

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 1 از 383
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V01	0001	CN	ME	120	MF	GCS	BK																			

طرح نگهداشت و افزایش تولید 27 مخزن

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نگهداشت و افزایش تولید میدان نفتی بینک

V01	MAR. 2025	IFI	MFS	M.Fakharian	S.Faramarzpour	
V00	DEC. 2024	IFI	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

 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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V01	0001	CN	ME	120	MF	GCS	BK											

REVISION RECORD SHEET

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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)																	
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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\C-100.Pvdb

Date of Analysis : Mar 4,2025 9:01am

PV Elite 2020, January 2020

 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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ASME Code, Section VIII Division 1, 2019

Diameter Spec	: 746.000 x 706.000 x 700.000 mm.	ID
Vessel Design Length, Tangent to Tangent	10626.57	mm.
Distance of Bottom Tangent above Grade	1600.00	mm.
Distance of Base above Grade	100.00	mm.
Specified Datum Line Distance	1500.00	mm.
Internal Design Temperature	148	°C
Internal Design Pressure	62.000	bars
External Design Temperature	100	°C
External Design Pressure	1.034	bars
Maximum Allowable Working Pressure	62.879	bars
External Max. Allowable Working Pressure	21.228	bars
Hydrostatic Test Pressure	80.600	bars
Required Minimum Design Metal Temperature	5.0	°C
Warmest Computed Minimum Design Metal Temperature	2.0	°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-516 70	...	...	K02700	Yes	No
Head	SA-516 70	...	...	K02700	Yes	No
Flange	SA-105	...	...	K03504	No	No
Skirt	SA-516 70	...	...	K02700	No	No
Nozzle	SA-106 B	...	...	K03006	No	No
Nozzle	SA-105	...	...	K03504	No	No
Nozzle Flg	SA-105	...	...	K03504	No	No
Nozzle Flg	SA-106 B	...	...	K03006	No	No
Basering	SA-283 C	...	...	K02401	No	No
Flg Bolting	SA-193 B7M	...	<= 2 1/2	G41400	No	No
Base Bolting	F1554 Gr.36	...	<= 2 1/2	G41400	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
Bottom Head	62.189	1.03	77.000	0.0000	No	No
Cylinder	62.167	1.03	75.000	0.0000	N/A	No

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Body Flg		62.103		1.03		64.000		0.0000		N/A		No
Body Flg		62.103		1.03		65.000		0.0000		N/A		No
Cylinder		62.103		1.03		75.000		0.0000		N/A		No
Body Flg		62.000		1.03		64.000		0.0000		N/A		No
Body Flg		62.000		1.03		65.000		3.0000		N/A		No
Cylinder		62.000		1.03		65.000		3.0000		N/A		No
Cylinder		62.000		1.03		65.000		3.0000		N/A		No
Cylinder		62.000		1.03		65.000		3.0000		N/A		No
Body Flg		62.000		1.03		65.000		3.0000		N/A		No
Body Flg		62.000		1.03		65.000		3.0000		N/A		No
Cylinder		62.000		1.03		65.000		3.0000		N/A		No
Top Head		62.000		1.03		67.000		3.0000		No		No

Liquid Level: 1925.00 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
Skirt	0.0	1500.0	...	25.0	...	...	0.70	0.55
Ellipse	50.0	50.0	25.0	20.0	16.0	1.9	1.00	1.00
Cylinder	2050.0	2000.0	...	20.0	16.5	3.7	1.00	1.00
Body Flg	2220.0	170.0	...	110.0	105.2	65.8	1.00	1.00
Body Flg	2399.5	170.0	...	110.0	103.7	65.8	1.00	1.00
Cylinder	4399.5	2000.0	...	20.0	16.3	3.6	1.00	1.00
Body Flg	4569.5	170.0	...	110.0	104.6	65.8	1.00	1.00
Body Flg	4754.1	175.0	...	115.0	111.3	74.9	1.00	1.00
Cylinder	6254.0	1500.0	...	20.0	19.3	8.2	1.00	1.00
Cylinder	7754.1	1500.0	...	20.0	19.3	8.2	1.00	1.00
Cylinder	9354.0	1600.0	...	20.0	19.3	8.2	1.00	1.00
Body Flg	9529.0	175.0	...	115.0	111.5	74.9	1.00	1.00
Body Flg	9713.6	175.0	...	115.0	111.3	74.9	1.00	1.00
Cylinder	10576.6	863.0	...	20.0	19.3	5.7	1.00	1.00
Ellipse	10626.6	50.0	25.0	20.0	18.8	4.9	1.00	1.00

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	750	13.0816	61.6481	98619.3	540768
20	30	1525	12.0663	60.8865	79750.8	448829
30	40	2550	12.0321	60.5887	79148.1	445791
40	50	3635	10.6622	58.2234	56444.5	326931
50	60	3814.53	10.5513	57.4572	54540.1	316547
60	70	4899.53	10.4404	56.6532	52755.1	306843
70	80	5984.53	9.04452	51.6946	33262.3	198452
80	90	6166.55	8.92671	50.4332	31649	189287
90	100	7004.05	8.80559	49.0545	30096.8	180578
100	110	8504.05	7.68632	40.0849	17722.9	113696
110	120	10054	6.52099	35.5	7063.07	56984.6

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 10 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

120	130	10941.5	1.19232	16.8833	889.924	15061
130	140	11126.1	1.05585	14.437	683.068	12181.8
140	150	11645.1	0.91891	11.9495	510.206	9872.03
150	160	12101.6	0.20306	8.43084	25.8768	1074.35

