

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004	V01	

طرح نگهداشت و افزایش تولید 27 مخزن

MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)

نگهداشت و افزایش تولید میدان نفتی بینک

V01	MAR. 2025	IFI	MFS	M.Fakharian	S.Faramarzpour	
V00	DEC. 2024	IFA	MFS	M.Fakharian	S.Faramarzpour	
Rev.	Date	Purpose of Issue/Status	Prepared by:	Checked by:	Approved by:	CLIENT Approval

Status:

IFA: Issued For Approval
IFI: Issued For Information
AFC: Approved For Construction

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REVISION RECORD SHEET

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DESIGN CALCULATION

In Accordance with ASME Section VIII Division 1

ASME Code Version : 2019

Analysis Performed by :

Job File : C:\USERS\TECHNICAL2\DESKTOP\F-100.Pvdb

Date of Analysis : Mar 4, 2025 12:47pm

PV Elite 2020, January 2020

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ASME Code, Section VIII Division 1, 2019

Diameter Spec :	307.181 mm. OD
Vessel Design Length, Tangent to Tangent	1406.90 mm.
Distance of Bottom Tangent above Grade	100.00 mm.
Specified Datum Line Distance	0.00 mm.
Internal Design Temperature	100 °C
Internal Design Pressure	8.000 bars
External Design Temperature	100 °C
External Design Pressure	1.034 bars
Maximum Allowable Working Pressure	16.977 bars
External Max. Allowable Working Pressure	1.856 bars
Hydrostatic Test Pressure	10.400 bars
Required Minimum Design Metal Temperature	5.0 °C
Warmest Computed Minimum Design Metal Temperature	-44.0 °C
Wind Design Code	ASCE-2010
Earthquake Design Code	ASCE 7-2010

Materials of Construction:

Component Type	Material	Class	Thickness	UNS #	Normal ized	Impact Tested
Shell	SA-106 B	...	...	K03006	No	No
Head	SA-234 WPB	...	...	K03006	No	No
Flange	SA-105	...	...	K03504	No	No
Nozzle	SA-105	...	...	K03504	No	No
Re-Pad	SA-516 70	...	...	K02700	Yes	No
Nozzle Flg	SA-105	...	...	K03504	No	No
Leg Baseplate	SA-283 C	...	...	K02401	No	No
Flg Bolting	SA-193 B7M	...	<= 2 1/2	G41400	No	No
Leg Bolting	SA-325	...	...		No	No

Normalized is determined based on the UCS-66 material curve selection and Figure UCS-66.
Impact Tested is based on material selection and material data properties.

Element Pressures and MAWP (bars & mm.):

Element Description or Type	Design Pressure + Stat. head	Ext. Press.	Element M.A.W.P	Corrosion Allowance	Str. Flg. Gov.	In Creep Range
Ellipse	8.130	1.03	26.000	6.0000	Yes	No
Cylinder	8.118	1.03	17.000	6.0000	N/A	No
Body Flg	8.000	1.03	18.000	6.0000	N/A	No
Body Flg	8.000	1.03	18.000	6.0000	N/A	No

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Liquid Level: 1326.20 mm. Dens.: 999.542 kg/m³ Sp. Gr.: 1.000

Element Types and Properties:

Element Type	"To" Elev mm.	Element Length mm.	Nominal Thickness mm.	Finished Thickness mm.	Reqd Thk Internal mm.	Reqd Thk External mm.	Long Eff	Circ Eff
Ellipse	50.0	50.0	9.5	9.5	7.5	7.5	1.00	1.00
Cylinder	1250.0	1200.0	9.5	8.3	7.5	7.8	1.00	1.00
Body Flg	1364.3	114.3	...	31.8	...	...	1.00	1.00
Body Flg	1406.9	31.7	...	31.8	...	...	1.00	1.00

Loads for Foundation/Support Design:

Factored Loads:

Total Wind Shear on top of all Legs	0.	kN
Total Earthquake Shear on top of all Legs	2.	kN
Total Wind Moment at top of all Legs	204.	N-m
Total Earthquake Moment at top of all Legs	1409.	N-m
Max. Wind Shear on one Leg (top & bottom)	0.	kN
Max. Earthq. Shear on one Leg (top & bottom)	1.	kN
Max. Wind Moment at base of one Leg	284.	N-m
Max. Earthquake Moment at base of one Leg	1171.	N-m
Max. Vertical Load (Wt. + Wind) on one Leg	3.	kN
Max. Vertical Load (Wt. + Eq.) on one Leg	9.	kN

Un-Factored Loads:

Total Wind Shear on top of all Legs	1.	kN
Total Earthquake Shear on top of all Legs	3.	kN
Total Wind Moment at top of all Legs	340.	N-m
Total Earthquake Moment at top of all Legs	2013.	N-m
Max. Wind Shear on one Leg (top & bottom)	0.	kN
Max. Earthq. Shear on one Leg (top & bottom)	2.	kN
Max. Wind Moment at base of one Leg	473.	N-m
Max. Earthquake Moment at base of one Leg	1673.	N-m
Max. Vertical Load (Wt. + Wind) on one Leg	4.	kN
Max. Vertical Load (Wt. + Eq.) on one Leg	13.	kN

Note:

Wind and Earthquake moments include the effects of user defined forces and moments if any exist in the job and were specified to act (compute loads and stresses) during these cases. Also included are moment effects due to eccentric weights if any are present in the input.

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Local Stress Analysis Results:

Description	Analysis Type	Max Stress Ratio	High Stress Location	Pass / Fail
LEGS	WRC-107/537	0.889	n/a	Passed
LEGS	WRC-107/537	0.076	n/a	Passed

Weights:

Fabricated - Bare W/O Removable Internals	258.2 kg.
Shop Test - Fabricated + Water (Full)	362.9 kg.
Shipping - Fab. + Rem. Intls.+ Shipping App.	271.0 kg.
Erected - Fab. + Rem. Intls.+ Insul. (etc)	360.0 kg.
Empty - Fab. + Intls. + Details + Wghts.	360.0 kg.
Operating - Empty + Operating Liquid (No CA)	456.3 kg.
Field Test - Empty Weight + Water (Full)	309.4 kg.

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Nozzle Calculation Summary:

Description	MAWP bars	Ext	MAPNC bars	UG-45	[tr] mm.	Weld Path	Areas or Stresses
N04 (1in)	26	OK	...	OK	7.50	OK	Passed
N02 (1in)	17	OK	...	OK	7.50	OK	Passed
N03 (1in)	17	OK	...	OK	7.50	OK	Passed
N01 (1in)	17	OK	...	OK	7.50	OK	Passed
N06 (1in)	17	OK	...	OK	7.50	OK	Passed
N05 (1in)	18	OK	...	OK	9.42	OK	Passed

Nozzle MAWP Summary:

Minimum MAWP Nozzles	:	17 Nozzle	:	N06 (1in)
Minimum MAWP Shells/Flanges	:	17 Element	:	
Minimum MAPnc Shells/Flanges	:	20 Element	:	
Computed Vessel M.A.W.P.	:	17 bars	:	

Note: MAWPs (Internal Case) shown above are at the High Point.

Check the Spatial Relationship between the Nozzles:

From Node	Nozzle Description	Y Coordinate mm.	Layout Angle deg	Dia. Limit mm.
10	N04 (1in)	0.000	0.000	74.800
20	N02 (1in)	150.000	0.000	74.800
20	N03 (1in)	350.000	180.000	74.800
20	N01 (1in)	1150.000	180.000	74.800
20	N06 (1in)	1150.000	0.000	74.800
40	N05 (1in)	0.000	0.000	102.300

The nozzle spacing is computed by the following:

= Sqrt($l_l^2 + l_c^2$) where

l_l - Arc length along the inside vessel surface in the long. direction.

l_c - Arc length along the inside vessel surface in the circ. direction

If any interferences/violations are found, they will be noted below.

No interference violations have been detected !

Checking Multiple Nozzles on Flat Head per ASME Sec. VIII Div. 1 UG-39

Comparing Nozzles on Element from Node: 40 to: 50

Note: No Nozzle pairs found on this element.

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UG-39 Nozzle Diameter and Distance to Edge Checks:

Nozzle Description	Nozzle dia. mm.	Head Dia. /2 mm.	Distance from Edge mm.	Nozzle dia./4 mm.
N05 (1in)	37.4	179.89	215.9	9.35

No Multiple Nozzle spacing violations detected!

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Bill of Materials:

QTY	DESCRIPTION	MATERIAL
1	ELLIPTICAL HEAD: 2.0 X 1, 9.5mm. THK X 304.8mm. ID X 50.0mm.	SA-234 WPB
1	CYLINDER: 9.5mm. THK X 307.2mm. ID X 1200.0mm.	SA-106 B
1	BODY FLANGE: 31.8mm. THK X 304.8mm. OD	SA-105
1	BODY FLANGE: 31.8mm. THK X 482.6mm. OD	SA-105
1	INSULATION: 104mm X 50mm THK	
1	INSULATION: 1200mm X 50mm THK	
3	LEGS, SHAPE: L60X60X8 999mm	...
3	BASEPLATES: 150mm X 150mm X 15mm	SA-283 C
3	BASEPLATE BOLTS: 20mm	SA-325
3	LEG RE-PADS: 100mm X 100mm X 8mm	SA-106 B
1	INSULATION: 101mm X 50mm THK	
1	INSULATION: 28mm X 50mm THK	
1	GASKET: 374mm. OD X 339mm. ID	...
12	BODY FLANGE BOLTS: 22mm. DIA	SA-193 B7M
24	NUTS FOR BODY FLANGE BOLTS: 22mm. DIA	...
1	NAMEPLATE	...

Nozzle Schedule:

Description	Nominal or Actual Size	Schd or FVC Type	Flg Type	Nozzle O/Dia in	Wall Thk mm	Reinforcing Diameter	Pad Thk mm	Cut Length in	Flg Class
N04 (1in)	1.000 in	Actual	LW	2.000	12.700	...	...	160.6	150
N02 (1in)	1.000 in	Actual	LW	2.000	12.700	...	...	160.4	150
N03 (1in)	1.000 in	Actual	LW	2.000	12.700	...	...	160.4	150
N01 (1in)	1.000 in	Actual	LW	2.000	12.700	...	...	160.4	150
N06 (1in)	1.000 in	Actual	LW	2.000	12.700	...	...	160.4	150
N05 (1in)	1.000 in	Actual	LW	2.000	12.700	150.00	8.00	231.8	150

General Notes for the above table:

The Cut Length is the Outside Projection + Inside Projection + Drop + In Plane Shell Thickness. This value does not include weld gaps,

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	<table><tr><td>پروژه</td><td>بسته کاری</td><td>صادرکننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01
	پروژه		بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0004	V01											

nor does it account for shrinkage.

In the case of Oblique Nozzles, the Outside Diameter must be increased. The Re-Pad WIDTH around the nozzle is calculated as follows:
Width of Pad = (Pad Outside Dia. (per above) - Nozzle Outside Dia.)/2

For hub nozzles, the thickness and diameter shown are those of the smaller and thinner section.

Nozzle Material and Weld Fillet Leg Size Details (mm.):

Description	Material	Shl Grve Weld	Noz Shl/Pad Weld	Pad OD Weld	Pad Grve Weld	Inside Weld
N04 (1in)	SA-105	8.334	10.000	...	...	...
N02 (1in)	SA-105	8.334	10.000	...	...	...
N03 (1in)	SA-105	8.334	10.000	...	...	...
N01 (1in)	SA-105	8.334	10.000	...	...	...
N06 (1in)	SA-105	8.334	10.000	...	...	...
N05 (1in)	SA-105	31.750	8.000	8.000	8.000	...

Note: The Outside projections below do not include the flange thickness.

Nozzle Miscellaneous Data:

Description	Elev/Distance From Datum mm.	Layout Angle deg	Proj Outside mm.	Proj Inside mm.	Installed in Component
N04 (1in)	...	0.0	150.00	0.00	Node: 10
N02 (1in)	150.000	0.0	150.00	0.00	Node: 20
N03 (1in)	350.000	180.0	150.00	0.00	Node: 20
N01 (1in)	1150.000	180.0	150.00	0.00	Node: 20
N06 (1in)	1150.000	0.0	150.00	0.00	Node: 20
N05 (1in)	...	0.0	200.00	0.00	Node: 40

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Minimum Design Metal Temperature Results Summary :

Description	Notes	Curve	Basic MDMT °C	Reduced MDMT °C	UG-20 (f) MDMT °C	Thickness ratio	Gov Thk mm.	E*	PWHT reqd
Nozzle Flg	[5]	A	-18	-48					
Nozzle Flg	[5]	A	-18	-48					
	[10]	C	-48	-48	-29	0.627	9.525	1.00	Yes
	[7]	C	-48	-48	-29	0.663	9.525	1.00	Yes
	[8]	C	-48	-48	-29	0.494	8.334	1.00	Yes
N04 (lin)	[1]	A	-8	-104	-29	0.269	9.525	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N02 (lin)	[1]	A	-8	-44	-29	0.472	8.334	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N03 (lin)	[1]	A	-8	-44	-29	0.471	8.334	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N01 (lin)	[1]	A	-8	-45	-29	0.466	8.334	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N06 (lin)	[1]	A	-8	-45	-29	0.466	8.334	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N05 (lin)	[1]	A	-8	-104	-29	0.054	8.000	1.00	Yes
Nozzle Flg	[5]	A	-18	-48					
Bolting	[21]		-48						
Warmest MDMT:			-8	-44					
Required Minimum Design Metal Temperature						5.0	°C		
Warmest Computed Minimum Design Metal Temperature						-44.0	°C		

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	BK	GCS	MF	120	ME	CN	0004		V01

Notes:

- [!] - This was an impact tested material.
- [1] - Governing Nozzle Weld.
- [4] - ANSI Flange MDMT Calcs; Thickness ratio per UCS-66(b)(1)(-c).
- [5] - ANSI Flange MDMT Calcs; Thickness ratio per UCS-66(b)(1)(-b).
- [6] - MDMT Calculations at the Shell/Head Joint.
- [7] - MDMT Calculations for the Straight Flange.
- [8] - Cylinder/Cone/Flange Junction MDMT.
- [9] - Calculations in the Spherical Portion of the Head.
- [10] - Calculations in the Knuckle Portion of the Head.
- [11] - Calculated (Body Flange) Flange MDMT.
- [12] - Calculated Flat Head MDMT per UCS-66.3
- [13] - Tubesheet MDMT, shell side, if applicable
- [14] - Tubesheet MDMT, tube side, if applicable
- [15] - Nozzle Material
- [16] - Shell or Head Material
- [17] - Impact Testing required
- [18] - Impact Testing not required, see UCS-66(b)(3)
- [20] - Cylinder/Cone Junction MDMT based on Longitudinal Stress considerations
- [21] - Bolting Material

UG-84(b)(2) was not considered.
UCS-66(g) was not considered.
UCS-66(i) was not considered.

Notes:

Impact test temps were not entered in and not considered in the analysis.
UCS-66(i) applies to impact tested materials not by specification and
UCS-66(g) applies to materials impact tested per UG-84.1 General Note (c).
The Basic MDMT includes the (30F) PWHT credit if applicable.

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Class From To : Basic Element Checks.

Class From To: Check of Additional Element Data

There were no geometry errors or warnings.

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	BK	GCS	MF	120	ME	CN	0004		V01

PV Elite Vessel Analysis Program: Input Data

Design Internal Pressure (for Hydrotest)	8	bars
Design Internal Temperature	100.0	°C
Type of Hydrotest	UG-99 (b) Note [36]	
Hydrotest Position	Vertical	
Projection of Nozzle from Vessel Top	0	mm.
Projection of Nozzle from Vessel Bottom	0	mm.
Minimum Design Metal Temperature	5.0	°C
Type of Construction	Welded	
Special Service	Lethal	
Degree of Radiography	RT-1	
Use Higher Longitudinal Stresses (Flag)	N	
Select t for Internal Pressure (Flag)	N	
Select t for External Pressure (Flag)	N	
Select t for Axial Stress (Flag)	N	
Select Location for Stiff. Rings (Flag)	N	
Consider Vortex Shedding	N	
Perform a Corroded Hydrotest	Y	
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	ASCE-7 2010	
Wind Load Reduction Scale Factor	0.600	
Basic Wind Speed	232	Km/hr
Surface Roughness Category	C: Open Terrain	
Importance Factor	1.0	
Type of Surface	Moderately Smooth	
Base Elevation	100	mm.
Percent Wind for Hydrotest	33.0	
Using User defined Wind Press. Vs Elev.	N	
Height of Hill or Escarpment	0	mm.
Distance Upwind of Crest	0	mm.
Distance from Crest to the Vessel	0	mm.
Type of Terrain (Hill, Escarpment)	Flat	

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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 ASCE 7-2010
Seismic Load Reduction Scale Factor 0.700
Importance Factor 1.250
Table Value Fa 1.000
Table Value Fv 1.330
Short Period Acceleration value Ss 1.125
Long Period Acceleration Value Sl 0.460
Moment Reduction Factor Tau 1.000
Force Modification Factor R 2.500
Site Class D
Component Elevation Ratio z/h 1.000
Amplification Factor Ap 1.000
Force Factor 0.000
Consider Vertical Acceleration Yes
Minimum Acceleration Multiplier 0.000
User Value of Sds (used if > 0) 1.020
User Value of Sd1 (used if > 0) 0.385

Design Pressure + Static 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 the MAWP to compute the MDMT Yes
For thickness ratios <= 0.35, MDMT will be -155F (-104C) Yes
For PWHT & P1 Materials the MDMT can be < -55F (-48C) No

Using Metric Material Databases, ASME II D No
Calculate B31.3 type stress for Nozzles with Loads Yes
Reduce the MDMT due to lower membrane stress Yes
Consider Longitudinal Stress in MDMT calcs. (Div. 1) Yes

Complete Listing of Vessel Elements and Details:

Element From Node 10
Element To Node 20
Element Type Elliptical
Description
Distance "FROM" to "TO" 50 mm.
Element Outside Diameter 323.85 mm.
Element Thickness 9.525 mm.
Internal Corrosion Allowance 6 mm.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
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BK	GCS	MF	120	ME	CN	0004	V01											

Nominal Thickness	9.525	mm.
External Corrosion Allowance	0	mm.
Design Internal Pressure	8	bars
Design Temperature Internal Pressure	100	°C
Design External Pressure	1.034	bars
Design Temperature External Pressure	100	°C
Effective Diameter Multiplier	1.2	
Material Name	SA-234	WPB
Allowable Stress, Ambient	117.9	N./mm ²
Allowable Stress, Operating	117.9	N./mm ²
Allowable Stress, Hydrotest	217.2	N./mm ²
Material Density	7750.4	kg/m ³
P Number Thickness	29.997	mm.
Yield Stress, Operating	220.3	N./mm ²
UCS-66 Chart Curve Designation	C	
External Pressure Chart Name	CS-2	
UNS Number	K03006	
Product Form	Smls. & wld. fittings	
Efficiency, Longitudinal Seam	1.0	
Efficiency, Circumferential Seam	1.0	
Elliptical Head Factor	2.0	
Weld is pre-Heated	No	
Element From Node	10	
Detail Type	Liquid	
Detail ID	Liquid: 10	
Dist. from "FROM" Node / Offset dist	-76.2	mm.
Height/Length of Liquid	126.2	mm.
Liquid Density	999.54	kg/m ³
Element From Node	10	
Detail Type	Insulation	
Detail ID	Ins: 10	
Dist. from "FROM" Node / Offset dist	-54.769	mm.
Height/Length of Insulation	104.77	mm.
Thickness of Insulation	50	mm.
Density	125	kg/m ³
Element From Node	10	
Detail Type	Nozzle	
Detail ID	N04 (1in)	
Dist. from "FROM" Node / Offset dist	0	mm.
Nozzle Diameter	1	in.
Nozzle Schedule	None	
Nozzle Class	150	
Layout Angle	0.0	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.03182	kN
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-105	

Element From Node	20
Element To Node	30

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه											
V01	0004	CN	ME	120	MF	GCS	BK											

Element Type	Cylinder		
Description			
Distance "FROM" to "TO"	1200	mm.	
Inside Diameter	307.18	mm.	
Element Thickness	8.3344	mm.	
Internal Corrosion Allowance	6	mm.	
Nominal Thickness	9.525	mm.	
External Corrosion Allowance	0	mm.	
Design Internal Pressure	8	bars	
Design Temperature Internal Pressure	100	°C	
Design External Pressure	1.034	bars	
Design Temperature External Pressure	100	°C	
Effective Diameter Multiplier	1.2		
Material Name	SA-106 B		
Allowable Stress, Ambient	117.9	N./mm ²	
Allowable Stress, Operating	117.9	N./mm ²	
Allowable Stress, Hydrotest	217.2	N./mm ²	
Material Density	7750.4	kg/m ³	
P Number Thickness	29.007	mm.	
Yield Stress, Operating	220.3	N./mm ²	
UCS-66 Chart Curve Designation	C		
External Pressure Chart Name	CS-2		
UNS Number	K03006		
Product Form	Smls. pipe		
Efficiency, Longitudinal Seam	1.0		
Efficiency, Circumferential Seam	1.0		
Weld is pre-Heated	No		
Element From Node	20		
Detail Type	Liquid		
Detail ID	Liquid: 20		
Dist. from "FROM" Node / Offset dist	0	mm.	
Height/Length of Liquid	1200	mm.	
Liquid Density	999.54	kg/m ³	
Element From Node	20		
Detail Type	Insulation		
Detail ID	Ins: 10		
Dist. from "FROM" Node / Offset dist	0	mm.	
Height/Length of Insulation	1200	mm.	
Thickness of Insulation	50	mm.	
Density	125	kg/m ³	
Element From Node	20		
Detail Type	Nozzle		
Detail ID	N02 (lin)		
Dist. from "FROM" Node / Offset dist	100	mm.	
Nozzle Diameter	1	in.	
Nozzle Schedule	None		
Nozzle Class	150		
Layout Angle	0.0		
Blind Flange (Y/N)	N		
Weight of Nozzle (Used if > 0)	0.03182	kN	
Grade of Attached Flange	GR 1.1		
Nozzle Matl	SA-105		

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	BK	GCS	MF	120	ME	CN	0004		V01

Element From Node 20
Detail Type Nozzle
Detail ID N03 (1in)
Dist. from "FROM" Node / Offset dist 300 mm.
Nozzle Diameter 1 in.
Nozzle Schedule None
Nozzle Class 150
Layout Angle 180.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 20
Detail Type Nozzle
Detail ID N01 (1in)
Dist. from "FROM" Node / Offset dist 1100 mm.
Nozzle Diameter 1 in.
Nozzle Schedule None
Nozzle Class 150
Layout Angle 180.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.03182 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 20
Detail Type Nozzle
Detail ID N06 (1in)
Dist. from "FROM" Node / Offset dist 1100 mm.
Nozzle Diameter 1 in.
Nozzle Schedule None
Nozzle Class 150
Layout Angle 0.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.03182 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 20
Detail Type Leg
Detail ID LEGS
Dist. from "FROM" Node / Offset dist 125 mm.
Diameter at Leg Centerline 377.48 mm.
Leg Orientation 3
Number of Legs 3
Section Identifier L60X60X8
Length of Legs 1000 mm.

