METPOR ingeniería de filtrado	**DATA BOOK**	**DOC. CLIENTE N°:** 3149-01-4700123401-TE-EM-CM-051 DB
	CUSTOMER/ Cliente: AESA / ANCAP	**P.O.:** 4700123401 — **REV 0**
	PROJECT/Proyecto: OBM 3149	**DOC. METPOR N°:** 28938-51
TAG: 3101L A/B		W.O. N°: 28938

DATA BOOK

ORDEN DE TRABAJO N°:	**28938**	**FECHA:**	**18/10/10**
ORDEN DE COMPRA N°:	**4700123401**		
CLIENTE:	**ASTRA EVANGELISTA / ANCAP**		
PROYECTO:	**OBM 3149**		
FILTRO:	**3101L A/B**		
CODIGO:	**SECC VIII DIV 1**		
AÑO:	**2010**		

Pamsei Inc.
20/10/10

METPOR Ingeniería de filtrado	**DATA BOOK**	**DOC. CLIENTE Nº:** 3149-01-4700123401-TE-EM-CM-051 DB
	CUSTOMER/ Cliente: AESA / ANCAP	**P.O.: 4700123401** / **REV 0**
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DATA BOOK

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CODIGO:	**SECC VIII DIV 1**		
AÑO:	**2010**		

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	CUSTOMER/ Cliente: AESA / ANCAP	**P.O.: 4700123401** / **REV 0**
	PROJECT/Proyecto: OBM 3149	**DOC. METPOR Nº:** 28938-51
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DATA BOOK

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FILTRO:	**3101L A/B**		
CODIGO:	**SECC VIII DIV 1**		
AÑO:	**2010**		

1

PLAN DE INSPECCION Y ENSAYOS

AESA

GASOIL Y GASOLINA DE BAJO AZUFRE

TÍTULO DOCUMENTO	PLAN DE INSPECCION Y ENSAYOS		
CÓDIGO AESA	3149-01-4700123401-TE-EM-PE-002	**REVISIÓN**	0
CÓDIGO PROVEEDOR	28938-ET-0015	**REVISIÓN**	0

NÚMERO DE PÁGINAS (incluyendo la carátula)	**ORDEN DE COMPRA**
2	4700123401

PROVEEDOR	MET-POR SA
DESCRIPCIÓN DEL PAQUETE	FEED FILTER
TAGS	3101 L A/B

EMITIDO PARA	☒REVISIÓN	☐INFORMACIÓN

Pozos YPF
20.10.15

MetPor

PLAN DE INSPECCIÓN Y ENSAYO

N°: 28938-ET-015
Fecha: 18/03/10

ORDEN DE COMPRA: 4700123401		FILTRO MODELO: FCU-20-5-3-8F	
CLIENTE: AESA - ANCAP	TAG N°: 3101 L A/B	OT N°: 28938	DOC CLIENTE: 3149-01-4700123401-TE-EM-PE-002_0

PASO	DESCRIPCIÓN	DOCUMENTO APLICABLE	PUNTOS DE CONTROL				INFORME	APROBACIÓN				NC N°
			Met-Por		Cliente			Met-Por		Cliente		
			PP	PD	PDO	VD		Fecha	Firma	Fecha	Firma	
01.00	**APROBACION DOCUMENTACION**											
01.01	Plano Conjunto General	3149-01-4700123401-TE-EM-PL-004		X		X		26/2				
01.02	Hoja de datos	3149-01-4700123401-TE-EM-HD-008	X			X		26/2				
01.03	Plano placa id ASME	3149-01-4700123401-TE-EM-PL-006		X		X		12/5				
01.04	Plano placa id ANCAP	3149-01-4700123401-TE-EM-PL-007		X		X		12/5				
01.05	Cálculos mecánicos	3149-01-4700123401-TE-EM-DM-009		X		X		7/4				
02.00	**SOLDADURA**											
02.01	Proced.de soldadura (WPSs)	3149-01-4700123401-TE-EM-WP-034	X			X		7/4				
02.02	Registros de proced. (PQRs)	3149-01-4700123401-TE-EM-WP-036	X			X		7/4				
03.00	**CONTROL DE MATERIALES**											
03.01	Certificados de origen	3149-01-4700123401-TE-EM-PL-004		X		X		18/9				
04.00	**ENSAYOS Y CONTROLES**											
04.01	Líquidos penetrantes	3149-01-4700123401-TE-EM-PR-040	X			X		01/07				
04.02	Radiografiado	3149-01-4700123401-TE-EM-PR-042	X			X		01/07				
04.03	Tratamiento térmico	3149-01-4700123401-TE-EM-PR-047	X			X		30/07				
04.04	Control dimensional	3149-01-4700123401-TE-EM-PL-004		X		X		6/8				
04.05	Prueba hidrostática	3149-01-4700123401-TE-EM-PR-048		X	X			6/8				
04.06	Espesor de pintura	3149-01-4700123401-TE-EM-PR-032		X		X		12/8				
05.00	**APROBACION FINAL**											
05.01	Armado	3149-01-4700123401-TE-EM-PL-004		X		X		14/10				
05.02	Data book	3149-01-4700123401-TE-EM-CM-051		X	X			19/10				
05.03	Inspección Final			X	X							

REV 1

Emitido
CDI

Aprobación final
.....Cliente

PP: Punto de presencia PD: Punto de detención PDO: Punto detención Obligatoria VD: Verificación documentos

METPOR Ingeniería de filtrado	DATA BOOK	DOC. CLIENTE Nº: 3149-01-4700123401-TE-EM-CM-051	
	CUSTOMER/ Cliente: AESA / ANCAP	P.O.: 4700123401	REV 0
	PROJECT/Proyecto: OBM 3149	DOC. METPOR Nº: 28938-51	
TAG: 3101L A/B		W.O. Nº: 28938	

DATA BOOK

ORDEN DE TRABAJO Nº:	**28938**	**FECHA:**	**18/10/10**
ORDEN DE COMPRA Nº:	**4700123401**		
CLIENTE:	**ASTRA EVANGELISTA / ANCAP**		
PROYECTO:	**OBM 3149**		
FILTRO:	**3101L A/B**		
CODIGO:	**SECC VIII DIV 1**		
AÑO:	**2010**		

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DATA BOOK
SUB PROVEEDOR

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PCIA. DE SANTA FE - ARGENTINA - TE/FAX: 54-341-4918600 y 4918639
E-mail: info@soime.com.ar Web: www.soime.com.ar

DATA BOOK

OBRA N°:	1654	FECHA:	17/02/2010
ORDEN DE COMPRA O CONTRATO N°:	31245-2893		
COMITENTE:	METPOR S.A.		
PROYECTO N°:	GAS Y GASOLINA DE BAJO AZUFRE		
UBICACIÓN:	FLORENCIO VARELA 155 V.MARTELLI BUENOS AIRES		
COMPONENTE (TAG N°):	3101L A Y B		

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COMPONENTE (TAG N°):	3101L A Y B

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DATA BOOK

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ORDEN DE COMPRA O CONTRATO N°:	31245-2893		
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UBICACIÓN:	FLORENCIO VARELA 155 V.MARTELLI BUENOS AIRES		
COMPONENTE (TAG N°):	3101L A Y B		

1

HOJA DE DATOS

GASOIL Y GASOLINA

DE BAJO AZUFRE

TITULO DOCUMENTO	HOJA DE DATOS		
CÓDIGO AESA	3149-01-4700123401-TE-EM-HD-008	**REVISIÓN**	1
CÓDIGO PROVEEDOR	28938-HD-0022	**REVISIÓN**	1

NÚMERO DE PÁGINAS (incluyendo la caratula)	**ORDEN DE COMPRA**
2	4700123401

PROVEEDOR	MET-POR SA
DESCRIPCIÓN DEL PAQUETE	FEED FILTER
TAGS	3101 L A/B

EMITIDO PARA	☑ REVISIÓN	☐ INFORMACIÓN

TECHINT / AESA	**GAS OIL Y GASOLINA** **DE BAJO AZUFRE** ***HDS FEED FILTERS 3101 L A/B*** *HOJA DE DATOS*	*N°:* 28938-HD-0022 *Hoja:* 2 of 2 *Rev:* 1 *Escala:* S/C *File:* 3149-01-4700123401-TE-EM-HD-008_1.xls

GENERAL

SERVICIO:	GAS OIL	VOLUMEN:	0,300	m3	10,71	ft3
TIPO:	CARTUCHO	PESO VACIO:	356,0	kg	161	lb
AISLACION:	POR OTROS	PESO EN PH:	656,0	kg	296	lb
TRACEADO:	NO	PESO EN OPERACIÓN:	557,0	0	252	lb
PINTURA INTERNA:	NO					
PINTURA EXTERNA:	SI (Note 1)					
CANTIDAD:	2					

DATOS DE DISEÑO

CAUDAL:	134,6 m³/h	CODIGO:	ASME VIII DIV 1
PRESION DE OPERACIÓN:	2 Kg/cm2	ESTAMPA:	SI
TEMPERATURA DE OPERACIÓN	50 °C	PRESION DE DISEÑO:	FV/16 Kg/cm2 @ -3/150 °C
TAMAÑO DE PARTICULA MIN:	≥ 10 µ	SOBREESP X CORROSION	3,2 mm
EFICIENCIA:	99,9 %		

MATERIALES

CUERPO:	ASTM A 516 °70 N	PATAS:	ASTM A-36
CASQUETES:	ASTM A 516 °70 N	SOPORTES INTERNOS:	ASTM A-240 °304
BRIDAS:	ASTM A 105	ESPARRAGOS:	ASTM A 193 Gr B7
CAÑOS:	ASTM A 106 Gr B	TUERCAS:	ASTM A 194 Gr 2H
ACCESORIOS:	ASTM A 234 Gr WPB	JUNTAS:	VITON
	ASTM A 105		

FILTRO

ELEMENTOS INTERNOS			
TIPO:	PLIZADOS		
CANTIDAD:	15		
DIMENSIONES:	150 X 460		

CONEXIONES

CON.	CANT.	DIAM.	TIPO	RAT.	SCH.	PROY.	SERVICIO
I	1	8"	WNRF	150 #	80	200 mm	ENTRADA
O	1	8"	WNRF	150 #	80	200 mm	SALIDA
V	1	2"	WNRF	150 #	160	200 mm	VENTEO
D	1	2"	WNRF	150 #	160	380 mm	DRENAJE
PSV	1	2"	WNRF	300 #	160	200 mm	ALIVIO
UC	1	2"	WNRF	150 #	160	200 mm	VAPOR PARA MANTENIMIENTO
P	1	1/2"	NPT(H)	3000 #	-	- -	PRESION

NOTES

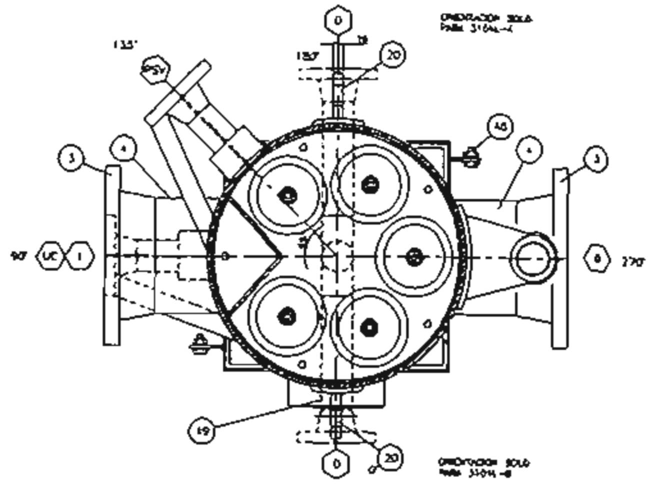
1.- 80 µm zinc inorganico de etilo + 300 µm epoxi altos sólidos. Color terminación RAL 9006

2.-

CUADRO DE CONEXIONES

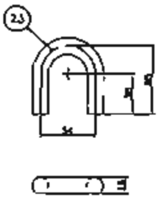
ITEM	CANT.	CONEXIÓN Ø PULG.	CONEXIÓN SCH/THK	BRIDA SERIE	BRIDA CARA	BRIDA TIPO	PROYECCIÓN	SERVICIO	OBSERVAC.
1	1	8	80	150	[illegible]	[illegible]		[illegible]	
0	1	8	40	150	[illegible]	[illegible]		[illegible]	
D	1	2	160	150	[illegible]	[illegible]		[illegible]	
UC	1	8	160	150	[illegible]	[illegible]		[illegible]	
PSV	1	2	160	300	[illegible]	[illegible]		[illegible]	
V	1	2	160	150	[illegible]	[illegible]		[illegible]	
P	1	1/2	-	6000	-	[illegible]		[illegible]	
F	1	30	5,52	-	-	[illegible]		[illegible]	

NP

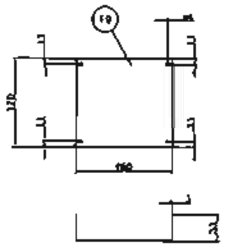


VER ORIENTACION REAL EN VISTA EN PLANTA

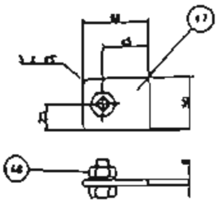
CORTE 'A-A'



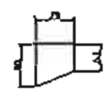
RODIZIO 'UC'



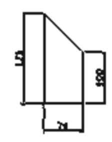
SOPORTE PORTAPLACAS (POS 19)



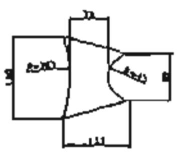
DETALLE PLACA DESCARGA A TIERRA



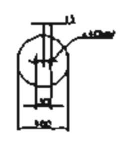
DETALLE POS 40



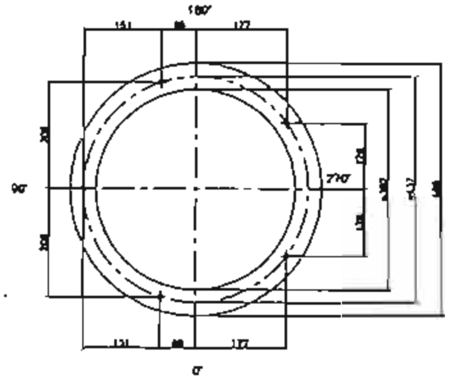
DETALLE POS 42

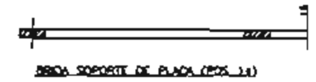


DETALLE POS 41

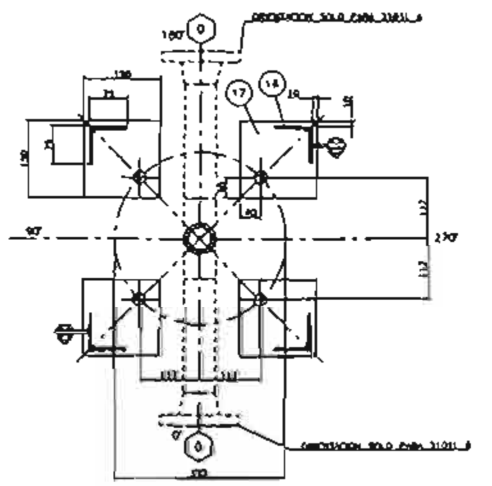


DETALLE POS 43

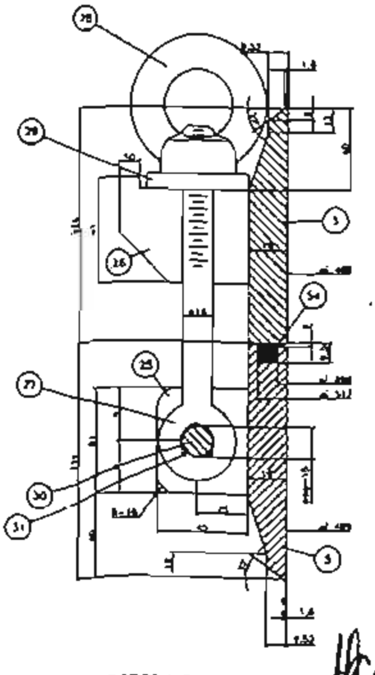




BRIDA SOPORTE DE PLACA (POS 34)



CORTE 'B-B'



CLOSURE & SWING BOLT DETAIL

ITEM	DESCRIPCION	PLANO Nº / CODIGO MATERIAL	MATERIAL	CANT.	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	
[illegible]	[illegible]		[illegible]	[illegible]	