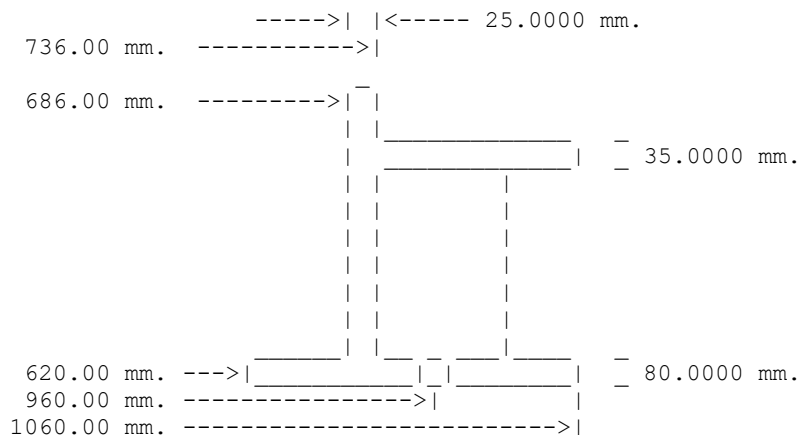
Abs Max of the all of the Stress Ratio's : 0.7848

Basering Data : Continuous Top Ring W/Gussets

Thickness of Basering	80.0000	mm.
Inside Diameter of Basering	620.0000	mm.
Outside Diameter of Basering	1060.0000	mm.
Nominal Diameter of Bolts	48.0000	mm.
Diameter of Bolt Circle	960.0000	mm.
Number of Bolts	12	

Thickness of Gusset Plates	12.0000	mm.
Average Width of Gusset Plates	162.0000	mm.
Height of Gussets	265.0000	mm.
Distance between Gussets	100.0000	mm.
Thickness of Top Plate or Ring	35.0000	mm.
Circumferential Width of the Top Plate	170.5000	mm.
Radial Width of the Top Plate	200.0000	mm.

Basering Sketch for Cylindrical Skirts:



Basering Cross Section View

Loads for Foundation/Support Design:

Factored Loads:

Total Wind Shear on Support	13.	kN
Total Earthquake Shear on Support	62.	kN
Wind Moment on Support	108135.	N-m
Earthquake Moment on Support	550283.	N-m

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 11 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Maximum Initial Bolt Load 180. kN

Un-Factored Loads:

Wind Shear on Support	22. kN
Earthquake Shear on Support	88. kN
Wind Moment on Support	180225. N-m
Earthquake Moment on Support	786119. N-m
Maximum Initial Bolt Load	300. 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.

Local Stress Analysis Results:

Description	Analysis Type	Max Stress Ratio	High Stress Location	Pass / Fail
N01 (6in)	WRC-107/537	0.817	n/a	Passed
N02 (6in)	WRC-107/537	0.837	n/a	Passed

Weights:

Fabricated - Bare W/O Removable Internals	8356.0 kg.
Shop Test - Fabricated + Water (Full)	12556.2 kg.
Shipping - Fab. + Rem. Intls.+ Shipping App.	8585.6 kg.
Erected - Fab. + Rem. Intls.+ Insul. (etc)	9285.6 kg.
Empty - Fab. + Intls. + Details + Wghts.	12732.3 kg.
Operating - Empty + Operating Liquid (No CA)	16087.8 kg.
Field Test - Empty Weight + Water (Full)	15342.8 kg.

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شماره پیمان: 053 - 073 - 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100) <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>0001</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	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 12 از 383
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه										
	V01	0001	CN	ME	120	MF	GCS	BK										

Nozzle Calculation Summary:

Description	MAWP bars	Ext	MAPNC bars	UG-45	[tr] mm.	Weld Path	Areas or Stresses
N07 (1.5in)	73	OK	...	OK	3.22	OK	Passed
K07A (3in)	77	OK	...	OK	4.80	OK	Passed
K07A (3in)	77	OK	...	OK	4.80	OK	Passed
K09A (2in)	68	OK	...	OK	3.42	OK	Passed
K09A (2in)	69	OK	...	OK	3.42	OK	Passed
N01 (6in)	75	OK	...	OK	6.22	OK	Passed
N09 (1in)	75	OK	...	OK	3.42	OK	Passed
K07B (3in)	75	OK	...	OK	5.73	OK	Passed
K08B (2in)	75	OK	...	OK	4.80	OK	Passed
K08A (2in)	75	OK	...	OK	4.80	OK	Passed
K09B (2in)	75	OK	...	OK	4.80	OK	Passed
N10A (8in)	75	OK	...	...	...	OK	Passed
N05 (2in)	75	OK	...	OK	4.80	OK	Passed
N04 (1in)	75	OK	...	OK	3.42	OK	Passed
N10B (8in)	75	OK	...	...	...	OK	Passed
K2B (2in)	75	OK	...	OK	4.80	OK	Passed
K2A (2in)	75	OK	...	OK	4.80	OK	Passed
K3A (2in)	75	OK	...	OK	4.80	OK	Passed
K3B (2in)	75	OK	...	OK	4.80	OK	Passed
K4B (3in)	75	OK	...	OK	5.73	OK	Passed
K4A (3in)	75	OK	...	OK	5.73	OK	Passed
K05 (2in)	69	OK	...	OK	7.80	OK	Passed
K10A (2in)	64	OK	...	OK	7.80	OK	Passed
K10B (2in)	64	OK	...	OK	7.80	OK	Passed
K1 (2in)	64	OK	...	OK	7.80	OK	Passed
N06 (2in)	64	OK	...	OK	7.80	OK	Passed
K6A (2in)	64	OK	...	OK	7.80	OK	Passed
K6B (2in)	64	OK	...	OK	7.80	OK	Passed
N03 (2in)	65	OK	...	OK	6.42	OK	Passed
N10C (8in)	63	OK	...	...	...	OK	Passed
N02 (6in)	67	OK	...	OK	9.22	OK	Passed
N08 (1.5in)	67	OK	...	OK	7.52	OK	Passed
N08 (1.5in)	67	OK	...	OK	7.52	OK	Passed