Element From Node 20
Detail Type Weight
Detail ID FILTER
Dist. from "FROM" Node / Offset dist 600 mm.
Miscellaneous Weight 0.4903 kN

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 20 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Offset from Element Centerline 0 mm.

Element From Node 20
Detail Type Weight
Detail ID PIPING
Dist. from "FROM" Node / Offset dist 738 mm.
Miscellaneous Weight 0.3824 kN
Offset from Element Centerline 0 mm.

Element From Node 30
Element To Node 40
Element Type Flange
Description
Distance "FROM" to "TO" 114.3 mm.
Flange Inside Diameter 304.8 mm.
Element Thickness 31.75 mm.
Internal Corrosion Allowance 6 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 8 bars
Design Temperature Internal Pressure 100 °C
Design External Pressure 1.034 bars
Design Temperature External Pressure 100 °C
Effective Diameter Multiplier 1.2
Material Name SA-105
Allowable Stress, Ambient 137.9 N./mm²
Allowable Stress, Operating 137.9 N./mm²
Allowable Stress, Hydrotest 223.4 N./mm²
Material Density 7750.4 kg/m³
P Number Thickness 30.988 mm.
Yield Stress, Operating 226.5 N./mm²
UCS-66 Chart Curve Designation A
External Pressure Chart Name CS-2
UNS Number K03504
Product Form Forgings
Perform Flange Stress Calculation (Y/N) Y
Weight of Standard Flange 0 kN
Class of Standard Flange
Grade of Standard Flange
Weld is pre-Heated No

Element From Node 30
Detail Type Insulation
Detail ID Ins: 10
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 101.6 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 40
Element To Node 50

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 21 از 129	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Element Type	Flange
Description	
Distance "FROM" to "TO"	31.75 mm.
Flange Outside Diameter	482.6 mm.
Element Thickness	31.75 mm.
Internal Corrosion Allowance	6 mm.
Nominal Thickness	0 mm.
External Corrosion Allowance	0 mm.
Design Internal Pressure	8 bars
Design Temperature Internal Pressure	100 °C
Design External Pressure	1.034 bars
Design Temperature External Pressure	100 °C
Effective Diameter Multiplier	1.2
Material Name	SA-105
Perform Flange Stress Calculation (Y/N)	Y
Weight of Standard Flange	0 kN
Class of Standard Flange	
Grade of Standard Flange	
Weld is pre-Heated	No
Element From Node	40
Detail Type	Insulation
Detail ID	Ins: 10
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	28.448 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m ³
Element From Node	40
Detail Type	Nozzle
Detail ID	N05 (1in)
Dist. from "FROM" Node / Offset dist	0 mm.
Nozzle Diameter	1 in.
Nozzle Schedule	None
Nozzle Class	150
Layout Angle	0.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.0471 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B) <table><tr><td>پروژه</td><td>بسته کاری</td><td>صادرکننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01	شماره صفحه : 22 از 129
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

XY Coordinate Calculations:

From	To	X (Horiz.) mm.	Y (Vert.) mm.	DX (Horiz.) mm.	DY (Vert.) mm.
10	20	...	50	...	50
20	30	...	1250	...	1200
30	40	...	1364.3	...	114.3
40	50	...	1406.9	...	31.75

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 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 23 از 129	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

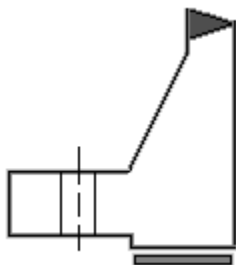
Flange Input Data Values

Description: FLANGE :

Item: Node 30 to 40

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	8.00	bars
Design Temperature		100	°C
Internal Corrosion Allowance	ci	6.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		No	
Flange Inside Diameter	B	304.800	mm.
Flange Outside Diameter	A	482.600	mm.
Flange Thickness	t	31.7500	mm.
Thickness of Hub at Small End	go	8.3344	mm.
Thickness of Hub at Large End	gl	29.0354	mm.
Length of Hub	h	82.5500	mm.
Flange Material		SA-105	
Flange Material UNS number		K03504	
Flange Allowable Stress At Temperature	Sfo	137.90	N./mm ²
Flange Allowable Stress At Ambient	Sfa	137.90	N./mm ²
Bolt Material		SA-193 B7M	
Bolt Allowable Stress At Temperature	Sb	137.90	N./mm ²
Bolt Allowable Stress At Ambient	Sa	137.90	N./mm ²
Diameter of Bolt Circle	C	431.800	mm.
Nominal Bolt Diameter	a	22.2250	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts		12	
Flange Face Outside Diameter	Fod	381.000	mm.
Flange Face Inside Diameter	Fid	304.800	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	374.650	mm.
Gasket Inside Diameter	Gi	339.852	mm.
Gasket Factor	m	3.0000	
Gasket Design Seating Stress	y	68.95	N./mm ²
Column for Gasket Seating	2, Code Column II		
Gasket Thickness	tg	4.5000	mm.
Flange Class		150	
Flange Grade		GR 1.1	
Flange Series	Series	A	

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B) <table><tr><td>پروژه</td><td>بسته کاری</td><td>صادرکننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01	شماره صفحه : 24 از 129
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											



ASME Code, Section VIII Division 1, 2019

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.0 \cdot (304.8/2 + 6.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 8.0) + C_a \\
 &= 6.9222 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 2.3344) / (158.4 + 0.6 \cdot 2.3344) \\
 &= 20.143 \text{ bars}
 \end{aligned}$$

Corroded Flange ID,	Bcor = B + 2 * Fcor	316.800	mm.
Corroded Large Hub,	glCor = gl-ci	23.035	mm.
Corroded Small Hub,	g0Cor = go-ci	2.334	mm.
Code R Dimension,	R = ((C - Bcor) / 2) - glcor	34.465	mm.
Gasket Contact Width,	N = (Go - Gi) / 2	17.399	mm.
Basic Gasket Width,	bo = N / 2	8.699	mm.
Effective Gasket Width,	b = Cb sqrt (bo)	7.432	mm.
Gasket Reaction Diameter,	G = Go - 2 * b	359.785	mm.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 359.785^2 \cdot 8.0 \\
 &= 81.331 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot P_i \cdot G \cdot m \cdot P \\
 &= 2 \cdot 7.4325 \cdot 3.1416 \cdot 359.785 \cdot 3.0 \cdot 8.0 \\
 &= 40.323 \text{ kN}
 \end{aligned}$$

Hydrostatic End Load at Flange ID [Hd]:

$$\begin{aligned}
 &= P_i \cdot B_{cor}^2 \cdot P / 4 \\
 &= 3.1416 \cdot 316.8^2 \cdot 8.0 / 4 \\
 &= 63.058 \text{ kN}
 \end{aligned}$$

Pressure Force on Flange Face [Ht]:

$$\begin{aligned}
 &= H - H_d \\
 &= 81 - 63 \\
 &= 18.273 \text{ kN}
 \end{aligned}$$

Operating Bolt Load [Wm1]:

$$= \max (H + H_p + H'p, 0)$$

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 - 073 - 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 25 از 129	
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری		پروژه
	V01	0004	CN	ME	120	MF	GCS		BK

$$= \max(81 + 40 + 0, 0)$$

$$= 121.654 \text{ kN}$$

Gasket Seating Bolt Load [Wm2]:

$$= y * b * \pi * G + y_{Part} * b_{Part} * l_p$$

$$= 68.95 * 7.4325 * 3.141 * 359.785 + 0.0 * 0.0 * 0.0$$

$$= 579.194 \text{ kN}$$

Required Bolt Area [Am]:

$$= \text{Maximum of } W_{m1}/S_b, W_{m2}/S_a$$

$$= \text{Maximum of } 122/138, 579/138$$

$$= 42.005 \text{ cm}^2$$

Min. Gasket Contact Width (Brownell Young) [Not an ASME Calc] [Nmin]:

$$= A_b * S_a / (y * \pi * (G_o + G_i))$$

$$= 32.439 * 137.9 / (68.95 * 3.14 * (374.65 + 339.85))$$

$$= 2.890 \text{ mm.}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$= S_a * (A_m + A_b) / 2$$

$$= 137.9 * (42.0046 + 32.4386) / 2$$

$$= 513.24 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= W_{m1} - H$$

$$= 122 - 81$$

$$= 40.32 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

$$= (C - G) / 2$$

$$= (431.8 - 359.785) / 2$$

$$= 36.0075 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

$$= (R + g_1 + h_g) / 2$$

$$= (34.4646 + 23.0354 + 36.0075) / 2$$

$$= 46.7537 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

$$= R + (g_1 / 2)$$

$$= 34.4646 + (23.0354 / 2.0)$$

$$= 45.9823 \text{ mm.}$$

Summary of Moments for Internal Pressure: (N-m)

Loading		Force	Distance	Bolt Corr	Moment
End Pressure,	Md	63.	45.9823	1.2110	3513.
Face Pressure,	Mt	18.	46.7537	1.2110	1035.
Gasket Load,	Mg	40.	36.0075	1.2110	1759.
Gasket Seating,	Matm	513.	36.0075	1.2110	22390.
Total Moment for Operation, Mop					6307. N-m
Total Moment for Gasket seating, Matm					22390. N-m

*You chose not to perform Stress Calculations on this Standard Flange.
The pressure rating of the flange will be used to check code compliance.*

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 26 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Estimated Finished Weight of Flange at given Thk. 39.2 kg.
Estimated Unfinished Weight of Forging at given Thk 97.4 kg.

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) -18 °C
Flange MDMT with Temp reduction per UCS-66(b) (1) (-b) -48 °C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = 8.00/19.60 = 0.408

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 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B) <table><tr><td>پروژه</td><td>بسته کاری</td><td>صادر کننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01	شماره صفحه : 27 از 129
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

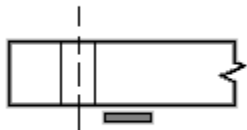
Flange Input Data Values

Description: FLANGE :

Item: Node 40 to 50

Description of Flange Geometry (Type)		Blind	
Design Pressure	P	8.00	bars
Design Temperature		100	°C
Internal Corrosion Allowance	ci	6.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Outside Diameter	A	482.600	mm.
Flange Thickness	t	31.7500	mm.
Flange Material		SA-105	
Flange Material UNS number		K03504	
Flange Allowable Stress At Temperature	Sfo	137.90	N./mm ²
Flange Allowable Stress At Ambient	Sfa	137.90	N./mm ²
Bolt Material		SA-193 B7M	
Bolt Allowable Stress At Temperature	Sb	137.90	N./mm ²
Bolt Allowable Stress At Ambient	Sa	137.90	N./mm ²
Diameter of the Load Reaction, Long Span	D	0.000	mm.
Diameter of the Load Reaction, Short Span	d	0.000	mm.
Perimeter along the Center of the Bolts	L	1356.540	mm.
Diameter of Bolt Circle	C	431.800	mm.
Nominal Bolt Diameter	a	22.2250	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts		12	
Flange Face Outside Diameter	Fod	381.000	mm.
Flange Face Inside Diameter	Fid	285.750	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	374.650	mm.
Gasket Inside Diameter	Gi	339.852	mm.
Gasket Factor	m	3.0000	
Gasket Design Seating Stress	y	68.95	N./mm ²
Column for Gasket Seating	2, Code Column II		
Gasket Thickness	tg	3.1750	mm.
Flange Class	150		
Flange Grade	GR 1.1		

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01



ASME Code, Section VIII Division 1, 2019

Gasket Contact Width,	$N = (G_o - G_i) / 2$	17.399	mm.
Basic Gasket Width,	$b_o = N / 2$	8.699	mm.
Effective Gasket Width,	$b = C_b \sqrt{b_o}$	7.432	mm.
Gasket Reaction Diameter,	$G = G_o - 2 * b$	359.785	mm.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 * G^2 * P_{eq} \\
 &= 0.785 * 359.785^2 * 8.0 \\
 &= 81.331 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 * b * P_i * G * m * P \\
 &= 2 * 7.4325 * 3.1416 * 359.785 * 3.0 * 8.0 \\
 &= 40.323 \text{ kN}
 \end{aligned}$$

Operating Bolt Load [Wm1]:

$$\begin{aligned}
 &= \max(H + H_p + H'p, 0) \\
 &= \max(81 + 40 + 0, 0) \\
 &= 121.654 \text{ kN}
 \end{aligned}$$

Gasket Seating Bolt Load [Wm2]:

$$\begin{aligned}
 &= y * b * P_i * G + y_{Part} * b_{Part} * l_p \\
 &= 68.95 * 7.4325 * 3.141 * 359.785 + 0.0 * 0.0 * 0.0 \\
 &= 579.194 \text{ kN}
 \end{aligned}$$

Required Bolt Area [Am]:

$$\begin{aligned}
 &= \text{Maximum of } W_{m1}/S_b, W_{m2}/S_a \\
 &= \text{Maximum of } 122/138, 579/138 \\
 &= 42.005 \text{ cm}^2
 \end{aligned}$$

Min. Gasket Contact Width (Brownell Young) [Not an ASME Calc] [Nmin]:

$$\begin{aligned}
 &= A_b * S_a / (y * P_i * (G_o + G_i)) \\
 &= 32.439 * 137.9 / (68.95 * 3.14 * (374.65 + 339.85)) \\
 &= 2.890 \text{ mm.}
 \end{aligned}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$\begin{aligned}
 &= S_a * (A_m + A_b) / 2 \\
 &= 137.9 * (42.0046 + 32.4386) / 2 \\
 &= 513.24 \text{ kN}
 \end{aligned}$$

Gasket Load for the Operating Condition [HG]:

$$= W_{m1}$$

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

$$= 121.65 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

$$= (C - G) / 2$$

$$= (431.8 - 359.785) / 2$$

$$= 36.0075 \text{ mm.}$$

*You chose not to perform Stress Calculations on this Standard Flange.
The pressure rating of the flange will be used to check code compliance.*

Estimated Finished Weight of Flange at given Thk.	45.0 kg.
Estimated Unfinished Weight of Forging at given Thk	45.0 kg.

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c)	-18 °C
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b)	-48 °C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :

$$\text{Design Pressure/Ambient Rating} = 8.00/19.60 = 0.408$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 30 از 129	
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	BK	GCS	MF	120	ME	CN	0004		V01

Element Thickness, Pressure, Diameter and Allowable Stress :

From	To	Int. Press + Liq. Hd bars	Nominal Thickness mm.	Total Corr Allowance mm.	Element Diameter mm.	Allowable Stress (SE) N./mm ²
10	20	8.13	9.525	6	323.85	117.9
20	30	8.1176	9.525	6	307.18	117.9
30	40	8	...	6	304.8	137.9
40	50	8	...	6	482.6	137.9

Element Required Thickness and MAWP :

From	To	Design Pressure bars	M.A.W.P. Corroded bars	M.A.P. New & Cold bars	Minimum Thickness mm.	Required Thickness mm.
10	20	8	25.7675	73.2256	9.525	7.5
20	30	8	16.9769	61.9559	8.33437	7.5
30	40	8	17.7001	19.6001	31.75	No Calc
40	50	8	17.7001	19.6001	31.75	No Calc
Minimum			17	20		

MAWP: 17 bars, limited by: Cylinder.

Elements Suitable for Design Internal Pressure.

Internal Pressure Calculation Results:

ASME Code, Section VIII Division 1, 2019

Elliptical Head From 10 To 20 SA-234 WPB , UCS-66 Crv. C at 100 °C

Material UNS Number: K03006

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P \cdot D_o \cdot K_{cor}) / (2 \cdot S \cdot E + 2 \cdot P \cdot (K_{cor} - 0.1)) \text{ per Appendix 1-4 (c)} \\
 &= (8.13 \cdot 323.85 \cdot 0.952) / (2 \cdot 117.9 \cdot 1.0 + 2 \cdot 8.13 \cdot (0.952 - 0.1)) \\
 &= 1.0571 + 6.0000 = 7.0571 \text{ mm.}
 \end{aligned}$$

Note: The thickness required was less than the Code Minimum, therefore the Code Minimum value of 1.5000 mm. per UG-16 will be used.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

Less Operating Hydrostatic Head Pressure of 0.130 bars

$$\begin{aligned}
 &= (2 \cdot S \cdot E \cdot t) / (K_{cor} \cdot D_o - 2 \cdot t \cdot (K_{cor} - 0.1)) \text{ per Appendix 1-4 (c)} \\
 &= (2 \cdot 117.9 \cdot 1.0 \cdot 3.525) / (0.952 \cdot 323.85 - 2 \cdot 3.525 \cdot (0.95 - 0.1)) \\
 &= 27 - 0 = 27 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (2 \cdot S \cdot E \cdot t) / (K \cdot D_o - 2 \cdot t \cdot (K - 0.1)) \text{ per Appendix 1-4 (c)} \\
 &= (2 \cdot 117.9 \cdot 1.0 \cdot 9.525) / (1.0 \cdot 323.85 - 2 \cdot 9.525 \cdot (1.0 - 0.1))
 \end{aligned}$$

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= 73 bars

Actual stress at given pressure and thickness, corroded [Sact]:

$$\begin{aligned}
 &= (P * (K_{cor} * D_o - 2 * t * (K_{cor} - 0.1))) / (2 * E * t) \\
 &= (8.13 * (0.952 * 323.85 - 2 * 3.525 * (0.952 - 0.1))) / (2 * 1.0 * 3.525) \\
 &= 34.871 \text{ N./mm}^2
 \end{aligned}$$

Straight Flange Required Thickness:

$$\begin{aligned}
 &= (P * R_o) / (S * E + 0.4 * P) + c_a \text{ per Appendix 1-1 (a) (1)} \\
 &= (8.13 * 161.925) / (117.9 * 1.0 + 0.4 * 8.13) + 6.0 \\
 &= 7.114 \text{ mm.}
 \end{aligned}$$

Straight Flange Maximum Allowable Working Pressure:

Less Operating Hydrostatic Head Pressure of 0.123 bars

$$\begin{aligned}
 &= (S * E * t) / (R_o - 0.4 * t) \text{ per Appendix 1-1 (a) (1)} \\
 &= (117.9 * 1.0 * 3.525) / (161.925 - 0.4 * 3.525) \\
 &= 26 - 0 = 26 \text{ bars}
 \end{aligned}$$

Factor K, corroded condition [Kcor]:

$$\begin{aligned}
 &= (2 + (\text{Inside Diameter} / (2 * \text{Inside Head Depth}))^2) / 6 \\
 &= (2 + (316.8 / (2 * 82.2))^2) / 6 \\
 &= 0.952226
 \end{aligned}$$

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 9.525, tr = 2.21, c = 6.0 mm., E* = 1.0

Thickness Ratio = tr * (E*) / (tg - c) = 0.627, Temp. Reduction = 21 °C

Min Metal Temp. w/o impact per UCS-66, Curve C -48 °C

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 9.525, tr = 2.336, c = 6.0 mm., E* = 1.0

Thickness Ratio = tr * (E*) / (tg - c) = 0.663, Temp. Reduction = 19 °C

Min Metal Temp. w/o impact per UCS-66, Curve C -48 °C

Note:

Post Weld Heat Treatment is required for this Element/Joint and it was specified as being heat treated.

Cylindrical Shell From 20 To 30 SA-106 B , UCS-66 Crv. C at 100 °C

Material UNS Number: K03006

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P * R) / (S * E - 0.6 * P) \text{ per UG-27 (c) (1)} \\
 &= (8.118 * 159.5906) / (117.9 * 1.0 - 0.6 * 8.118) \\
 &= 1.1034 + 6.0000 = 7.1034 \text{ mm.}
 \end{aligned}$$

Note: The thickness required was less than the Code Minimum, therefore the Code Minimum value of 1.5000 mm. per UG-16 will be used.

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

Less Operating Hydrostatic Head Pressure of 0.118 bars

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$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (117.9 \cdot 1.0 \cdot 2.3344) / (159.5906 + 0.6 \cdot 2.3344) \\
 &= 17 - 0 = 17 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (117.9 \cdot 1.0 \cdot 8.3344) / (153.5906 + 0.6 \cdot 8.3344) \\
 &= 62 \text{ bars}
 \end{aligned}$$

Actual stress at given pressure and thickness, corroded [Sact]:

$$\begin{aligned}
 &= (P \cdot (R + 0.6 \cdot t)) / (E \cdot t) \\
 &= (8.118 \cdot (159.5906 + 0.6 \cdot 2.3344)) / (1.0 \cdot 2.3344) \\
 &= 55.987 \text{ N./mm}^2
 \end{aligned}$$

Minimum Design Metal Temperature Results:

Govrn. thk, $t_g = 8.334$, $t_r = 1.154$, $c = 6.0 \text{ mm.}$, $E^* = 1.0$
 Thickness Ratio = $t_r \cdot (E^*) / (t_g - c) = 0.494$, Temp. Reduction = 33°C

Min Metal Temp. w/o impact per UCS-66, Curve C -48°C

Note:

Post Weld Heat Treatment is required for this Element/Joint and it was specified as being heat treated.

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

Hydrostatic Test Pressure Results:

Pressure per UG99b	= $1.30 \cdot \text{M.A.W.P.} \cdot \text{Sa/S}$	22.070 bars
Pressure per UG99b[36]	= $1.30 \cdot \text{Design Pres} \cdot \text{Sa/S}$	10.400 bars
Pressure per UG99c	= $1.30 \cdot \text{M.A.P.} - \text{Head(Hyd)}$	25.477 bars
Pressure per UG100	= $1.10 \cdot \text{M.A.W.P.} \cdot \text{Sa/S}$	18.675 bars
Pressure per PED	= $\max(1.43 \cdot \text{DP}, 1.25 \cdot \text{DP} \cdot \text{ratio})$	11.440 bars
Pressure per App 27-4	= M.A.W.P.	16.977 bars

UG-99(b) Note 36, Test Pressure Calculation:

$$\begin{aligned}
 &= \text{Test Factor} \cdot \text{Design Pressure} \cdot \text{Stress Ratio} \\
 &= 1.3 \cdot 8.0 \cdot 1.0 \\
 &= 10.400 \text{ bars}
 \end{aligned}$$

Vertical Test performed per: UG-99b (Note 36)

Please note that Nozzle, Shell, Head, Flange, etc MAWPs are all considered when determining the hydrotest pressure for those test types that are based on the MAWP of the vessel.