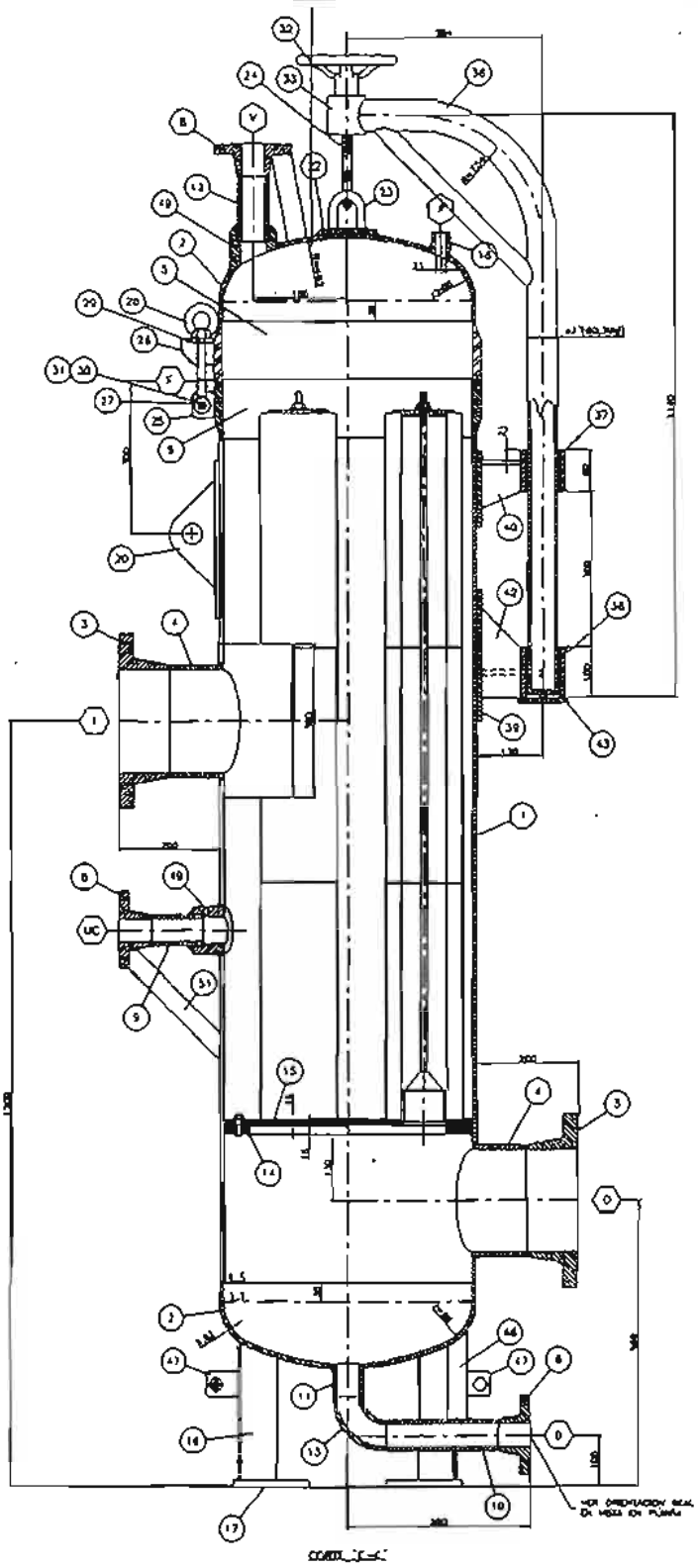
GASOIL Y GASOLINA DE BAJO AZUFRE

TITULO DOCUMENTO	PLANO DE CONJUNTO GENERAL 3101LA/B		
CODIGO AESA	3146-01-4700123401-TE-EH-PL-004	REVISION	0
CODIGO PROVEEDOR	28938-PL-0002	REVISION	0
	ORDEN DE COMPRA		
	4700123401		
PROVEEDOR	MET-POR		
DESCRIPCION DEL PAQUETE	HDS FEED FILTERS		
TAGS	3101 L A/B		
EMITIDO PARA	☒ REVISION	☐ INFORMACION	

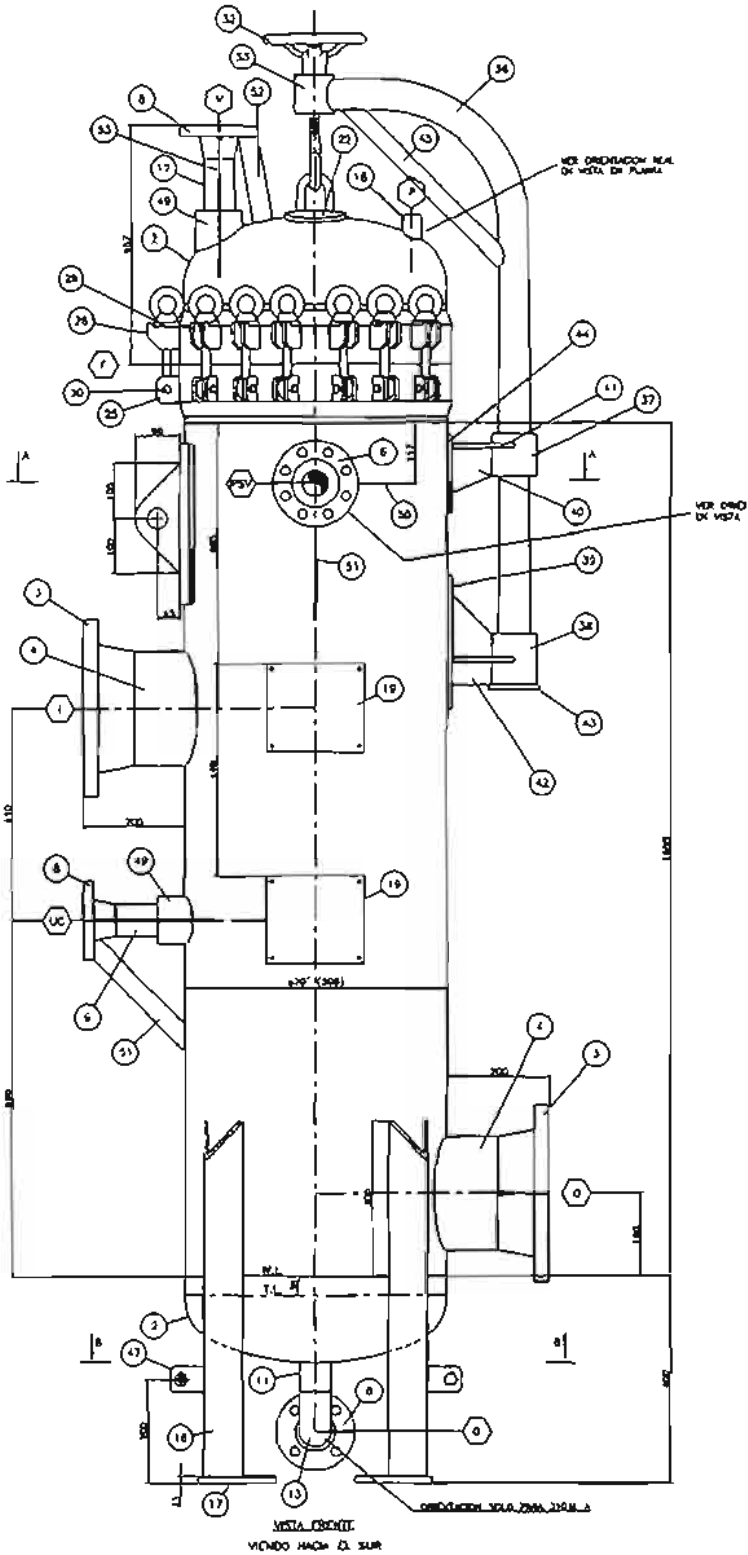
PROYECCIÓN	O.T. Nº 28938	HDS FEED FILTERS
ESCALA: 1:5		PLANO DE CONJUNTO GENERAL 3146-01-4700123401-TE-EH-PL-004 3101 L A/B
ORDEN DE COMPRA	—	28938-PL-0002 — REV. 0

INGENIERIA DE FILTRADO

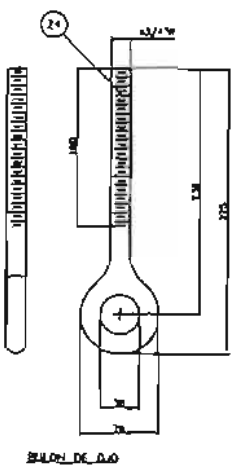
20-10.10



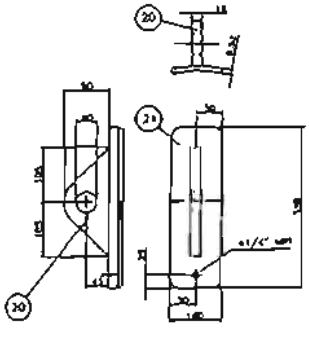
CORTE "C-C"
MIRADO HACIA EL SUR



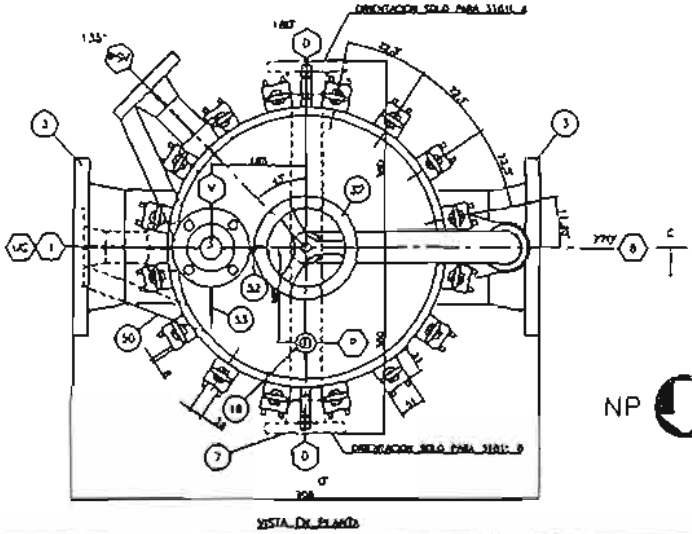
VISTA FRONTAL
MIRADO HACIA EL SUR



BRIDA DE 4"



DETALLE CANCAMO DE IZAJE



VISTA DE PLANTA

SOIME SRL BORGHI 35 - (2156) FRAY LUIS BELTRAN
PCIA. DE SANTA FE - ARGENTINA - TE/FAX: 54-341-4918600 y 4918639
E-mail: info@soime.com.ar Web: www.soime.com.ar

DATA BOOK

OBRA N°:	1654	FECHA:	17/02/2010
ORDEN DE COMPRA O CONTRATO N°:	31245-2893		
COMITENTE:	METPOR S.A.		
PROYECTO N°:	GAS Y GASOLINA DE BAJO AZUFRE		
UBICACIÓN:	FLORENCIO VARELA 155 V.MARTELLI BUENOS AIRES		
COMPONENTE (TAG N°):	3101L A Y B		

2

MEMORIA DE CALCULO

20-10-10

	CUSTOMER'S SPECIFICATION REVIEW (REVISION DE LAS ESPECIFICACIONES DEL CLIENTE)	SPECIFICATION No. (ESPECIFICACION N°) 1654-01 31011 A/B

1.0	DESIGN PRESSURE (PRESION DE DISEÑO)	1.5691 MPa	U-2(a)	
2.0	DESIGN TEMPERATURE (TEMPERATURA DE DISEÑO)	150°C	U-2(a)	
3.0	MDMT (TEMPERATURA MINIMA DEL METAL DE DISEÑO)	-3°C at 1.5691MP	U-2(a)	
4.0	CORROSION ALLOWANCE (ESPESOR DE CORROSION)	3.2mm	U-2(a)	
5.0	SERVICE (SERVICIO)	LCAN MDEA	U-2(a)	
6.0	PWHT FOR SERVICE (TRATAMIENTO POST SOLDADURA)	SI	U-2(a)	
7.0	MATERIALS (MATERIALES)	SA516 Gr.70 MT - Plate SA-105 N - Flange SA 106 Gr.B - nozzles neck - SA 105 Fitng		UG-4(f)
8.0	JOINT TYPE (TIPO DE JUNTA)	1	UW-12(a)	
9.0	RT LEVEL (NIVEL DE RADIOGRAFIA)	FULL	UW-12(a)	
10.0	LOADINGS (CARGAS)		UG-22	

10.1.1	INTERNAL DESIGN PRESSURE (PRESION INTERNA DE DISEÑO)	☑ YES	☐ NO
10.1.2	EXTERNAL DESIGN PRESSURE (PRESION EXTERNA DE DISEÑO)	☐ YES	☑ NO
10.2.1	WEIGHT UNDER OPERATION CONDITIONS (PESO BAJO CONDICIONES DE OPERACION)	☑ YES	☐ NO
10.2.2	WEIGHT UNDER TEST CONDITIONS (PESO BAJO CONDICIONES DE PRUEBA)	☑ YES	☐ NO
10.3	WEIGHT OF ATTACHED EQUIPMENTS AND OTHERS (PESO DE EQUIPOS ADJUNTOS Y OTROS)	☐ YES	☑ NO
10.4.1	ATTACHMENT OF INTERNALS (ADHESION DE INTERNOS)	☐ YES	☑ NO
10.4.2	ATTACHMENT OF SUPPORTS (ADHESION DE SOPORTES)	☐ YES	☑ NO
10.5	CYCLIC OR DINAMIC REACTIONS (REACCIONES DINAMICAS O CICLICAS)	☐ YES	☑ NO
10.6.1	WIND REACTIONS (REACCIONES POR VIENTO)	☑ YES	☐ NO
10.6.2	SNOW REACTIONS (REACCIONES POR NIEVE)	☐ YES	☑ NO
10.6.3	SEISMIC REACTIONS (REACCIONES POR SISMO)	☐ YES	☑ NO
10.7	IMPACT REACTIONS (REACCIONES POR IMPACTO)	☐ YES	☑ NO
10.8	TEMPERATURE GRADIENTS (GRADIENTES DE TEMPERATURA)	☐ YES	☑ NO
10.9	ABNORMAL PRESSURE CAUSED BY DEFLAGRATION (PRESIÓN ANORMAL CAUSADA POR DEFLAGRACION(IGNICIÓN))	☐ YES	☑ NO
10.10	TEST AND HYDRO HEAD PRESSURE DURING TEST (PRESION DE PRUEBA HIDRAULICA)	☑ YES	☐ NO

REVIEWED BY (REVISADO POR)	I.E.A.	DATE (FECHA)	06/04/2010	CUSTOMER (CLIENTE)	

JOB 1654
TAG. 3101L A/B

METPOR SA - AESA - ANCAP
FILTRO TAG 3101L A/B
SOIME SRL - 1654-MC-01 REV.C

DESIGN CALCULATION

In Accordance with ASME Section VIII Division 1

ASME Code Version : 2007, Addenda A-09

Analysis Performed by : S.O.I.M.E. S.R.L.

Job File : Z:\PRODUCCION\OBRAS\METPOR\O1654\MC\1654-MC-3101

Date of Analysis : May 17,2010

PV Elite 2010, March 2010

METPOR SA - AESA - ANCAP
FILTRO TAG 3101L A/B
SOIME SRL - 1654-MC-01 REV.C

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Note: PV Elite performs all calculations internally in Imperial Units to remain compliant with the ASME Code and any built in assumptions in the ASME Code formulas. The customary Imperial database is used for consistency. The finalized results are reflected to show the users set of selected units.