Nozzle MAWP Summary:

Minimum MAWP Nozzles	:	63 Nozzle	:	N10C (8in)
Minimum MAWP Shells/Flanges	:	64 Element	:	
Minimum MAPnc Shells/Flanges	:	64 Element	:	
Computed Vessel M.A.W.P.	:	63 bars	:	

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

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شماره پیمان: 053 - 073 - 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)	شماره صفحه : 13 از 383																
	<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>0001</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01
	پروژه		بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0001	V01											

Check the Spatial Relationship between the Nozzles:

From Node	Nozzle Description	Y Coordinate mm.	Layout Angle deg	Dia. Limit mm.
20	N07 (1.5in)	0.000	0.000	88.260
20	K07A (3in)	0.000	180.000	159.299
20	K09A (2in)	0.000	0.000	100.325
30	N01 (6in)	1400.000	90.000	311.658
30	N09 (1in)	200.000	90.000	94.000
30	K07B (3in)	1100.000	180.000	157.000
30	K08B (2in)	828.000	45.000	124.000
30	K08A (2in)	472.000	45.000	124.000
30	K09B (2in)	300.000	0.000	124.000
30	N10A (8in)	1650.000	180.000	409.524
30	N05 (2in)	200.000	270.000	124.328
60	N04 (1in)	2499.525	90.000	94.000
60	N10B (8in)	3893.226	180.000	409.524
60	K2B (2in)	3781.175	45.000	124.000
60	K2A (2in)	3425.175	45.000	124.000
60	K3A (2in)	2703.175	0.000	124.000
60	K3B (2in)	3059.176	0.000	124.000
60	K4B (3in)	4253.176	315.000	157.000
60	K4A (3in)	2703.175	315.000	157.000
60	K05 (2in)	4099.526	270.000	124.000
90	K10A (2in)	4874.050	90.000	118.000
110	K10B (2in)	9247.050	90.000	118.000
140	K1 (2in)	9920.574	225.000	118.000
140	N06 (2in)	9920.574	270.000	118.000
140	K6A (2in)	9963.574	0.000	118.000
140	K6B (2in)	10263.575	0.000	118.000
140	N03 (2in)	9823.574	90.000	88.000
140	N10C (8in)	9963.574	180.000	405.700
150	N02 (6in)	0.000	0.000	310.145
150	N08 (1.5in)	0.000	0.000	104.100

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 !

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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Bill of Materials:

QTY	DESCRIPTION	MATERIAL
1	SKIRT: 25.0mm. THK X 686.0mm. ID X 1500.0mm.	SA-516 70
1	ELLIPTICAL HEAD: 2.0 X 1, 25.0mm. THK X 706.0mm. ID X 50.0mm.	SA-516 70
2	CYLINDER: 20.0mm. THK X 706.0mm. ID X 2000.0mm.	SA-516 70
3	BODY FLANGE: 110.0mm. THK X 706.0mm. OD	SA-105
3	BODY FLANGE: 115.0mm. THK X 700.0mm. OD	SA-105
2	CYLINDER: 20.0mm. THK X 700.0mm. ID X 1500.0mm.	SA-516 70
1	CYLINDER: 20.0mm. THK X 700.0mm. ID X 1600.0mm.	SA-516 70
1	CYLINDER: 20.0mm. THK X 700.0mm. ID X 863.0mm.	SA-516 70
1	ELLIPTICAL HEAD: 2.0 X 1, 25.0mm. THK X 700.0mm. ID X 50.0mm.	SA-516 70
3	INSULATION: 1500mm X 50mm THK	
2	INSULATION: 225mm X 50mm THK	
1	LINING: 212.500mm X 3.000mm THK	...
2	INSULATION: 2000mm X 50mm THK	
2	LINING: 2000.000mm X 3.000mm THK	...
4	INSULATION: 175mm X 50mm THK	
2	INSULATION: 169mm X 50mm THK	
1	PACKING: 1270.000mm	...
1	PACKING: 1500.000mm	...
1	PLATFORM: 1050mm X 1100mm WIDE	
1	LADDER: 10500mm	...
1	PACKING: 1380.000mm	...
1	INSULATION: 1600mm X 50mm THK	
1	INSULATION: 863mm X 50mm THK	
3	CLASS 600 GR 1.1, 8.0" BLIND FLANGE(S)	SA-105
1	CLASS 600 GR 1.1, 1.5" BLIND FLANGE(S)	SA-105

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

1	BASERING: 1060.0mm. OD X 620.0 ID X 80.0mm.	SA-283 C
12	BASERING BOLTS: 48.0mm. DIA	SA-193 B7
12	NUTS FOR BODY BASERING BOLTS: 48.0mm. DIA	...
1	BASERING TOP RING: 1020.0mm. OD X 620.0 ID X 35.0mm.	SA-283 C
24	BASERING GUSSET PLATES: 162mm. X 200mm. X 265mm. X 12mm.	...
3	GASKET: 787mm. OD X 736mm. ID	...
66	BODY FLANGE BOLTS: 44mm. DIA	SA-193 B7M
132	NUTS FOR BODY FLANGE BOLTS: 44mm. DIA	...
1	NAMEPLATE	...