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پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

Stresses on Elements due to Test Pressure (N./mm² & bars):

From	To	Stress	Allowable	Ratio	Pressure
10	20	45.2	217.2	0.208	10.54
20	30	72.6	217.2	0.334	10.53

Stress ratios for Nozzle and Pad Materials (N./mm²):

Description	Pad/Nozzle	Ambient	Operating	Ratio
N04 (lin)	Nozzle	137.90	137.90	1.000
N02 (lin)	Nozzle	137.90	137.90	1.000
N03 (lin)	Nozzle	137.90	137.90	1.000
N01 (lin)	Nozzle	137.90	137.90	1.000
N06 (lin)	Nozzle	137.90	137.90	1.000
N05 (lin)	Nozzle	137.90	137.90	1.000
N05 (lin)	Pad	137.90	137.90	1.000
Minimum				1.000

Stress ratios for Pressurized Vessel Elements (N./mm²):

Description	Ambient	Operating	Ratio
	117.90	117.90	1.000
	117.90	117.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
Minimum			1.000

Hoop Stress in Nozzle Wall during Pressure Test (N./mm²):

Description	Ambient	Operating	Ratio
N04 (lin)	3.58	223.40	0.016
N02 (lin)	3.57	223.40	0.016
N03 (lin)	3.56	223.40	0.016
N01 (lin)	3.54	223.40	0.016
N06 (lin)	3.54	223.40	0.016
N05 (lin)	3.53	223.40	0.016

Elements Suitable for Test Pressure.

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK	شماره صفحه : 34 از 129
MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0004	CN	ME	120	MF	GCS	BK																			

External Pressure Calculation Results :

External Pressure Calculations:

From	To	Section Length mm.	Outside Diameter mm.	Corroded Thickness mm.	Factor A	Factor B N./mm ²
10	20	No Calc	323.85	3.525	0.0015118	96.9913
20	30	1275.4	323.85	2.33437	0.00019316	19.3115
30	40	No Calc	...	25.75	No Calc	No Calc
40	50	No Calc	...	25.75	No Calc	No Calc

External Pressure Calculations:

From	To	External Actual T. mm.	External Required T. mm.	External Design Pressure bars	External M.A.W.P. bars
10	20	9.525	7.5	1.034	11.7295
20	30	8.33437	7.83462	1.034	1.85591
30	40	31.75	No Calc	1.034	No Calc
40	50	31.75	No Calc	1.034	No Calc

Minimum

2

External Pressure Calculations:

From	To	Actual Length Bet. Stiffeners mm.	Allowable Length Bet. Stiffeners mm.	Ring Inertia Required cm**4	Ring Inertia Available cm**4
10	20	No Calc	No Calc	No Calc	No Calc
20	30	1275.4	2176.83	No Calc	No Calc
30	40	No Calc	No Calc	No Calc	No Calc
40	50	No Calc	No Calc	No Calc	No Calc

Elements Suitable for External Pressure.

ASME Code, Section VIII Division 1, 2019

Elliptical Head From 10 to 20 Ext. Chart: CS-2 at 100 °C

Elastic Modulus from Chart: CS-2 at 100 °C: 199943392.000 KPa.

Results for Maximum Allowable Ext. Pressure				MAEP
Tca	Outer Dia	Do/t	Factor A	Factor B
3.525	323.85	91.87	0.0015118	96.99

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$$MAEP = B / (K0 * Do / t) = 96.9913 / (0.9 * 91.8723) = 11.7295 \text{ bars}$$

Results for Required Thickness						Tca	
Tca	Outer Dia	Do/t	Factor A			Factor B	
0.838	323.85	386.25	0.0003596			35.95	

$$MAEP = B / (K0 * Do / t) = 35.9501 / (0.9 * 386.2507) = 1.0341 \text{ bars}$$

Check the requirements of UG-33(a)(1) using $P = 1.67 * \text{External Design pressure for this head.}$

Material UNS Number: K03006

Required Thickness due to Internal Pressure [tr]:

$$= (P * D * K_{cor}) / (2 * S * E - 0.2 * P) \text{ Appendix 1-4 (c)}$$

$$= (1.727 * 316.8 * 0.952) / (2 * 117.9 * 1.0 - 0.2 * 1.727)$$

$$= 0.2210 + 6.0000 = 6.2210 \text{ mm.}$$

Max. Allowable Working Pressure at given Thickness, corroded [MAWP]:

$$= ((2 * S * E * t) / (K_{cor} * D + 0.2 * t)) / 1.67 \text{ per Appendix 1-4 (c)}$$

$$= ((2 * 117.9 * 1.0 * 3.525) / (0.952 * 316.8 + 0.2 * 3.525)) / 1.67$$

$$= 16 \text{ bars}$$

Maximum Allowable External Pressure [MAEP]:

$$= \min(MAEP, MAWP)$$

$$= \min(11.73, 16.4597)$$

$$= 11.730 \text{ bars}$$

Thickness requirements per UG-33(a)(1) govern the required thickness of this head.

Cylindrical Shell From 20 to 30 Ext. Chart: CS-2 at 100 °C

Elastic Modulus from Chart: CS-2 at 100 °C: 199943392.000 KPa.

Results for Maximum Allowable Ext. Pressure						MAEP	
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
2.334	323.85	1275.40	138.73	3.9382	0.0001932	19.31	

$$MAEP = (4 * B) / (3 * (Do / t)) = (4 * 19.3115) / (3 * 138.731) = 1.8559 \text{ bars}$$

Results for Required Thickness						Tca	
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
1.835	323.85	1275.40	176.52	3.9382	0.0001369	13.69	

$$MAEP = (4 * B) / (3 * (Do / t)) = (4 * 13.6905) / (3 * 176.5213) = 1.034 \text{ bars}$$

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BK	GCS	MF	120	ME	CN	0004	V01											

Results for Maximum Stiffened Length							Slen
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
2.334	323.85	2176.83	138.73	6.7217	0.0001077	10.76	
MAEP = (4*B) / (3*(Do/t)) = (4*10.7641) / (3*138.731) = 1.0345 bars							

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پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

Element and Detail Weights:

From	To	Element Metal Wgt. kg.	Element ID Volume Cm.	Corroded Metal Wgt. kg.	Corroded ID Volume Cm.	Extra due Misc % kg.
10	20	12.3745	7356.28	4.57956	8104.59	1.23746
20	30	88.142	88948.4	33.2375	96033.7	8.8142
30	40	39.2067	8527.53	34.0168	9011.23	3.92067
40	50	45.013	...	45.013	...	4.5013
Total		184	104832.26	116	113149.53	18

Weight of Details:

From	Type	Weight of Detail kg.	X Offset, Dtl. Cent. mm.	Y Offset, Dtl. Cent. mm.	Description
10	Liqd	7.35179	...	-38.1	Liquid: 10
10	Insl	1.24608	...	-2.38437	Ins: 10
10	Nozl	3.56901	...	-201.206	N04 (1in)
20	Liqd	88.8942	...	600	Liquid: 20
20	Insl	8.80887	...	600	Ins: 10
20	Nozl	3.56901	166.291	100	N02 (1in)
20	Nozl	3.56916	166.291	300	N03 (1in)
20	Nozl	3.56901	166.291	1100	N01 (1in)
20	Nozl	3.56901	166.291	1100	N06 (1in)
20	Legs	31.8203	...	-375	LEGS
20	Wght	50	...	600	FILTER
20	Wght	39	...	738	PIPING
30	Insl	1.36147	...	50.8	Ins: 10
40	Insl	1.4575	...	14.224	Ins: 10
40	Nozl	5.28403	...	131.75	N05 (1in)

Total Weight of Each Detail Type:

Liquid	96.2
Insulation	12.9
Nozzles	23.1
Legs	31.8
Weights	89.0
Sum of the Detail Weights	
	253.1 kg.

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Weight Summation Results: (kg.)

	Fabricated	Shop Test	Shipping	Erected	Empty	Operating
Main Elements	203.2	203.2	203.2	203.2	203.2	203.2
Nozzles	23.1	23.1	23.1	23.1	23.1	23.1
Legs	31.8	31.8	31.8	31.8	31.8	31.8
Insulation	...	...	12.9	12.9	12.9	12.9
Empty Weights	...	...	...	89.0	89.0	...
Ope Weights	...	...	...	...	...	89.0
Ope. Liquid	...	...	...	...	...	96.2
Test Liquid	...	104.8	...	...	...	...
Totals	258.2	362.9	271.0	360.0	360.0	456.3

Field Installation Options:

Miscellaneous Weight Percent: 10.0 %

Note that the above value for the miscellaneous weight percent has been applied to the shells/heads/flange/tubesheets/tubes etc. in the weight calculations for metallic components.

Weight Summary:

Fabricated Wt.	- Bare Weight without Removable Internals	258.2 kg.
Shop Test Wt.	- Fabricated Weight + Water (Full)	362.9 kg.
Shipping Wt.	- Fab. Weight + removable Intls.+ Shipping App.	271.0 kg.
Erected Wt.	- Fab. Wt + or - loose items (trays,platforms etc.)	360.0 kg.
Ope. Wt. no Liq	- Fab. Weight + Internals. + Details + Weights	360.0 kg.
Operating Wt.	- Empty Weight + Operating Liq. Uncorroded	456.3 kg.
Field Test Wt.	- Empty Weight + Water (Full)	309.4 kg.
Mass of the Upper 1/3 of the Vertical Vessel		137.1 kg.

Note: The Field Test weight as computed in the corroded condition.

Outside Surface Areas of Elements:

From	To	Surface Area cm ²
10	20	1645.57
20	30	12298.6
30	40	2521.99
40	50	2310.59
Total		18776.781 cm ²

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Element and Detail Weights:

From	To	Total Ele. Empty Wgt. kg.	Total. Ele. Oper. Wgt. kg.	Total. Ele. Hydro. Wgt. kg.	Total Dtl. Offset Mom. N-m	Oper. Wgt. No Liquid kg.
10	20	18.4271	25.7789	17.9522	...	18.4271
20	Legs	21.7751	31.0349	16.2106	2.42592	21.7751
Legs	30	187.266	266.901	139.411	20.8629	187.266
30	40	44.4889	44.4889	47.7857	...	44.4889
40	50	56.2559	56.2559	56.2559	...	56.2559

Cumulative Vessel Weight

From	To	Cumulative Ope Wgt. No Liquid kg.	Cumulative Oper. Wgt. kg.	Cumulative Hydro. Wgt. kg.
10	20	...	...	...
20	Legs	-18.4271	-25.7789	-17.9522
Legs	30	288.011	367.645	243.452
30	40	100.745	100.745	104.042
40	50	56.2559	56.2559	56.2559

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-m	Cumulative Oper. Mom. N-m	Cumulative Hydro. Mom. N-m
10	20	...	...	...
20	Legs	2.42592	2.42592	2.42592
Legs	30	20.8629	20.8629	20.8629
30	40	...	...	...
40	50	...	...	...

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V01	0004	CN	ME	120	MF	GCS	BK																			

Nozzle Flange MAWP Results: (bars & °C)

Nozzle Description	Flange Rating		Design Temp	Class	Grade/Group	Equiv. Press	Max Pressure			
	Ope.	Ambient					UG-44 (b)	50%	DNV	
N04 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
N02 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
N03 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
N01 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
N06 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
N05 (1in)	17.70	19.60	100	150	GR 1.1	...	...	...	...	
Min Rating	17.700	19.600	bars [for Core Elements]				0.000	0.000	0.000	

ANSI Ratings are per ANSI/ASME B16.5 2013 Metric Edition

Warning:

There are nozzles in this model, but no flange MAWPs were de-rated. Be sure this is what you intended. There is a check box in the nozzle dialog that instructs PV Elite to perform the de-rating for each nozzle flange. See ASME VIII-1, UG-44(b) for more information.

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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 18.2058 Hz.

The Natural Frequency for the Vessel (Ope...) is 16.6102 Hz.

The Natural Frequency for the Vessel (Filled) is 19.2682 Hz.

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	V01	0004	CN	ME	120	MF	GCS		BK

Input Values:

Wind Design Code	ASCE-7 2010
Wind Load Reduction Scale Factor	0.600
Basic Wind Speed	232 Km/hr
Surface Roughness Category	C: Open Terrain
Importance Factor	1.0
Type of Surface	Moderately Smooth
Base Elevation	100 mm.
Percent Wind for Hydrotest	33.0
Using User defined Wind Press. Vs Elev.	N
Height of Hill or Escarpment H or Hh	0 mm.
Distance Upwind of Crest Lh	0 mm.
Distance from Crest to the Vessel x	0 mm.
Type of Terrain (Hill, Escarpment)	Flat
Damping Factor (Beta) for Wind (Ope)	0.0100
Damping Factor (Beta) for Wind (Empty)	0.0000
Damping Factor (Beta) for Wind (Filled)	0.0000

Wind Analysis Results

Static Gust-Effect Factor, Operating Case [G]:

$$\begin{aligned}
 &= \min(0.85, 0.925((1 + 1.7 * gQ * Izbar * Q) / (1 + 1.7 * gV * Izbar))) \\
 &= \min(0.85, 0.925((1 + 1.7 * 3.4 * 0.228 * 0.979) / (1 + 1.7 * 3.4 * 0.228))) \\
 &= \min(0.85, 0.914) \\
 &= 0.850
 \end{aligned}$$

Natural Frequency of Vessel (Operating)	16.610 Hz
Natural Frequency of Vessel (Empty)	18.206 Hz
Natural Frequency of Vessel (Test)	19.268 Hz

Force Coefficient	[Cf] 0.539
Structure Height to Diameter ratio	3.338
Height to top of Structure	1406.900 mm.

This is classified as a rigid structure. Static analysis performed.

Sample Calculation for the First Element

The ASCE code performs all calculations in Imperial Units only. The wind pressure is therefore computed in these units.

Value of [Alpha] and [Zg]:

Exposure Category: C from Table 26.9.1
Alpha = 9.5: Zg = 274320. mm.

Effective Height [z]:

$$\begin{aligned}
 &= \text{Centroid Height} + \text{Vessel Base Elevation} \\
 &= 104.496 + 100.0 = 204.496 \text{ mm.} \\
 &= 0.671 \text{ ft. Imperial Units}
 \end{aligned}$$

Velocity Pressure coefficient evaluated at height z [Kz]:

Because z (0.671 ft.) < 15 ft.

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							V01	

$$= 2.01 * (15 / Zg) ^ { 2 / Alpha }$$

$$= 2.01 * (15 / 900.0) ^ { 2 / 9.5 }$$

$$= 0.849$$

Type of Hill: No Hill

Wind Directionality Factor [Kd]:
= 0.95, per Table 26.6-1

As there is No Hill Present: [Kzt]:
K1 = 0, K2 = 0, K3 = 0

Topographical Factor [Kzt]:
= (1 + K1 * K2 * K3) ^ 2
= (1 + 0.0* 0.0* 0.0) ^ 2
= 1.0

Velocity Pressure evaluated at height z, Imperial Units [qz]:
= max(16, 0.00256 * Kz * Kzt * Kd * V(mph) ^ 2)
= max(16, 0.00256 * 0.849 * 1.0 * 0.95 * 144.162 ^ 2)
= 42.9 psf [209.487] Kgs/m²

Force on the first element [F]:
= qz * G * Cf * WindArea
= 42.906 * 0.85 * 0.539 * 0.857
= 16.9 lbs. [0.1] kN

Element	Hgt (z) mm.	K1	K2	K3	Kz	Kzt	qz Kgs/m ²
Node 10 to 20	204.5	0.000	0.000	0.000	0.849	1.000	209.487
Node 20 to 30	826.2	0.000	0.000	0.000	0.849	1.000	209.487
Node 30 to 40	1483.4	0.000	0.000	0.000	0.849	1.000	209.487
Node 40 to 50	1567.2	0.000	0.000	0.000	0.849	1.000	209.487

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/L²) (10⁴)
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 kN

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Ws - Cor. vessel weight excl. weight of parts which do not effect stiff. kN
Z - Maximum amplitude of vibration at top of vessel mm.
Dl - Logarithmic decrement (taken as 0.03 for Welded Structures)
Vp - Vib. Chance, $\leq 0.314E-08$ (High); $0.314E-08 < 0.393E-08$ (Probable)
P30 - wind pressure 30 feet above the base

Check other Conditions and Basic Assumptions:

#1 - Total Cone Length / Total Length < 0.5
 $0.0/1406.9 = 0.0$

#2 - $(D / L^2) * 10^4 < 8.0$ (English Units)
 $-(1.38/4.62^2) * 10^4 = 649.029$ [Geometry Violation]

Compute the vibration possibility. If $V_p > 0.393E-08$ no chance. [Vp]:

$$= W / (L * Dr^2)$$

$$= 4 / (1406.9 * 326.83^2)$$

$$= 0.24900E-07$$

Since V_p is $> 0.393E-08$ no further vibration analysis is required !

Wind Loads on Masses/Equipment/Piping

ID	Wind Area cm ²	Elevation mm.	Pressure Kgs/m ²	Force kN
FILTER	0.00	750.00	209.49	0.00
PIPING	0.00	888.00	209.49	0.00

The Natural Frequency for the Vessel (Ope...) is 16.6102 Hz.

Wind Load Calculation:

From	To	Wind Height mm.	Wind Diameter mm.	Wind Area cm ²	Wind Pressure Kgs/m ²	Element Wind Load kN
10	20	204.496	508.62	796.49	209.487	0.044974
20	30	826.2	508.62	6103.44	209.487	0.34463
30	40	1483.35	472.427	539.984	209.487	0.03049
40	50	1567.23	686.64	218.008	209.487	0.01231

Note:

The Wind Loads calculated and printed in the Wind Load calculation report have been factored by the input scalar/load reduction factor of: 0.600.

Be sure the wind speed is in accordance with the specified wind design code.

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Earthquake Load Calculation:

Input Values:

Seismic Design Code		ASCE 7-2010
Seismic Load Reduction Scale Factor		0.700
Importance Factor		1.250
Table Value Fa		1.000
Table Value Fv		1.330
Short Period Acceleration value Ss		1.125
Long Period Acceleration Value Sl		0.460
Moment Reduction Factor Tau		1.000
Force Modification Factor R		2.500
Site Class		D
Component Elevation Ratio	z/h	1.000
Amplification Factor	Ap	1.000
Force Factor		0.000
Consider Vertical Acceleration		Yes
Minimum Acceleration Multiplier		0.000
User Value of Sds (used if > 0)		1.020
User Value of Sd1 (used if > 0)		0.385

Seismic Analysis Results:

$$Sms = Fa * Ss = 1.0 * 1.125 = 1.125$$

$$Sm1 = Fv * S1 = 1.33 * 0.46 = 0.612$$

$$Sds = 2/3 * Sms = 2/3 * 1.125 = 0.75$$

$$Sds = \text{Max}(0.8 * Sds, SdsUser)$$

$$= \text{Max}(0.6, 1.02)$$

$$= 1.020$$

$$Sd1 = 2/3 * Sm1 = 2/3 * 0.612 = 0.408$$

$$Sd1 = \text{Max}(0.8 * Sd1, Sd1User)$$

$$= \text{Max}(0.326, 0.385)$$

$$= 0.385$$

Check Approximate Fundamental Period from 12.8-7 [Ta]:

$$= Ct * hn^x \text{ where } Ct = 0.020, x = 0.75 \text{ and } hn = \text{Structural Height (ft.)}$$

$$= 0.020 * (7.2869^{0.75})$$

$$= 0.089 \text{ seconds}$$

The Coefficient Cu from Table 12.8-1 is : 1.400

Fundamental Period (1/Frequency) [T]:

$$= (1/\text{Natural Frequency}) = (1/16.61)$$

$$= 0.060$$

Check the Value of T which is the smaller of Cu*Ta and T:

$$= \text{Minimum Value of } (1.4 * 0.089, 0.06) \text{ per 12.8.2}$$

$$= 0.060$$

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Compute the Seismic Force per equation 13.3-1, [Fp]:

$$= 0.4 * A_p * S_{ds} * W * (1 + 2 * (z/h)) / (R / I_e)$$

$$= 0.4 * 1.0 * 1.02 * 4 * (1 + 2 * 1.0) / (2.5 / 1.25)$$

$$= 2.547 \text{ kN}$$

Check the Maximum value of Fp per equation 13.3-2:

$$= 1.6 * S_{ds} * I * W$$

$$= 1.6 * 1.02 * 1.25 * 4 = 8.49 \text{ kN}$$

Check the Minimum value of Fp per equation 13.3-3:

$$= 0.3 * 1.02 * 1.25 * 4$$

$$= 1.592 \text{ kN}$$

Compute the Total Base Shear V = Fp, [V]:

$$= 2.547 \text{ kN}$$

Vertical load per 12.4-4, [YEq]:

$$= 0.2 * S_{ds} * W$$

$$= 0.2 * 1.02 * 4$$

$$= 0.8 \text{ kN}$$

Final Base Shear, V = 1.78 kN

Final Vertical Load, YEq = 0.59 kN

Distribute the Base shear force to each element according to the equations

$F_x = C_{vx} * V$ (eqn. 12.8-11) and the vertical distribution factor

$C_{vx} = W_x * h_x^k / (\text{Sum of } W_i * h_i^k)$ and k is an exponent which is related to the period of Vibration.

In this case, the value of k was 1.0

The Natural Frequency for the Vessel (Ope...) is 16.6102 Hz.

Earthquake Load Calculation:

From	To	Earthquake Height mm.	Earthquake Weight kN	Element Ope Load kN	Element Emp Load kN	Element Vertical Load kN
10	20	25	0.25279	0.0034546	0.0023173	-0.036098
20	Legs	175	0.30433	0.029112	0.019168	-0.079556
Legs	30	712.5	2.61723	1.01935	0.67116	0.51481
30	40	1307.15	0.43626	0.31172	0.29252	0.14107
40	50	1391.03	0.55164	0.41946	0.39362	0.078775

Note:

The Earthquake Loads calculated and printed in the Earthquake

Load calculation report have been factored by the input

scalar/load reduction factor of: 0.700.

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The following table is for the Operating Case.

Wind/Earthquake Shear, Bending:

From	To	Distance to Support mm.	Cumulative Wind Shear kN	Earthquake Shear kN	Wind Bending N-m	Earthquake Bending N-m
10	20	206.229	...	...	...	...
20	Legs	62.5	0.044974	0.0034546	3.65468	0.28073
Legs	30	537.5	0.39651	1.75399	203.997	1408.93
30	40	1132.15	0.0428	0.73118	3.47993	77.0008
40	50	1216.03	0.01231	0.41946	0.1955	6.66163

Note:

The Wind Shears/Moments and the Earthquake Shears/Moments calculated and printed in the Wind/Earthquake Shear and Bending report have been factored by the input Scalar/Load reductions factors of;
Wind: 0.600; Earthquake: 0.700.

Note:

Review the Vessel Design Summary for the cumulative shear force and bending moment on the support.

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Wind Deflection Calculations:

The following table is for the Operating Case.