PV Elite Vessel Analysis Program: Input Data

METPOR SA - AESA - ANCAP
FILTRO TAG 3101L A/B
SOIME SRL - 1654-MC-01 REV.C

Design Internal Pressure (for Hydrotest)	1.5691	MPa
Design Internal Temperature	150	C
Type of Hydrotest	UG99-b Note [34]	
Hydrotest Position	Vertical	
Projection of Nozzle from Vessel Top	0.0000	mm
Projection of Nozzle from Vessel Bottom	0.0000	mm
Minimum Design Metal Temperature	-3	C
Type of Construction	Welded	
Special Service	Severe Sour	
Degree of Radiography	RT 1	
Miscellaneous Weight Percent	0.	
Use Higher Longitudinal Stresses (Flag)	Y	
Select t for Internal Pressure (Flag)	Y	
Select t for External Pressure (Flag)	Y	
Select t for Axial Stress (Flag)	Y	
Select Location for Stiff. Rings (Flag)	N	
Consider Vortex Shedding	N	
Perform a Corroded Hydrotest	N	
Is this a Heat Exchanger	No	
User Defined Hydro. Press. (Used if > 0)	2.3537	MPa
User defined MAWP	0.0000	MPa
User defined MAPnc	0.0000	MPa

Load Case 1	NP+EW+WI+FW+BW
Load Case 2	NP+EW+EE+FS+BS
Load Case 3	NP+OW+WI+FW+BW
Load Case 4	NP+OW+EQ+FS+BS
Load Case 5	NP+HW+HI
Load Case 6	NP+HW+HE
Load Case 7	IP+OW+WI+FW+BW
Load Case 8	IP+OW+EQ+FS+BS
Load Case 9	EP+OW+WI+FW+BW
Load Case 10	EP+OW+EQ+FS+BS
Load Case 11	HP+HW+HI
Load Case 12	HP+HW+HE
Load Case 13	IP+WE+EW
Load Case 14	IP+WF+CW
Load Case 15	IP+VO+OW
Load Case 16	IP+VE+EW
Load Case 17	NP+VO+OW
Load Case 18	FS+BS+IP+OW
Load Case 19	FS+BS+EP+OW

Wind Design Code	User Defined

Wind Profile Height mm	Pressure kPa

2800.0000	1.1885
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
0.0000	0.0000
Damping Factor (Beta) for Wind (Ope)	0.0100
Damping Factor (Beta) for Wind (Empty)	0.0000
Damping Factor (Beta) for Wind (Filled)	0.0000
Seismic Design Code	No Seismic
Design Nozzle for Des. Press. + St. Head	Y
Consider MAP New and Cold in Noz. Design	N
Consider External Loads for Nozzle Des.	Y
Use ASME VIII-1 Appendix 1-9	N
Material Database Year	Current w/Addenda or Code Year

Configuration Directives:

Do not use Nozzle MDMT Interpretation VIII-1 01-37	No
Use Table G instead of exact equation for "A"	Yes
Shell Head Joints are Tapered	Yes
Compute "K" in corroded condition	Yes
Use Code Case 2286	No
Use Flange Bolt Stress ratio for Hydrotest ratio	Yes
Use the MAWP to compute the MDMT	Yes

Complete Listing of Vessel Elements and Details:

Element From Node	10	
Element To Node	20	
Element Type	Elliptical	
Description	CAB. INF.	
Distance "FROM" to "TO"	40.000	mm
Element Outside Diameter	508.00	mm
Element Thickness	8.3344	mm
Internal Corrosion Allowance	3.2000	mm
Nominal Thickness	9.5000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1.5691	MPa
Design Temperature Internal Pressure	150	C
Design External Pressure	0.1034	MPa
Design Temperature External Pressure	150	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Allowable Stress, Ambient	137.90	MPa
Allowable Stress, Operating	137.90	MPa
Allowable Stress, Hydrotest	179.27	MPa
Material Density	0.007833	kg/cm³

P Number Thickness	31.750	mm
Yield Stress, Operating	231.52	MPa
UCS-66 Chart Curve Designation	D	
External Pressure Chart Name	CS-2	
UNS Number	K02700	
Product Form	Plate	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	
Elliptical Head Factor	2.	
Element From Node	10	
Detail Type	Liquid	
Detail ID	MDEA	
Dist. from "FROM" Node / Offset dist	-122.83	mm
Height/Length of Liquid	162.83	mm
Liquid Density	0.001016	kg/cm³
Element From Node	10	
Detail Type	Nozzle	
Detail ID	D	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Nozzle Diameter	2.	in.
Nozzle Schedule	160	
Nozzle Class	150	
Layout Angle	180.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-106 B	

Element From Node	20	
Element To Node	30	
Element Type	Cylinder	
Description	CUERPO	
Distance "FROM" to "TO"	1650.0	mm
Element Outside Diameter	508.00	mm
Element Thickness	9.5000	mm
Internal Corrosion Allowance	3.2000	mm
Nominal Thickness	9.5000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1.5691	MPa
Design Temperature Internal Pressure	150	C
Design External Pressure	0.1034	MPa
Design Temperature External Pressure	150	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	
Element From Node	20	
Detail Type	Liquid	

Detail ID	MDEA	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Height/Length of Liquid	1650.0	mm
Liquid Density	0.001016	kg/cm³
Element From Node	20	
Detail Type	Nozzle	
Detail ID	O	
Dist. from "FROM" Node / Offset dist	160.00	mm
Nozzle Diameter	8.	in.
Nozzle Schedule	80	
Nozzle Class	150	
Layout Angle	270.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-106 B	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	I	
Dist. from "FROM" Node / Offset dist	1100.0	mm
Nozzle Diameter	8.	in.
Nozzle Schedule	80	
Nozzle Class	150	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-106 B	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	UC	
Dist. from "FROM" Node / Offset dist	690.00	mm
Nozzle Diameter	3.625	in.
Nozzle Schedule	None	
Nozzle Class	None	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	None	
Nozzle Matl	SA-105	
Element From Node	20	
Detail Type	Nozzle	
Detail ID	PSV	
Dist. from "FROM" Node / Offset dist	1533.0	mm
Nozzle Diameter	3.625	in.
Nozzle Schedule	None	
Nozzle Class	None	
Layout Angle	135.	
Blind Flange (Y/N)	N	

Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	None	
Nozzle Matl	SA-105	
Element From Node	20	
Detail Type	Leg	
Detail ID	LEGS	
Dist. from "FROM" Node / Offset dist	180.00	mm
Diameter at Leg Centerline	555.57	mm
Leg Orientation	3	
Number of Legs	4	
Section Identifier	L3X3X0.3125	
Length of Legs	700.00	mm
Element From Node	20	
Detail Type	Weight	
Detail ID	CABEZAL	
Dist. from "FROM" Node / Offset dist	1650.0	mm
Miscellaneous Weight	686.42	N
Offset from Element Centerline	515.00	mm
Element From Node	20	
Detail Type	Weight	
Detail ID	PLACA+CARTUCHOS	
Dist. from "FROM" Node / Offset dist	295.00	mm
Miscellaneous Weight	490.30	N
Offset from Element Centerline	0.0000	mm

Element From Node	30	
Element To Node	40	
Element Type	Cylinder	
Description	BRIDA 1	
Distance "FROM" to "TO"	114.00	mm
Element Outside Diameter	527.00	mm
Element Thickness	19.000	mm
Internal Corrosion Allowance	3.2000	mm
Nominal Thickness	19.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1.5691	MPa
Design Temperature Internal Pressure	150	C
Design External Pressure	0.1034	MPa
Design Temperature External Pressure	150	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	
Element From Node	30	
Detail Type	Liquid	
Detail ID	MDEA	
Dist. from "FROM" Node / Offset dist	0.0000	mm

Height/Length of Liquid	114.00	mm
Liquid Density	0.001016	kg/cm³

Element From Node	40	
Element To Node	50	
Element Type	Cylinder	
Description	BRIDA 2	
Distance "FROM" to "TO"	114.00	mm
Element Outside Diameter	527.00	mm
Element Thickness	19.000	mm
Internal Corrosion Allowance	3.2000	mm
Nominal Thickness	19.000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1.5691	MPa
Design Temperature Internal Pressure	150	C
Design External Pressure	0.1034	MPa
Design Temperature External Pressure	150	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	

Element From Node	40	
Detail Type	Liquid	
Detail ID	MDEA	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Height/Length of Liquid	114.00	mm
Liquid Density	0.001016	kg/cm³

Element From Node	50	
Element To Node	60	
Element Type	Elliptical	
Description	CAB. SUP.	
Distance "FROM" to "TO"	40.000	mm
Element Outside Diameter	508.00	mm
Element Thickness	8.3344	mm
Internal Corrosion Allowance	3.2000	mm
Nominal Thickness	9.5000	mm
External Corrosion Allowance	0.0000	mm
Design Internal Pressure	1.5691	MPa
Design Temperature Internal Pressure	150	C
Design External Pressure	0.1034	MPa
Design Temperature External Pressure	150	C
Effective Diameter Multiplier	1.2	
Material Name [Normalized]	SA-516 70	
Efficiency, Longitudinal Seam	1.	
Efficiency, Circumferential Seam	1.	
Elliptical Head Factor	2.	

Element From Node	50	
Detail Type	Liquid	
Detail ID	MDEA	
Dist. from "FROM" Node / Offset dist	0.0000	mm
Height/Length of Liquid	162.83	mm
Liquid Density	0.001016	kg/cm³
Element From Node	50	
Detail Type	Nozzle	
Detail ID	V	
Dist. from "FROM" Node / Offset dist	185.00	mm
Nozzle Diameter	3.625	in.
Nozzle Schedule	None	
Nozzle Class	None	
Layout Angle	90.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	None	
Nozzle Matl	SA-105	
Element From Node	50	
Detail Type	Nozzle	
Detail ID	P	
Dist. from "FROM" Node / Offset dist	185.00	mm
Nozzle Diameter	1.5	in.
Nozzle Schedule	None	
Nozzle Class	None	
Layout Angle	0.	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.0000	N
Grade of Attached Flange	None	
Nozzle Matl	SA-105	

XY Coordinate Calculations

From	To	X (Horiz.) mm	Y (Vert.) mm	DX (Horiz.) mm	DY (Vert.) mm
CAB. INF.		0.00000	40.0000	0.00000	40.0000
CUERPO		0.00000	1690.00	0.00000	1650.00
BRIDA 1		0.00000	1804.00	0.00000	114.000
BRIDA 2		0.00000	1918.00	0.00000	114.000
CAB. SUP.		0.00000	1958.00	0.00000	40.0000

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd MPa	Nominal Thickness mm	Total Corr Allowance mm	Element Diameter mm	Allowable Stress(SE) MPa
CAB. INF.		1.59107	9.50000	3.20000	508.000	137.900
CUERPO		1.58945	9.50000	3.20000	508.000	137.900
BRIDA 1		1.57301	19.0000	3.20000	527.000	137.900
BRIDA 2		1.57188	19.0000	3.20000	527.000	137.900
CAB. SUP.		1.57074	9.50000	3.20000	508.000	137.900

Element Required Thickness and MAWP :

From	To	Design Pressure MPa	M.A.W.P. Corroded MPa	M.A.P. New & Cold MPa	Minimum Thickness mm	Required Thickness mm
CAB. INF.		1.56912	2.86568	4.66253	8.33437	6.05227
CUERPO		1.56912	3.43429	5.23601	9.50000	6.11420
BRIDA 1		1.56912	8.46807	10.2388	19.0000	6.19207
BRIDA 2		1.56912	8.46921	10.2388	19.0000	6.18992
CAB. SUP.		1.56912	2.88641	4.66253	8.33437	6.01547
Minimum			1.557	1.965		

Note : The M.A.W.P is Governed by an ANSI Flange !

Flange MAWP including Static Pressure: 1.557 = 1.582 - 0.025 MPa

Note : The M.A.P.(NC) is Governed by a Flange !

Internal Pressure Calculation Results :

ASME Code, Section VIII, Division 1, 2007 A-09

Elliptical Head From 10 To 20 SA-516 70 , UCS-66 Crv. D at 150 C

CAB. INF.

Longitudinal Joint: Seamless
Circumferential Joint: Full Radiography per UW-11(a) Type 1

Required Thickness due to Internal Pressure [tr]:
 = (P*Do*Kcor)/(2*S*E+2*P*(Kcor-0.1)) per Appendix 1-4 (c)
 = (1.591*508.0000*0.983)/(2*137.90*1.00+2*1.591*(0.98-0.1))
 = 2.8523 + 3.2000 = 6.0523 mm

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.022 MPa
 = (2*S*E*t)/(Kcor*Do-2*t*(Kcor-0.1)) per Appendix 1-4 (c)
 = (2*137.90*1.00*5.1344)/(0.983*508.0000-2*5.1344*(0.98-0.1))
 = 2.888 - 0.022 = 2.866 MPa

Maximum Allowable Pressure, New and Cold [MAPNC]:
 = (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
 = (2*137.90*1.00*8.3344)/(1.000*508.0000-2*8.3344*(1.000-0.1))
 = 4.663 MPa

Actual stress at given pressure and thickness, corroded [Sact]:
 = (P*(Kcor*Do-2*t*(Kcor-0.1)))/(2*E*t)
 = (1.591*(0.983*508.0000-2*5.1344*(0.983-0.1)))/(2*1.00*5.1344)
 = 75.982 MPa

Straight Flange Required Thickness:
 = (P*Ro)/(S*E+0.4*P) + c per Appendix 1-1 (a)(1)
 = (1.591*254.0000)/(137.90*1.00+0.4*1.591)+3.200
 = 6.117 mm

Straight Flange Maximum Allowable Working Pressure:
Less Operating Hydrostatic Head Pressure of 0.022 MPa
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90 * 1.00 * 6.3000) / (254.0000 - 0.4 * 6.3000)
 = 3.455 - 0.022 = 3.433 MPa

Factor K, corroded condition [Kcor]:
 = (2 + (Inside Diameter/(2 * Inside Head Depth))^(2))/6
 = (2 + (497.731 /(2 * 126.033))^(2))/6
 = 0.983181

Percent Elong. per UCS-79, VIII-1-01-57 (75*tnom/Rf)*(1-Rf/Ro) 8.108 %
Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 8.334 , tr = 2.852 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.556 , Temp. Reduction = 27 C

Min Metal Temp. w/o impact per UCS-66 -48 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -65 C

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 9.500 , tr = 2.879 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.457 , Temp. Reduction = 40 C

Min Metal Temp. w/o impact per UCS-66 -48 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -65 C

Cylindrical Shell From 20 To 30 SA-516 70 , UCS-66 Crv. D at 150 C

CUERPO

Longitudinal Joint: Full Radiography per UW-11(a) Type 1
Circumferential Joint: Full Radiography per UW-11(a) Type 1

Required Thickness due to Internal Pressure [tr]:
 = (P*Ro) / (S*E+0.4*P) per Appendix 1-1 (a)(1)
 = (1.589*254.0000)/(137.90*1.00+0.4*1.589)
 = 2.9142 + 3.2000 = 6.1142 mm

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.020 MPa
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*6.3000)/(254.0000-0.4*6.3000)
 = 3.455 - 0.020 = 3.434 MPa

Maximum Allowable Pressure, New and Cold [MAPNC]:
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*9.5000)/(254.0000-0.4*9.5000)
 = 5.236 MPa

Actual stress at given pressure and thickness, corroded [Sact]:
 = (P*(Ro-0.4*t))/(E*t)
 = (1.589*((254.0000-0.4*6.3000))/(1.00*6.3000)
 = 63.447 MPa

Percent Elongation per UCS-79 (50*tnom/Rf)*(1-Rf/Ro) 1.906 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 9.500 , tr = 2.914 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.463 , Temp. Reduction = 38 C

Min Metal Temp. w/o impact per UCS-66 -48 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -65 C

Cylindrical Shell From 30 To 40 SA-516 70 , UCS-66 Crv. D at 150 C

BRIDA 1

Longitudinal Joint: Full Radiography per UW-11(a) Type 1
Circumferential Joint: Full Radiography per UW-11(a) Type 1

Required Thickness due to Internal Pressure [tr]:
 = (P*Ro) / (S*E+0.4*P) per Appendix 1-1 (a)(1)
 = (1.573*263.5000)/(137.90*1.00+0.4*1.573)
 = 2.9921 + 3.2000 = 6.1921 mm

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.004 MPa
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*15.8000)/(263.5000-0.4*15.8000)
 = 8.472 - 0.004 = 8.468 MPa

Maximum Allowable Pressure, New and Cold [MAPNC]:
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*19.0000)/(263.5000-0.4*19.0000)
 = 10.239 MPa

Actual stress at given pressure and thickness, corroded [Sact]:
 = (P*(Ro-0.4*t))/(E*t)
 = (1.573*((263.5000-0.4*15.8000))/(1.00*15.8000)
 = 25.604 MPa

Percent Elongation per UCS-79 (50*tnom/Rf)*(1-Rf/Ro) 3.740 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 19.000 , tr = 2.992 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.189 , Temp. Reduction = 78 C

Min Metal Temp. w/o impact per UCS-66 -41 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -58 C
Min Metal Temp. at Required thickness (UCS 66.1) -104 C

Cylindrical Shell From 40 To 50 SA-516 70 , UCS-66 Crv. D at 150 C

BRIDA 2

Longitudinal Joint: Full Radiography per UW-11(a) Type 1
Circumferential Joint: Full Radiography per UW-11(a) Type 1

Required Thickness due to Internal Pressure [tr]:
 = (P*Ro) / (S*E+0.4*P) per Appendix 1-1 (a)(1)
 = (1.572*263.5000)/(137.90*1.00+0.4*1.572)
 = 2.9899 + 3.2000 = 6.1899 mm

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.003 MPa
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*15.8000)/(263.5000-0.4*15.8000)
 = 8.472 - 0.003 = 8.469 MPa

Maximum Allowable Pressure, New and Cold [MAPNC]:
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90*1.00*19.0000)/(263.5000-0.4*19.0000)
 = 10.239 MPa

Actual stress at given pressure and thickness, corroded [Sact]:
 = (P*(Ro-0.4*t))/(E*t)
 = (1.572*((263.5000-0.4*15.8000))/(1.00*15.8000)
 = 25.586 MPa

Percent Elongation per UCS-79 (50*tnom/Rf)*(1-Rf/Ro) 3.740 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 19.000 , tr = 2.990 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.189 , Temp. Reduction = 78 C

Min Metal Temp. w/o impact per UCS-66 -41 C

Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -58 C
Min Metal Temp. at Required thickness (UCS 66.1) -104 C

Elliptical Head From 50 To 60 SA-516 70 , UCS-66 Crv. D at 150 C

CAB. SUP.