Nozzle Schedule:

Description	Nominal or Actual Size	Schd or FVC Type	Flg Type	Nozzle O/Dia in	Wall Thk mm	Reinforcing Pad Diameter	Pad Thk mm	Cut Length in	Flg Class
N09 (1in)	1.000 in	Actual	LW	2.126	14.300	...	...	545.0	600
N04 (1in)	1.000 in	Actual	LW	2.126	14.300	...	...	247.2	600
N03 (2in)	1.000 in	Actual	LW	2.126	14.300	...	...	221.0	600
N07 (1.5in)	1.500 in	XXS	WN	1.900	10.160	...	...	220.4	600
N08 (1.5in)	1.500 in	Actual	LW	2.760	16.000	...	...	240.3	600
K09A (2in)	2.000 in	XXS	WN	2.375	11.074	...	...	228.4	600
K08B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K08A (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K09B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
N05 (2in)	2.000 in	Actual	LW	3.320	16.764	...	...	222.5	600
K2B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K2A (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K3A (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K3B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K05 (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K10A (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K10B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K1 (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
N06 (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K6A (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K6B (2in)	2.000 in	Actual	LW	3.307	16.600	...	...	222.5	600
K07A (3in)	3.000 in	STD	WN	3.500	5.486	...	...	243.5	600
K07B (3in)	3.000 in	Actual	LW	4.606	20.400	...	...	224.8	600
K4B (3in)	3.000 in	Actual	LW	4.606	20.400	...	...	224.8	600
K4A (3in)	3.000 in	Actual	LW	4.606	20.400	...	...	224.8	600
N01 (6in)	6.000 in	STD	WN	6.625	7.112	...	...	238.5	600
N02 (6in)	6.000 in	80	WN	6.625	10.973	...	...	229.3	600
N10A (8in)	8.000 in	STD	WN	8.625	8.179	...	...	252.2	600
N10B (8in)	8.000 in	STD	WN	8.625	8.179	...	...	252.2	600
N10C (8in)	8.000 in	80	WN	8.625	12.700	...	...	250.7	600

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 16 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

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, 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
N09 (1in)	SA-105	18.000	10.000	...	...	15.000
N04 (1in)	SA-105	18.000	10.000	...	...	...
N03 (2in)	SA-105	20.000	10.000	...	...	...
N07 (1.5in)	SA-106 B	18.000	10.000	...	...	...
N08 (1.5in)	SA-105	20.000	10.000	...	...	...
K09A (2in)	SA-106 B	18.000	12.000	...	...	...
K08B (2in)	SA-105	18.000	10.000	...	...	...
K08A (2in)	SA-105	18.000	10.000	...	...	...
K09B (2in)	SA-105	18.000	10.000	...	...	...
N05 (2in)	SA-105	18.000	10.000	...	...	...
K2B (2in)	SA-105	18.000	10.000	...	...	...
K2A (2in)	SA-105	18.000	10.000	...	...	...
K3A (2in)	SA-105	18.000	10.000	...	...	...
K3B (2in)	SA-105	18.000	10.000	...	...	...
K05 (2in)	SA-105	18.000	10.000	...	...	...
K10A (2in)	SA-105	18.000	10.000	...	...	...
K10B (2in)	SA-105	18.000	10.000	...	...	...
K1 (2in)	SA-105	20.000	10.000	...	...	...
N06 (2in)	SA-105	20.000	10.000	...	...	...
K6A (2in)	SA-105	20.000	10.000	...	...	...
K6B (2in)	SA-105	20.000	10.000	...	...	...
K07A (3in)	SA-105	18.000	10.000	...	...	...
K07B (3in)	SA-105	18.000	10.000	...	...	...
K4B (3in)	SA-105	18.000	10.000	...	...	...
K4A (3in)	SA-105	18.000	10.000	...	...	...
N01 (6in)	SA-105	15.000	10.000	...	...	...
N02 (6in)	SA-105	15.000	10.000	...	...	...
N10A (8in)	SA-105	18.000	10.000	...	...	...
N10B (8in)	SA-105	18.000	10.000	...	...	...
N10C (8in)	SA-105	20.000	10.000	...	...	...

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

 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 CONTACTOR (C-100)							شماره صفحه : 17 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Nozzle Miscellaneous Data:

Description	Elev/Distance From Datum mm.	Layout Angle deg	Proj Outside mm.	Proj Inside mm.	Installed in Component
N09 (1in)	200.000	90.0	200.00	325.00	Node: 30
N04 (1in)	2499.525	90.0	226.19	0.00	Node: 60
N03 (2in)	9823.574	90.0	200.00	0.00	Node: 140
N07 (1.5in)	...	0.0	200.00	0.00	Bottom Head
N08 (1.5in)	...	0.0	200.00	0.00	Top Head
K09A (2in)	...	0.0	200.00	0.00	Bottom Head
K08B (2in)	828.000	45.0	200.00	0.00	Node: 30
K08A (2in)	472.000	45.0	200.00	0.00	Node: 30
K09B (2in)	300.000	0.0	200.00	0.00	Node: 30
N05 (2in)	200.000	270.0	200.00	0.00	Node: 30
K2B (2in)	3781.176	45.0	200.00	0.00	Node: 60
K2A (2in)	3425.176	45.0	200.00	0.00	Node: 60
K3A (2in)	2703.176	0.0	200.00	0.00	Node: 60
K3B (2in)	3059.175	0.0	200.00	0.00	Node: 60
K05 (2in)	4099.526	270.0	200.00	0.00	Node: 60
K10A (2in)	4874.050	90.0	200.00	0.00	Node: 90
K10B (2in)	9247.050	90.0	200.00	0.00	Node: 110
K1 (2in)	9920.574	225.0	200.00	0.00	Node: 140
N06 (2in)	9920.574	270.0	200.00	0.00	Node: 140
K6A (2in)	9963.574	0.0	200.00	0.00	Node: 140
K6B (2in)	10263.574	0.0	200.00	0.00	Node: 140
K07A (3in)	...	180.0	200.00	0.00	Bottom Head
K07B (3in)	1100.000	180.0	200.00	0.00	Node: 30
K4B (3in)	4253.176	315.0	200.00	0.00	Node: 60
K4A (3in)	2703.176	315.0	200.00	0.00	Node: 60
N01 (6in)	1400.000	90.0	200.00	0.00	Node: 30
N02 (6in)	...	0.0	200.00	0.00	Top Head
N10A (8in)	1650.000	180.0	200.00	0.00	Node: 30
N10B (8in)	3893.226	180.0	200.00	0.00	Node: 60
N10C (8in)	9963.574	180.0	200.00	0.00	Node: 140

