudinal Moment (daN.m)	Circular Moment (daN.m)	Torsional moment (daN.m)
A	01[01]	A	0,2	0,0	0	0	0	0	0	0
Nozzle Type	A = Process, H = manhole, E = With Blind Flange, L = Instrument, AP = Boot, XT = transition by head, CA = Shell Inlet, CS = Shell Outlet, TA = Channel Inlet, TS = Tubeside Outlet.									
Flange Weight	With blind flange if present.									

Summary of Geometry.

Type Tag	Diameter outside (mm)	Length (mm)	Height / base (mm)	Thickness (mm)	Angle (°)	Mass (kg)	Flanges rating	Specific Gravity	Material
01[01] 31.05	21,3	400,0	400,0	3,700	0	0,7		8,00	SA249TP304L
Angle : half angle at apex for a concentric cone ; maximum angle between cone an cylinder for an eccentric cone. Material : (N) = normalized NB : Italic line indicates an element without pressure..									