Longitudinal Joint: Seamless
Circumferential Joint: Full Radiography per UW-11(a) Type 1

Required Thickness due to Internal Pressure [tr]:
 = (P*Do*Kcor)/(2*S*E+2*P*(Kcor-0.1)) per Appendix 1-4 (c)
 = (1.570*508.0000*0.983)/(2*137.90*1.00+2*1.570*(0.98-0.1))
 = 2.8155 + 3.2000 = 6.0155 mm

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:
Less Operating Hydrostatic Head Pressure of 0.001 MPa
 = (2*S*E*t)/(Kcor*Do-2*t*(Kcor-0.1)) per Appendix 1-4 (c)
 = (2*137.90*1.00*5.1344)/(0.983*508.0000-2*5.1344*(0.98-0.1))
 = 2.888 - 0.001 = 2.886 MPa

Maximum Allowable Pressure, New and Cold [MAPNC]:
 = (2*S*E*t)/(K*Do-2*t*(K-0.1)) per Appendix 1-4 (c)
 = (2*137.90*1.00*8.3344)/(1.000*508.0000-2*8.3344*(1.000-0.1))
 = 4.663 MPa

Actual stress at given pressure and thickness, corroded [Sact]:
 = (P*(Kcor*Do-2*t*(Kcor-0.1)))/(2*E*t)
 = (1.570*(0.983*508.0000-2*5.1344*(0.983-0.1)))/(2*1.00*5.1344)
 = 74.992 MPa

Straight Flange Required Thickness:
 = (P*Ro)/(S*E+0.4*P) + c per Appendix 1-1 (a)(1)
 = (1.570*254.0000)/(137.90*1.00+0.4*1.570)+3.200
 = 6.079 mm

Straight Flange Maximum Allowable Working Pressure:
Less Operating Hydrostatic Head Pressure of 0.001 MPa
 = (S*E*t)/(Ro-0.4*t) per Appendix 1-1 (a)(1)
 = (137.90 * 1.00 * 6.3000) / (254.0000 - 0.4 * 6.3000)
 = 3.455 - 0.001 = 3.453 MPa

Factor K, corroded condition [Kcor]:
 = (2 + (Inside Diameter/(2 * Inside Head Depth))^(2))/6
 = (2 + (497.731 /(2 * 126.033))^(2))/6
 = 0.983181

Percent Elong. per UCS-79, VIII-1-01-57 (75*tnom/Rf)*(1-Rf/Ro) 8.108 %
Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 8.334 , tr = 2.815 , c = 3.2000 mm , E* = 1.00

Stress Ratio = tr * (E*) / (tg - c) = 0.548 , Temp. Reduction = 28 C

Min Metal Temp. w/o impact per UCS-66 -48 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -65 C

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 9.500 , tr = 2.879 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.457 , Temp. Reduction = 40 C

Min Metal Temp. w/o impact per UCS-66 -48 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -65 C

Note: Heads and Shells Exempted to -20F (-29C) by paragraph UG-20F

Hydrostatic Test Pressure Results:

Pressure per UG99b	= 1.3 * M.A.W.P. * Sa/S	2.024 MPa
Pressure per UG99b[34]	= 1.3 * Design Pres * Sa/S	2.040 MPa
Pressure per UG99c	= 1.3 * M.A.P. - Head(Hyd)	2.555 MPa
Pressure per UG100	= 1.1 * M.A.W.P. * Sa/S	1.712 MPa
Pressure per PED	= 1.43 * MAWP	2.226 MPa
User Defined Hydrostatic Test Pressure at High Point		2.354 MPa

UG-99(b) Note 34, Test Pressure Calculation:
 = Test Factor * Design Pressure * Stress Ratio
 = 1.3 * 1.569 * 1.000
 = 2.354 MPa

Vertical Test performed per: UG-99b (Note 34)

Stresses on Elements due to Hydrostatic Test Pressure:

From To	Stress	Allowable	Ratio	Pressure
CAB. INF.	70.3	179.3	0.392	2.38
CUERPO	62.5	179.3	0.349	2.37
BRIDA 1	31.8	179.3	0.177	2.36
BRIDA 2	31.7	179.3	0.177	2.36
CAB. SUP.	69.7	179.3	0.389	2.36

Elements Suitable for Internal Pressure.

External Pressure Calculation Results :

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Elliptical Head From 10 to 20 Ext. Chart: CS-2 at 150 C

CAB. INF.

Elastic Modulus from Chart: CS-2 at 150 C : 0.19982E+06 MPa

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	D/t	Factor A	B
5.134	508.00	98.94	0.0014038	94.83

EMAP = B/(K0*D/t) = 94.8336 /(0.9000 *98.9410) = 1.0650 MPa

Results for Required Thickness (Tca):

Tca	OD	D/t	Factor A	B
1.316	508.00	386.09	0.0003597	35.94

EMAP = B/(K0*D/t) = 35.9410 /(0.9000 *386.0854) = 0.1034 MPa

Since the internal pressure is > 1.67 times the external pressure
the requirements of UG-33(1)(a) do not govern.

Cylindrical Shell From 20 to 30 Ext. Chart: CS-2 at 150 C

CUERPO

Elastic Modulus from Chart: CS-2 at 150 C : 0.19982E+06 MPa

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	SLEN	D/t	L/D	Factor A	B
6.300	508.00	2039.89	80.63	4.0155	0.0004178	41.74

EMAP = (4*B)/(3*(D/t)) = (4*41.7444)/(3*80.6349) = 0.6903 MPa

Results for Required Thickness (Tca):

Tca	OD	SLEN	D/t	L/D	Factor A	B
2.903	508.00	2039.89	175.00	4.0155	0.0001359	13.58

EMAP = (4*B)/(3*(D/t)) = (4*13.5752)/(3*174.9999) = 0.1034 MPa

Results for Maximum Stiffened Length (Slen):

Tca	OD	SLEN	D/t	L/D	Factor A	B
6.300	508.00	0.11E+21	80.63	.5000E+02	0.0001697	16.95

EMAP = (4*B)/(3*(D/t)) = (4*16.9511)/(3*80.6349) = 0.2803 MPa

Cylindrical Shell From 30 to 40 Ext. Chart: CS-2 at 150 C

BRIDA 1

Elastic Modulus from Chart: CS-2 at 150 C : 0.19982E+06 MPa

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	SLEN	D/t	L/D	Factor A	B

Tca	OD	SLEN	D/t	L/D	Factor A	B
15.800	527.00	2039.89	33.35	3.8708	0.0016027	98.26

EMAP = (4*B)/(3*(D/t)) = (4*98.2557)/(3*33.3544) = 3.9277 MPa

Results for Required Thickness (Tca):

Tca	OD	SLEN	D/t	L/D	Factor A	B
2.965	527.00	2039.89	177.75	3.8708	0.0001380	13.79

EMAP = (4*B)/(3*(D/t)) = (4*13.7887)/(3*177.7488) = 0.1034 MPa

Results for Maximum Stiffened Length (Slen):

Tca	OD	SLEN	D/t	L/D	Factor A	B
15.800	527.00	0.26E+33	33.35	.5000E+02	0.0010147	85.58

EMAP = (4*B)/(3*(D/t)) = (4*85.5813)/(3*33.3544) = 3.4211 MPa

Cylindrical Shell From 40 to 50 Ext. Chart: CS-2 at 150 C

BRIDA 2

Elastic Modulus from Chart: CS-2 at 150 C : 0.19982E+06 MPa

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	SLEN	D/t	L/D	Factor A	B
15.800	527.00	2039.89	33.35	3.8708	0.0016027	98.26

EMAP = (4*B)/(3*(D/t)) = (4*98.2557)/(3*33.3544) = 3.9277 MPa

Results for Required Thickness (Tca):

Tca	OD	SLEN	D/t	L/D	Factor A	B
2.965	527.00	2039.89	177.75	3.8708	0.0001380	13.79

EMAP = (4*B)/(3*(D/t)) = (4*13.7887)/(3*177.7488) = 0.1034 MPa

Results for Maximum Stiffened Length (Slen):

Tca	OD	SLEN	D/t	L/D	Factor A	B
15.800	527.00	0.26E+33	33.35	.5000E+02	0.0010147	85.58

EMAP = (4*B)/(3*(D/t)) = (4*85.5813)/(3*33.3544) = 3.4211 MPa

Elliptical Head From 50 to 60 Ext. Chart: CS-2 at 150 C

CAB. SUP.

Elastic Modulus from Chart: CS-2 at 150 C : 0.19982E+06 MPa

Results for Maximum Allowable External Pressure (MAEP):

Tca	OD	D/t	Factor A	B
5.134	508.00	98.94	0.0014038	94.83

EMAP = B/(K0*D/t) = 94.8336 /(0.9000 *98.9410) = 1.0650 MPa

Results for Required Thickness (Tca):

Tca	OD	D/t	Factor A	B
1.316	508.00	386.09	0.0003597	35.94

EMAP = B/(K0*D/t) = 35.9410 /(0.9000 *386.0854) = 0.1034 MPa

Since the internal pressure is > 1.67 times the external pressure
the requirements of UG-33(1)(a) do not govern.

External Pressure Calculations

From	To	Section Length mm	Outside Diameter mm	Corroded Thickness mm	Factor A	Factor B MPa
10	20	No Calc	508.000	5.13437	0.0014038	94.8336
20	30	2039.89	508.000	6.30000	0.00041782	41.7444
30	40	2039.89	527.000	15.8000	0.0016027	98.2557
40	50	2039.89	527.000	15.8000	0.0016027	98.2557
50	60	No Calc	508.000	5.13437	0.0014038	94.8336

External Pressure Calculations

From	To	External Actual T. mm	External Required T. mm	External Des. Press. MPa	External M.A.W.P. MPa
10	20	8.33437	4.51577	0.10343	1.06498
20	30	9.50000	6.10286	0.10343	0.69026
30	40	19.0000	6.16486	0.10343	3.92774
40	50	19.0000	6.16486	0.10343	3.92774
50	60	8.33437	4.51577	0.10343	1.06498
Minimum					0.690

External Pressure Calculations

From	To	Actual Len. Bet. Stiff. mm	Allow. Len. Bet. Stiff. mm	Ring Inertia Required mm**4	Ring Inertia Available mm**4
10	20	No Calc	No Calc	No Calc	No Calc
20	30	2039.89	113.3E+18	No Calc	No Calc
30	40	2039.89	256.6E+30	No Calc	No Calc
40	50	2039.89	256.6E+30	No Calc	No Calc
50	60	No Calc	No Calc	No Calc	No Calc

Elements Suitable for External Pressure.

Element and Detail Weights

From	To	Element Metal Wgt. kgm	ID	Element Volume ltr	Corroded Metal Wgt. kgm	Corroded ID Volume ltr	Extra due Misc % kgm
10	20	27.0248		23.1142	17.9217	23.9279	0.00000
20	30	192.301		309.934	128.344	318.100	0.00000
30	40	27.0789		21.4136	22.6601	21.9778	0.00000
40	50	27.0789		21.4136	22.6601	21.9778	0.00000
50	60	27.0248		23.1142	17.9217	23.9279	0.00000
Total		300		398.99	209	409.91	0

Weight of Details

From	Type	Weight of Detail kgm	X Offset, Dtl. Cent. mm	Y Offset, Dtl. Cent. mm	Description
10	Liqd	23.4789	0.00000	-122.833	MDEA
10	Nozl	7.91357	0.00000	-122.833	D
20	Liqd	314.824	0.00000	825.000	MDEA
20	Nozl	23.5539	342.925	160.000	O
20	Nozl	23.5539	342.925	1100.00	I
20	Nozl	2.73709	290.537	690.000	UC
20	Nozl	2.73709	290.537	1533.00	PSV
20	Legs	34.1423	0.00000	-170.000	LEGS
20	Wght	70.0000	515.000	1650.00	CABEZAL
20	Wght	50.0000	0.00000	295.000	PLACA+CARTUCHOS
30	Liqd	21.7515	0.00000	57.0000	MDEA
40	Liqd	21.7515	0.00000	57.0000	MDEA
50	Liqd	23.4789	0.00000	0.00000	MDEA
50	Nozl	2.77187	185.000	690.419	V
50	Nozl	0.19360	0.00000	690.419	P

Total Weight of Each Detail Type

Total Weight of Liquid	405.3
Total Weight of Nozzles	63.5
Total Weight of Legs	34.1
Total Weight of Weights	120.0
Sum of the Detail Weights	622.9 kgm

Weight Summary

Fabricated Wt.	- Bare Weight W/O Removable Internals	398.1 kgm
Shop Test Wt.	- Fabricated Weight + Water (Full)	796.9 kgm
Shipping Wt.	- Fab. Wt + Rem. Intls.+ Shipping App.	398.1 kgm
Erected Wt.	- Fab. Wt + Rem. Intls.+ Insul. (etc)	518.1 kgm
Ope. Wt. no Liq	- Fab. Wt + Intls. + Details + Wghts.	518.1 kgm

Operating Wt. - Empty Wt. + Operating Liquid (No CA) 853.4 kgm
Field Test Wt. - Empty Weight + Water (Full) 796.9 kgm
Mass of the Upper 1/3 of the Vertical Vessel 309.2 kgm

Outside Surface Areas of Elements

From	To	Surface Area mm²
10	20	346441.
20	30	2.633E+06
30	40	188741.
40	50	188741.
50	60	346441.
Total		3703646.000 mm²

Element and Detail Weights

From	To	Total Ele. Empty Wgt. kgm	Total. Ele. Oper. Wgt. kgm	Total. Ele. Hydro. Wgt. kgm	Total Dtl. Offset Mom. N-mm	Oper. Wgt. No Liquid kgm
10	20	34.9384	58.4173	58.0385	0.00000	34.9384
20	Legs	39.8054	66.5135	60.5048	18990.2	32.1690
Legs	30	325.077	543.193	494.123	155087.	262.714
30	40	27.0789	48.8303	48.4794	0.00000	27.0789
40	50	27.0789	48.8303	48.4794	0.00000	27.0789
50	60	29.9903	53.4692	53.0904	5030.52	29.9903

Cumulative Vessel Weight

From	To	Cumulative Ope Wgt. No Liquid kgm	Cumulative Oper. Wgt. kgm	Cumulative Hydro. Wgt. kgm
10	20	0.00000	0.00000	0.00000
20	Legs	-34.9384	-58.4173	-58.0385
Legs	30	346.862	694.323	644.172
30	40	84.1480	151.130	150.049
40	50	57.0691	102.299	101.570
50	60	29.9903	53.4692	53.0904

Note: The cumulative operating weights no liquid in the column above are the cumulative operating weights minus the operating liquid weight minus any weights absent in the empty condition.

Cumulative Vessel Moment

From	To	Cumulative Empty Mom. N-mm	Cumulative Oper. Mom. N-mm	Cumulative Hydro. Mom. N-mm

10	20	0.00000	0.00000	0.00000
20	Legs	18990.2	18990.2	18990.2
Legs	30	160117.	160117.	160117.
30	40	5030.52	5030.52	5030.52
40	50	5030.52	5030.52	5030.52
50	60	5030.52	5030.52	5030.52

Nozzle Flange MAWP Results :

Nozzle Description	Flange Rating Operating MPa	Ambient MPa	Temperature C	Class	Grade|Group
D	1.6	2.0	150	150	GR 1.1
O	1.6	2.0	150	150	GR 1.1
I	1.6	2.0	150	150	GR 1.1
Minimum Rating	1.582	1.965	MPa		

Note: ANSI Ratings are per ANSI/ASME B16.5 2003 Edition

The Natural Frequencies for the vessel have been computed iteratively by solving a system of matrices. These matrices describe the mass and the stiffness of the vessel. This is the generalized eigenvalue/ eigenvector problem and is referenced in some mathematical texts.