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 18 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

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
	[11]	B	-11	-20	-29	0.834	18.000	1.00	Yes
	[11]	B	-11	-20	-29	0.834	18.000	1.00	Yes
	[11]	B	-11	-20	-29	0.832	18.000	1.00	Yes
	[11]	B	-7	-9	-29	0.966	20.000	1.00	Yes
	[11]	B	-7	-9	-29	0.968	20.000	1.00	Yes
	[11]	B	-7	-9	-29	0.966	20.000	1.00	Yes
Bottom Head	[10]	D	-40	-48	-29	0.811	20.000	1.00	Yes
Bottom Head	[7]	D	-35	-48	-29	0.664	25.000	1.00	Yes
	[8]	D	-40	-48	-29	0.837	20.000	1.00	Yes
	[8]	D	-40	-48	-29	0.829	20.000	1.00	Yes
	[8]	D	-40	-41	-29	0.974	20.000	1.00	Yes
	[8]	D	-40	-41	-29	0.974	20.000	1.00	Yes
	[8]	D	-40	-41	-29	0.974	20.000	1.00	Yes
	[8]	D	-40	-41	-29	0.974	20.000	1.00	Yes
Top Head	[10]	D	-40	-43	-29	0.941	20.000	1.00	Yes
Top Head	[7]	D	-35	-48	-29	0.752	25.000	1.00	Yes
N07 (1.5in)	[1]	B	-8	-104	-29	0.093	8.890	1.00	Yes
Nozzle Flg	[5]	A	-18	-39					
K07A (3in)	[1]	A	12	-3		0.720	20.000	1.00	Yes
Nozzle Flg	[5]	A	-18	-39					
K09A (2in)	[1]	B	-8	-104	-29	0.115	9.690	1.00	Yes
Nozzle Flg	[5]	A	-18	-39					
N01 (6in)	[1]	D	-8	-32	-29	0.579	6.223	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N09 (1in)	[1]	A	3	-104		0.041	14.300	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
K07B (3in)	[1]	A	12	2		0.816	20.000	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
K08B (2in)	[1]	A	7	-104		0.070	16.600	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
K08A (2in)	[1]	A	7	-104		0.071	16.600	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
K09B (2in)	[1]	A	7	-104		0.071	16.600	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N10A (8in)	[1]	D	-8	-29	-29	0.661	7.156	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N05 (2in)	[1]	A	7	-104		0.070	16.764	1.00	Yes
Nozzle Flg	[5]	A	-29	-48					
N04 (1in)	[1]	A	3	-104		0.041	14.300	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N10B (8in)	[1]	D	5	-14		0.661	7.156	1.00	Yes
Nozzle Flg	[5]	!	-18	-40					
K2B (2in)	[1]	A	7	-104		0.070	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K2A (2in)	[1]	A	7	-104		0.070	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K3A (2in)	[1]	A	7	-104		0.070	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					

 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 CONTACTOR (C-100)							شماره صفحه : 19 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

K3B (2in)	[1]	A	7	-104		0.070	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K4B (3in)	[1]	A	12	2		0.816	20.000	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K4A (3in)	[1]	A	12	2		0.817	20.000	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K05 (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K10A (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K10B (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K1 (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N06 (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K6A (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
K6B (2in)	[1]	A	7	-104		0.096	16.600	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N03 (2in)	[1]	A	3	-104		0.064	14.300	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N10C (8in)	[1]	D	5	-19		0.578	11.113	1.00	Yes
Nozzle Flg	[5]	!	-18	-40					
N02 (6in)	[1]	D	-8	-35	-29	0.543	9.601	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
N08 (1.5in)	[1]	A	6	-104		0.078	16.000	1.00	Yes
Nozzle Flg	[5]	A	-18	-40					
Bolting	[21]		-48						
Bolting	[21]		-48						
Bolting	[21]		-48						

Warmest MDMT: 12 2

Required Minimum Design Metal Temperature 5.0 °C

Warmest Computed Minimum Design Metal Temperature 2.0 °C

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

 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 CONTACTOR (C-100)							شماره صفحه : 20 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

[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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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 21 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Class From To : Basic Element Checks.

Note 10 30 There is a high jump in the Joint Eff.

Class From To: Check of Additional Element Data

There were no geometry errors or warnings.