Wind Deflection:

From	To	Cumulative Wind Shear kN	Centroid Deflection mm.	Elem. End Deflection mm.	Elem. Ang. Rotation
10	20	...	0.74154	0.74154	0.0011082
20	Legs	0.044974	0.74162	0.74184	0.0011128
Legs	30	0.39651	0.74852	0.75913	0.0011288
30	40	0.0428	0.76031	0.76149	0.0011288
40	50	0.01231	0.76181	0.76214	0.0011288

Critical Wind Velocity for Tower Vibration:

From	To	1st Crit. Wind Speed Km/hr	2nd Crit. Wind Speed Km/hr
10	20	151.659	947.871
20	30	151.659	947.871
30	40	140.867	880.421
40	50	204.741	1279.63

Allowable deflection at the Tower Top (Ope) (6.000"/100ft. Criteria)
Allowable deflection : 7.035 Actual deflection : 0.762 mm.

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Longitudinal Stress Constants:

From		To	Metal Area		Section Modulus	
			New	Corroded	New	Corroded
			cm ²	cm ²	mm. ³	mm. ³
10		20	94.0576	35.4732	718036	281016
20		30	82.6121	23.5789	635308	188168
30		40	82.6121	23.5789	635308	188168
40		50	82.6121	23.5789	635308	188168

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Longitudinal Allowable Stresses:

From To		Tensile	Hydrotest Tensile	Compressive	Hydrotest Compressive
		N./mm ²	N./mm ²	N./mm ²	N./mm ²
10 20		117.9	217.2	-110.124	-132.148
20 Legs		117.9	217.2	-101.346	-121.615
Legs 30		117.9	217.2	-101.346	-121.615
30 40		137.9	223.4	-101.346	-121.615
40 50		137.9	223.4	-101.346	-121.615

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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 also been computed in the corroded condition.

Longitudinal Pressure Stresses due to:

		Longitudinal Stress Internal Pressure	Longitudinal Stress External Pressure	Longitudinal Stress Hydrotest Pressure
		N./mm ²	N./mm ²	N./mm ²
10	20	17.8155	-2.40117	23.1602
20	30	27.1878	-3.61244	35.3441
30	40	...	...	...
40	50	...	...	...

Longitudinal Stresses due to Weight Loads for these Conditions:

		Wght. Str. Empty	Wght. Str. Operating	Wght. Str. Hydrotest	Wght. Str. Emp. Mom.	Wght. Str. Opr. Mom.
		N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	...	...	...
20	Legs	0.076641	0.10722	0.074666	0.012888	0.012888
Legs	30	-1.19788	-1.15937	-1.19788	0.11084	0.11084
30	40	-0.41901	-0.41901	-0.41901	...	...
40	50	-0.23398	-0.23398	-0.23398	...	...

Longitudinal Stresses due to Weight Loads and Bending for these Conditions:

		Wght. Str. Hyd. Mom.	Bend. Str. Oper. Wind	Bend. Str. Oper. Equ.	Bend. Str. Hyd. Wind	Bend. Str. Hyd. Equ.
		N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	...	...	...
20	Legs	0.012888	0.019416	0.0014914	0.0064073	...
Legs	30	0.11084	1.08377	7.48523	0.35764	...
30	40	...	0.018488	0.40908	0.006101	...
40	50	...	0.0010386	0.035391	0.00034274	...

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Longitudinal Stresses due to these Conditions:

From	To	Vortex Shedding		Vortex Shedding		Vortex Shedding		Earthquake	
		Operating Case	Empty Case	Test Case	Empty Case	Test Case	Empty Case	Empty Case	Empty Case
		N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	...	...	...	...	...	...
20	Legs	...	...	...	...	...	...	0.0010004	...
Legs	30	...	...	...	...	...	...	6.21255	...
30	40	...	...	...	...	...	...	0.38388	...
40	50	...	...	...	...	...	...	0.033211	...

Longitudinal Stresses due to Applied Axial Forces:

From	To	Longitudinal Stress		Longitudinal Stress	
		Y Forces Wind	Y Forces Seismic	Y Forces Wind	Y Forces Seismic
		N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	-0.010177	...
20	Legs	...	...	-0.033743	...
Legs	30	...	...	0.21835	...
30	40	...	...	0.059835	...
40	50	...	...	0.033412	...

Longitudinal Stresses due to User Forces and Moments:

From	To	Wind For/Mom		Earthquake For/Mom		Wind For/Mom		Earthquake For/Mom	
		Corroded	Corroded	Corroded	Corroded	No Corrosion	No Corrosion	No Corrosion	No Corrosion
		N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	...	...	...	...	...	...
20	Legs	...	...	...	...	...	...	...	...
Legs	30	...	...	...	...	...	...	...	...
30	40	...	...	...	...	...	...	...	...
40	50	...	...	...	...	...	...	...	...

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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 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	117.90	0.00	110.12	0.0000	0.0000
20	0.11	117.90		101.35	0.0009	
20		117.90	-2.39	101.35		0.0236

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
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10		117.90	-0.01	110.12		0.0001
20	0.06	117.90		101.35	0.0005	
20	5.34	117.90	-7.30	101.35	0.0453	0.0721

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	117.90	0.00	110.12	0.0000	0.0000
20	0.14	117.90		101.35	0.0012	
20	0.04	117.90	-2.35	101.35	0.0003	0.0232

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		117.90	-0.01	110.12		0.0001
20	0.09	117.90		101.35	0.0007	
20	6.66	117.90	-8.54	101.35	0.0564	0.0842

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	217.20	0.00	132.15	0.0000	0.0000
20	0.09	217.20		121.61	0.0004	
20		217.20	-1.67	121.61		0.0137

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	217.20	0.00	132.15	0.0000	0.0000
20	0.09	217.20		121.61	0.0004	
20		217.20	-1.31	121.61		0.0108

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	17.82	117.90		110.12	0.1511	
20	27.33	117.90		101.35	0.2318	
20	27.22	117.90		101.35	0.2309	

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	17.81	117.90		110.12	0.1510	
20	27.28	117.90		101.35	0.2313	
20	33.84	117.90		101.35	0.2870	

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
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BK	GCS	MF	120	ME	CN	0004	V01											

Node	Stress	Stress	Stress	Stress	Ratio	Ratio
10		117.90	-2.40	110.12		0.0218
20		117.90	-3.54	101.35		0.0349
20		117.90	-5.97	101.35		0.0589

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		117.90	-2.41	110.12		0.0219
20		117.90	-3.55	101.35		0.0351
20	3.04	117.90	-12.15	101.35	0.0258	0.1199

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	23.16	217.20		132.15	0.1066	
20	35.44	217.20		121.61	0.1632	
20	34.61	217.20		121.61	0.1594	

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	23.16	217.20		132.15	0.1066	
20	35.43	217.20		121.61	0.1631	
20	34.26	217.20		121.61	0.1577	

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	17.82	117.90		110.12	0.1511	
20	27.28	117.90		101.35	0.2314	
20	26.10	117.90		101.35	0.2214	

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	17.82	117.90		110.12	0.1511	
20	27.22	117.90		101.35	0.2309	
20	26.86	117.90		101.35	0.2278	

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	17.82	117.90		110.12	0.1511	
20	27.31	117.90		101.35	0.2316	
20	26.14	117.90		101.35	0.2217	

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BK	GCS	MF	120	ME	CN	0004	V01											

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	17.82	117.90		110.12	0.1511	
20	27.28	117.90		101.35	0.2314	
20	26.10	117.90		101.35	0.2214	

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	117.90	0.00	110.12	0.0000	0.0000
20	0.12	117.90		101.35	0.0010	
20		117.90	-1.27	101.35		0.0125

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	17.81	117.90		110.12	0.1510	
20	27.27	117.90		101.35	0.2313	
20	26.36	117.90		101.35	0.2236	

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		117.90	-2.41	110.12		0.0219
20		117.90	-3.55	101.35		0.0350
20		117.90	-4.66	101.35		0.0460

Absolute Maximum of the all of the Stress Ratio's 0.2870

Element From : 20 to : 30

Governing Load Case 8 : IP+OW+EQ+FS+BS

Element Description	Long Pressure Stress	Weight + Axial Load Stress	Eccentric Moment Stress	Wind or Earthquake Stress	Combined Stress	Which Side
Element # 1	17.8	-0.0	...	...	17.8	+ Tens
Element # 1	17.8	-0.0	...	...	...	- Comp
Element # 2	27.2	0.1	...	...	27.3	+ Tens
Element # 2	27.2	0.1	-0.0	-0.0	...	- Comp
Element # 2	27.2	-0.9	0.1	7.5	33.8	+ Tens
Element # 2	27.2	-0.9	-0.1	-7.5	...	- Comp

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Shop/Field Installation Options :

Insulation is installed in the Shop.

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

Center of Gravity of the Liquid	597.439 mm.
Center of Gravity of the Insulation	739.387 mm.
Center of Gravity of the Nozzles	745.277 mm.
Center of Gravity of the Legs	-325.000 mm.
Center of Gravity of the Added Weights (Operating)	710.472 mm.
Center of Gravity of the Added Weights (Empty)	710.472 mm.
Center of Gravity of Bare Shell New and Cold	925.813 mm.
Center of Gravity of Bare Shell Corroded	1100.908 mm.
Vessel CG in the Operating Condition	730.212 mm.
Vessel CG in the Fabricated (Shop/Empty) Condition	743.768 mm.
Vessel CG in the Test Condition	724.241 mm.

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BK	GCS	MF	120	ME	CN	0004	V01											

RESULTS FOR LEGS : Operating Case Description: LEGS

Legs attached to: node 20

Section Properties : Single Angle L60X60X8

European Structural Steel Data

Overall Leg Length		1000.000	mm.
Effective Leg Length	Leglen	925.000	mm.
Distance Leg Up Side of Vessel		125.000	mm.
Number of Legs	Nleg	3	
Cross Sectional Area for L60X60X8	Aleg	9.030	cm ²
Section Inertia (strong axis)		29.200	cm ⁴
Section Inertia (weak axis)		29.200	cm ⁴
Section Modulus (strong axis)		6890.028	mm. ³
Section Modulus (weak axis)		6890.028	mm. ³
Radius of Gyration (strong axis)		18.000	mm.
Radius of Gyration (weak axis)		18.000	mm.

Leg Orientation - Diagonal

Overturning Moment at top of Legs		1408.9	N-m
Total Weight Load at top of Legs	W	4.8	kN
Total Shear force at top of Legs		1.8	kN
Additional force in Leg due to Bracing	Fadd	0.0	kN
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

Pad Width along Circumference	C11P	100.000	mm.
Pad Length along Vessel Axis	C22P	100.000	mm.
Pad Thickness	Tpad	8.000	mm.

Maximum Shear at top of one Leg [Vleg]:

$$\begin{aligned}
 &= (\max(\text{Wind}, \text{Seismic}) + \text{applied forces}) (I_{\max} / I_{\text{tot}}) \\
 &= (1.8) (47.1/71.7) \\
 &= 1.17 \text{ kN}
 \end{aligned}$$

Axial Compression, Leg furthest from the Neutral Axis [Sma]:

$$\begin{aligned}
 &= W/N_{\text{leg}} + (M_{\text{leg}} / (N_{\text{legm}} * R_n)) / A_{\text{leg}} \\
 &= 4785/3 + (1408374 / (1 * 188.741)) / 902.998 \\
 &= 10.03 \text{ N./mm}^2
 \end{aligned}$$

Axial Compression, Leg closest to the Neutral Axis [Sva]:

$$\begin{aligned}
 &= (W / N_{\text{leg}}) / A_{\text{leg}} \\
 &= (5/3) / 9.03 \\
 &= 1.77 \text{ N./mm}^2
 \end{aligned}$$

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness: 60.000 60.000 8.0000

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BK	GCS	MF	120	ME	CN	0004	V01											

Distance to geometric centroid: 17.700 17.700
Arm about YY: 13.700 16.300
Arm about ZZ: 12.300 13.700
Leg areas: 4.8000 4.1600
Geometric inertia components YY: 9.2650 20.426
Geometric inertia components ZZ: 21.662 8.0297
Geometric inertias Iy & Iz: 29.691 29.691
Product of inertia: 0.17378E+06
Mohrs Radius: 10.605
Average Inertia: 29.691

QFACT = 1.0000 FBZ = 0.16383
Principal Axis Inertias (Z&W) = 12.313 47.069
Angle to Principal Axis = 45.000
Distances to extreme fibers CW & CZ = 42.426 17.395
FOB from Eq 5-5 = 1.6846
Bending allowables Fby & Fbz = 0.16383 0.16383

Shear Center Coordinates Wo & Zo: 18.583 0.0000
Values for Elastic Flexural-Torsional Buckling Stress:
E, G, J, R0²: 29500. 11346. 0.46282E-01 1.5546
AREA, LENGTH, Kw, Kz: 1.3996 36.417 1.0000 1.0000
H, Few, Fez, Fej: 0.65569 177.37 46.401 241.34
Fe computed from C4-1: 127.82

Initial (Kl/r)max, & (Kl/r)equiv = 79.213 47.727
Final (Kl/r)max, & Cc = 79.213 127.18
Fa based on Eq 4-1 = 0.10699

	Actual	Allowable	
Weak Axis Bending :	108.17	218.38	N./mm ²
Strong Axis Bending :	69.02	218.38	N./mm ²
Axial Compression :	10.03	142.62	N./mm ²

UNITY CHECKS ARE: H1-1 0.000
H1-2 0.000
H1-3 0.882

AISC Unity Check : 0.882 Should be <= to 1

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

Rectangular Attachment Parameter	C11	84.853	mm.
Rectangular Attachment Parameter	C22	80.950	mm.

Input Echo, WRC107/537 Item 1, Description: LEGS

Diameter Basis for Vessel	Vbasis	ID
Cylindrical or Spherical Vessel	Cylsph	Cylindrical
Internal Corrosion Allowance	Cas	6.0000 mm.
Vessel Diameter	Dv	307.181 mm.
Vessel Thickness	Tv	8.334 mm.
Design Temperature	T1	100.0 °C

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Attachment Type	Type	Rectangular
Parameter C11	C11	84.85 mm.
Parameter C22	C22	80.95 mm.
Thickness of Reinforcing Pad	Tpad	8.000 mm.
Pad Parameter C11P	C11p	100.000 mm.
Pad Parameter C22P	C22p	100.000 mm.
Design Internal Pressure	Dp	8.000 bars
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 kN
Global Force (SUS)	Fy	1.6 kN
Global Force (SUS)	Fz	0.0 kN
Global Moment (SUS)	Mx	0.0 N-m
Global Moment (SUS)	My	0.0 N-m
Global Moment (SUS)	Mz	42.8 N-m
Internal Pressure (SUS)	P	8.00 bars
Include Pressure Thrust	No	
Global Force (OCC)	Fx	1.2 kN
Global Force (OCC)	Fy	7.5 kN
Global Force (OCC)	Fz	0.0 kN
Global Moment (OCC)	Mx	0.0 N-m
Global Moment (OCC)	My	0.0 N-m
Global Moment (OCC)	Mz	741.8 N-m
Occasional Internal Pressure (OCC)	Pvar	0.00 bars
Use Interactive Control	No	
WRC107 Version	Version	March 1979
Include Pressure Stress Indices per Div. 2	No	
Compute Pressure Stress per WRC-368	No	
Local Loads applied at end of Nozzle/Attachment	No	

Note:

WRC Bulletin 537 provides equations for the dimensionless curves found in bulletin 107. As noted in the foreword to bulletin 537, "537 is equivalent to WRC 107". Where 107 is printed in the results below, "537" can be interchanged with "107".

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	BK	GCS	MF	120	ME	CN	0004		V01

Circ. Memb. MC		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Circ. Memb. ML		1.0		1.0		-1.0		-1.0		0.0		0.0		0.0		0.0		0.0
Circ. Bend. ML		1.7		-1.7		-1.7		1.7		0.0		0.0		0.0		0.0		0.0
Tot. Circ. Str.		2.7		-0.8		-2.7		0.8		0.0		0.0		0.0		0.0		0.0
Long. Memb. P		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Long. Bend. P		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Long. Memb. MC		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Long. Bend. MC		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Long. Memb. ML		0.4		0.4		-0.4		-0.4		0.0		0.0		0.0		0.0		0.0
Long. Bend. ML		2.7		-2.7		-2.7		2.7		0.0		0.0		0.0		0.0		0.0
Tot. Long. Str.		3.1		-2.4		-3.1		2.4		0.0		0.0		0.0		0.0		0.0
Shear VC		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Shear VL		0.0		0.0		0.0		0.0		-1.0		-1.0		1.0		1.0		1.0
Shear MT		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0		0.0
Tot. Shear		0.0		0.0		0.0		0.0		-1.0		-1.0		1.0		1.0		1.0
Str. Int.		3.1		2.4		3.1		2.4		1.9		1.9		1.9		1.9		1.9

Dimensionless Parameters used : Gamma = 68.87

Dimensionless Loads for Cylindrical Shells at Pad edge:

Curves read for 1979	Beta	Figure	Value	Location
N(PHI) / (P/Rm)	0.311	4C	6.034	(A,B)
N(PHI) / (P/Rm)	0.311	3C	2.361	(C,D)
M(PHI) / (P)	0.311	2C1	0.009	(A,B)
M(PHI) / (P)	0.311	1C !	0.067	(C,D)
N(PHI) / (MC/ (Rm**2 * Beta))	0.311	3A	1.801	(A,B,C,D)
M(PHI) / (MC/ (Rm * Beta))	0.311	1A	0.057	(A,B,C,D)
N(PHI) / (ML/ (Rm**2 * Beta))	0.311	3B	3.647	(A,B,C,D)
M(PHI) / (ML/ (Rm * Beta))	0.311	1B	0.007	(A,B,C,D)
N(x) / (P/Rm)	0.311	3C	2.361	(A,B)
N(x) / (P/Rm)	0.311	4C	6.034	(C,D)
M(x) / (P)	0.311	1C1	0.025	(A,B)
M(x) / (P)	0.311	2C !	0.035	(C,D)
N(x) / (MC/ (Rm**2 * Beta))	0.311	4A	6.314	(A,B,C,D)
M(x) / (MC/ (Rm * Beta))	0.311	2A	0.022	(A,B,C,D)
N(x) / (ML/ (Rm**2 * Beta))	0.311	4B	2.038	(A,B,C,D)
M(x) / (ML/ (Rm * Beta))	0.311	2B	0.010	(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

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Stresses in the Vessel at the Edge of Reinforcing Pad (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		8.3	8.3	-8.3	-8.3	0.0	0.0	0.0	0.0
Circ. Bend. ML		6.9	-6.9	-6.9	6.9	0.0	0.0	0.0	0.0
Tot. Circ. Str.		15.2	1.4	-15.2	-1.4	0.0	0.0	0.0	0.0
Long. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML		4.6	4.6	-4.6	-4.6	0.0	0.0	0.0	0.0
Long. Bend. ML		9.8	-9.8	-9.8	9.8	0.0	0.0	0.0	0.0
Tot. Long. Str.		14.4	-5.1	-14.4	5.1	0.0	0.0	0.0	0.0
Shear VC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL		0.0	0.0	0.0	0.0	-3.4	-3.4	3.4	3.4
Shear MT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear		0.0	0.0	0.0	0.0	-3.4	-3.4	3.4	3.4
Str. Int.		15.2	6.5	15.2	6.5	6.8	6.8	6.8	6.8

WRC 107 Stress Calculation for OCCasional loads:

Radial Load	P	1.2	kN
Circumferential Shear	VC	0.0	kN
Longitudinal Shear	VL	7.5	kN
Circumferential Moment	MC	0.0	N-m
Longitudinal Moment	ML	-741.8	N-m
Torsional Moment	MT	0.0	N-m

Dimensionless Parameters used : Gamma = 15.94

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-1.7	-1.7	-1.7	-1.7	-1.3	-1.3	-1.3	-1.3
Circ. Bend. P		-3.0	3.0	-3.0	3.0	-4.8	4.8	-4.8	4.8
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		16.7	16.7	-16.7	-16.7	0.0	0.0	0.0	0.0

	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		

Circ. Bend. ML	30.2	-30.2	-30.2	30.2	0.0	0.0	0.0	0.0
Tot. Circ. Str.	42.2	-12.2	-51.5	14.7	-6.1	3.6	-6.1	3.6
Long. Memb. P	-1.3	-1.3	-1.3	-1.3	-1.7	-1.7	-1.7	-1.7
Long. Bend. P	-5.0	5.0	-5.0	5.0	-3.0	3.0	-3.0	3.0
Long. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML	6.2	6.2	-6.2	-6.2	0.0	0.0	0.0	0.0
Long. Bend. ML	47.3	-47.3	-47.3	47.3	0.0	0.0	0.0	0.0
Tot. Long. Str.	47.2	-37.4	-59.8	45.0	-4.7	1.3	-4.7	1.3
Shear VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL	0.0	0.0	0.0	0.0	-4.5	-4.5	4.5	4.5
Shear MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear	0.0	0.0	0.0	0.0	-4.5	-4.5	4.5	4.5
Str. Int.	47.2	37.4	59.8	45.0	9.9	9.2	9.9	9.2

Dimensionless Parameters used : Gamma = 68.87

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Edge of Reinforcing Pad (N./mm²)

Type of Stress	Load	Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-18.8	-18.8	-18.8	-18.8	-7.4	-7.4	-7.4	-7.4
Circ. Bend. P		-12.2	12.2	-12.2	12.2	-86.8	86.8	-86.8	86.8
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		144.1	144.1	-144.1	-144.1	0.0	0.0	0.0	0.0
Circ. Bend. ML		119.8	-119.8	-119.8	119.8	0.0	0.0	0.0	0.0
Tot. Circ. Str.		233.0	17.7	-295.0	-31.0	-94.2	79.5	-94.2	79.5
Long. Memb. P		-7.4	-7.4	-7.4	-7.4	-18.8	-18.8	-18.8	-18.8
Long. Bend. P		-32.7	32.7	-32.7	32.7	-45.4	45.4	-45.4	45.4
Long. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML		80.5	80.5	-80.5	-80.5	0.0	0.0	0.0	0.0
Long. Bend. ML		169.3	-169.3	-169.3	169.3	0.0	0.0	0.0	0.0
Tot. Long. Str.		209.8	-63.4	-289.8	114.0	-64.2	26.6	-64.2	26.6
Shear VC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL		0.0	0.0	0.0	0.0	-16.0	-16.0	16.0	16.0
Shear MT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear		0.0	0.0	0.0	0.0	-16.0	-16.0	16.0	16.0
Str. Int.		233.0	81.1	295.0	145.0	101.1	83.9	101.1	83.9

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	BK	GCS	MF	120	ME	CN	0004		V01

WRC 107/537 Stress Summations:

Vessel Stress Summation at Attachment Junction (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)		12.0	12.8	12.0	12.8	12.0	12.8	12.0	12.8
Circ. Pm (OCC)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Pm(TOTAL)		12.0	12.8	12.0	12.8	12.0	12.8	12.0	12.8
Circ. Pl (SUS)		1.0	1.0	-1.0	-1.0	0.0	0.0	0.0	0.0
Circ. Pl (OCC)		15.0	15.0	-18.4	-18.4	-1.3	-1.3	-1.3	-1.3
Circ. Pl(TOTAL)		16.0	16.0	-19.4	-19.4	-1.3	-1.3	-1.3	-1.3
Circ. Q (SUS)		1.7	-1.7	-1.7	1.7	0.0	0.0	0.0	0.0
Circ. Q (OCC)		27.2	-27.2	-33.1	33.1	-4.8	4.8	-4.8	4.8
Circ. Q (TOTAL)		28.9	-28.9	-34.9	34.9	-4.8	4.8	-4.8	4.8
Long. Pm (SUS)		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Long. Pm (OCC)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Pm(TOTAL)		6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Long. Pl (SUS)		0.4	0.4	-0.4	-0.4	0.0	0.0	0.0	0.0
Long. Pl (OCC)		4.9	4.9	-7.4	-7.4	-1.7	-1.7	-1.7	-1.7
Long. Pl(TOTAL)		5.3	5.3	-7.8	-7.8	-1.7	-1.7	-1.7	-1.7
Long. Q (SUS)		2.7	-2.7	-2.7	2.7	0.0	0.0	0.0	0.0
Long. Q (OCC)		42.3	-42.3	-52.4	52.4	-3.0	3.0	-3.0	3.0
Long. Q (TOTAL)		45.0	-45.0	-55.1	55.1	-3.0	3.0	-3.0	3.0
Shear Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pm (OCC)		0.0	0.0	0.0	0.0	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	-1.0	-1.0	1.0	1.0
Shear Pl (OCC)		0.0	0.0	0.0	0.0	-4.5	-4.5	4.5	4.5
Shear Pl(TOTAL)		0.0	0.0	0.0	0.0	-5.4	-5.4	5.4	5.4
Shear Q (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Q (OCC)		0.0	0.0	0.0	0.0	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)		12.0	12.8	12.0	12.8	12.0	12.8	12.0	12.8
Pm (SUS+OCC)		12.0	12.8	12.0	12.8	12.0	12.8	12.0	12.8
Pm+Pl (SUS)		12.9	13.7	11.0	11.8	12.1	12.9	12.1	12.9
Pm+Pl (SUS+OCC)		27.9	28.7	7.4	6.6	13.8	14.4	13.8	14.4
Pm+Pl+Q (Total)		56.9	33.8	56.9	53.3	11.7	18.9	11.7	18.9

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Shear Q (TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pm (SUS)	54.3	55.1	54.3	55.1	54.3	55.1	54.3	55.1	55.1
Pm (SUS+OCC)	54.3	55.1	54.3	55.1	54.3	55.1	54.3	55.1	55.1
Pm+Pl (SUS)	62.6	63.4	46.0	46.8	54.7	55.5	54.7	55.5	55.5
Pm+Pl (SUS+OCC)	187.9	188.7	117.0	116.2	55.0	55.7	55.0	55.7	55.7
Pm+Pl+Q (Total)	302.5	115.6	277.1	146.3	57.9	139.0	57.9	139.0	139.0

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	55.10	117.90	Passed
Pm (SUS+OCC)	55.10	141.48	Passed
Pm+Pl (SUS)	63.41	176.85	Passed
Pm+Pl (SUS+OCC)	188.73	212.22	Passed
Pm+Pl+Q (TOTAL)	302.48	353.70	Passed

The Pm+Pl+Q allowable above was based on the rules of ASME VIII-2 Part 4, 4.1.6.3 (a)&(b) or per ASME VIII-2, 5.5.6.1(1)&(2) Part 5 as applicable.