The Natural Frequency for the Vessel (Empty.) is 34.3509 Hz.

The Natural Frequency for the Vessel (Ope...) is 24.5846 Hz.

The Natural Frequency for the Vessel (Filled) is 26.4131 Hz.

Note: Using the User Defined Wind Profile ...

Wind Vibration Calculations

This evaluation is based on work by Kanti Mahajan and Ed Zorilla

Nomenclature

Cf - Correction factor for natural frequency
D - Average internal diameter of vessel mm
Df - Damping Factor < 0.75 Unstable, > 0.95 Stable
Dr - Average internal diameter of top half of vessel mm
f - Natural frequency of vibration (Hertz)
f1 - Natural frequency of bare vessel based on a unit value of $(D/L^2)(10^{(4)})$
L - Total height of structure mm
Lc - Total length of conical section(s) of vessel mm
tb - Uncorroded plate thickness at bottom of vessel mm
V30 - Design Wind Speed provided by user km/hr
Vc - Critical wind velocity km/hr
Vw - Maximum wind speed at top of structure km/hr
W - Total corroded weight of structure N
Ws - Cor. vessel weight excl. weight of parts which do not effect stiff. N
Z - Maximum amplitude of vibration at top of vessel mm
Dl - Logarithmic decrement (taken as 0.03 for Welded Structures)
Vp - Vib. Chance, <= 0.314E-05 (High); 0.314E-05 < 0.393E-05 (Probable)
P30 - wind pressure 30 feet above the base

Check other Conditions and Basic Assumptions:
#1 - Total Cone Length / Total Length < 0.5
0.000 / 1958.000 = 0.000

#2 - $(D / L^2) * 10^{(4)} < 8.0$ (English Units)
- $(1.67 / 6.42^2) * 10^{(4)} = 405.640$ [Geometry Violation]

Compute the vibration possibility. If Vp > 0.393E-05 no chance. [Vp]:
$= W / (L * Dr^2)$
$= 8162 / (1958.00 * 495.495^2)$
$= 0.16980E-04$

Since Vp is > 0.393E-05 no further vibration analysis is required !

Wind Loads on Masses/Equipment/Piping

ID	Wind Area mm^2	Elevation mm	Pressure kPa	Force N
CABEZAL	0.00	1690.00	1.19	0.00
PLACA+CARTUCH	0.00	335.00	1.19	0.00

The Natural Frequency for the Vessel (Ope...) is 24.5846 Hz.

Wind Load Calculation

From	To	Wind Height mm	Wind Diameter mm	Wind Area mm²	Height Factor kPa	Element Wind Load N
10	20	96.6615	609.600	87184.1	1.18853	103.619
20	30	987.833	609.600	1.006E+06	1.18853	1195.45
30	40	1869.83	632.400	72093.6	1.18853	85.6837
40	50	1983.83	632.400	72093.6	1.18853	85.6837
50	60	2115.34	609.600	87184.1	1.18853	103.619

The following table is for the Operating Case.

Wind/Earthquake Shear, Bending

From	To	Distance to Support mm	Cummulative Wind Shear N	Earthquake Shear N	Wind Bending N-mm	Earthquake Bending N-mm
10	20	254.506	0.00000	0.00000	0.00000	0.00000
20	Legs	90.0000	103.619	0.00000	3576.88	0.00000
Legs	30	735.000	1443.64	0.00000	1.200E+06	0.00000
30	40	1527.00	274.986	0.00000	46755.4	0.00000
40	50	1641.00	189.303	0.00000	20280.2	0.00000
50	60	1732.51	103.619	0.00000	3576.88	0.00000

Wind Deflection Calculations:

The following table is for the Operating Case.

Wind Deflection

From	To	Cumulative Wind Shear N	Centroid Deflection mm	Elem. End Deflection mm	Elem. Ang. Rotation
10	20	0.00000	0.32247	0.32247	0.00068804
20	Legs	103.619	0.32255	0.32281	0.00069173
Legs	30	1443.64	0.32976	0.34100	0.00070421
30	40	274.986	0.34192	0.34285	0.00070423
40	50	189.303	0.34377	0.34469	0.00070424
50	60	103.619	0.34502	0.34534	0.00070424

Critical Wind Velocity for Tower Vibration

From	To	1st Crit. Wind Speed km/hr	2nd Crit. Wind Speed km/hr
10	20	269.035	1681.47
20	30	269.035	1681.47
30	40	279.097	1744.36
40	50	279.097	1744.36
50	60	269.035	1681.47

Allowable deflection at the Tower Top (Ope)(6.000"/100ft. Criteria)
Allowable deflection : 9.790   Actual Deflection : 0.345 mm

Longitudinal Stress Constants

From	To	Metal Area New & Cold mm²	Metal Area Corroded mm²	New & Cold Sect. Mod. mm ³	Corroded Sect. Mod. mm ³
10	20	13082.9	8111.28	1.608E+06	1.010E+06
20	30	14877.8	9929.67	1.820E+06	1.230E+06
30	40	30322.7	25374.5	3.717E+06	3.149E+06
40	50	30322.7	25374.5	3.717E+06	3.149E+06
50	60	13082.9	8111.28	1.608E+06	1.010E+06

Longitudinal Allowable Stresses

From	To	All. Str. Long. Ten. MPa	All. Str. Hydr. Ten. MPa	All. Str. Long. Com. MPa	All. Str. Hyr. Comp. MPa
10	20	165.480	215.124	-130.122	-175.286
20	Legs	165.480	215.124	-134.658	-177.877
Legs	30	165.480	215.124	-134.658	-177.877
30	40	165.480	215.124	-147.212	-184.096
40	50	165.480	215.124	-147.212	-184.096
50	60	165.480	215.124	-130.122	-175.286

Longitudinal Stress Report

Note: Longitudinal Operating and Empty Stresses are computed in the corroded condition. Stresses due to loads in the hydrostatic test cases have been computed in the new and cold condition.

Longitudinal Stresses Due to . . .

From	To	Long. Str. Int. Pres. MPa	Long. Str. Ext. Pres. MPa	Long. Str. Hyd. Pres. MPa
10	20	37.7142	-2.58436	34.2180
20	30	30.5331	-2.11110	29.8174
30	40	11.9859	-0.88908	14.6733
40	50	11.9859	-0.88908	14.6733
50	60	37.7142	-2.58436	34.2180

Longitudinal Stresses Due to . . .

From	To	Wght. Str. Empty MPa	Wght. Str. Operating MPa	Wght. Str. Hydrotest MPa	Wght. Str. Emp. Mom. MPa	Wght. Str. Opr. Mom. MPa
10	20	0.00000	0.00000	0.00000	0.00000	0.00000
20	Legs	0.034506	0.057695	0.038257	0.015432	0.015432
Legs	30	-0.34257	-0.30865	-0.22864	0.13012	0.13012
30	40	-0.032522	-0.032522	-0.027215	0.0015972	0.0015972
40	50	-0.022056	-0.022056	-0.018457	0.0015972	0.0015972
50	60	-0.036259	-0.036259	-0.022481	0.0049815	0.0049815

Longitudinal Stresses Due to . . .

From	To	Wght. Str. Hyd. Mom. MPa	Bend. Str. Oper. Wind MPa	Bend. Str. Oper. Equ. MPa	Bend. Str. Hyd. Wind MPa	Bend. Str. Hyd. Equ. MPa
10	20	0.00000	0.00000	0.00000	0.00000	0.00000
20	Legs	0.010430	0.0029067	0.00000	0.00064830	0.00000
Legs	30	0.087942	0.97539	0.00000	0.21755	0.00000
30	40	0.0013528	0.014845	0.00000	0.0041493	0.00000
40	50	0.0013528	0.0064389	0.00000	0.0017998	0.00000
50	60	0.0031276	0.0035420	0.00000	0.00073387	0.00000

Longitudinal Stresses Due to . . .

From	To	Long. Str. Vortex Ope. MPa	Long. Str. Vortex Emp. MPa	Long. Str. Vortex Tst. MPa	EarthQuake Empty MPa
10	20	0.00000	0.00000	0.00000	0.00000
20	Legs	0.00000	0.00000	0.00000	0.00000

Longitudinal Stresses Due to . . . Step: 13 10:20a May 17,2010

Legs	30	0.00000	0.00000	0.00000	0.00000
30	40	0.00000	0.00000	0.00000	0.00000
40	50	0.00000	0.00000	0.00000	0.00000
50	60	0.00000	0.00000	0.00000	0.00000

Longitudinal Stresses Due to . . .

From	To	Long. Str. Y Forces W MPa	Long. Str. Y ForceS S MPa
10	20	0.00000	0.00000
20	Legs	0.00000	0.00000
Legs	30	0.00000	0.00000
30	40	0.00000	0.00000
40	50	0.00000	0.00000
50	60	0.00000	0.00000

Long. Stresses due to User Forces and Moments

From	To	Wind For/Mom Corroded MPa	Eqk For/Mom Corroded MPa	Wnd For/Mom No Corr. MPa	Eqk For/Mom No Corr. MPa
10	20	0.00000	0.00000	0.00000	0.00000
20	Legs	0.00000	0.00000	0.00000	0.00000
Legs	30	0.00000	0.00000	0.00000	0.00000
30	40	0.00000	0.00000	0.00000	0.00000
40	50	0.00000	0.00000	0.00000	0.00000
50	60	0.00000	0.00000	0.00000	0.00000

Stress Combination Load Cases for Vertical Vessels:

Load Case Definition Key

IP = Longitudinal Stress due to Internal Pressure
EP = Longitudinal Stress due to External Pressure
HP = Longitudinal Stress due to Hydrotest Pressure
NP = No Pressure
EW = Longitudinal Stress due to Weight (No Liquid)
OW = Longitudinal Stress due to Weight (Operating)
HW = Longitudinal Stress due to Weight (Hydrotest)
WI = Bending Stress due to Wind Moment (Operating)
EQ = Bending Stress due to Earthquake Moment (Operating)
EE = Bending Stress due to Earthquake Moment (Empty)
HI = Bending Stress due to Wind Moment (Hydrotest)
HE = Bending Stress due to Earthquake Moment (Hydrotest)
WE = Bending Stress due to Wind Moment (Empty) (no CA)
WF = Bending Stress due to Wind Moment (Filled) (no CA)
CW = Longitudinal Stress due to Weight (Empty) (no CA)
VO = Bending Stress due to Vortex Shedding Loads (Ope)
VE = Bending Stress due to Vortex Shedding Loads (Emp)
VF = Bending Stress due to Vortex Shedding Loads (Test No CA.)
FW = Axial Stress due to Vertical Forces for the Wind Case
FS = Axial Stress due to Vertical Forces for the Seismic Case
BW = Bending Stress due to Lat. Forces for the Wind Case, Corroded
BS = Bending Stress due to Lat. Forces for the Seismic Case, Corroded
BN = Bending Stress due to Lat. Forces for the Wind Case, UnCorroded
BU = Bending Stress due to Lat. Forces for the Seismic Case, UnCorroded

General Notes:

Case types HI and HE are in the Un-Corroded condition.

Case types WE, WF, and CW are in the Un-Corroded condition.

A blank stress and stress ratio indicates that the corresponding stress comprising those components that did not contribute to that type of stress.

An asterisk (*) in the final column denotes overstress.

Analysis of Load Case 1 : NP+EW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	165.48	0.00	130.12	0.0000	0.0000
20	0.05	165.48		134.66	0.0003	
20	0.76	165.48	-1.45	134.66	0.0046	0.0108
30		165.48	-0.05	147.21		0.0003
40		165.48	-0.03	147.21		0.0002
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 2 : NP+EW+EE+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	165.48	0.00	130.12	0.0000	0.0000
20	0.05	165.48		134.66	0.0003	
20		165.48	-0.47	134.66		0.0035
30		165.48	-0.03	147.21		0.0002
40		165.48	-0.02	147.21		0.0002
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 3 : NP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	165.48	0.00	130.12	0.0000	0.0000
20	0.08	165.48		134.66	0.0005	
20	0.80	165.48	-1.41	134.66	0.0048	0.0105
30		165.48	-0.05	147.21		0.0003
40		165.48	-0.03	147.21		0.0002
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 4 : NP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	165.48	0.00	130.12	0.0000	0.0000
20	0.07	165.48		134.66	0.0004	
20		165.48	-0.44	134.66		0.0033
30		165.48	-0.03	147.21		0.0002
40		165.48	-0.02	147.21		0.0002
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 5 : NP+HW+HI

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	215.12	0.00	175.29	0.0000	0.0000
20	0.05	215.12		177.88	0.0002	
20	0.08	215.12	-0.53	177.88	0.0004	0.0030
30		215.12	-0.03	184.10		0.0002
40		215.12	-0.02	184.10		0.0001
50		215.12	-0.03	175.29		0.0002

Analysis of Load Case 6 : NP+HW+HE

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	215.12	0.00	175.29	0.0000	0.0000
20	0.05	215.12		177.88	0.0002	
20		215.12	-0.32	177.88		0.0018
30		215.12	-0.03	184.10		0.0002
40		215.12	-0.02	184.10		0.0001
50		215.12	-0.03	175.29		0.0001

Analysis of Load Case 7 : IP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio

10	37.71	165.48		130.12	0.2279	
20	30.61	165.48		134.66	0.1850	
20	12.78	165.48		134.66	0.0772	
30	11.97	165.48		147.21	0.0723	
40	37.70	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 8 : IP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.61	165.48		134.66	0.1850	
20	11.81	165.48		134.66	0.0714	
30	11.95	165.48		147.21	0.0722	
40	37.69	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 9 : EP+OW+WI+FW+BW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10		165.48	-2.58	130.12		0.0199
20		165.48	-2.07	134.66		0.0154
20		165.48	-2.30	134.66		0.0171
30		165.48	-0.94	147.21		0.0064
40		165.48	-2.61	147.21		0.0178
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 10 : EP+OW+EQ+FS+BS

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10		165.48	-2.58	130.12		0.0199
20		165.48	-2.07	134.66		0.0154
20		165.48	-1.33	134.66		0.0099
30		165.48	-0.92	147.21		0.0063
40		165.48	-2.61	147.21		0.0177
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 11 : HP+HW+HI

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	34.22	215.12		175.29	0.1591	
20	29.87	215.12		177.88	0.1388	
20	14.75	215.12		177.88	0.0686	
30	14.65	215.12		184.10	0.0681	
40	34.20	215.12		184.10	0.1590	
50		215.12	-0.03	175.29		0.0002

Analysis of Load Case 12 : HP+HW+HE

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	34.22	215.12		175.29	0.1591	
20	29.87	215.12		177.88	0.1388	
20	14.53	215.12		177.88	0.0676	

30	14.65	215.12		184.10	0.0681	
40	34.20	215.12		184.10	0.1590	
50		215.12	-0.03	175.29		0.0001

Analysis of Load Case 13 : IP+WE+EW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.58	165.48		134.66	0.1848	
20	11.77	165.48		134.66	0.0711	
30	11.95	165.48		147.21	0.0722	
40	37.69	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 14 : IP+WF+CW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.59	165.48		134.66	0.1848	
20	11.78	165.48		134.66	0.0712	
30	11.96	165.48		147.21	0.0723	
40	37.70	165.48		147.21	0.2278	
50		165.48	-0.02	130.12		0.0002

Analysis of Load Case 15 : IP+VO+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.61	165.48		134.66	0.1850	
20	11.81	165.48		134.66	0.0714	
30	11.95	165.48		147.21	0.0722	
40	37.69	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 16 : IP+VE+EW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.58	165.48		134.66	0.1848	
20	11.77	165.48		134.66	0.0711	
30	11.95	165.48		147.21	0.0722	
40	37.69	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 17 : NP+VO+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	0.00	165.48	0.00	130.12	0.0000	0.0000
20	0.07	165.48		134.66	0.0004	
20		165.48	-0.44	134.66		0.0033
30		165.48	-0.03	147.21		0.0002
40		165.48	-0.02	147.21		0.0002
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 18 : FS+BS+IP+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	37.71	165.48		130.12	0.2279	
20	30.61	165.48		134.66	0.1850	
20	11.81	165.48		134.66	0.0714	
30	11.95	165.48		147.21	0.0722	
40	37.69	165.48		147.21	0.2278	
50		165.48	-0.04	130.12		0.0003

Analysis of Load Case 19 : FS+BS+EP+OW

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10		165.48	-2.58	130.12		0.0199
20		165.48	-2.07	134.66		0.0154
20		165.48	-1.33	134.66		0.0099
30		165.48	-0.92	147.21		0.0063
40		165.48	-2.61	147.21		0.0177
50		165.48	-0.04	130.12		0.0003