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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 CONTACTOR (C-100)							شماره صفحه : 22 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

PV Elite Vessel Analysis Program: Input Data

Design Internal Pressure (for Hydrotest)	62	bars
Design Internal Temperature	148.0	°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	Y	
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 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	

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادرکننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 23 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

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	2.000
Site Class	D
Component Elevation Ratio	z/h
Amplification Factor	Ap
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	Skirt Sup.
Description	Skirt
Distance "FROM" to "TO"	1500 mm.
Skirt Outside Diameter	736 mm.
Diameter of Skirt at Base	736 mm.
Skirt Thickness	25 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 CONTACTOR (C-100)							شماره صفحه : 24 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Internal Corrosion Allowance	0	mm.
Nominal Thickness	0	mm.
External Corrosion Allowance	0	mm.
Design Temperature Internal Pressure	148	°C
Design Temperature External Pressure	100	°C
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	
Allowable Stress, Ambient	137.9	N./mm ²
Allowable Stress, Operating	137.9	N./mm ²
Allowable Stress, Hydrotest	235.81	N./mm ²
Material Density	7750.4	kg/m ³
P Number Thickness	31.75	mm.
Yield Stress, Operating	231.81	N./mm ²
UCS-66 Chart Curve Designation	B	
External Pressure Chart Name	CS-2	
UNS Number	K02700	
Product Form	Plate	
Efficiency, Longitudinal Seam	0.7	
Efficiency, Head-to-Skirt or Circ. Seam	0.55	
Weld is pre-Heated	No	
Element From Node	10	
Detail Type	Insulation	
Detail ID	FIREPROOF	
Dist. from "FROM" Node / Offset dist	0	mm.
Height/Length of Insulation	1500	mm.
Thickness of Insulation	50	mm.
Density	2500	kg/m ³

Element From Node	20	
Element To Node	30	
Element Type	Elliptical	
Description	Bottom Head	
Distance "FROM" to "TO"	50	mm.
Inside Diameter	706	mm.
Element Thickness	20	mm.
Internal Corrosion Allowance	0	mm.
Nominal Thickness	25	mm.
External Corrosion Allowance	0	mm.
Design Internal Pressure	62	bars
Design Temperature Internal Pressure	148	°C
Design External Pressure	1.034	bars
Design Temperature External Pressure	100	°C
Effective Diameter Multiplier	1.2	
Material Name	SA-516 70	[Normalized]
Efficiency, Longitudinal Seam	1.0	
Efficiency, Circumferential Seam	1.0	
Elliptical Head Factor	2.0	
Weld is pre-Heated	No	
Element From Node	20	
Detail Type	Liquid	
Detail ID	Liquid: 20	

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Dist. from "FROM" Node / Offset dist -175 mm.
Height/Length of Liquid 225 mm.
Liquid Density 999.54 kg/m³

Element From Node 20
Detail Type Insulation
Detail ID Ins: 30
Dist. from "FROM" Node / Offset dist -175 mm.
Height/Length of Insulation 225 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 20
Detail Type Lining
Detail ID CLAD
Dist. from "FROM" Node / Offset dist -162.5 mm.
Height/Length of Lining 212.5 mm.
Thickness of Lining 3 mm.
Density 8027 kg/m³

Element From Node 20
Detail Type Nozzle
Detail ID N07 (1.5in)
Dist. from "FROM" Node / Offset dist 0 mm.
Nozzle Diameter 1.5 in.
Nozzle Schedule XXS
Nozzle Class 600
Layout Angle 0.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.09588 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-106 B

Element From Node 20
Detail Type Nozzle
Detail ID K07A (3in)
Dist. from "FROM" Node / Offset dist 200 mm.
Nozzle Diameter 3 in.
Nozzle Schedule STD
Nozzle Class 600
Layout Angle 180.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.219 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 20
Detail Type Nozzle
Detail ID K09A (2in)
Dist. from "FROM" Node / Offset dist 150 mm.
Nozzle Diameter 2 in.
Nozzle Schedule XXS
Nozzle Class 600
Layout Angle 0.0
Blind Flange (Y/N) N

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Weight of Nozzle (Used if > 0) 0.1415 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-106 B

Element From Node 20
Detail Type Weight
Detail ID VORTEX BREAKER
Dist. from "FROM" Node / Offset dist -162.5 mm.
Miscellaneous Weight 0.4903 kN
Offset from Element Centerline 0 mm.

Element From Node 30
Element To Node 40
Element Type Cylinder
Description
Distance "FROM" to "TO" 2000 mm.
Element Outside Diameter 746 mm.
Element Thickness 20 mm.
Internal Corrosion Allowance 0 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °C
Design External Pressure 1.034 bars
Design Temperature External Pressure 100 °C
Effective Diameter Multiplier 1.2
Material Name SA-516 70 [Normalized]
Efficiency, Longitudinal Seam 1.0
Efficiency, Circumferential Seam 1.0
Weld is pre-Heated No

Element From Node 30
Detail Type Liquid
Detail ID Liquid: 30
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Liquid 650 mm.
Liquid Density 999.54 kg/m³

Element From Node 30
Detail Type Insulation
Detail ID Ins: 30
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 2000 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 30
Detail Type Lining
Detail ID CLAD
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Lining 2000 mm.
Thickness of Lining 3 mm.
Density 8027 kg/m³

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Element From Node 30
Detail Type Nozzle
Detail ID N01 (6in)
Dist. from "FROM" Node / Offset dist 1350 mm.
Nozzle Diameter 6 in.
Nozzle Schedule STD
Nozzle Class 600
Layout Angle 90.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.7592 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105 [Impact Tested]

Element From Node 30
Detail Type Nozzle
Detail ID N09 (1in)
Dist. from "FROM" Node / Offset dist 150 mm.
Nozzle Diameter 1 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 90.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.09276 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 30
Detail Type Nozzle
Detail ID K07B (3in)
Dist. from "FROM" Node / Offset dist 1050 mm.
Nozzle Diameter 3 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 180.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1851 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 30
Detail Type Nozzle
Detail ID K08B (2in)
Dist. from "FROM" Node / Offset dist 778 mm.
Nozzle Diameter 2 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 45.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1025 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 30
Detail Type Nozzle