The Pm+Pl+Q allowable was based on a temperature range cycling from ambient to design temperature.

Bolting Size Requirement for Leg Baseplates :

Baseplate Material	SA-283 C	
Baseplate Allowable Stress	SBA 108.25	N./mm ²
Baseplate Length	B 150.0000	mm.
Baseplate Width	D 150.0000	mm.
Baseplate Thickness	BTHK 15.0000	mm.
Leg Dimension Along Baseplate Length	d 59.9999	mm.
Leg Dimension Along Baseplate Width	b 59.9999	mm.
Bolt Circle Diameter	BCD 331.8000	mm.
Bolt Material	SA-325	
Bolt Allowable Tensile Stress	STBA 300.00	N./mm ²
Bolt Allowable Shear Stress	SBShear 180.00	N./mm ²
Anchor Bolt Nominal Diameter	BOD 20.0000	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	N./mm ²

Shear Stress in a Single Bolt [taub]:

$$= \text{Shear Force} / (2 * \text{Bolt Area} * \text{Number of Bolts})$$

$$= 2 / (2 * 2.17 * 1)$$

$$= 4.1 \text{ N./mm}^2. \text{ Must be less than } 180.0 \text{ N./mm}^2.$$

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

Since there is only 1 bolt, the standard computation for this

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geometry is not possible. A reasonable bolt size should be selected. Per Megyesy, use a 1 inch (25.4 mm) bolt.

Computing the required bolt area based on a standard method not including the baseplate's interaction with the foundation.

Calculation of Load per Bolt, Wind Empty [W,wind]:

$$\begin{aligned}
 &= ((4 * \text{Moment/BCD}) - \text{Weight}) / \text{Num Bolts} \\
 &= ((4 * 204/331.8) - 4) / 3 \\
 &= -0.357 \text{ kN}
 \end{aligned}$$

Calculation of Load per Bolt, Seismic Operating [W,seismic]:

$$\begin{aligned}
 &= ((4 * \text{Moment/BCD}) - \text{Weight}) / \text{Num Bolts} \\
 &= ((4 * 1409/331.8) - 4) / 3 \\
 &= 4.366 \text{ kN}
 \end{aligned}$$

There was a vertical load reducing the weight on the support.

Calculation of Maximum Load per Bolt [Wmax]:

$$\begin{aligned}
 &= \max(W, \text{wind}, W, \text{seismic}) \\
 &= \max(-0.4, 4.37) \\
 &= 4.366 \text{ kN}
 \end{aligned}$$

Area Available in a Single Bolt, corroded [Ab]:

$$= 2.171 \text{ cm}^2$$

Required Area of a single Bolt, Simplified Method:

$$\begin{aligned}
 &= W_{\max} / \text{Bolt Allowable Stress} \\
 &= 4.366 / 280707.844 \\
 &= 0.146 \text{ cm}^2
 \end{aligned}$$

Note: The Seismic Operating case governs.

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BK	GCS	MF	120	ME	CN	0004	V01											

RESULTS FOR LEGS : HydroTest Case Description: LEGS

Legs attached to: node 20

Section Properties : Single Angle L60X60X8

European Structural Steel Data

Overall Leg Length		1000.000	mm.
Effective Leg Length	Leglen	925.000	mm.
Distance Leg Up Side of Vessel		125.000	mm.
Number of Legs	Nleg	3	
Cross Sectional Area for L60X60X8	Aleg	9.030	cm ²
Section Inertia (strong axis)		29.200	cm ⁴
Section Inertia (weak axis)		29.200	cm ⁴
Section Modulus (strong axis)		6890.028	mm. ³
Section Modulus (weak axis)		6890.028	mm. ³
Radius of Gyration (strong axis)		18.000	mm.
Radius of Gyration (weak axis)		18.000	mm.

Leg Orientation - Diagonal

Overturning Moment at top of Legs		67.3	N-m
Total Weight Load at top of Legs	W	3.3	kN
Total Shear force at top of Legs		0.1	kN
Additional force in Leg due to Bracing	Fadd	0.0	kN
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

Pad Width along Circumference	C11P	100.000	mm.
Pad Length along Vessel Axis	C22P	100.000	mm.
Pad Thickness	Tpad	8.000	mm.

Maximum Shear at top of one Leg [Vleg]:

$$\begin{aligned}
 &= (\max(\text{Wind}, \text{Seismic}) + \text{applied forces}) (I_{\max} / I_{\text{tot}}) \\
 &= (0.1) (47.1/71.7) \\
 &= 0.09 \text{ kN}
 \end{aligned}$$

Axial Compression, Leg furthest from the Neutral Axis [Sma]:

$$\begin{aligned}
 &= W/N_{\text{leg}} + (M_{\text{leg}} / (N_{\text{leg}} * R_n)) / A_{\text{leg}} \\
 &= 3275/3 + (67292 / (1 * 188.741)) / 902.998 \\
 &= 1.60 \text{ N./mm}^2
 \end{aligned}$$

Axial Compression, Leg closest to the Neutral Axis [Sva]:

$$\begin{aligned}
 &= (W / N_{\text{leg}}) / A_{\text{leg}} \\
 &= (3/3) / 9.03 \\
 &= 1.21 \text{ N./mm}^2
 \end{aligned}$$

Computing Principal Axis and Inertias for Angle.

Leg lengths and thickness: 60.000 60.000 8.0000

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پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

Distance to geometric centroid: 17.700 17.700
Arm about YY: 13.700 16.300
Arm about ZZ: 12.300 13.700
Leg areas: 4.8000 4.1600
Geometric inertia components YY: 9.2650 20.426
Geometric inertia components ZZ: 21.662 8.0297
Geometric inertias Iy & Iz: 29.691 29.691
Product of inertia: 0.17378E+06
Mohrs Radius: 10.605
Average Inertia: 29.691

QFACT = 1.0000 FBZ = 0.16383
Principal Axis Inertias (Z&W) = 12.313 47.069
Angle to Principal Axis = 45.000
Distances to extreme fibers CW & CZ = 42.426 17.395
FOB from Eq 5-5 = 1.6846
Bending allowables Fby & Fbz = 0.16383 0.16383

Shear Center Coordinates Wo & Zo: 18.583 0.0000
Values for Elastic Flexural-Torsional Buckling Stress:
E, G, J, R0²: 29500. 11346. 0.46282E-01 1.5546
AREA, LENGTH, Kw, Kz: 1.3996 36.417 1.0000 1.0000
H, Few, Fez, Fej: 0.65569 177.37 46.401 241.34
Fe computed from C4-1: 127.82

Initial (Kl/r)max, & (Kl/r)equiv = 79.213 47.727
Final (Kl/r)max, & Cc = 79.213 127.18
Fa based on Eq 4-1 = 0.10699

	Actual	Allowable	
Weak Axis Bending :	8.66	218.38	N./mm ²
Strong Axis Bending :	5.52	218.38	N./mm ²
Axial Compression :	1.60	142.62	N./mm ²

UNITY CHECKS ARE: H1-1 0.000
H1-2 0.000
H1-3 0.076

AISC Unity Check : 0.076 Should be <= to 1

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

Rectangular Attachment Parameter	C11	84.853	mm.
Rectangular Attachment Parameter	C22	80.950	mm.

Input Echo, WRC107/537 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	307.181 mm.
Vessel Thickness	Tv	8.334 mm.
Design Temperature	T1	100.0 °C

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 71 از 129	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Attachment Type	Type	Rectangular
Parameter C11	C11	84.85 mm.
Parameter C22	C22	80.95 mm.
Thickness of Reinforcing Pad	Tpad	8.000 mm.
Pad Parameter C11P	C11p	100.000 mm.
Pad Parameter C22P	C22p	100.000 mm.
Design Internal Pressure	Dp	8.000 bars
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 kN
Global Force (SUS)	Fy	1.1 kN
Global Force (SUS)	Fz	0.0 kN
Global Moment (SUS)	Mx	0.0 N-m
Global Moment (SUS)	My	0.0 N-m
Global Moment (SUS)	Mz	29.3 N-m
Internal Pressure (SUS)	P	8.00 bars
Include Pressure Thrust	No	
Global Force (OCC)	Fx	0.1 kN
Global Force (OCC)	Fy	0.4 kN
Global Force (OCC)	Fz	0.0 kN
Global Moment (OCC)	Mx	0.0 N-m
Global Moment (OCC)	My	0.0 N-m
Global Moment (OCC)	Mz	52.9 N-m
Occasional Internal Pressure (OCC)	Pvar	2.52 bars
Use Interactive Control	No	
WRC107 Version	Version	March 1979
Include Pressure Stress Indices per Div. 2	No	
Compute Pressure Stress per WRC-368	No	
Local Loads applied at end of Nozzle/Attachment	No	

Note:

WRC Bulletin 537 provides equations for the dimensionless curves found in bulletin 107. As noted in the foreword to bulletin 537, "537 is equivalent to WRC 107". Where 107 is printed in the results below, "537" can be interchanged with "107".

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شماره پیمان: 053-073-9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 73 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	
	BK	GCS	MF	120	ME	CN	0004	V01	

Circ. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML	0.3	0.3	-0.3	-0.3	0.0	0.0	0.0	0.0	0.0
Circ. Bend. ML	0.6	-0.6	-0.6	0.6	0.0	0.0	0.0	0.0	0.0
Tot. Circ. Str.	0.9	-0.3	-0.9	0.3	0.0	0.0	0.0	0.0	0.0
Long. Memb. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML	0.1	0.1	-0.1	-0.1	0.0	0.0	0.0	0.0	0.0
Long. Bend. ML	0.9	-0.9	-0.9	0.9	0.0	0.0	0.0	0.0	0.0
Tot. Long. Str.	1.0	-0.8	-1.0	0.8	0.0	0.0	0.0	0.0	0.0
Shear VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL	0.0	0.0	0.0	0.0	-0.4	-0.4	0.4	0.4	0.4
Shear MT	0.0	0.0	0.0	0.0	0.0	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	0.4
Str. Int.	1.0	0.8	1.0	0.8	0.8	0.8	0.8	0.8	0.8

Dimensionless Parameters used : Gamma = 18.93

Dimensionless Loads for Cylindrical Shells at Pad edge:

Curves read for 1979	Beta	Figure	Value	Location
N(PHI) / (P/Rm)	0.317	4C	2.505	(A,B)
N(PHI) / (P/Rm)	0.317	3C	1.577	(C,D)
M(PHI) / (P)	0.317	2C1	0.029	(A,B)
M(PHI) / (P)	0.317	1C !	0.059	(C,D)
N(PHI) / (MC/ (Rm**2 * Beta))	0.317	3A	0.812	(A,B,C,D)
M(PHI) / (MC/ (Rm * Beta))	0.317	1A	0.079	(A,B,C,D)
N(PHI) / (ML/ (Rm**2 * Beta))	0.317	3B	1.829	(A,B,C,D)
M(PHI) / (ML/ (Rm * Beta))	0.317	1B	0.023	(A,B,C,D)
N(x) / (P/Rm)	0.317	3C	1.577	(A,B)
N(x) / (P/Rm)	0.317	4C	2.505	(C,D)
M(x) / (P)	0.317	1C1	0.054	(A,B)
M(x) / (P)	0.317	2C !	0.032	(C,D)
N(x) / (MC/ (Rm**2 * Beta))	0.317	4A	1.642	(A,B,C,D)
M(x) / (MC/ (Rm * Beta))	0.317	2A	0.036	(A,B,C,D)
N(x) / (ML/ (Rm**2 * Beta))	0.317	4B	0.776	(A,B,C,D)
M(x) / (ML/ (Rm * Beta))	0.317	2B	0.038	(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

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B) <table><tr><td>پروژه</td><td>بسته کاری</td><td>صادرکننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01	شماره صفحه : 74 از 129
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

Stresses in the Vessel at the Edge of Reinforcing Pad (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		0.8	0.8	-0.8	-0.8	0.0	0.0	0.0	0.0
Circ. Bend. ML		1.1	-1.1	-1.1	1.1	0.0	0.0	0.0	0.0
Tot. Circ. Str.		2.0	-0.3	-2.0	0.3	0.0	0.0	0.0	0.0
Long. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML		0.3	0.3	-0.3	-0.3	0.0	0.0	0.0	0.0
Long. Bend. ML		1.9	-1.9	-1.9	1.9	0.0	0.0	0.0	0.0
Tot. Long. Str.		2.3	-1.6	-2.3	1.6	0.0	0.0	0.0	0.0
Shear VC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL		0.0	0.0	0.0	0.0	-0.7	-0.7	0.7	0.7
Shear MT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear		0.0	0.0	0.0	0.0	-0.7	-0.7	0.7	0.7
Str. Int.		2.3	1.6	2.3	1.6	1.3	1.3	1.3	1.3

WRC 107 Stress Calculation for OCCasional loads:

Radial Load	P	0.1	kN
Circumferential Shear	VC	0.0	kN
Longitudinal Shear	VL	0.4	kN
Circumferential Moment	MC	0.0	N-m
Longitudinal Moment	ML	-52.9	N-m
Torsional Moment	MT	0.0	N-m

Dimensionless Parameters used : Gamma = 9.90

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-0.1	-0.1	-0.1	-0.1	-0.0	-0.0	-0.0	-0.0
Circ. Bend. P		-0.1	0.1	-0.1	0.1	-0.2	0.2	-0.2	0.2
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		0.5	0.5	-0.5	-0.5	0.0	0.0	0.0	0.0

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پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

Circ. Bend. ML	1.0	-1.0	-1.0	1.0	0.0	0.0	0.0	0.0
Tot. Circ. Str.	1.4	-0.4	-1.7	0.6	-0.2	0.1	-0.2	0.1
Long. Memb. P	-0.0	-0.0	-0.0	-0.0	-0.1	-0.1	-0.1	-0.1
Long. Bend. P	-0.2	0.2	-0.2	0.2	-0.1	0.1	-0.1	0.1
Long. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML	0.2	0.2	-0.2	-0.2	0.0	0.0	0.0	0.0
Long. Bend. ML	1.7	-1.7	-1.7	1.7	0.0	0.0	0.0	0.0
Tot. Long. Str.	1.6	-1.4	-2.1	1.7	-0.2	0.1	-0.2	0.1
Shear VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1
Shear MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear	0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1
Str. Int.	1.6	1.4	2.1	1.7	0.3	0.3	0.3	0.3

Dimensionless Parameters used : Gamma = 18.93

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Edge of Reinforcing Pad (N./mm²)

Type of Stress	Load	Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-0.2	-0.2	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
Circ. Bend. P		-0.2	0.2	-0.2	0.2	-0.5	0.5	-0.5	0.5
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		1.5	1.5	-1.5	-1.5	0.0	0.0	0.0	0.0
Circ. Bend. ML		2.1	-2.1	-2.1	2.1	0.0	0.0	0.0	0.0
Tot. Circ. Str.		3.1	-0.5	-3.9	0.6	-0.6	0.4	-0.6	0.4
Long. Memb. P		-0.1	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2	-0.2
Long. Bend. P		-0.4	0.4	-0.4	0.4	-0.3	0.3	-0.3	0.3
Long. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Bend. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Memb. ML		0.6	0.6	-0.6	-0.6	0.0	0.0	0.0	0.0
Long. Bend. ML		3.5	-3.5	-3.5	3.5	0.0	0.0	0.0	0.0
Tot. Long. Str.		3.5	-2.5	-4.6	3.2	-0.4	0.1	-0.4	0.1
Shear VC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear VL		0.0	0.0	0.0	0.0	-0.2	-0.2	0.2	0.2
Shear MT		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tot. Shear		0.0	0.0	0.0	0.0	-0.2	-0.2	0.2	0.2
Str. Int.		3.5	2.5	4.6	3.2	0.7	0.5	0.7	0.5

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پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0004	V01											

WRC 107/537 Stress Summations:

Vessel Stress Summation at Attachment Junction (N./mm²)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Pm (SUS)		7.1	7.9	7.1	7.9	7.1	7.9	7.1	7.9
Circ. Pm (OCC)		2.2	2.5	2.2	2.5	2.2	2.5	2.2	2.5
Circ. Pm(TOTAL)		9.4	10.4	9.4	10.4	9.4	10.4	9.4	10.4
Circ. Pl (SUS)		0.3	0.3	-0.3	-0.3	0.0	0.0	0.0	0.0
Circ. Pl (OCC)		0.5	0.5	-0.6	-0.6	-0.0	-0.0	-0.0	-0.0
Circ. Pl(TOTAL)		0.7	0.7	-0.9	-0.9	-0.0	-0.0	-0.0	-0.0
Circ. Q (SUS)		0.6	-0.6	-0.6	0.6	0.0	0.0	0.0	0.0
Circ. Q (OCC)		0.9	-0.9	-1.2	1.2	-0.2	0.2	-0.2	0.2
Circ. Q (TOTAL)		1.5	-1.5	-1.7	1.7	-0.2	0.2	-0.2	0.2
Long. Pm (SUS)		3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6
Long. Pm (OCC)		1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Long. Pm(TOTAL)		4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Long. Pl (SUS)		0.1	0.1	-0.1	-0.1	0.0	0.0	0.0	0.0
Long. Pl (OCC)		0.1	0.1	-0.2	-0.2	-0.1	-0.1	-0.1	-0.1
Long. Pl(TOTAL)		0.2	0.2	-0.3	-0.3	-0.1	-0.1	-0.1	-0.1
Long. Q (SUS)		0.9	-0.9	-0.9	0.9	0.0	0.0	0.0	0.0
Long. Q (OCC)		1.5	-1.5	-1.9	1.9	-0.1	0.1	-0.1	0.1
Long. Q (TOTAL)		2.4	-2.4	-2.8	2.8	-0.1	0.1	-0.1	0.1
Shear Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pm (OCC)		0.0	0.0	0.0	0.0	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	-0.4	-0.4	0.4	0.4
Shear Pl (OCC)		0.0	0.0	0.0	0.0	-0.1	-0.1	0.1	0.1
Shear Pl(TOTAL)		0.0	0.0	0.0	0.0	-0.5	-0.5	0.5	0.5
Shear Q (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Q (OCC)		0.0	0.0	0.0	0.0	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)		7.1	7.9	7.1	7.9	7.1	7.9	7.1	7.9
Pm (SUS+OCC)		9.4	10.4	9.4	10.4	9.4	10.4	9.4	10.4
Pm+Pl (SUS)		7.4	8.2	6.9	7.7	7.2	8.0	7.2	8.0
Pm+Pl (SUS+OCC)		10.1	11.2	8.5	9.6	9.4	10.4	9.4	10.4
Pm+Pl+Q (Total)		11.6	9.7	6.8	11.3	9.2	10.6	9.2	10.6

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	BK	GCS	MF	120	ME	CN	0004		V01

Shear Q (TOTAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pm (SUS)	14.4	15.2	14.4	15.2	14.4	15.2	14.4	15.2
Pm (SUS+OCC)	18.9	19.9	18.9	19.9	18.9	19.9	18.9	19.9
Pm+Pl (SUS)	15.2	16.0	13.5	14.3	14.4	15.2	14.4	15.2
Pm+Pl (SUS+OCC)	21.0	22.0	16.4	17.5	18.8	19.9	18.8	19.9
Pm+Pl+Q (Total)	23.9	19.1	13.0	20.9	18.4	20.4	18.4	20.4

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	15.15	217.20	Passed
Pm (SUS+OCC)	19.93	260.64	Passed
Pm+Pl (SUS)	15.97	325.80	Passed
Pm+Pl (SUS+OCC)	22.03	390.96	Passed
Pm+Pl+Q (TOTAL)	23.95	651.60	Passed

The Pm+Pl+Q allowable above was based on the rules of ASME VIII-2 Part 4, 4.1.6.3 (a)&(b) or per ASME VIII-2, 5.5.6.1(1)&(2) Part 5 as applicable.