Absolute Maximum of the all of the Stress Ratio's 0.2279

Governing Element: CAB. INF.
Governing Load Case 7 : IP+OW+WI+FW+BW

Shop/Field Installation Options :

Note : The CG is computed from the first Element From Node

Center of Gravity of Liquid	969.6 mm
Center of Gravity of Nozzles	703.2 mm
Center of Gravity of Legs	-130.0 mm
Center of Gravity of Added Weights (Empty)	1125.4 mm
Center of Gravity of Added Weights (Operating)	335.0 mm
Center of Gravity of Bare Shell New and Cold	1054.73 mm
Center of Gravity of Bare Shell Corroded	1087.63 mm
Vessel CG in the Operating Condition	888.98 mm
Vessel CG in the Fabricated (Shop/Empty) Condition	949.98 mm

RESULTS FOR LEGS : Operating Case Description: LEGS

Legs attached to: CUERPO

Section Properties : Single Angle L3X3X0.3125

USA AISC 1989 Steel Table

Overall Leg Length		700.000	mm
Effective Leg Length	Leglen	550.000	mm
Distance Leg Up Side of Vessel		180.000	mm
Number of Legs	Nleg	4	
Cross Sectional Area for L3X3X0.3125	Aleg	1148.385	mm^2
Section Inertia (strong axis)		628508.812	mm**4
Section Inertia (weak axis)		628508.812	mm**4
Section Modulus (strong axis)		11585.653	mm^3
Section Modulus (weak axis)		11585.653	mm^3
Radius of Gyration (strong axis)		23.419	mm
Radius of Gyration (weak axis)		23.419	mm

Leg Orientation - Diagonal

Overturning Moment at top of Legs		1553938.9	N-mm
Total Weight Load at top of Legs	W	8033.6	N
Total Shear force at top of Legs		1574.1	N
Additional force in Leg due to Bracing	Fadd	0.0	N
Occasional Load Factor	Occfac	1.333	
Effective Leg End Condition Factor	k	1.000	

Note: The Legs are Not Cross Braced
The Leg Shear Force includes Wind and Seismic Effects

Maximum Shear at top of one Leg [Vleg]:
= (Max(Wind, Seismic) + Fadd) * (Imax / Itot)
= (1574.1 + 0.0) * (1000107 / 2513800)
= 626.23 N

Axial Compression, Leg futhest from N.A. [Sma]
= ((W/Nleg)+(Mleg/(Nlegm*Rn)))/Aleg)
= ((8033 / 4) + (1553938 /(2 * 277.79)))/ 1148.385)
= 4.18 MPa

Axial Compression, Leg closest to N.A. [Sva]
= (W / Nleg) / Aleg
= (8033 / 4) / 1148.385
= 1.75 MPa

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness:	76.200	76.200	7.9375
Distance to geometric centroid:	21.971	21.971	
Arm about YY:	18.002	20.098	
Arm about ZZ:	16.129	18.002	

Leg Check, (Operating Case) : Step: 16 10:20a May 17,2010

Leg areas:	604.84	541.83
Geometric inertia components YY:	0.19919E+06	0.42926E+06
Geometric inertia components ZZ:	0.45001E+06	0.17844E+06
Geometric inertias Iy & Iz:	0.62845E+06	0.62845E+06
Product of inertia:	0.37166E+06	
Mohrs Radius:	22.680	
Average Inertia:	0.62845E+06	

QFACT = 1.0000	FBZ	= 0.16383	
Principal Axis Inertias (Z&W)		= 0.25679E+06	0.10001E+07
Angle to Principal Axis		= 45.000	
Distances to extreme fibers CW & CZ		= 53.882	22.810
FOB from Eq 5-5		= 2.8111	
Bending allowables Fby & Fbz		= 0.16383	0.16383

Shear Center Coordinates Wo & Zo:	24.850	0.0000		
Values for Elastic Flexural-Torsional Buckling Stress:				
E, G, J, $R0^2$:	29500.	11346.	0.57943E-01	2.6536
AREA, LENGTH, Kw, Kz:	1.7800	21.654	1.0000	1.0000
H, Few, Fez, Fej:	0.63931	838.22	215.22	139.18
Fe computed from C4-1:	130.50			

Initial (Kl/r)max, & (Kl/r)equiv	= 36.780	47.233
Final (Kl/r)max, & Cc	= 47.233	127.18
Fa based on Eq 4-1	= 0.12842	

	Actual	Allowable	
Weak Axis Bending :	21.64	218.38	MPa
Strong Axis Bending :	13.12	218.38	MPa
Axial Compression :	4.18	171.19	MPa

UNITY CHECKS ARE: H1-1 0.000
H1-2 0.000
H1-3 0.184

AISC Unity Check : 0.184 Should be <= to 1

WRC 107 Stress Analysis for Leg to Shell Junction, Ope Condition

Rectangular Attachment Parameter	C11	107.763	mm
Rectangular Attachment Parameter	C22	180.000	mm

Input Echo, WRC107 Item 1, Description: LEGS

Diameter Basis for Vessel	Vbasis	ID	
Cylindrical or Spherical Vessel	Cylsph	Cylindrical	
Internal Corrosion Allowance	Cas	3.2000	mm
Vessel Diameter	Dv	489.000	mm
Vessel Thickness	Tv	9.500	mm

Design Temperature		150.00	C
Attachment Type	Type	Rectangular	

Parameter C11	C11	107.76	mm
Parameter C22	C22	180.00	mm
Design Internal Pressure	Dp	1.569	MPa
Include Pressure Thrust		No	
Vessel Centerline Direction Cosine	Vx	0.000	
Vessel Centerline Direction Cosine	Vy	1.000	
Vessel Centerline Direction Cosine	Vz	0.000	
Nozzle Centerline Direction Cosine	Nx	1.000	
Nozzle Centerline Direction Cosine	Ny	0.000	
Nozzle Centerline Direction Cosine	Nz	0.000	
Global Force (SUS)	Fx	0.0	N
Global Force (SUS)	Fy	2008.4	N
Global Force (SUS)	Fz	0.0	N
Global Moment (SUS)	Mx	0.0	N-mm
Global Moment (SUS)	My	0.0	N-mm
Global Moment (SUS)	Mz	47789.2	N-mm
Internal Pressure (SUS)	P	1.57	MPa
Include Pressure Thrust		No	
Global Force (OCC)	Fx	626.2	N
Global Force (OCC)	Fy	2795.9	N
Global Force (OCC)	Fz	0.0	N
Global Moment (OCC)	Mx	0.0	N-mm
Global Moment (OCC)	My	0.0	N-mm
Global Moment (OCC)	Mz	238810.6	N-mm
Occasional Internal Pressure (OCC)	Pvar	0.00	MPa
Use Interactive Control		No	
WRC107 Version	Version	March 1979	
Include Pressure Stress Indices per Div. 2		No	
Compute Pressure Stress per WRC-368		No	

WRC 107 Stress Calculation for SUStained loads:

Radial Load	P	0.0	N
Circumferential Shear	VC	0.0	N
Longitudinal Shear	VL	2008.4	N
Circumferential Moment	MC	0.0	N-mm
Longitudinal Moment	ML	-47789.2	N-mm
Torsional Moment	MT	0.0	N-mm

Dimensionless Parameters used : Gamma = 39.82

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979	Beta	Figure	Value	Location

N(PHI) / (P/Rm)	0.349	4C	3.904	(A,B)
N(PHI) / (P/Rm)	0.349	3C	1.741	(C,D)
M(PHI) / (P)	0.260	2C1	0.022	(A,B)
M(PHI) / (P)	0.260	1C !	0.062	(C,D)
N(PHI) / (MC/(Rm**2 * Beta))	0.255	3A	1.540	(A,B,C,D)
M(PHI) / (MC/(Rm * Beta))	0.277	1A	0.068	(A,B,C,D)
N(PHI) / (ML/(Rm**2 * Beta))	0.302	3B	2.890	(A,B,C,D)
M(PHI) / (ML/(Rm * Beta))	0.290	1B	0.014	(A,B,C,D)
N(x) / (P/Rm)	0.307	3C	2.083	(A,B)
N(x) / (P/Rm)	0.307	4C	4.345	(C,D)
M(x) / (P)	0.315	1C1	0.036	(A,B)
M(x) / (P)	0.315	2C !	0.032	(C,D)
N(x) / (MC/(Rm**2 * Beta))	0.255	4A	3.502	(A,B,C,D)
M(x) / (MC/(Rm * Beta))	0.332	2A	0.026	(A,B,C,D)
N(x) / (ML/(Rm**2 * Beta))	0.302	4B	1.469	(A,B,C,D)
M(x) / (ML/(Rm * Beta))	0.330	2B	0.018	(A,B,C,D)

Note - The ! mark next to the figure name denotes curve value exceeded.

Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of Stress	Load	Stress Values at (MPa) Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb.	P	0	0	0	0	0	0	0	0
Circ. Bend.	P	0	0	0	0	0	0	0	0
Circ. Memb.	MC	0	0	0	0	0	0	0	0
Circ. Bend.	MC	0	0	0	0	0	0	0	0
Circ. Memb.	ML	1	1	-1	-1	0	0	0	0
Circ. Bend.	ML	1	-1	-1	1	0	0	0	0
Tot. Circ. Str.		2.4	-0.3	-2.4	0.3	0.0	0.0	0.0	0.0
Long. Memb.	P	0	0	0	0	0	0	0	0
Long. Bend.	P	0	0	0	0	0	0	0	0
Long. Memb.	MC	0	0	0	0	0	0	0	0
Long. Bend.	MC	0	0	0	0	0	0	0	0
Long. Memb.	ML	0	0	0	0	0	0	0	0
Long. Bend.	ML	1	-1	-1	1	0	0	0	0
Tot. Long. Str.		2.2	-0.9	-2.2	0.9	0.0	0.0	0.0	0.0
Shear	VC	0	0	0	0	0	0	0	0
Shear	VL	0	0	0	0	0	0	0	0
Shear	MT	0	0	0	0	0	0	0	0

Tot. Shear	0.0	0.0	0.0	0.0	-0.9	-0.9	0.9	0.9
Str. Int.	2.35	0.90	2.35	0.90	1.77	1.77	1.77	1.77

WRC 107 Stress Calculation for OCCasional loads:

Radial Load	P	626.2	N
Circumferential Shear	VC	0.0	N
Longitudinal Shear	VL	2795.9	N
Circumferential Moment	MC	0.0	N-mm
Longitudinal Moment	ML	-238810.6	N-mm
Torsional Moment	MT	0.0	N-mm

Dimensionless Parameters used : Gamma = 39.82
Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of	Stress Values at (MPa)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	-1	-1	-1	-1	0	0	0	0
Circ. Bend. P	-2	2	-2	2	-5	5	-5	5
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	5	5	-5	-5	0	0	0	0
Circ. Bend. ML	6	-6	-6	6	0	0	0	0
Tot. Circ. Str.	8.2	-1.2	-15.3	2.2	-6.6	5.2	-6.6	5.2
Long. Memb. P	0	0	0	0	-1	-1	-1	-1
Long. Bend. P	-3	3	-3	3	-3	3	-3	3
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	3	3	-3	-3	0	0	0	0
Long. Bend. ML	7	-7	-7	7	0	0	0	0
Tot. Long. Str.	7.0	-1.9	-15.4	7.0	-4.8	1.3	-4.8	1.3
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	-1	-1	1	1
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0.0	0.0	0.0	0.0	-1.2	-1.2	1.2	1.2
Str. Int.	8.17	1.94	15.36	7.01	7.22	5.58	7.22	5.58

WRC 107 Stress Summations:

Vessel Stress Summation at Attachment Junction

Type of Stress Int.	Stress Values at (MPa)							
Location	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)	60	62	60	62	60	62	60	62
Circ. Pm (OCC)	0	0	0	0	0	0	0	0
Circ. Pm(TOTAL)	60.9	62.5	60.9	62.5	60.9	62.5	60.9	62.5
Circ. Pl (SUS)	1	1	-1	-1	0	0	0	0
Circ. Pl (OCC)	3	3	-6	-6	0	0	0	0
Circ. Pl(TOTAL)	4.5	4.5	-7.6	-7.6	-0.7	-0.7	-0.7	-0.7
Circ. Q (SUS)	1	-1	-1	1	0	0	0	0
Circ. Q (OCC)	4	-4	-8	8	-5	5	-5	5
Circ. Q (TOTAL)	6.1	-6.1	-10.1	10.1	-5.9	5.9	-5.9	5.9
Long. Pm (SUS)	30	30	30	30	30	30	30	30
Long. Pm (OCC)	0	0	0	0	0	0	0	0
Long. Pm(TOTAL)	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
Long. Pl (SUS)	0	0	0	0	0	0	0	0
Long. Pl (OCC)	2	2	-4	-4	-1	-1	-1	-1
Long. Pl(TOTAL)	3.2	3.2	-4.8	-4.8	-1.7	-1.7	-1.7	-1.7
Long. Q (SUS)	1	-1	-1	1	0	0	0	0
Long. Q (OCC)	4	-4	-11	11	-3	3	-3	3
Long. Q (TOTAL)	6.0	-6.0	-12.8	12.8	-3.0	3.0	-3.0	3.0
Shear Pm (SUS)	0	0	0	0	0	0	0	0
Shear Pm (OCC)	0	0	0	0	0	0	0	0
Shear Pm(TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pl (SUS)	0	0	0	0	0	0	0	0
Shear Pl (OCC)	0	0	0	0	-1	-1	1	1
Shear Pl(TOTAL)	0.0	0.0	0.0	0.0	-2.1	-2.1	2.1	2.1
Shear Q (SUS)	0	0	0	0	0	0	0	0
Shear Q (OCC)	0	0	0	0	0	0	0	0
Shear Q (TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pm (SUS)	60.9	62.5	60.9	62.5	60.9	62.5	60.9	62.5
Pm (SUS+OCC)	60.9	62.5	60.9	62.5	60.9	62.5	60.9	62.5
Pm+Pl (SUS)	61.9	63.5	59.9	61.5	60.9	62.5	60.9	62.5
Pm+Pl (SUS+OCC)	65.4	67.0	53.4	54.9	60.4	61.9	60.4	61.9
Pm+Pl+Q (Total)	71.4	60.9	43.2	65.1	54.5	67.8	54.5	67.8

Type of Stress Int.	Max. S.I. MPa	S.I. Allowable	Result
Pm (SUS)	62.49	137.90	Passed

Pm (SUS+OCC)	62.49	165.48	Passed
Pm+Pl (SUS)	63.49	206.85	Passed
Pm+Pl (SUS+OCC)	66.95	248.22	Passed
Pm+Pl+Q (TOTAL)	71.44	413.70	Passed

Bolting Size Requirement for Leg Baseplates :

Baseplate Material		SA-36	
Baseplate Allowable Stress	SBA	114.46	MPa
Baseplate Length	B	150.0000	mm
Baseplate Width	D	150.0000	mm
Baseplate Thickness	BTHK	12.7000	mm
Leg Dimension Along Baseplate Length	d	76.2000	mm
Leg Dimension Along Baseplate Width	b	76.2000	mm
Dist. from the Leg Edge to Bolt Hole Center	z	76.2000	mm
Bolt Material		SA-307 B	
Bolt Allowable Stress	STBA	48.26	MPa
Anchor Bolt Nominal Diameter	BOD	25.4000	mm
Number of Anchor Bolts in Tension per Leg	NB	1	
Total Number of Anchors Bolt per Leg	NBT	1	
Ultimate 28-day Concrete Strength	FCPRIME	20.685	MPa

Plate thickness required (1/2"; 13mm) per D. Moss

Since there is only 1 bolt, the standard computation for this geometry is not possible. A reasonable bolt size should be selected. Per Megyesy, use a 1 inch (25.4 mm) bolt.