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Detail ID	K08A (2in)	
Dist. from "FROM" Node / Offset dist	422	mm.
Nozzle Diameter	2	in.
Nozzle Schedule	None	
Nozzle Class	600	
Layout Angle	45.0	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.1025	kN
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-105	
Element From Node	30	
Detail Type	Nozzle	
Detail ID	K09B (2in)	
Dist. from "FROM" Node / Offset dist	250	mm.
Nozzle Diameter	2	in.
Nozzle Schedule	None	
Nozzle Class	600	
Layout Angle	0.0	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.1025	kN
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-105	
Element From Node	30	
Detail Type	Nozzle	
Detail ID	N10A (8in)	
Dist. from "FROM" Node / Offset dist	1600	mm.
Nozzle Diameter	8	in.
Nozzle Schedule	STD	
Nozzle Class	600	
Layout Angle	180.0	
Blind Flange (Y/N)	Y	
Weight of Nozzle (Used if > 0)	1.405	kN
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-105	[Impact Tested]
Element From Node	30	
Detail Type	Nozzle	
Detail ID	N05 (2in)	
Dist. from "FROM" Node / Offset dist	150	mm.
Nozzle Diameter	2	in.
Nozzle Schedule	None	
Nozzle Class	600	
Layout Angle	270.0	
Blind Flange (Y/N)	N	
Weight of Nozzle (Used if > 0)	0.1032	kN
Grade of Attached Flange	GR 1.1	
Nozzle Matl	SA-105	
Element From Node	30	
Detail Type	Weight	
Detail ID	DEMISTER PAD 1	
Dist. from "FROM" Node / Offset dist	1800	mm.
Miscellaneous Weight	0.9806	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)																									
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Offset from Element Centerline 0 mm.

Element From Node 30
Detail Type Weight
Detail ID N01 INLET
Dist. from "FROM" Node / Offset dist 1350 mm.
Miscellaneous Weight 0.9806 kN
Offset from Element Centerline 0 mm.

Element From Node 40
Element To Node 50
Element Type Flange
Description
Distance "FROM" to "TO" 170 mm.
Flange Inside Diameter 706 mm.
Element Thickness 110 mm.
Internal Corrosion Allowance 0 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °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 29.997 mm.
Yield Stress, Operating 219.4 N./mm²
UCS-66 Chart Curve Designation B
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 40
Detail Type Insulation
Detail ID Ins: 40
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 175 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 50
Element To Node 60

 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 CONTACTOR (C-100)							شماره صفحه : 30 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Element Type	Flange
Description	
Distance "FROM" to "TO"	170 mm.
Flange Inside Diameter	706 mm.
Element Thickness	110 mm.
Internal Corrosion Allowance	0 mm.
Nominal Thickness	0 mm.
External Corrosion Allowance	0 mm.
Design Internal Pressure	62 bars
Design Temperature Internal Pressure	148 °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	50
Detail Type	Insulation
Detail ID	Ins: 50
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	170 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m ³

Element From Node	60
Element To Node	70
Element Type	Cylinder
Description	
Distance "FROM" to "TO"	2000 mm.
Inside Diameter	706 mm.
Element Thickness	20 mm.
Internal Corrosion Allowance	0 mm.
Nominal Thickness	0 mm.
External Corrosion Allowance	0 mm.
Design Internal Pressure	62 bars
Design Temperature Internal Pressure	148 °C
Design External Pressure	1.034 bars
Design Temperature External Pressure	100 °C
Effective Diameter Multiplier	1.2
Material Name	SA-516 70 [Normalized]
Allowable Stress, Ambient	137.9 N./mm ²
Allowable Stress, Operating	137.9 N./mm ²
Allowable Stress, Hydrotest	235.8 N./mm ²
Material Density	7750.4 kg/m ³
P Number Thickness	30.988 mm.
Yield Stress, Operating	231.8 N./mm ²
UCS-66 Chart Curve Designation	D
External Pressure Chart Name	CS-2
UNS Number	K02700

 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 08_0010_CO-GCS-HD-BK)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 31 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Product Form	Plate
Efficiency, Longitudinal Seam	1.0
Efficiency, Circumferential Seam	1.0
Weld is pre-Heated	No

Element From Node	60
Detail Type	Liquid
Detail ID	Liquid: 40
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Liquid	1050 mm.
Liquid Density	999.54 kg/m ³

Element From Node	60
Detail Type	Insulation
Detail ID	Ins: 30
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	2000 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m ³

Element From Node	60
Detail Type	Lining
Detail ID	CLAD
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Lining	2000 mm.
Thickness of Lining	3 mm.
Density	8027 kg/m ³

Element From Node	60
Detail Type	Nozzle
Detail ID	N04 (1in)
Dist. from "FROM" Node / Offset dist	100 mm.
Nozzle Diameter	1 in.
Nozzle Schedule	None
Nozzle Class	600
Layout Angle	90.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.05226 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

Element From Node	60
Detail Type	Nozzle
Detail ID	N10B (8in)
Dist. from "FROM" Node / Offset dist	1493.7 mm.
Nozzle Diameter	8 in.
Nozzle Schedule	STD
Nozzle Class	600
Layout Angle	180.0
Blind Flange (Y/N)	Y
Weight of Nozzle (Used if > 0)	1.405 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105 [Impact Tested]

Element From Node	60

 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 CONTACTOR (C-100)							شماره صفحه : 32 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Detail Type	Nozzle
Detail ID	K2B (2in)
Dist. from "FROM" Node / Offset dist	1381.7 mm.
Nozzle Diameter	2 in.
Nozzle Schedule	None
Nozzle Class	600
Layout Angle	45.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.1025 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