The Pm+Pl+Q allowable was based on a temperature range cycling from ambient to design temperature.

Bolting Size Requirement for Leg Baseplates :

Baseplate Material	SA-283 C
Baseplate Allowable Stress	SBA 108.25 N./mm ²
Baseplate Length	B 150.0000 mm.
Baseplate Width	D 150.0000 mm.
Baseplate Thickness	BTHK 15.0000 mm.
Leg Dimension Along Baseplate Length	d 59.9999 mm.
Leg Dimension Along Baseplate Width	b 59.9999 mm.
Bolt Circle Diameter	BCD 331.8000 mm.
Bolt Material	SA-325
Bolt Allowable Tensile Stress	STBA 300.00 N./mm ²
Bolt Allowable Shear Stress	SBShear 180.00 N./mm ²
Anchor Bolt Nominal Diameter	BOD 20.0000 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 N./mm ²

Shear Stress in a Single Bolt [taub]:

$$= \text{Shear Force} / (2 * \text{Bolt Area} * \text{Number of Bolts})$$

$$= 2 / (2 * 2.17 * 1)$$

$$= 4.1 \text{ N./mm}^2. \text{ Must be less than } 180.0 \text{ N./mm}^2.$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)	شماره صفحه : 79 از 129																
	<table><tr><td>پروژه</td><td>بسته کاری</td><td>صادر کننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01
	پروژه		بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0004	V01											

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.

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 80 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Input, Nozzle Desc: N04 (1in)

From: 10

Pressure for Reinforcement Calculations	P	8.130	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-234 WPB	
Shell Allowable Stress at Temperature	Sv	117.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	117.90	N./mm ²
Inside Diameter of Elliptical Head	D	304.80	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	9.5250	mm.
Head Internal Corrosion Allowance	c	6.0000	mm.
Head External Corrosion Allowance	co	0.0000	mm.
Distance from Head Centerline	L1	0.0000	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

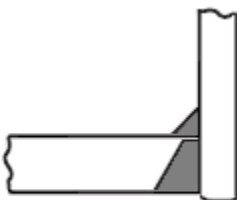
Type of Element Connected to the Shell : Nozzle

Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	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.
Flange Class		150	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	
	BK	GCS	MF	120	ME	CN	0004	
							V01	

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



Insert/Set-in Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: N04 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000 in.
Actual Thickness Used in Calculation	0.500 in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Elliptical Head, Tr [Int. Press]

$$= (P \cdot K_1 \cdot D) / (2 \cdot S_v \cdot E - 0.2 \cdot P) \text{ per UG-37 (a) (3)}$$

$$= (8.13 \cdot 0.869 \cdot 316.8) / (2 \cdot 117.9 \cdot 1.0 - 0.2 \cdot 8.13)$$

$$= 0.9496 \text{ mm.}$$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)}$$

$$= (8.13 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.13)$$

$$= 0.1106 \text{ mm.}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2564 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	D1	74.8000 mm.
Parallel to Vessel Wall, opening length	d	37.4000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	8.8125 mm.

Weld Strength Reduction Factor [fr1]:

$$= \min(1, S_n / S_v)$$

$$= \min(1, 137.9 / 117.9)$$

$$= 1.000$$

Weld Strength Reduction Factor [fr2]:

$$= \min(1, S_n / S_v)$$

$$= \min(1, 137.9 / 117.9)$$

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	BK	GCS	MF	120	ME	CN	0004		V01

= 1.000

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)

= min(1.0, 1.0)

= 1.000

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.355	0.280	NA
Area in Shell	A1	0.963	0.757	NA
Area in Nozzle Wall	A2	1.161	1.136	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		0.986	0.986	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	3.110	2.879	NA

The External 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]:

= 0.5(d * tr*F + 2 * tn * tr*F(1-fr1)) per UG-37(d)

= 0.5(37.4*1.5*1+2*6.7*1.5*1(1-1.0))

= 0.280 cm²

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)

= 37.4(1.0 * 3.525 - 1.0 * 1.5) - 2 * 6.7

(1.0 * 3.525 - 1.0 * 1.5) * (1 - 1.0)

= 0.757 cm²

Area Available in Nozzle Projecting Outward [A2]:

= (2 * tlnp) (tn - trn) fr2

= (2 * 8.81) (6.7 - 0.26) 1.0

= 1.136 cm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:

= (Wo² - Area Lost) * fr2 + ((Wi-can/0.707)² - Area Lost) * fr2

= (10.0² - 0.0141) * 1.0 + (0.0² - 0.0) * 1.0

= 0.986 cm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures ta = 6.2564 mm.

Wall Thickness per UG16(b), tr16b = 7.5000 mm.

Wall Thickness, shell/head, internal pressure trb1 = 7.0409 mm.

Wall Thickness tb1 = max(trb1, tr16b) = 7.5000 mm.

Wall Thickness tb2 = max(trb2, tr16b) = 7.5000 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Wall Thickness per table UG-45

tb3 = 9.4200 mm.

Determine Nozzle Thickness candidate [tb]:

$$= \min[tb3, \max(tb1, tb2)]$$

$$= \min[9.42, \max(7.5, 7.5)]$$

$$= 7.5000 \text{ mm.}$$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:

$$= \max(ta, tb)$$

$$= \max(6.2564, 7.5)$$

$$= 7.5000 \text{ mm.}$$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:C)

Govrn. thk, tg = 9.525, tr = 0.95, c = 6.0 mm., E* = 1.0

Thickness Ratio = $tr * (E^*) / (tg - c) = 0.269$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve A -8 °C

Min Metal Temp. at Required thickness (UCS 66.1) -104 °C

Min Metal Temp. w/o impact per UG-20(f) -29 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -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) -48 °C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :

Design Pressure/Ambient Rating = $8.13 / 19.60 = 0.415$

Weld Size Calculations, Description: N04 (1in)

Intermediate Calc. for nozzle/shell Welds Tmin 3.5250 mm.

Results Per UW-16.1:

Required Thickness Actual Thickness

Nozzle Weld 2.4675 = $0.7 * t_{min}$. 7.0700 = $0.7 * W_o$ mm.

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:

$$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - t_r)) S_v)$$

$$= \max(0, (0.2805 - 0.7573 + 2 * 6.7 * 1.0 * (1.0 * 3.525 - 1.5)) 118)$$

$$= \max(0, -2.42) \text{ kN}$$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0004		V01

$$= (A2+A5+A4-(Wi-Can/.707)^2*fr2)*Sv$$

$$= (1.1357 + 0.0 + 0.9859 - 0.0 * 1.0) * 118$$

$$= 25.01 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv$$

$$= (1.1357 + 0.0 + 0.9859 + (0.4723)) * 118$$

$$= 30.58 \text{ kN}$$

Weld Load [W3]:

$$= (A2+A3+A4+A5+(2*tn*t*fr1))*S$$

$$= (1.1357 + 0.0 + 0.9859 + 0.0 + (0.4723)) * 118$$

$$= 30.58 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (\pi/2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416/2.0) * 50.8 * 10.0 * 0.49 * 118$$

$$= 46. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (\pi * (Dlr + Dlo) / 4) * (Thk - Can) * 0.7 * Sn$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

$$= (\pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng$$

$$= (3.1416/2.0) * 50.8 * (8.3344 - 6.0) * 0.74 * 138$$

$$= 19. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (46 + 45) = 91 \text{ kN}$$

$$PATH22 = (Sonw + Tpgw + Tngw + Sinw)$$

$$= (46 + 0 + 19 + 0) = 65 \text{ kN}$$

$$PATH33 = (Sonw + Tngw + Sinw)$$

$$= (46 + 19 + 0) = 65 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 90 kN , must exceed W = 0 kN or W1 = 25 kN

Path 2-2 = 65 kN , must exceed W = 0 kN or W2 = 30 kN

Path 3-3 = 65 kN , must exceed W = 0 kN or W3 = 30 kN

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	BK	GCS	MF	120	ME	CN	0004		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 26 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Drop for this Nozzle is : 1.1465 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 160.6715 mm.

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK	شماره صفحه : 86 از 129
MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0004	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: N02 (1in)

From: 20

Pressure for Reinforcement Calculations	P	8.108	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-106 B	
Shell Allowable Stress at Temperature	Sv	117.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	117.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	307.18	mm.
Design Length of Section	L	1275.4000	mm.
Shell Finished (Minimum) Thickness	t	8.3344	mm.
Shell Internal Corrosion Allowance	c	6.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		150.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

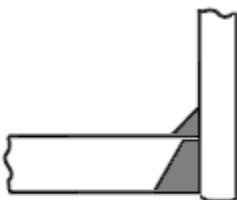
Type of Element Connected to the Shell : Nozzle

Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	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.
Flange Class		150	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		V01

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



Insert/Set-in Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: N02 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000 in.
Actual Thickness Used in Calculation	0.500 in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Cylindrical Shell, Tr [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.11 \cdot 159.5906) / (118 \cdot 1.0 - 0.6 \cdot 8.11) \\
 &= 1.1021 \text{ mm.}
 \end{aligned}$$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.11 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.11) \\
 &= 0.1103 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2564 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	D1	74.8000 mm.
Parallel to Vessel Wall, opening length	d	37.4000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	5.8359 mm.

Weld Strength Reduction Factor [fr1]:

$$\begin{aligned}
 &= \min(1, S_n / S_v) \\
 &= \min(1, 137.9 / 117.9) \\
 &= 1.000
 \end{aligned}$$

Weld Strength Reduction Factor [fr2]:

$$\begin{aligned}
 &= \min(1, S_n / S_v) \\
 &= \min(1, 137.9 / 117.9)
 \end{aligned}$$

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		V01

= 1.000

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)

= min(1.0, 1.0)

= 1.000

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.412	0.343	NA
Area in Shell	A1	0.461	0.187	NA
Area in Nozzle Wall	A2	0.769	0.752	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		0.827	0.827	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	2.057	1.766	NA

The External 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]:

= 0.5(d * tr*F + 2 * tn * tr*F(1-fr1)) per UG-37(d)

= 0.5(37.4*1.8346*1+2*6.7*1.8346*1(1-1.0))

= 0.343 cm²

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)

= 37.4(1.0 * 2.3344 - 1.0 * 1.835) - 2 * 6.7

(1.0 * 2.3344 - 1.0 * 1.8346) * (1 - 1.0)

= 0.187 cm²

Area Available in Nozzle Projecting Outward [A2]:

= (2 * tlnp) (tn - trn) fr2

= (2 * 5.84) (6.7 - 0.26) 1.0

= 0.752 cm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:

= (Wo² - Area Lost) * fr2 + ((Wi-can/0.707)² - Area Lost) * fr2

= (10.0² - 0.1734) * 1.0 + (0.0² - 0.0) * 1.0

= 0.827 cm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures ta = 6.2564 mm.

Wall Thickness per UG16(b), tr16b = 7.5000 mm.

Wall Thickness, shell/head, internal pressure trb1 = 7.1021 mm.

Wall Thickness tb1 = max(trb1, tr16b) = 7.5000 mm.

Wall Thickness tb2 = max(trb2, tr16b) = 7.5000 mm.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		V01

Wall Thickness per table UG-45

tb3 = 9.4200 mm.

Determine Nozzle Thickness candidate [tb]:

$$= \min[tb3, \max(tb1, tb2)]$$

$$= \min[9.42, \max(7.5, 7.5)]$$

$$= 7.5000 \text{ mm.}$$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:

$$= \max(ta, tb)$$

$$= \max(6.2564, 7.5)$$

$$= 7.5000 \text{ mm.}$$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:C)

Govrn. thk, tg = 8.334, tr = 1.102, c = 6.0 mm., E* = 1.0

Thickness Ratio = $tr * (E^*) / (tg - c) = 0.472$, Temp. Reduction = 36 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-44 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -44 °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)	-48 °C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :

$$\text{Design Pressure/Ambient Rating} = 8.11/19.60 = 0.414$$

Weld Size Calculations, Description: N02 (1in)

Intermediate Calc. for nozzle/shell Welds Tmin 3.5250 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	$2.4675 = 0.7 * t_{min}$	$7.0700 = 0.7 * W_o \text{ mm.}$

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:

$$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - t_r)) S_v)$$

$$= \max(0, (0.3431 - 0.1869 + 2 * 6.7 * 1.0 * (1.0 * 2.3344 - 1.8346)) 118)$$

$$= 2.63 \text{ kN}$$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0004		V01

$$= (A2+A5+A4-(Wi-Can/.707)^2*fr2)*Sv$$

$$= (0.7521 + 0.0 + 0.8266 - 0.0 * 1.0) * 118$$

$$= 18.61 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv$$

$$= (0.7521 + 0.0 + 0.8266 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Weld Load [W3]:

$$= (A2+A3+A4+A5+(2*tn*t*fr1))*S$$

$$= (0.7521 + 0.0 + 0.8266 + 0.0 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (\pi/2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416/2.0) * 50.8 * 10.0 * 0.49 * 118$$

$$= 46. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (\pi * (Dlr + Dlo) / 4) * (Thk - Can) * 0.7 * Sn$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

$$= (\pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng$$

$$= (3.1416/2.0) * 50.8 * (8.3344 - 6.0) * 0.74 * 138$$

$$= 19. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (46 + 45) = 91 \text{ kN}$$

$$PATH22 = (Sonw + Tpgw + Tngw + Sinw)$$

$$= (46 + 0 + 19 + 0) = 65 \text{ kN}$$

$$PATH33 = (Sonw + Tngw + Sinw)$$

$$= (46 + 19 + 0) = 65 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 90 kN , must exceed W = 2 kN or W1 = 18 kN

Path 2-2 = 65 kN , must exceed W = 2 kN or W2 = 22 kN

Path 3-3 = 65 kN , must exceed W = 2 kN or W3 = 22 kN

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Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 17 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Drop for this Nozzle is : 2.1148 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 160.4492 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Input, Nozzle Desc: N03 (1in)

From: 20

Pressure for Reinforcement Calculations	P	8.088	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-106 B	
Shell Allowable Stress at Temperature	Sv	117.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	117.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	307.18	mm.
Design Length of Section	L	1275.4000	mm.
Shell Finished (Minimum) Thickness	t	8.3344	mm.
Shell Internal Corrosion Allowance	c	6.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		350.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

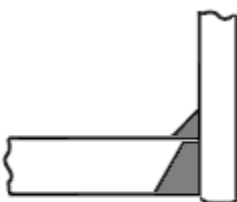
Type of Element Connected to the Shell : Nozzle

Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		180.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	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.
Flange Class		150	
Flange Grade		GR 1.1	
Flange Series	Series	A	

The Pressure Design option was Design Pressure + static head.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		V01

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



Insert/Set-in Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: N03 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000 in.
Actual Thickness Used in Calculation	0.500 in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Cylindrical Shell, Tr [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.09 \cdot 159.5906) / (118 \cdot 1.0 - 0.6 \cdot 8.09) \\
 &= 1.0994 \text{ mm.}
 \end{aligned}$$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.09 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.09) \\
 &= 0.1101 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2564 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	D1	74.8000 mm.
Parallel to Vessel Wall, opening length	d	37.4000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	5.8359 mm.

Weld Strength Reduction Factor [fr1]:

$$\begin{aligned}
 &= \min(1, S_n / S_v) \\
 &= \min(1, 137.9 / 117.9) \\
 &= 1.000
 \end{aligned}$$

Weld Strength Reduction Factor [fr2]:

$$= \min(1, S_n / S_v)$$

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 94 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

= min(1, 137.9/117.9)
= 1.000

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)
= min(1.0, 1.0)
= 1.000

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.411	0.343	NA
Area in Shell	A1	0.462	0.187	NA
Area in Nozzle Wall	A2	0.769	0.752	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		0.827	0.827	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	2.058	1.766	NA

The External 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]:

= 0.5(d * tr*F + 2 * tn * tr*F(1-fr1)) per UG-37(d)
= 0.5(37.4*1.8346*1+2*6.7*1.8346*1(1-1.0))
= 0.343 cm²

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)
= 37.4(1.0 * 2.3344 - 1.0 * 1.835) - 2 * 6.7
(1.0 * 2.3344 - 1.0 * 1.8346) * (1 - 1.0)
= 0.187 cm²

Area Available in Nozzle Projecting Outward [A2]:

= (2 * tlnp) (tn - trn) fr2
= (2 * 5.84) (6.7 - 0.26) 1.0
= 0.752 cm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:

= (Wo² - Area Lost) * fr2 + ((Wi-can/0.707)² - Area Lost) * fr2
= (10.0² - 0.1734) * 1.0 + (0.0² - 0.0) * 1.0
= 0.827 cm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures ta = 6.2564 mm.
Wall Thickness per UG16(b), tr16b = 7.5000 mm.
Wall Thickness, shell/head, internal pressure trb1 = 7.0994 mm.
Wall Thickness tb1 = max(trb1, tr16b) = 7.5000 mm.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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Wall Thickness $tb2 = \max(trb2, tr16b) = 7.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 9.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[9.42, \max(7.5, 7.5)]$
 $= 7.5000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(6.2564, 7.5)$
 $= 7.5000 \text{ mm.}$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:C)

Govrn. thk, $tg = 8.334$, $tr = 1.099$, $c = 6.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.471$, Temp. Reduction = $37 \text{ }^{\circ}\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $-8 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-44 \text{ }^{\circ}\text{C}$
Min Metal Temp. w/o impact per UG-20(f) $-29 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-44 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-29 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b) (1) (-b) $-48 \text{ }^{\circ}\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $8.09/19.60 = 0.413$

Weld Size Calculations, Description: N03 (1in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 3.5250 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $2.4675 = 0.7 * t_{min}$ $7.0700 = 0.7 * W_o \text{ mm.}$

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:
 $= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (0.3431 - 0.1869 + 2 * 6.7 * 1.0 * (1.0 * 2.3344 - 1.8346))118)$
 $= 2.63 \text{ kN}$

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

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0004		V01

Weld Load [W1]:

$$= (A2+A5+A4-(W_i-Can/.707)^2*fr2)*Sv$$

$$= (0.7521 + 0.0 + 0.8266 - 0.0 * 1.0) * 118$$

$$= 18.61 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv$$

$$= (0.7521 + 0.0 + 0.8266 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Weld Load [W3]:

$$= (A2+A3+A4+A5+(2*tn*t*fr1))*S$$

$$= (0.7521 + 0.0 + 0.8266 + 0.0 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (pi/2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416/2.0) * 50.8 * 10.0 * 0.49 * 118$$

$$= 46. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (pi * (Dlr + Dlo) /4) * (Thk - Can) * 0.7 * Sn$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

$$= (pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng$$

$$= (3.1416/2.0) * 50.8 * (8.3344 - 6.0) * 0.74 * 138$$

$$= 19. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (46 + 45) = 91 \text{ kN}$$

$$PATH22 = (Sonw + Tpgw + Tngw + Sinw)$$

$$= (46 + 0 + 19 + 0) = 65 \text{ kN}$$

$$PATH33 = (Sonw + Tngw + Sinw)$$

$$= (46 + 19 + 0) = 65 \text{ kN}$$

Summary of Failure Path Calculations:

$$\text{Path 1-1} = 90 \text{ kN} , \text{ must exceed } W = 2 \text{ kN} \text{ or } W1 = 18 \text{ kN}$$

$$\text{Path 2-2} = 65 \text{ kN} , \text{ must exceed } W = 2 \text{ kN} \text{ or } W2 = 22 \text{ kN}$$

$$\text{Path 3-3} = 65 \text{ kN} , \text{ must exceed } W = 2 \text{ kN} \text{ or } W3 = 22 \text{ kN}$$

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	BK	GCS	MF	120	ME	CN	0004		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 17 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Drop for this Nozzle is : 2.1148 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 160.4492 mm.

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 98 از 129	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Input, Nozzle Desc: N01 (1in)

From: 20

Pressure for Reinforcement Calculations	P	8.010	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-106 B	
Shell Allowable Stress at Temperature	Sv	117.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	117.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	307.18	mm.
Design Length of Section	L	1275.4000	mm.
Shell Finished (Minimum) Thickness	t	8.3344	mm.
Shell Internal Corrosion Allowance	c	6.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1150.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

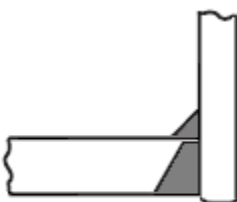
Type of Element Connected to the Shell : Nozzle

Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		180.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	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.
Flange Class		150	
Flange Grade		GR 1.1	
Flange Series	Series	A	

The Pressure Design option was Design Pressure + static head.

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	BK	GCS	MF	120	ME	CN	0004		V01

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



Insert/Set-in Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: N01 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000 in.
Actual Thickness Used in Calculation	0.500 in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Cylindrical Shell, Tr [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.01 \cdot 159.5906) / (118 \cdot 1.0 - 0.6 \cdot 8.01) \\
 &= 1.0887 \text{ mm.}
 \end{aligned}$$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.01 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.01) \\
 &= 0.1090 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2564 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	D1	74.8000 mm.
Parallel to Vessel Wall, opening length	d	37.4000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	5.8359 mm.