RESULTS FOR LEGS : HydroTest Case Description: LEGS

Legs attached to: CUERPO

Section Properties : Single Angle L3X3X0.3125

USA AISC 1989 Steel Table

Overall Leg Length		700.000	mm
Effective Leg Length	Leglen	550.000	mm
Distance Leg Up Side of Vessel		180.000	mm
Number of Legs	Nleg	4	
Cross Sectional Area for L3X3X0.3125	Aleg	1148.385	mm^2
Section Inertia (strong axis)		628508.812	mm**4
Section Inertia (weak axis)		628508.812	mm**4
Section Modulus (strong axis)		11585.653	mm^3
Section Modulus (weak axis)		11585.653	mm^3
Radius of Gyration (strong axis)		23.419	mm
Radius of Gyration (weak axis)		23.419	mm

Leg Orientation - Diagonal

Overturning Moment at top of Legs		749745.0	N-mm
Total Weight Load at top of Legs	W	7479.2	N
Total Shear force at top of Legs		519.4	N
Additional force in Leg due to Bracing	Fadd	0.0	N
Occasional Load Factor	Occfac	1.333	
Effective Leg End Condition Factor	k	1.000	

Note: The Legs are Not Cross Braced
The Leg Shear Force includes Wind and Seismic Effects

Maximum Shear at top of one Leg [Vleg]:
= (Max(Wind, Seismic) + Fadd) * (Imax / Itot)
= (519.4 + 0.0) * (1000107 / 2513800)
= 206.66 N

Axial Compression, Leg futhest from N.A. [Sma]
= ((W/Nleg)+(Mleg/(Nlegm*Rn)))/Aleg)
= ((7479 / 4) + (749745 /(2 * 277.79)))/ 1148.385)
= 2.80 MPa

Axial Compression, Leg closest to N.A. [Sva]
= (W / Nleg) / Aleg
= (7479 / 4) / 1148.385
= 1.63 MPa

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness:	76.200	76.200	7.9375
Distance to geometric centroid:	21.971	21.971	
Arm about YY:	18.002	20.098	
Arm about ZZ:	16.129	18.002	

```
Leg areas:                          604.84      541.83
Geometric inertia components YY: 0.19919E+06 0.42926E+06
Geometric inertia components ZZ: 0.45001E+06 0.17844E+06
Geometric inertias Iy & Iz:      0.62845E+06 0.62845E+06
Product of inertia:              0.37166E+06
Mohrs Radius:                     22.680
Average Inertia:                 0.62845E+06

QFACT =   1.0000        FBZ         =  0.16383
Principal Axis Inertias (Z&W)       =  0.25679E+06 0.10001E+07
Angle to Principal Axis             =   45.000
Distances to extreme fibers CW & CZ =   53.882      22.810
FOB from Eq 5-5                     =   2.8111
Bending allowables Fby & Fbz        =  0.16383     0.16383

Shear Center Coordinates Wo & Zo:   24.850      0.0000
Values for Elastic Flexural-Torsional Buckling Stress:
E,    G,      J,   R0²:    29500.      11346.     0.57943E-01  2.6536
AREA, LENGTH, Kw,  Kz:     1.7800      21.654      1.0000      1.0000
H,    Few,    Fez, Fej:   0.63931      838.22      215.22      139.18
Fe computed from C4-1:     130.50

Initial (Kl/r)max, & (Kl/r)equiv    =   36.780      47.233
Final (Kl/r)max, & Cc               =   47.233      127.18
Fa based on Eq 4-1                  =  0.12842

                              Actual   Allowable
Weak Axis Bending    :          7.14      218.38   MPa
Strong Axis Bending  :          4.33      218.38   MPa
Axial Compression    :          2.80      171.19   MPa

UNITY CHECKS ARE: H1-1     0.000
                  H1-2     0.000
                  H1-3     0.069

AISC Unity Check :   0.069 Should be <= to 1

WRC 107 Stress Analysis for Leg to Shell Junction, Test Condition

Rectangular Attachment Parameter            C11     107.763  mm
Rectangular Attachment Parameter            C22     180.000  mm

Input Echo, WRC107 Item     1,           Description: LEGS

Diameter Basis for Vessel                Vbasis      ID
Cylindrical or Spherical Vessel          Cylsph      Cylindrical
Internal Corrosion Allowance                Cas      0.0000  mm
Vessel Diameter                              Dv     489.000  mm
Vessel Thickness                             Tv       9.500  mm

Design Temperature                                    150.00  C

Attachment Type                             Type      Rectangular
```

Parameter C11	C11	107.76	mm
Parameter C22	C22	180.00	mm
Design Internal Pressure	Dp	1.569	MPa
Include Pressure Thrust		No	
Vessel Centerline Direction Cosine	Vx	0.000	
Vessel Centerline Direction Cosine	Vy	1.000	
Vessel Centerline Direction Cosine	Vz	0.000	
Nozzle Centerline Direction Cosine	Nx	1.000	
Nozzle Centerline Direction Cosine	Ny	0.000	
Nozzle Centerline Direction Cosine	Nz	0.000	
Global Force (SUS)	Fx	0.0	N
Global Force (SUS)	Fy	1869.8	N
Global Force (SUS)	Fz	0.0	N
Global Moment (SUS)	Mx	0.0	N-mm
Global Moment (SUS)	My	0.0	N-mm
Global Moment (SUS)	Mz	44491.1	N-mm
Internal Pressure (SUS)	P	1.57	MPa
Include Pressure Thrust		No	
Global Force (OCC)	Fx	206.7	N
Global Force (OCC)	Fy	1349.0	N
Global Force (OCC)	Fz	0.0	N
Global Moment (OCC)	Mx	0.0	N-mm
Global Moment (OCC)	My	0.0	N-mm
Global Moment (OCC)	Mz	88951.6	N-mm
Occasional Internal Pressure (OCC)	Pvar	0.00	MPa
Use Interactive Control		No	
WRC107 Version	Version	March 1979	
Include Pressure Stress Indices per Div. 2		No	
Compute Pressure Stress per WRC-368		No	

WRC 107 Stress Calculation for SUStained loads:

Radial Load	P	0.0	N
Circumferential Shear	VC	0.0	N
Longitudinal Shear	VL	1869.8	N
Circumferential Moment	MC	0.0	N-mm
Longitudinal Moment	ML	-44491.1	N-mm
Torsional Moment	MT	0.0	N-mm

Dimensionless Parameters used : Gamma = 26.24

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979	Beta	Figure	Value	Location

N(PHI) / (P/Rm)	0.351	4C	2.940	(A,B)
N(PHI) / (P/Rm)	0.351	3C	1.524	(C,D)
M(PHI) / (P)	0.261	2C1	0.029	(A,B)
M(PHI) / (P)	0.261	1C !	0.060	(C,D)
N(PHI) / (MC/(Rm**2 * Beta))	0.256	3A	1.123	(A,B,C,D)
M(PHI) / (MC/(Rm * Beta))	0.280	1A	0.076	(A,B,C,D)
N(PHI) / (ML/(Rm**2 * Beta))	0.304	3B	2.298	(A,B,C,D)
M(PHI) / (ML/(Rm * Beta))	0.294	1B	0.020	(A,B,C,D)
N(x) / (P/Rm)	0.309	3C	1.773	(A,B)
N(x) / (P/Rm)	0.309	4C	3.190	(C,D)
M(x) / (P)	0.317	1C1	0.045	(A,B)
M(x) / (P)	0.317	2C !	0.030	(C,D)
N(x) / (MC/(Rm**2 * Beta))	0.256	4A	2.063	(A,B,C,D)
M(x) / (MC/(Rm * Beta))	0.338	2A	0.030	(A,B,C,D)
N(x) / (ML/(Rm**2 * Beta))	0.304	4B	1.058	(A,B,C,D)
M(x) / (ML/(Rm * Beta))	0.334	2B	0.027	(A,B,C,D)

Note - The ! mark next to the figure name denotes curve value exceeded.

Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of Stress	Load	Stress Values at (MPa) Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb.	P	0	0	0	0	0	0	0	0
Circ. Bend.	P	0	0	0	0	0	0	0	0
Circ. Memb.	MC	0	0	0	0	0	0	0	0
Circ. Bend.	MC	0	0	0	0	0	0	0	0
Circ. Memb.	ML	0	0	0	0	0	0	0	0
Circ. Bend.	ML	0	0	0	0	0	0	0	0
Tot. Circ. Str.		1.3	-0.3	-1.3	0.3	0.0	0.0	0.0	0.0
Long. Memb.	P	0	0	0	0	0	0	0	0
Long. Bend.	P	0	0	0	0	0	0	0	0
Long. Memb.	MC	0	0	0	0	0	0	0	0
Long. Bend.	MC	0	0	0	0	0	0	0	0
Long. Memb.	ML	0	0	0	0	0	0	0	0
Long. Bend.	ML	0	0	0	0	0	0	0	0
Tot. Long. Str.		1.3	-0.7	-1.3	0.7	0.0	0.0	0.0	0.0
Shear	VC	0	0	0	0	0	0	0	0
Shear	VL	0	0	0	0	0	0	0	0
Shear	MT	0	0	0	0	0	0	0	0

Tot. Shear	0.0	0.0	0.0	0.0	-0.5	-0.5	0.5	0.5
Str. Int.	1.28	0.65	1.28	0.65	1.09	1.09	1.09	1.09

WRC 107 Stress Calculation for OCCasional loads:

Radial Load	P	206.7	N
Circumferential Shear	VC	0.0	N
Longitudinal Shear	VL	1349.0	N
Circumferential Moment	MC	0.0	N-mm
Longitudinal Moment	ML	-88951.6	N-mm
Torsional Moment	MT	0.0	N-mm

Dimensionless Parameters used : Gamma = 26.24
Stress Concentration Factors Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction

Type of	Stress Values at (MPa)							
Stress Load	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P	0	0	0	0	0	0	0	0
Circ. Bend. P	0	0	0	0	0	0	0	0
Circ. Memb. MC	0	0	0	0	0	0	0	0
Circ. Bend. MC	0	0	0	0	0	0	0	0
Circ. Memb. ML	0	0	0	0	0	0	0	0
Circ. Bend. ML	1	-1	-1	1	0	0	0	0
Tot. Circ. Str.	1.9	-0.4	-3.2	0.7	-1.0	0.7	-1.0	0.7
Long. Memb. P	0	0	0	0	0	0	0	0
Long. Bend. P	0	0	0	0	0	0	0	0
Long. Memb. MC	0	0	0	0	0	0	0	0
Long. Bend. MC	0	0	0	0	0	0	0	0
Long. Memb. ML	0	0	0	0	0	0	0	0
Long. Bend. ML	1	-1	-1	1	0	0	0	0
Tot. Long. Str.	1.8	-0.8	-3.3	1.8	-0.7	0.1	-0.7	0.1
Shear VC	0	0	0	0	0	0	0	0
Shear VL	0	0	0	0	0	0	0	0
Shear MT	0	0	0	0	0	0	0	0
Tot. Shear	0.0	0.0	0.0	0.0	-0.4	-0.4	0.4	0.4
Str. Int.	1.91	0.85	3.29	1.76	1.24	0.96	1.24	0.96

WRC 107 Stress Summations:

Vessel Stress Summation at Attachment Junction

Type of Stress Int.	Stress Values at (MPa)							
Location	Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)	39	41	39	41	39	41	39	41
Circ. Pm (OCC)	0	0	0	0	0	0	0	0
Circ. Pm(TOTAL)	39.6	41.2	39.6	41.2	39.6	41.2	39.6	41.2
Circ. Pl (SUS)	0	0	0	0	0	0	0	0
Circ. Pl (OCC)	0	0	-1	-1	0	0	0	0
Circ. Pl(TOTAL)	1.2	1.2	-1.7	-1.7	-0.1	-0.1	-0.1	-0.1
Circ. Q (SUS)	0	0	0	0	0	0	0	0
Circ. Q (OCC)	1	-1	-1	1	0	0	0	0
Circ. Q (TOTAL)	2.0	-2.0	-2.8	2.8	-0.8	0.8	-0.8	0.8
Long. Pm (SUS)	19	19	19	19	19	19	19	19
Long. Pm (OCC)	0	0	0	0	0	0	0	0
Long. Pm(TOTAL)	19.8	19.8	19.8	19.8	19.8	19.8	19.8	19.8
Long. Pl (SUS)	0	0	0	0	0	0	0	0
Long. Pl (OCC)	0	0	0	0	0	0	0	0
Long. Pl(TOTAL)	0.8	0.8	-1.1	-1.1	-0.3	-0.3	-0.3	-0.3
Long. Q (SUS)	0	0	0	0	0	0	0	0
Long. Q (OCC)	1	-1	-2	2	0	0	0	0
Long. Q (TOTAL)	2.3	-2.3	-3.5	3.5	-0.4	0.4	-0.4	0.4
Shear Pm (SUS)	0	0	0	0	0	0	0	0
Shear Pm (OCC)	0	0	0	0	0	0	0	0
Shear Pm(TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pl (SUS)	0	0	0	0	0	0	0	0
Shear Pl (OCC)	0	0	0	0	0	0	0	0
Shear Pl(TOTAL)	0.0	0.0	0.0	0.0	-0.9	-0.9	0.9	0.9
Shear Q (SUS)	0	0	0	0	0	0	0	0
Shear Q (OCC)	0	0	0	0	0	0	0	0
Shear Q (TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pm (SUS)	39.6	41.2	39.6	41.2	39.6	41.2	39.6	41.2
Pm (SUS+OCC)	39.6	41.2	39.6	41.2	39.6	41.2	39.6	41.2
Pm+Pl (SUS)	40.1	41.7	39.1	40.7	39.6	41.2	39.6	41.2
Pm+Pl (SUS+OCC)	40.8	42.4	37.9	39.4	39.5	41.1	39.5	41.1
Pm+Pl+Q (Total)	42.8	40.5	35.1	42.2	38.7	41.9	38.7	41.9

Type of Stress Int.	Max. S.I. MPa	S.I. Allowable	Result
Pm (SUS)	41.18	137.90	Passed

Leg Check, (Filled w/Water) : Step: 17 10:20a May 17,2010

Pm (SUS+OCC)	41.18	165.48	Passed
Pm+Pl (SUS)	41.68	206.85	Passed
Pm+Pl (SUS+OCC)	42.42	248.22	Passed
Pm+Pl+Q (TOTAL)	42.81	413.70	Passed

Bolting Size Requirement for Leg Baseplates :

Baseplate Material		SA-36	
Baseplate Allowable Stress	SBA	114.46	MPa
Baseplate Length	B	150.0000	mm
Baseplate Width	D	150.0000	mm
Baseplate Thickness	BTHK	12.7000	mm
Leg Dimension Along Baseplate Length	d	76.2000	mm
Leg Dimension Along Baseplate Width	b	76.2000	mm
Dist. from the Leg Edge to Bolt Hole Center	z	76.2000	mm
Bolt Material		SA-307 B	
Bolt Allowable Stress	STBA	48.26	MPa
Anchor Bolt Nominal Diameter	BOD	25.4000	mm
Number of Anchor Bolts in Tension per Leg	NB	1	
Total Number of Anchors Bolt per Leg	NBT	1	
Ultimate 28-day Concrete Strength	FCPRIME	20.685	MPa

Plate thickness required (1/2"; 13mm) per D. Moss

Since there is only 1 bolt, the standard computation for this geometry is not possible. A reasonable bolt size should be selected. Per Megyesy, use a 1 inch (25.4 mm) bolt.

INPUT VALUES, Nozzle Description: D From : 10

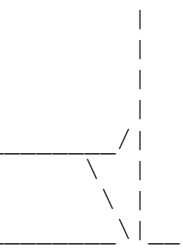
Pressure for Reinforcement Calculations	P	1.5911	MPa
Temperature for Internal Pressure	Temp	150	C
Design External Pressure	Pext	0.10	MPa
Temperature for External Pressure	Tempex	150	C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	MPa
Shell Allowable Stress At Ambient	Sa	137.90	MPa
Inside Diameter of Elliptical Head	D	491.33	mm
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	8.3344	mm
Head Internal Corrosion Allowance	c	3.2000	mm
Head External Corrosion Allowance	co	0.0000	mm
Distance from Head Centerline	L1	0.0000	mm
User Entered Minimum Design Metal Temperature		-3.00	C

Type of Element Connected to the Shell : Nozzle

Material		SA-106 B	
Material UNS Number		K03006	
Material Specification/Type		Smls. pipe	
Allowable Stress at Temperature	Sn	117.90	MPa
Allowable Stress At Ambient	Sna	117.90	MPa
Diameter Basis (for tr calc only)		ID	
Layout Angle		180.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	160	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.2000	mm
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	152.4000	mm
Weld leg size between Nozzle and Pad/Shell	Wo	6.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	8.3344	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
ASME Code Weld Type per UW-16		None	
Class of attached Flange		150	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: D

ASME Code, Section VIII, Division 1, 2007, A-09 UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.773	in.
Actual Thickness Used in Calculation	0.301	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Elliptical Head, Tr [Int. Press]
= (P*K1*D))/(2*S*E-0.2*P) per UG-37(a)(3)
= (1.59*0.889*497.7312)/(2 *137.90*1.00-0.2*1.59)
= 2.5559 mm

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (1.59*25.72)/(117*1.00-0.6*1.59)
= 0.3499 mm

Required Nozzle thickness under External Pressure per UG-28 : 0.2847 mm

UG-40, Limits of Reinforcement : [Int. Press]

Parallel to Vessel Wall (Diameter Limit)	Dl	102.8684	mm
Parallel to Vessel Wall, opening length	d	51.4342	mm
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	11.1135	mm

Note: Taking a UG-36(c)(3)(a) exemption for D.
This calculation is valid for nozzles that meet all the requirements of paragraph UG-36. Please check the Code carefully, especially for nozzles that are not isolated or do not meet Code spacing requirements. To force the computation of areas for small nozzles go to Tools->Configuration and check the box to force the area computation.

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]
Wall Thickness per UG45(a), tra = 3.5499 mm
Wall Thickness per UG16(b), tr16b = 4.7000 mm
Wall Thickness per UG45(b)(1), trb1 = 6.0263 mm

Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 6.0263 mm
Std. Wall Pipe per UG45(b)(4), trb4 = 6.6227 mm
Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 6.0263 mm

Final Required Thickness, tr45 = Max(tra, trb) = 6.0263 mm
Available Nozzle Neck Thickness = 7.6454 mm --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

MDMT of the Nozzle Neck to Flange Weld, Curve: B

Govrn. thk, tg = 7.645 , tr = 0.350 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.079 , Temp. Reduction = 78 C

Min Metal Temp. w/o impact per UCS-66 -29 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -46 C
Min Metal Temp. at Required thickness (UCS 66.1) -104 C

MDMT of Nozzle-Shell/Head Weld for the Nozzle (UCS-66(a)1(b)), Curve: B

Govrn. thk, tg = 7.645 , tr = 0.350 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.079 , Temp. Reduction = 78 C

Min Metal Temp. w/o impact per UCS-66 -29 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -46 C
Min Metal Temp. at Required thickness (UCS 66.1) -104 C

Governing MDMT of all the sub-joints of this Junction : -104 C

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) -29 C
Flange MDMT with Temp reduction per UCS-66(b)(1)(b) -39 C
Flange MDMT with Temp reduction per UCS-66(b)(1)(c) -104 C

Where the Stress Reduction Ratio per UCS-66(b)(1)(b) is :
Design Pressure/Ambient Rating = 1.59/1.97 = 0.810

Note: Using the minimum value from (b)(1)(b) and (b)(1)(c) above
as the calculated nozzle flange MDMT.

Weld Size Calculations, Description: D

Intermediate Calc. for nozzle/shell Welds Tmin 4.4454 mm

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	3.1118 = 0.7 * tmin.	4.2420 = 0.7 * Wo mm

NOTE : Skipping the nozzle attachment weld strength calculations.
Per UW-15(b)(2) the nozzles exempted by UG-36(c)(3)(a)
(small nozzles) do not require a weld strength check.

Maximum Allowable Pressure for this Nozzle at this Location:
Converged Max. Allow. Pressure in Operating case 2.8876 MPa

Note: The MAWP of this junction was limited by the parent Shell/Head.

The Drop for this Nozzle is : 1.0146 mm
The Cut Length for this Nozzle is, Drop + Ho + H + T : 161.7489 mm

INPUT VALUES, Nozzle Description: O From : 20

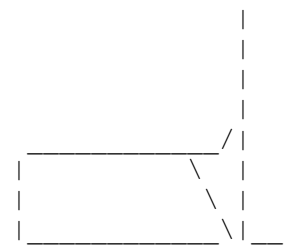
Pressure for Reinforcement Calculations	P	1.5879	MPa
Temperature for Internal Pressure	Temp	150	C
Design External Pressure	Pext	0.10	MPa
Temperature for External Pressure	Tempex	150	C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	MPa
Shell Allowable Stress At Ambient	Sa	137.90	MPa
Inside Diameter of Cylindrical Shell	D	489.00	mm
Design Length of Section	L	2039.8887	mm
Shell Finished (Minimum) Thickness	t	9.5000	mm
Shell Internal Corrosion Allowance	c	3.2000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		200.0000	mm
User Entered Minimum Design Metal Temperature		-3.00	C

Type of Element Connected to the Shell : Nozzle

Material		SA-106 B	
Material UNS Number		K03006	
Material Specification/Type		Smls. pipe	
Allowable Stress at Temperature	Sn	117.90	MPa
Allowable Stress At Ambient	Sna	117.90	MPa
Diameter Basis (for tr calc only)		ID	
Layout Angle		270.00	deg
Diameter		8.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	80	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.2000	mm
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	171.5520	mm
Weld leg size between Nozzle and Pad/Shell	Wo	8.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	8.3344	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
ASME Code Weld Type per UW-16		None	
Class of attached Flange		150	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: O

ASME Code, Section VIII, Division 1, 2007, A-09 UG-37 to UG-45

Actual Inside Diameter Used in Calculation	7.750	in.
Actual Thickness Used in Calculation	0.438	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (1.59*247.7000)/(137*1.00-0.6*1.59)
= 2.8720 mm

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (1.59*101.62)/(117*1.00-0.6*1.59)
= 1.3798 mm

Required Nozzle thickness under External Pressure per UG-28 : 0.6325 mm

UG-40, Limits of Reinforcement : [Int. Press]

Parallel to Vessel Wall (Diameter Limit)	Dl	406.5000	mm
Parallel to Vessel Wall, opening length	d	203.2500	mm
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	15.7500	mm

Weld Strength Reduction Factor [fr1]:
= min(1, Sn/S)
= min(1, 117.9 /137.9)
= 0.855

Weld Strength Reduction Factor [fr2]:
= min(1, Sn/S)
= min(1, 117.9 /137.9)
= 0.855

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)
= min(0.9 , 1.0)
= 0.855

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	590.324	298.333	NA	mm²
Area in Shell	A1	688.875	682.674	NA	mm²
Area in Nozzle Wall	A2	175.943	196.069	NA	mm²
Area in Inward Nozzle	A3	0.000	0.000	NA	mm²
Area in Welds	A41+A42+A43	54.720	54.720	NA	mm²
Area in Element	A5	0.000	0.000	NA	mm²
TOTAL AREA AVAILABLE	Atot	919.538	933.463	NA	mm²

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (203.2500*2.8720*1.0+2*7.9125*2.8720*1.0*(1-0.86))
= 590.324 mm²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 203.250 (1.00 * 6.3000 - 1.0 * 2.872) - 2 * 7.912
(1.00 * 6.3000 - 1.0 * 2.8720) * (1 - 0.855)
= 688.875 mm²

Area Available in Nozzle Projecting Outward [A2]:
= (2 * tlnp) * (tn - trn) * fr2
= (2 * 15.75) * (7.91 - 1.38) * 0.8550)
= 175.943 mm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:
= Wo² * fr2 + (Wi-can/0.707)² * fr2
= 8.0000² * 0.8550 + (0.0000)² * 0.8550
= 54.720 mm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]
Wall Thickness per UG45(a), tra = 4.5798 mm
Wall Thickness per UG16(b), tr16b = 4.7000 mm
Wall Thickness per UG45(b)(1), trb1 = 6.0720 mm
Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 6.0720 mm
Std. Wall Pipe per UG45(b)(4), trb4 = 10.3565 mm
Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 6.0720 mm

Final Required Thickness, tr45 = Max(tra, trb) = 6.0720 mm
Available Nozzle Neck Thickness = 11.1125 mm --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

MDMT of the Nozzle Neck to Flange Weld, Curve: B

Govrn. thk, tg = 11.113 , tr = 1.380 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.174 , Temp. Reduction = 78 C

Min Metal Temp. w/o impact per UCS-66 -26 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -42 C
Min Metal Temp. at Required thickness (UCS 66.1) -104 C

MDMT of Nozzle-Shell/Head Weld for the Nozzle (UCS-66(a)1(b)), Curve: B

Govrn. thk, tg = 9.500 , tr = 2.872 , c = 3.2000 mm , E* = 1.00
Stress Ratio = tr * (E*) / (tg - c) = 0.456 , Temp. Reduction = 41 C

Min Metal Temp. w/o impact per UCS-66 -29 C
Min Metal Temp per UCS-66 and UCS-68(c),PWHT credit -46 C
Min Metal Temp. at Required thickness (UCS 66.1) -65 C

Governing MDMT of all the sub-joints of this Junction : -65 C

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) -29 C
Flange MDMT with Temp reduction per UCS-66(b)(1)(b) -40 C
Flange MDMT with Temp reduction per UCS-66(b)(1)(c) -104 C

Where the Stress Reduction Ratio per UCS-66(b)(1)(b) is :
Design Pressure/Ambient Rating = 1.59/1.97 = 0.808

Note: Using the minimum value from (b)(1)(b) and (b)(1)(c) above
as the calculated nozzle flange MDMT.

Weld Size Calculations, Description: O

Intermediate Calc. for nozzle/shell Welds Tmin 6.3000 mm

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	4.4100 = 0.7 * tmin.	5.6560 = 0.7 * Wo mm

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)
Weld Load [W]:
= (A-A1+2*tn*fr1*(E1*t-tr))*Sv
= (590.3238 - 688.8753 + 2 * 7.9125 * 0.8550 *
(1.00 * 6.3000 - 2.8720)) * 137
= 0.00 N

Note: F is always set to 1.0 throughout the calculation.

Weld Load [W1]:
= (A2+A5+A4-(Wi-Can/.707)²*fr2)*Sv
= (175.9429 + 0.0000 + 54.7200 - 0.0000 * 0.86) * 137
= 31805.71 N

Weld Load [W2]:
= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv
= (175.9429 + 0.0000 + 54.7200 + (85.2414)) * 137
= 43559.49 N

Weld Load [W3]:
= (A2+A3+A4+A5+(2*tn*t*fr1))*S
= (175.9429 + 0.0000 + 54.7200 + 0.0000 + (85.2414)) * 137
= 43559.49 N

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:
= (pi/2) * Dlo * Wo * 0.49 * Snw
= (3.1416 / 2.0) * 219.0750 * 8.0000 * 0.49 * 117
= 159035. N

Shear, Nozzle Wall [Snw]:
= (pi *(Dlr + Dlo)/4) * (Thk - Can) * 0.7 * Sn
= (3.1416 * 105.5812) * (11.1125 - 3.2000) * 0.7 * 117
= 216592. N

Tension, Shell Groove Weld [Tngw]:
= (pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng
= (3.1416 / 2.0) * 219.0750 * (8.3344 - 3.2000) * 0.74 * 137
= 180286. N

Strength of Failure Paths:

PATH11 = (SONW + SNW) = (159034 + 216591) = 375626 N
PATH22 = (Sonw + Tpgw + Tngw + Sinw)
= (159034 + 0 + 180285 + 0) = 339320 N
PATH33 = (Sonw + Tngw + Sinw)
= (159034 + 180285 + 0) = 339320 N

Summary of Failure Path Calculations:
Path 1-1 = 375626 N , must exceed W = 0 N or W1 = 31805 N
Path 2-2 = 339320 N , must exceed W = 0 N or W2 = 43559 N
Path 3-3 = 339320 N , must exceed W = 0 N or W3 = 43559 N

Maximum Allowable Pressure for this Nozzle at this Location:
Converged Max. Allow. Pressure in Operating case 2.0179 MPa

Nozzle is O.K. for the External Pressure 0.103 MPa

The Drop for this Nozzle is : 25.9096 mm
The Cut Length for this Nozzle is, Drop + Ho + H + T : 206.9616 mm

INPUT VALUES, Nozzle Description: I From : 20

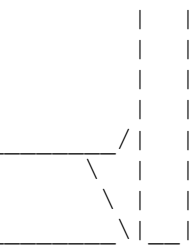
Pressure for Reinforcement Calculations	P	1.5785	MPa
Temperature for Internal Pressure	Temp	150	C
Design External Pressure	Pext	0.10	MPa
Temperature for External Pressure	Tempex	150	C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	S	137.90	MPa
Shell Allowable Stress At Ambient	Sa	137.90	MPa
Inside Diameter of Cylindrical Shell	D	489.00	mm
Design Length of Section	L	2039.8887	mm
Shell Finished (Minimum) Thickness	t	9.5000	mm
Shell Internal Corrosion Allowance	c	3.2000	mm
Shell External Corrosion Allowance	co	0.0000	mm
Distance from Bottom/Left Tangent		1140.0000	mm
User Entered Minimum Design Metal Temperature		-3.00	C

Type of Element Connected to the Shell : Nozzle

Material		SA-106 B	
Material UNS Number		K03006	
Material Specification/Type		Smls. pipe	
Allowable Stress at Temperature	Sn	117.90	MPa
Allowable Stress At Ambient	Sna	117.90	MPa
Diameter Basis (for tr calc only)		ID	
Layout Angle		90.00	deg
Diameter		8.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	80	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	3.2000	mm
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	171.5520	mm
Weld leg size between Nozzle and Pad/Shell	Wo	8.0000	mm
Groove weld depth between Nozzle and Vessel	Wgnv	8.3344	mm
Inside Projection	h	0.0000	mm
Weld leg size, Inside Element to Shell	Wi	0.0000	mm
ASME Code Weld Type per UW-16		None	
Class of attached Flange		150	
Grade of attached Flange		GR 1.1	

The Pressure Design option was Design Pressure + static head.

Nozzle Sketch (may not represent actual weld type/configuration)



Insert Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: I

ASME Code, Section VIII, Division 1, 2007, A-09 UG-37 to UG-45

Actual Inside Diameter Used in Calculation	7.750	in.
Actual Thickness Used in Calculation	0.438	in.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a)of Cylindrical Shell, Tr [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (1.58*247.7000)/(137*1.00-0.6*1.58)
= 2.8549 mm

Reqd thk per UG-37(a)of Nozzle Wall, Trn [Int. Press]
= (P*R)/(S*E-0.6*P) per UG-27 (c)(1)
= (1.58*101.62)/(117*1.00-0.6*1.58)
= 1.3716 mm

Required Nozzle thickness under External Pressure per UG-28 : 0.6325 mm

UG-40, Limits of Reinforcement : [Int. Press]

Parallel to Vessel Wall (Diameter Limit)	Dl	406.5000	mm
Parallel to Vessel Wall, opening length	d	203.2500	mm
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	15.7500	mm

Weld Strength Reduction Factor [fr1]:
= min(1, Sn/S)
= min(1, 117.9 /137.9)
= 0.855

Weld Strength Reduction Factor [fr2]:
= min(1, Sn/S)
= min(1, 117.9 /137.9)
= 0.855

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)
= min(0.9 , 1.0)
= 0.855

Results of Nozzle Reinforcement Area Calculations:

AREA AVAILABLE, A1 to A5		Design	External	Mapnc	
Area Required	Ar	586.818	298.333	NA	mm²
Area in Shell	A1	692.303	682.674	NA	mm²
Area in Nozzle Wall	A2	176.164	196.069	NA	mm²
Area in Inward Nozzle	A3	0.000	0.000	NA	mm²
Area in Welds	A41+A42+A43	54.720	54.720	NA	mm²
Area in Element	A5	0.000	0.000	NA	mm²
TOTAL AREA AVAILABLE	Atot	923.187	933.463	NA	mm²

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:
= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (203.2500*2.8549*1.0+2*7.9125*2.8549*1.0*(1-0.86))
= 586.818 mm²

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:
= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1)
= 203.250 (1.00 * 6.3000 - 1.0 * 2.855) - 2 * 7.912
(1.00 * 6.3000 - 1.0 * 2.8549) * (1 - 0.855)
= 692.303 mm²

Area Available in Nozzle Projecting Outward [A2]:
= (2 * tlnp) * (tn - trn) * fr2
= (2 * 15.75) * (7.91 - 1.37) * 0.8550)
= 176.164 mm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:
= Wo² * fr2 + (Wi-can/0.707)² * fr2
= 8.0000² * 0.8550 + (0.0000)² * 0.8550
= 54.720 mm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]
Wall Thickness per UG45(a), tra = 4.5716 mm
Wall Thickness per UG16(b), tr16b = 4.7000 mm
Wall Thickness per UG45(b)(1), trb1 = 6.0549 mm
Wall Thickness per UG45(b)(3), trb3 = Max(trb1, trb2, tr16b) = 6.0549 mm
Std. Wall Pipe per UG45(b)(4), trb4 = 10.3565 mm
Wall Thickness per UG45(b), trb = Min(trb3, trb4) = 6.0549 mm

Final Required Thickness, tr45 = Max(tra, trb) = 6.0549 mm
Available Nozzle Neck Thickness = 11.1125 mm --> OK