Weld Strength Reduction Factor [fr1]:

$$\begin{aligned}
 &= \min(1, S_n / S_v) \\
 &= \min(1, 137.9 / 117.9) \\
 &= 1.000
 \end{aligned}$$

Weld Strength Reduction Factor [fr2]:

$$= \min(1, S_n / S_v)$$

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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

= min(1, 137.9/117.9)
= 1.000

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)
= min(1.0, 1.0)
= 1.000

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.407	0.343	NA
Area in Shell	A1	0.466	0.187	NA
Area in Nozzle Wall	A2	0.769	0.752	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		0.827	0.827	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	2.062	1.766	NA

The External 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]:

= 0.5(d * tr*F + 2 * tn * tr*F(1-fr1)) per UG-37(d)
= 0.5(37.4*1.8346*1+2*6.7*1.8346*1(1-1.0))
= 0.343 cm²

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)
= 37.4(1.0 * 2.3344 - 1.0 * 1.835) - 2 * 6.7
(1.0 * 2.3344 - 1.0 * 1.8346) * (1 - 1.0)
= 0.187 cm²

Area Available in Nozzle Projecting Outward [A2]:

= (2 * tlnp) (tn - trn) fr2
= (2 * 5.84) (6.7 - 0.26) 1.0
= 0.752 cm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:

= (Wo² - Area Lost) * fr2 + ((Wi-can/0.707)² - Area Lost) * fr2
= (10.0² - 0.1734) * 1.0 + (0.0² - 0.0) * 1.0
= 0.827 cm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures ta = 6.2564 mm.
Wall Thickness per UG16(b), tr16b = 7.5000 mm.
Wall Thickness, shell/head, internal pressure trb1 = 7.0887 mm.
Wall Thickness tb1 = max(trb1, tr16b) = 7.5000 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Wall Thickness $tb2 = \max(trb2, tr16b) = 7.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 9.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[9.42, \max(7.5, 7.5)]$
 $= 7.5000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(6.2564, 7.5)$
 $= 7.5000 \text{ mm.}$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:C)

Govrn. thk, $tg = 8.334$, $tr = 1.089$, $c = 6.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.466$, Temp. Reduction = $37 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $-8 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-45 \text{ }^\circ\text{C}$
Min Metal Temp. w/o impact per UG-20(f) $-29 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-45 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-29 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b) (1) (-b) $-48 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $8.01/19.60 = 0.409$

Weld Size Calculations, Description: N01 (1in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 3.5250 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $2.4675 = 0.7 * t_{min}$ $7.0700 = 0.7 * W_o \text{ mm.}$

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:
 $= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (0.3431 - 0.1869 + 2 * 6.7 * 1.0 * (1.0 * 2.3344 - 1.8346))118)$
 $= 2.63 \text{ kN}$

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

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	BK	GCS	MF	120	ME	CN	0004	
							V01	

Weld Load [W1]:

$$= (A2+A5+A4 - (W_i - Can / .707)^2 * fr2) * Sv$$

$$= (0.7521 + 0.0 + 0.8266 - 0.0 * 1.0) * 118$$

$$= 18.61 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * t_n * t * fr1)) * Sv$$

$$= (0.7521 + 0.0 + 0.8266 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Weld Load [W3]:

$$= (A2+A3+A4+A5+(2*t_n*t*fr1))*S$$

$$= (0.7521 + 0.0 + 0.8266 + 0.0 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (pi/2) * D_{lo} * W_o * 0.49 * S_{nw}$$

$$= (3.1416/2.0) * 50.8 * 10.0 * 0.49 * 118$$

$$= 46. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (pi * (D_{lr} + D_{lo}) / 4) * (Thk - Can) * 0.7 * S_n$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

$$= (pi/2) * D_{lo} * (W_{gvi} - Cas) * 0.74 * S_{ng}$$

$$= (3.1416/2.0) * 50.8 * (8.3344 - 6.0) * 0.74 * 138$$

$$= 19. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (46 + 45) = 91 \text{ kN}$$

$$PATH22 = (Sonw + Tpgw + Tngw + Sinw)$$

$$= (46 + 0 + 19 + 0) = 65 \text{ kN}$$

$$PATH33 = (Sonw + Tngw + Sinw)$$

$$= (46 + 19 + 0) = 65 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 90 kN , must exceed W = 2 kN or W1 = 18 kN

Path 2-2 = 65 kN , must exceed W = 2 kN or W2 = 22 kN

Path 3-3 = 65 kN , must exceed W = 2 kN or W3 = 22 kN

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	BK	GCS	MF	120	ME	CN	0004		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 17 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Drop for this Nozzle is : 2.1148 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 160.4492 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Input, Nozzle Desc: N06 (1in)

From: 20

Pressure for Reinforcement Calculations	P	8.010	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-106 B	
Shell Allowable Stress at Temperature	Sv	117.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	117.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	307.18	mm.
Design Length of Section	L	1275.4000	mm.
Shell Finished (Minimum) Thickness	t	8.3344	mm.
Shell Internal Corrosion Allowance	c	6.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1150.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

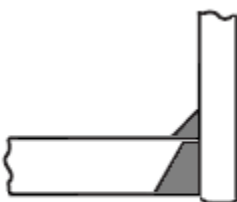
Type of Element Connected to the Shell : Nozzle

Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	150.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	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.
Flange Class		150	
Flange Grade		GR 1.1	
Flange Series	Series	A	

The Pressure Design option was Design Pressure + static head.

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری		پروژه
	V01	0004	CN	ME	120	MF	GCS		BK

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



Insert/Set-in Nozzle No Pad, no Inside projection

Reinforcement CALCULATION, Description: N06 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000 in.
Actual Thickness Used in Calculation	0.500 in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Cylindrical Shell, Tr [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.01 \cdot 159.5906) / (118 \cdot 1.0 - 0.6 \cdot 8.01) \\
 &= 1.0887 \text{ mm.}
 \end{aligned}$$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.01 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.01) \\
 &= 0.1090 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2564 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	D1	74.8000 mm.
Parallel to Vessel Wall, opening length	d	37.4000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	5.8359 mm.

Weld Strength Reduction Factor [fr1]:

$$\begin{aligned}
 &= \min(1, S_n / S_v) \\
 &= \min(1, 137.9 / 117.9) \\
 &= 1.000
 \end{aligned}$$

Weld Strength Reduction Factor [fr2]:

$$= \min(1, S_n / S_v)$$

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	V01	0004	CN	ME	120	MF	GCS		BK

= min(1, 137.9/117.9)
= 1.000

Weld Strength Reduction Factor [fr3]:

= min(fr2, fr4)
= min(1.0, 1.0)
= 1.000

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	0.407	0.343	NA
Area in Shell	A1	0.466	0.187	NA
Area in Nozzle Wall	A2	0.769	0.752	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		0.827	0.827	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	2.062	1.766	NA

The External 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]:

= 0.5(d * tr*F + 2 * tn * tr*F(1-fr1)) per UG-37(d)
= 0.5(37.4*1.8346*1+2*6.7*1.8346*1(1-1.0))
= 0.343 cm²

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)
= 37.4(1.0 * 2.3344 - 1.0 * 1.835) - 2 * 6.7
(1.0 * 2.3344 - 1.0 * 1.8346) * (1 - 1.0)
= 0.187 cm²

Area Available in Nozzle Projecting Outward [A2]:

= (2 * tlnp) (tn - trn) fr2
= (2 * 5.84) (6.7 - 0.26) 1.0
= 0.752 cm²

Area Available in Inward Weld + Outward Weld [A41 + A43]:

= (Wo² - Area Lost) * fr2 + ((Wi-can/0.707)² - Area Lost) * fr2
= (10.0² - 0.1734) * 1.0 + (0.0² - 0.0) * 1.0
= 0.827 cm²

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures ta = 6.2564 mm.
Wall Thickness per UG16(b), tr16b = 7.5000 mm.
Wall Thickness, shell/head, internal pressure trb1 = 7.0887 mm.
Wall Thickness tb1 = max(trb1, tr16b) = 7.5000 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Wall Thickness $tb2 = \max(trb2, tr16b) = 7.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 9.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[9.42, \max(7.5, 7.5)]$
 $= 7.5000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(6.2564, 7.5)$
 $= 7.5000 \text{ mm.}$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:C)

Govrn. thk, $tg = 8.334$, $tr = 1.089$, $c = 6.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.466$, Temp. Reduction = $37 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $-8 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-45 \text{ }^\circ\text{C}$
Min Metal Temp. w/o impact per UG-20(f) $-29 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-45 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-29 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b) (1) (-b) $-48 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $8.01/19.60 = 0.409$

Weld Size Calculations, Description: N06 (1in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 3.5250 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $2.4675 = 0.7 * t_{min}$ $7.0700 = 0.7 * W_o \text{ mm.}$

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:
 $= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (0.3431 - 0.1869 + 2 * 6.7 * 1.0 * (1.0 * 2.3344 - 1.8346))118)$
 $= 2.63 \text{ kN}$

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

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							V01	

Weld Load [W1]:

$$= (A2+A5+A4-(W_i-Can/.707)^2*fr2)*Sv$$

$$= (0.7521 + 0.0 + 0.8266 - 0.0 * 1.0) * 118$$

$$= 18.61 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv$$

$$= (0.7521 + 0.0 + 0.8266 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Weld Load [W3]:

$$= (A2+A3+A4+A5+(2*tn*t*fr1))*S$$

$$= (0.7521 + 0.0 + 0.8266 + 0.0 + (0.3128)) * 118$$

$$= 22.30 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (pi/2) * Dlo * Wo * 0.49 * Snw$$

$$= (3.1416/2.0) * 50.8 * 10.0 * 0.49 * 118$$

$$= 46. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (pi * (Dlr + Dlo) /4) * (Thk - Can) * 0.7 * Sn$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

$$= (pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng$$

$$= (3.1416/2.0) * 50.8 * (8.3344 - 6.0) * 0.74 * 138$$

$$= 19. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (46 + 45) = 91 \text{ kN}$$

$$PATH22 = (Sonw + Tpgw + Tngw + Sinw)$$

$$= (46 + 0 + 19 + 0) = 65 \text{ kN}$$

$$PATH33 = (Sonw + Tngw + Sinw)$$

$$= (46 + 19 + 0) = 65 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 90 kN , must exceed W = 2 kN or W1 = 18 kN

Path 2-2 = 65 kN , must exceed W = 2 kN or W2 = 22 kN

Path 3-3 = 65 kN , must exceed W = 2 kN or W3 = 22 kN

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Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 17 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Drop for this Nozzle is : 2.1148 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 160.4492 mm.

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	BK	GCS	MF	120	ME	CN	0004		V01

Input, Nozzle Desc: N05 (1in)

From: 40

Pressure for Reinforcement Calculations	P	8.000	bars
Temperature for Internal Pressure	Temp	100	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material		SA-105	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Outside Diameter of Bolted Blind Flange	D	482.60	mm.
Head Finished (Minimum) Thickness	t	31.7500	mm.
Head Internal Corrosion Allowance	c	6.0000	mm.
Head External Corrosion Allowance	co	0.0000	mm.
Distance from Head Centerline	L1	0.0000	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

Type of Element Connected to the Shell : Nozzle

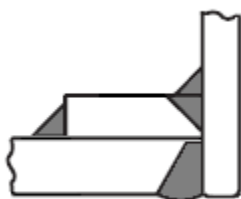
Material		SA-105	
Material UNS Number		K03504	
Material Specification/Type		Forgings	
Allowable Stress at Temperature	Sn	137.90	N./mm ²
Allowable Stress At Ambient	Sna	137.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	12.7000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	6.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	200.0000	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	8.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	31.7500	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Pad Material [Normalized]		SA-516 70	
Pad Allowable Stress at Temperature	Sp	137.90	N./mm ²

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Pad Allowable Stress At Ambient	Spa	137.90	N./mm ²
Diameter of Pad along vessel surface	Dp	150.0000	mm.
Thickness of Pad	te	8.0000	mm.
Weld leg size between Pad and Shell	Wp	8.0000	mm.
Groove weld depth between Pad and Nozzle	Wgpn	8.0000	mm.
Reinforcing Pad Width		49.6000	mm.
Flange Class		150	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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



Insert/Set-in Nozzle With Pad, no Inside projection

Reinforcement CALCULATION, Description: N05 (1in)

ASME Code, Section VIII, Div. 1, 2019, UG-37 to UG-45

Actual Inside Diameter Used in Calculation	1.000	in.
Actual Thickness Used in Calculation	0.500	in.

Note:

Post Weld Heat Treatment is required for this nozzle and it was specified as being heat treated.

Nozzle input data check completed without errors.

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (8.0 \cdot 18.7) / (138 \cdot 1.0 - 0.6 \cdot 8.0) \\
 &= 0.1089 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2877 mm.

UG-40, Limits of Reinforcement : [Internal Pressure]

Parallel to Vessel Wall (Diameter Limit)	Dl	102.3000	mm.
Parallel to Vessel Wall	Rn+tn+t	51.1500	mm.

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	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

Normal to Vessel Wall (Thickness Limit), pad side Tlwp 24.7500 mm.

Note: The Pad diameter is greater than the Diameter Limit. The excess will not be considered.

Weld Strength Reduction Factor [fr1]:

$$= \min(1, S_n/S_v)$$

$$= \min(1, 137.9/137.9)$$

$$= 1.000$$

Weld Strength Reduction Factor [fr2]:

$$= \min(1, S_n/S_v)$$

$$= \min(1, 137.9/137.9)$$

$$= 1.000$$

Weld Strength Reduction Factor [fr4]:

$$= \min(1, S_p/S_v)$$

$$= \min(1, 137.9/137.9)$$

$$= 1.000$$

Weld Strength Reduction Factor [fr3]:

$$= \min(fr2, fr4)$$

$$= \min(1.0, 1.0)$$

$$= 1.000$$

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	4.815	NA	NA
Area in Shell	A1	0.000	NA	NA
Area in Nozzle Wall	A2	3.263	NA	NA
Area in Inward Nozzle	A3	0.000	NA	NA
Area in Welds	A41+A42+A43	0.640	NA	NA
Area in Element	A5	4.120	NA	NA
TOTAL AREA AVAILABLE	Atot	8.023	NA	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degr.

The area available without a pad is Insufficient.

The area available with the given pad is Sufficient.

SELECTION OF POSSIBLE REINFORCING PADS:	Diameter	Thickness
Based on given Pad Thickness:	62.2080	8.0000 mm.
Based on given Pad Diameter:	150.0000	1.7721 mm.
Based on Shell or Nozzle Thickness:	57.9861	12.7000 mm.

Area Required [A]:

$$= 0.5 * d * t + t * \ln(1-fr1) \text{ per UG-39(a) (1)}$$

$$= 0.5*37.4*25.75+25.75*6.7(1-1.0)$$

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	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

$$= 4.815 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$\begin{aligned}
 &= d(E1*t - F*tr) - 2 * tn(E1*t - F*tr) * (1 - fr1) \\
 &= 64.9(1.0 * 25.75 - 1.0 * 25.75) - 2 * 6.7 \\
 &\quad (1.0 * 25.75 - 1.0 * 25.75) * (1 - 1.0) \\
 &= 0.000 \text{ cm}^2
 \end{aligned}$$

Area Available in Nozzle Wall Projecting Outward [A2]:

$$\begin{aligned}
 &= (2 * Tlwp) * (tn - trn) * fr2 \\
 &= (2 * 24.75) * (6.7 - 0.11) * 1.0 \\
 &= 3.263 \text{ cm}^2
 \end{aligned}$$

Area Available in Welds [A41 + A42 + A43]:

$$\begin{aligned}
 &= Wo^2 * fr3 + (Wi-can/0.707)^2 * fr2 + Wp^2 * fr4 \\
 &= 8.0^2 * 1.0 + (0.0)^2 * 1.0 + 0.0^2 * 1.0 \\
 &= 0.640 \text{ cm}^2
 \end{aligned}$$

Area Available in Element [A5]:

$$\begin{aligned}
 &= (\min(Dp, DL) - (\text{Nozzle OD})) * (\min(tp, Tlwp, te)) * fr4 \\
 &= (102.3 - 50.8) * 8.0 * 1.0 \\
 &= 4.120 \text{ cm}^2
 \end{aligned}$$

UG-45 Minimum Nozzle Neck Thickness Requirement: [Int. Press.]

Wall Thickness for Internal/External pressures	ta = 6.2877 mm.
Wall Thickness per UG16(b),	tr16b = 7.5000 mm.
Wall Thickness, shell/head, internal pressure	trb1 = 31.7500 mm.
Wall Thickness	tb1 = max(trb1, tr16b) = 31.7500 mm.
Wall Thickness	tb2 = max(trb2, tr16b) = 7.5000 mm.
Wall Thickness per table UG-45	tb3 = 9.4200 mm.

Determine Nozzle Thickness candidate [tb]:

$$\begin{aligned}
 &= \min[tb3, \max(tb1, tb2)] \\
 &= \min[9.42, \max(31.75, 7.5)] \\
 &= 9.4200 \text{ mm.}
 \end{aligned}$$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:

$$\begin{aligned}
 &= \max(ta, tb) \\
 &= \max(6.2877, 9.42) \\
 &= 9.4200 \text{ mm.}
 \end{aligned}$$

Available Nozzle Neck Thickness = 12.7000 mm. --> OK

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	<table><tr><td>نسخه</td><td>سریال</td><td>نوع مدرک</td><td>رشته</td><td>تسهیلات</td><td>صادر کننده</td><td>بسته کاری</td><td>پروژه</td></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>		نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK
	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Pad Weld for the Nozzle, Curve: A

Govrn. thk, $t_g = 8.0$, $c = 6.0$ mm., $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (t_g - c) = 0.054$, Temp. Reduction = 78°C
Pad governing, Conservatively assuming Pad stress = Shell stress(Div. 1 L-9.3).

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-104 °C
Min Metal Temp. w/o impact per UG-20 (f)	-29 °C

Nozzle Neck to Pad Weld for Reinforcement pad, Curve: D

Govrn. thk, $t_g = 8.0$, $c = 6.0$ mm., $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (t_g - c) = 0.054$, Temp. Reduction = 78°C
Pad governing, Conservatively assuming Pad stress = Shell stress(Div. 1 L-9.3).

Min Metal Temp. w/o impact per UCS-66, Curve D	-48 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-104 °C

Shell to Pad Weld Junction at Pad OD, min(Curve:D, Curve:B)

Govrn. thk, $t_g = 8.0$, $c = 6.0$ mm., $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (t_g - c) = 0.054$, Temp. Reduction = 78°C
Pad governing, Conservatively assuming Pad stress = Shell stress(Div. 1 L-9.3).

Min Metal Temp. w/o impact per UCS-66, Curve B	-29 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-104 °C

Nozzle-Shell/Head Weld (UCS-66(a)1(b)), min(Curve:A, Curve:B)

Govrn. thk, $t_g = 12.7$, $tr = 0.109$, $c = 6.0$ mm., $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (t_g - c) = 0.016$, Temp. Reduction = 78°C

Min Metal Temp. w/o impact per UCS-66, Curve A	-1 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-104 °C
Min Metal Temp. w/o impact per UG-20 (f)	-29 °C

Gov. MDMT of the Nozzle	: -104 °C
Gov. MDMT of the Reinforcement Pad	: -104 °C
Gov. MDMT of the nozzle to shell joint welded assembly	: -104 °C

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c)	-18 °C
Flange MDMT with Temp reduction per UCS-66 (b) (1) (-b)	-48 °C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :

Design Pressure/Ambient Rating = $8.00/19.60 = 0.408$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 115 از 129	
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری		پروژه
	V01	0004	CN	ME	120	MF	GCS		BK

Weld Size Calculations, Description: N05 (1in)

Intermediate Calc. for nozzle/shell Welds T_{min} 6.7000 mm.
Intermediate Calc. for pad/shell Welds T_{minPad} 8.0000 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	$4.6900 = 0.7 * t_{min}$	$5.6560 = 0.7 * W_o$ mm.
Pad Weld	$4.0000 = 0.5 * T_{minPad}$	$5.6560 = 0.7 * W_p$ mm.

Weld Strength and Weld Loads per UG-41.1, Sketch (a) or (b)

Weld Load [W]:

$$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - t_r)) * S_v)$$

$$= \max(0, (4.8152 - 0.0 + 2 * 6.7 * 1.0 * (1.0 * 25.75 - 25.75)) * 138)$$

$$= 66.40 \text{ kN}$$

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

Weld Load [W1]:

$$= (A2 + A5 + A4 - (W_i - Can / .707)^2 * f_{r2}) * S_v$$

$$= (3.2626 + 4.12 + 0.64 - 0.0 * 1.0) * 138$$

$$= 110.62 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * t_n * t * f_{r1})) * S_v$$

$$= (3.2626 + 0.0 + 0.64 + (3.4505)) * 138$$

$$= 101.39 \text{ kN}$$

Weld Load [W3]:

$$= (A2 + A3 + A4 + A5 + (2 * t_n * t * f_{r1})) * S$$

$$= (3.2626 + 0.0 + 0.64 + 4.12 + (3.4505)) * 138$$

$$= 158.20 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$= (\pi / 2) * D_{lo} * W_o * 0.49 * S_{nw}$$

$$= (3.1416 / 2.0) * 50.8 * 8.0 * 0.49 * 138$$

$$= 43. \text{ kN}$$

Shear, Pad Element Weld [Spew]:

$$= (\pi / 2) * DP * WP * 0.49 * SEW$$

$$= (3.1416 / 2.0) * 150.0 * 8.0 * 0.49 * 138$$

$$= 127. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

$$= (\pi * (D_{lr} + D_{lo}) / 4) * (Thk - Can) * 0.7 * S_n$$

$$= (3.1416 * 22.05) * (12.7 - 6.0) * 0.7 * 138$$

$$= 45. \text{ kN}$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)	شماره صفحه : 116 از 129																
	<table><tr><td>نسخه</td><td>سریال</td><td>نوع مدرک</td><td>رشته</td><td>تسهیلات</td><td>صادرکننده</td><td>بسته کاری</td><td>پروژه</td></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>		نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK
	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

Tension, Pad Groove Weld [Tpgw]:

$$\begin{aligned}
 &= (\pi/2) * D_{lo} * W_{gpn} * 0.74 * S_{eg} \\
 &= (3.1416/2) * 50.8 * 8.0 * 0.74 * 138 \\
 &= 65. \text{ kN}
 \end{aligned}$$

Tension, Shell Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi/2) * D_{lo} * (W_{gnvi} - C_{as}) * 0.74 * S_{ng} \\
 &= (3.1416/2.0) * 50.8 * (31.75 - 6.0) * 0.74 * 138 \\
 &= 210. \text{ kN}
 \end{aligned}$$

Strength of Failure Paths:

$$\begin{aligned}
 \text{PATH11} &= (\text{SPEW} + \text{SNW}) = (127 + 45) = 172 \text{ kN} \\
 \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\
 &= (43 + 65 + 210 + 0) = 318 \text{ kN} \\
 \text{PATH33} &= (\text{Spew} + \text{Tngw} + \text{Sinw}) \\
 &= (127 + 210 + 0) = 337 \text{ kN}
 \end{aligned}$$

Summary of Failure Path Calculations:

Path 1-1 = 172 kN , must exceed W = 66 kN or W1 = 110 kN
 Path 2-2 = 317 kN , must exceed W = 66 kN or W2 = 101 kN
 Path 3-3 = 337 kN , must exceed W = 66 kN or W3 = 158 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 18 bars

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

Nozzle is O.K. for the External Pressure 1 bars

The Cut Length for this Nozzle is, Drop + Ho + H + T : 231.8008 mm.

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	<table><tr><td>پروژه</td><td>بسته کاری</td><td>صادر کننده</td><td>تسهیلات</td><td>رشته</td><td>نوع مدرک</td><td>سریال</td><td>نسخه</td></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0004</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0004	V01
	پروژه		بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0004	V01											

G Loading Seismic Setting Bolt Calc. F-100

Seismic Calculation	
Seismic Design Method:	G Loading
Vessel Diameter	D = 304.7 (mm)
Vessel Height (T.L.-T.L.)	H = 1250 (mm)
Shell Thickness	Thk. = 4 (mm)
High Liquid Level	HLL = 1250 (mm)
Content Specific Gravity	G = 1.02
Material Density	ρ = 7750 (Kg/m ³)
Elastic modulus	E = 1.98E+11 (N/mm ²)
No of Lugs	N _L = 3
No of Bolts per Lug	N _B = 1
Importance Factor	I = 1.25
	S _{ds} = 1.02
	A _p = 1
	R = 2.5
	z/h = 1
Global Scalar for Seismic Load	G _{ss} = 0.7
Empty Weight	W _E = 360 (kg)
Operating Weight	W _O = 457 (kg)
Test Weight	W _T = 363 (kg)
G Loading Parameters:	
Longitudinal Acceleration = $0.4 * A_p * S_{ds} * (1 + 2 * (z/h)) / (R/I)$	
	G _x = 0.612
Lateral Acceleration	G _z = 0
Vertical Acceleration = $0.2 * S_{ds}$	G _y = 0.204
Distance from CG to bottom of base plate	d = 1584 (mm)
Seismic Shear Force = $G_x * W$	S _L = 280 (kg)
Seismic Vertical Force = $G_y * W$	S _V = 93 (kg)
Final Seismic Loads	
Seismic Shear Force = $G_{ss} * S_L$	= 196 (kg)
Seismic Vertical Force = $G_{ss} * S_V$	= 93 (kg)
Seismic Moment = $G_{ss} * S_L * d$	= 310 (kg.m)
Final Loads Acc. To PV	
Shear Force	= 152 (kg)
Moment	= 120 (kg.m)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نم زدای گاز ابستگاه تقویت فشار گاز بینک
(قرارداد 08_0010_GCS-HD-BK)



شماره پیمان:

053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL
PARTICLE FILTER (F-100 A/B)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
V01	0004	CN	ME	120	MF	GCS	BK

شماره صفحه : 118 از 129

SETTING BOLT CALCULATION

Setting Bolt Material

SA-325

Allowable Tensile Stress

$$\sigma_u = \frac{3059.1 \text{ kg/cm}^2}{1835.5 \text{ kg/cm}^2} = \frac{300}{180} \text{ Mpa}$$

Allowable Shear Stress

Using Parameters:

F= seismic force

$$\frac{0.20}{3} \text{ ton} = \frac{196}{3} \text{ kg}$$

n= Number of bolt

$$\frac{2}{65.3} \text{ cm} = \frac{20}{217} \text{ mm}$$

d=bolt's diameter

V= shearing force at one bolt

$$V = \frac{F(\text{ton}) \times 1000}{n}$$

A=According to Table 5-DM of TEMA

$$\tau = \frac{V(Kg)}{A(\text{cm}^2)}$$

T=shear stress at one bolt (kg / cm²)

$$\frac{2.17}{30.07} \text{ cm}^2 = \frac{217}{2.95} \text{ Mpa}$$

Shear stress in bolts (T=2.95 Mpa) is less than maximum allowable shear stress. (T_y=180 Mpa)

M_{LUG} (OPERATING)

$$\frac{31011.362}{16.6} \text{ kg-cm} = \frac{310}{166} \text{ kg-m}$$

R_{LUG} (Distance from bolt to center line of vessel)

$$\frac{0.4}{3} \text{ cm} = \frac{4}{3} \text{ mm}$$

D_{LUG} (Distance from bolt to outer surfacer of vessel)

N_{LUG} (NUMBER OF LUG)

W_{OP} (OPERATING)

σ allow= bolt allowable stress

$$\frac{457}{3059.1} \text{ kgf} = \frac{457}{300} \text{ Kg}$$

F_b= axial force on bolts

$$F_b = \left[\frac{M_{LUG(OPERATING)}}{\left(R_{LUG} \times \frac{N_{LUG}}{2} \right)} - \frac{W_{(OPERATING)}}{N_{LUG}} \right]$$

σ_b= Tension stress on one bolt

$$\frac{1093.1}{251.9} \text{ kg} = \frac{24.7}{25.2} \text{ Mpa}$$

σ_{eq}= equivalent stress

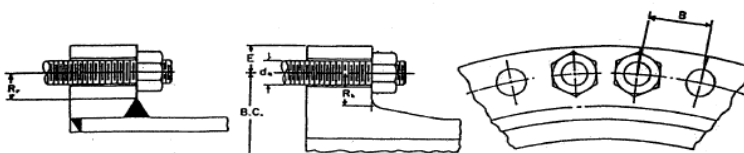
$$\sigma_{eq} = \sqrt{\sigma_b^2 + 3\tau^2}$$

Tension stress in bolts (σ_b=24.70 Mpa) is less than maximum allowable stress. (σ_{allow}=300.00 Mpa)

Equivalent stress in bolts (σ_{eq}=25.22 Mpa) is less than maximum allowable stress. (σ_{allow}=300.00 Mpa)

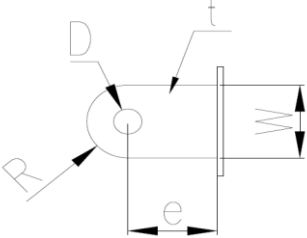
TABLE D-5M
METRIC BOLTING DATA - RECOMMENDED MINIMUM
(All Dimensions in Millimeters Unless Noted)

Bolt Size d _g	Threads		Nut Dimensions		Bolt Spacing B	Radial Distance R _h	Radial Distance R _h	Edge Distance E	Bolt Size d _g
	Pitch	Root Area (mm ²)	Across Flats	Across Corners					
M12	1.75	72.398	21.00	24.25	31.75	20.64	15.88	15.88	M12
M16	2.00	138.324	27.00	31.18	44.45	28.58	20.64	20.64	M16
M20	2.50	217.051	34.00	39.26	52.39	31.75	23.81	23.81	M20
M22	2.50	272.419	36.00	41.57	53.98	33.34	25.40	25.40	M22
M24	3.00	312.748	41.00	47.34	58.74	36.51	28.58	28.58	M24
M27	3.00	413.852	46.00	53.12	63.50	38.10	29.00	29.00	M27
M30	3.50	502.965	50.00	57.74	73.03	46.04	33.34	33.34	M30
M36	4.00	738.015	60.00	69.28	84.14	53.97	39.69	39.69	M36
M42	4.50	1018.218	70.00	80.83	100.00	61.91		49.21	M42
M48	5.00	1342.969	80.00	92.38	112.71	68.26		55.56	M48
M56	5.50	1862.725	90.00	103.92	127.00	76.20		63.50	M56
M64	6.00	2467.150	100.00	115.47	139.70	84.14		66.68	M64
M72	6.00	3221.775	110.00	127.02	155.58	88.90		69.85	M72
M80	6.00	4076.831	120.00	138.56	166.69	93.66		74.61	M80
M90	6.00	5287.085	135.00	155.88	188.91	107.95		84.14	M90
M100	6.00	6651.528	150.00	173.21	207.96	119.06		93.66	M100



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	BK	GCS	MF	120	ME	CN	0004		V01

Lifting Lug Calculation - F-100

1	Lifting Lug Calculation			
3	Tag No.:	F-100 A/B		
4	Equipment:	Glycol Particle Filter		
5	Reference:	Pressure Vessel Design Manual By Dennis R.Moss		
7	A: Lifting Lug Design			
9	A1: Loads			
11	Wt. of Exchanger =	360	Kg	
12	Material =	SA-283 C		
13	Yield Stress =	191	Mpa	
14	Allowable Stress =	108.3	Mpa	
15	Impact Factor =	2		
16	Sling Angle (θ) =	90		
17	NO. of Lifting Points =	2		
18	Total Vertical Wt. (Fv) =	7.06	KN	
19	Total Load at Lifting Point (Ft) =	3.53	KN	
22	A2: Dimentions			
24	Lug Thickness (t) =	10	mm	
25	Plate Thickness =	9.53	mm	
26	Radius (R) =	55	mm	
27	e =	120	mm	
28	Lug Width (W) =	110	mm	
29	Hole (D) =	38	mm	
				
41	A3: Stress Analysis			
43	Bearing Stress:			
45	Bearing Area =	3.8	cm^2	Ab=Dxt
46	Alowable Bearing Stress =	171.9	Mpa	0.9xFy
47	Bearing Stess (fp) =	9.3	Mpa	(O.K !!)

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	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

49 Shear Stress: (At Top of Lug)

51	Shear Area =	3.6	cm ²	$As=(W-D/2)xt$
52	Alloawable Shear Stress =	76.4	Mpa	$0.4xF_y$
53	Actual shear streess(fv) =	9.8	Mpa	(O.K !!)

55 Shear Stress: (At Pin Hole)

57	Shear Area =	7.2	cm ²	$As=2x(W-D/2)xt$
58	Alloawable Shear Stress =	76.4	Mpa	$0.4xF_y$
59	Actual shear streess(fv) =	4.9	Mpa	(O.K !!)

61 Tensile Stress:

63	Tensile Area =	7.2	cm ²	$At=2x(W-D/2)xt$
64	Alloawable Tensile Stress =	114.6	Mpa	$0.6xF_y$
65	Actual Tensile streess(ft) =	4.9	Mpa	(O.K !!)

67 Bending Stress:

69	Section Modulus =	20.2	cm ³	$Z=t*W^2/6$
70	Alloawable Bending Stress =	114.6	Mpa	$0.6xF_y$
71	Bending moment (M) =	42.4	KN.cm	
72	Actual Bending streess(fb) =	21.0	Mpa	(O.K !!)

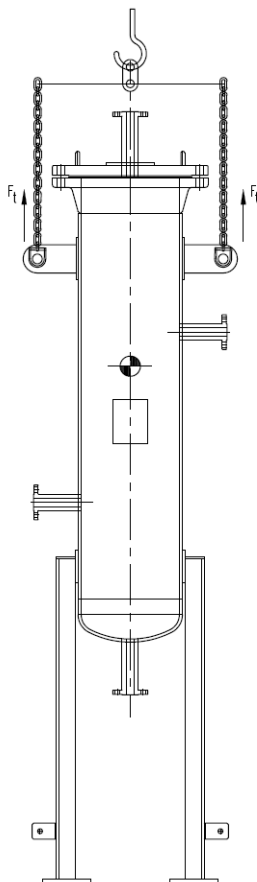
74 Combined Stress:

76	Combined Tensile & Bending Stress			
77	Stress Ratio, $[(ft/Ft) + (fb/Fb)] \leq 1$	0.23		(O.K !!)
79	Combined Tensile & Shear Stress	17.7	Mpa	$f_{cr} = \sqrt{(ft^2 + 3fv^2)}$
80	$f_c \leq S$ allowable	108.3		(O.K !!)

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 121 از 129	
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری		پروژه
	V01	0004	CN	ME	120	MF	GCS		BK

82 A4: Weld Calculation

84	Weld leg Size =	7	mm	(OK !!)
85	Shear Load Due Fv	16.05	N/mm	
86	Shear Load Due M	105.1	N/mm	
87	Total Load	106.3	N/mm	
88	Allowable Shear	105.1	Mpa	
89	Require Weld Size	1.4	mm	



 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 122 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Lifting WRC

Input Echo, 107/537 Item 1, Description: New WRC 107/537

Diameter Basis for Vessel	Vbasis	ID
Cylindrical or Spherical Vessel	Cylsph	Cylindrical
Internal Corrosion Allowance	Cas	6.0000 mm.
Vessel Diameter	Dv	304.800 mm.
Vessel Thickness	Tv	9.530 mm.
Design Temperature		85.00 C
Vessel Material		SA-106 B
Vessel UNS Number		K03006
Vessel Cold S.I. Allowable	Smc	117.90 N./mm ²
Vessel Hot S.I. Allowable	Smh	117.90 N./mm ²

*Note: Using 2 * Yield for Discontinuity Stress Allowable (UG-23(e)), Sps.
Make sure that material properties at this temperature are not
time-dependent for Material: SA-106 B*

Attachment Type	Type	Rectangular
Parameter C11	C11	10.00 mm.
Parameter C22	C22	110.00 mm.
Thickness of Reinforcing Pad	Tpad	8.000 mm.
Pad Parameter C11P	C11p	85.000 mm.
Pad Parameter C22P	C22p	165.000 mm.
Design Internal Pressure	Dp	0.000 bars
Include Pressure Thrust		No

External Forces and Moments in WRC 107/537 Convention:

Radial Load (SUS)	P	0.0 Kgf
Longitudinal Shear (SUS)	Vl	360.0 Kgf
Circumferential Shear (SUS)	Vc	0.0 Kgf
Circumferential Moment (SUS)	Mc	0.0 Kg-m.
Longitudinal Moment (SUS)	Ml	43.2 Kg-m.
Torsional Moment (SUS)	Mt	0.0 Kg-m.

Use Interactive Control No
WRC107 Version Version March 1979 (B1 & B2)

Include Pressure Stress Indices per Div. 2 No
Compute Pressure Stress per WRC-368 No

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)	شماره صفحه : 123 از 129																
	<table><tr><td>نسخه</td><td>سریال</td><td>نوع مدرک</td><td>رشته</td><td>تسهیلات</td><td>صادرکننده</td><td>بسته کاری</td><td>پروژه</td></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>		نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK
	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

Note:

WRC Bulletin 537 provides equations for the dimensionless curves found in bulletin 107. As noted in the foreword to bulletin 537, "537 is equivalent to WRC 107". Where 107 is printed in the results below, "537" can be interchanged with "107".

WRC 107 Stress Calculation for SUSTAINED loads:

Radial Load	P	0.0	Kgf
Circumferential Shear	VC	0.0	Kgf
Longitudinal Shear	VL	360.0	Kgf
Circumferential Moment	MC	0.0	Kg-m.
Longitudinal Moment	ML	43.2	Kg-m.
Torsional Moment	MT	0.0	Kg-m.

Dimensionless Parameters used : Gamma = 14.24

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979 B1/B2	Beta	Figure	Value	Location
N (PHI) / (P/Rm)	0.160	4C	2.515	(A, B)
N (PHI) / (P/Rm)	0.160	3C	2.251	(C, D)
M (PHI) / (P)	0.086	2C1	0.148	(A, B)
M (PHI) / (P)	0.086	1C	0.181	(C, D)
N (PHI) / (MC/ (Rm**2 * Beta))	0.068	3A !	0.153	(A, B, C, D)
M (PHI) / (MC/ (Rm * Beta))	0.089	1A	0.103	(A, B, C, D)
N (PHI) / (ML/ (Rm**2 * Beta))	0.151	3B !	1.380	(A, B, C, D)
M (PHI) / (ML/ (Rm * Beta))	0.136	1B1	0.051	(A, B, C, D)
N (x) / (P/Rm)	0.126	3C	2.483	(A, B)
N (x) / (P/Rm)	0.126	4C	2.637	(C, D)
M (x) / (P)	0.132	1C1	0.142	(A, B)
M (x) / (P)	0.132	2C	0.106	(C, D)
N (x) / (MC/ (Rm**2 * Beta))	0.068	4A !	0.193	(A, B, C, D)
M (x) / (MC/ (Rm * Beta))	0.125	2A	0.058	(A, B, C, D)
N (x) / (ML/ (Rm**2 * Beta))	0.151	4B !	0.387	(A, B, C, D)
M (x) / (ML/ (Rm * Beta))	0.187	2B1	0.069	(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

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B) <table><tr><td>نسخه</td><td>سریال</td><td>نوع مدرک</td><td>رشته</td><td>تسهیلات</td><td>صادرکننده</td><td>بسته کاری</td><td>پروژه</td></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK	شماره صفحه : 124 از 129
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه										
V01	0004	CN	ME	120	MF	GCS	BK											

Stresses in the Vessel at the Attachment Junction (N./mm²)

		Stress Intensity Values at						
Type of								
Stress	Load	Au	Al	Bu	Bl	Cu	Cl	Du
Dl								

Circ. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Circ. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Circ. Memb. ML		-8.5	-8.5	8.5	8.5	0.0	0.0	
0.0	0.0							
Circ. Bend. ML		-44.0	44.0	44.0	-44.0	0.0	0.0	
0.0	0.0							

Tot. Circ. Str.		-52.5	35.6	52.5	-35.6	0.0	0.0	
0.0	0.0							

Long. Memb. P		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Long. Bend. P		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Long. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Long. Bend. MC		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Long. Memb. ML		-4.2	-4.2	4.2	4.2	0.0	0.0	
0.0	0.0							
Long. Bend. ML		-42.9	42.9	42.9	-42.9	0.0	0.0	
0.0	0.0							

Tot. Long. Str.		-47.1	38.7	47.1	-38.7	0.0	0.0	
0.0	0.0							

Shear VC		0.0	0.0	0.0	0.0	0.0	0.0	
0.0	0.0							
Shear VL		0.0	0.0	0.0	0.0	-1.4	-1.4	
1.4	1.4							

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)							
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 125 از 129
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	
	BK	GCS	MF	120	ME	CN	0004	V01

Shear MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Tot. Shear	0.0	0.0	0.0	0.0	0.0	-1.4	-1.4
1.4	1.4						
Str. Int.	52.5	38.7	52.5	38.7	2.8	2.8	
2.8	2.8						

Dimensionless Parameters used : Gamma = 45.37

Dimensionless Loads for Cylindrical Shells at Pad edge:

Curves read for 1979 B1/B2	Beta	Figure	Value	Location
N(PHI) / (P/Rm)	0.484	4C	2.957	(A,B)
N(PHI) / (P/Rm)	0.484	3C	1.076	(C,D)
M(PHI) / (P)	0.341	2C1	0.011	(A,B)
M(PHI) / (P)	0.341	1C !	0.064	(C,D)
N(PHI) / (MC/(Rm**2 * Beta))	0.331	3A	1.407	(A,B,C,D)
M(PHI) / (MC/(Rm * Beta))	0.358	1A	0.061	(A,B,C,D)
N(PHI) / (ML/(Rm**2 * Beta))	0.413	3B	2.005	(A,B,C,D)
M(PHI) / (ML/(Rm * Beta))	0.384	1B1	0.010	(A,B,C,D)
N(x) / (P/Rm)	0.418	3C	1.367	(A,B)
N(x) / (P/Rm)	0.418	4C	3.548	(C,D)
M(x) / (P)	0.429	1C1	0.017	(A,B)
M(x) / (P)	0.429	2C !	0.033	(C,D)
N(x) / (MC/(Rm**2 * Beta))	0.331	4A	4.362	(A,B,C,D)
M(x) / (MC/(Rm * Beta))	0.435	2A	0.024	(A,B,C,D)
N(x) / (ML/(Rm**2 * Beta))	0.413	4B	1.213	(A,B,C,D)
M(x) / (ML/(Rm * Beta))	0.454	2B1	0.016	(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 Edge of Reinforcing Pad (N./mm^2)

		Stress Intensity Values at					
Type of							
Stress	Load	Au	Al	Bu	Bl	Cu	Cl
D1							

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 126 از 129	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Circ. Memb. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Circ. Bend. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Circ. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Circ. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Circ. Memb. ML	-19.4	-19.4	19.4	19.4	0.0	0.0	0.0
0.0	0.0						
Circ. Bend. ML	-32.4	32.4	32.4	-32.4	0.0	0.0	0.0
0.0	0.0						
Tot. Circ. Str.	-51.8	13.0	51.8	-13.0	0.0	0.0	0.0
0.0	0.0						

Long. Memb. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Long. Bend. P	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Long. Memb. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Long. Bend. MC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Long. Memb. ML	-16.9	-16.9	16.9	16.9	0.0	0.0	0.0
0.0	0.0						
Long. Bend. ML	-44.9	44.9	44.9	-44.9	0.0	0.0	0.0
0.0	0.0						
Tot. Long. Str.	-61.8	28.0	61.8	-28.0	0.0	0.0	0.0
0.0	0.0						

Shear VC	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Shear VL	0.0	0.0	0.0	0.0	-3.0	-3.0	-3.0
3.0	3.0						
Shear MT	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0						
Tot. Shear	0.0	0.0	0.0	0.0	-3.0	-3.0	-3.0
3.0	3.0						

Str. Int.	61.8	28.0	61.8	28.0	6.1	6.1	6.1
6.1	6.1						

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
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	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه										
V01	0004	CN	ME	120	MF	GCS	BK											

WRC 107/537 Stress Summations:

Vessel Stress Summation at Attachment Junction (N./mm²)

		Stress Intensity Values at						
Type of								
Stress	Load	Au	Al	Bu	Bl	Cu	Cl	Du
Dl								

Circ. Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Circ. Pl (SUS)	0.0 0.0	-8.5	-8.5	8.5	8.5	0.0	0.0	
Circ. Q (SUS)	0.0 0.0	-44.0	44.0	44.0	-44.0	0.0	0.0	

Long. Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Long. Pl (SUS)	0.0 0.0	-4.2	-4.2	4.2	4.2	0.0	0.0	
Long. Q (SUS)	0.0 0.0	-42.9	42.9	42.9	-42.9	0.0	0.0	

Shear Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Shear Pl (SUS)	1.4 1.4	0.0	0.0	0.0	0.0	-1.4	-1.4	
Shear Q (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Pm+Pl (SUS)	2.8 2.8	8.5	8.5	8.5	8.5	2.8	2.8	

Pm+Pl+Q (Total)	2.8 2.8	52.5	38.7	52.5	38.7	2.8	2.8	

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																	
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)	شماره صفحه : 128 از 129																
	<table><tr><td>نسخه</td><td>سریال</td><td>نوع مدرک</td><td>رشته</td><td>تسهیلات</td><td>صادرکننده</td><td>بسته کاری</td><td>پروژه</td></tr><tr><td>V01</td><td>0004</td><td>CN</td><td>ME</td><td>120</td><td>MF</td><td>GCS</td><td>BK</td></tr></table>		نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0004	CN	ME	120	MF	GCS	BK
	نسخه		سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه									
V01	0004	CN	ME	120	MF	GCS	BK											

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	0.00	117.90	Passed
Pm+Pl (SUS)	8.49	176.86	Passed
Pm+Pl+Q (TOTAL)	52.54	353.71	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

WRC 107/537 Stress Summations:

Vessel Stress Summation at Reinforcing Pad Edge (N./mm²)

		Stress Intensity Values at						
Type of Stress	Load	Au	Al	Bu	Bl	Cu	Cl	Du
Circ. Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Circ. Pl (SUS)	0.0 0.0	-19.4	-19.4	19.4	19.4	0.0	0.0	
Circ. Q (SUS)	0.0 0.0	-32.4	32.4	32.4	-32.4	0.0	0.0	
Long. Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Long. Pl (SUS)	0.0 0.0	-16.9	-16.9	16.9	16.9	0.0	0.0	
Long. Q (SUS)	0.0 0.0	-44.9	44.9	44.9	-44.9	0.0	0.0	
Shear Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Shear Pl (SUS)	3.0 3.0	0.0	0.0	0.0	0.0	-3.0	-3.0	
Shear Q (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Pm (SUS)	0.0 0.0	0.0	0.0	0.0	0.0	0.0	0.0	

 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL PARTICLE FILTER (F-100 A/B)							شماره صفحه : 129 از 129	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0004		V01

Pm+Pl (SUS)		19.4		19.4		19.4	
6.1		6.1				6.1	

Pm+Pl+Q (Total)		61.8		28.0		61.8	
6.1		6.1				6.1	

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	0.00	117.90	Passed
Pm+Pl (SUS)	19.43	176.86	Passed
Pm+Pl+Q (TOTAL)	61.78	353.71	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

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