Element From Node	60
Detail Type	Nozzle
Detail ID	K2A (2in)
Dist. from "FROM" Node / Offset dist	1025.7 mm.
Nozzle Diameter	2 in.
Nozzle Schedule	None
Nozzle Class	600
Layout Angle	45.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.1025 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

Element From Node	60
Detail Type	Nozzle
Detail ID	K3A (2in)
Dist. from "FROM" Node / Offset dist	303.65 mm.
Nozzle Diameter	2 in.
Nozzle Schedule	None
Nozzle Class	600
Layout Angle	0.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.1025 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

Element From Node	60
Detail Type	Nozzle
Detail ID	K3B (2in)
Dist. from "FROM" Node / Offset dist	659.65 mm.
Nozzle Diameter	2 in.
Nozzle Schedule	None
Nozzle Class	600
Layout Angle	0.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.1025 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105

Element From Node	60
Detail Type	Nozzle
Detail ID	K4B (3in)
Dist. from "FROM" Node / Offset dist	1853.7 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 CONTACTOR (C-100) <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>0001</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 33 از 383
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0001	V01											

Nozzle Diameter 3 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 315.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1851 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 60
Detail Type Nozzle
Detail ID K4A (3in)
Dist. from "FROM" Node / Offset dist 303.65 mm.
Nozzle Diameter 3 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 315.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1851 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 60
Detail Type Nozzle
Detail ID K05 (2in)
Dist. from "FROM" Node / Offset dist 1700 mm.
Nozzle Diameter 2 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 270.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1025 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 60
Detail Type Weight
Detail ID CHIMNEY
Dist. from "FROM" Node / Offset dist 193 mm.
Miscellaneous Weight 2.4515 kN
Offset from Element Centerline 0 mm.

Element From Node 70
Element To Node 80
Element Type Flange
Description
Distance "FROM" to "TO" 170 mm.
Flange Inside Diameter 706 mm.
Element Thickness 110 mm.
Internal Corrosion Allowance 0 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars

 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 CONTACTOR (C-100)							شماره صفحه : 34 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Design Temperature Internal Pressure	148	°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./mm ²
Allowable Stress, Operating	137.9	N./mm ²
Allowable Stress, Hydrotest	223.4	N./mm ²
Material Density	7750.4	kg/m ³
P Number Thickness	29.997	mm.
Yield Stress, Operating	219.4	N./mm ²
UCS-66 Chart Curve Designation	B	
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	70	
Detail Type	Insulation	
Detail ID	Ins: 70	
Dist. from "FROM" Node / Offset dist	0	mm.
Height/Length of Insulation	170	mm.
Thickness of Insulation	50	mm.
Density	125	kg/m ³

Element From Node	80	
Element To Node	90	
Element Type	Flange	
Description		
Distance "FROM" to "TO"	175	mm.
Flange Inside Diameter	700	mm.
Element Thickness	115	mm.
Internal Corrosion Allowance	3	mm.
Nominal Thickness	0	mm.
External Corrosion Allowance	0	mm.
Design Internal Pressure	62	bars
Design Temperature Internal Pressure	148	°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	80	
Detail Type	Insulation	

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 35 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Detail ID	Ins: 80
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	175 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m ³

Element From Node	90
Element To Node	100
Element Type	Cylinder
Description	
Distance "FROM" to "TO"	1500 mm.
Inside Diameter	700 mm.
Element Thickness	20 mm.
Internal Corrosion Allowance	3 mm.
Nominal Thickness	0 mm.
External Corrosion Allowance	0 mm.
Design Internal Pressure	62 bars
Design Temperature Internal Pressure	148 °C
Design External Pressure	1.034 bars
Design Temperature External Pressure	100 °C
Effective Diameter Multiplier	1.2
Material Name	SA-516 70 [Normalized]
Allowable Stress, Ambient	137.9 N./mm ²
Allowable Stress, Operating	137.9 N./mm ²
Allowable Stress, Hydrotest	235.8 N./mm ²
Material Density	7750.4 kg/m ³
P Number Thickness	30.988 mm.
Yield Stress, Operating	231.8 N./mm ²
UCS-66 Chart Curve Designation	D
External Pressure Chart Name	CS-2
UNS Number	K02700
Product Form	Plate
Efficiency, Longitudinal Seam	1.0
Efficiency, Circumferential Seam	1.0
Weld is pre-Heated	No

Element From Node	90
Detail Type	Packing
Detail ID	Pack: [1 of 1]
Dist. from "FROM" Node / Offset dist	230 mm.
Height of Packed Section	1270 mm.
Density	350 kg/m ³
Percent Volume Holdup	30.0
Specific Gravity of Packing Liquid	1.0

Element From Node	90
Detail Type	Insulation
Detail ID	Ins: 30
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	1500 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m ³

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Element From Node 90
Detail Type Nozzle
Detail ID K10A (2in)
Dist. from "FROM" Node / Offset dist 120 mm.
Nozzle Diameter 2 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 90.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1025 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 90
Detail Type Weight
Detail ID SUPPORT GRID
Dist. from "FROM" Node / Offset dist 230 mm.
Miscellaneous Weight 0.9806 kN
Offset from Element Centerline 0 mm.

Element From Node 90
Detail Type Weight
Detail ID ATTACHMENTS
Dist. from "FROM" Node / Offset dist 0 mm.
Miscellaneous Weight 12.297 kN
Offset from Element Centerline 0 mm.

Element From Node 100
Element To Node 110
Element Type Cylinder
Description
Distance "FROM" to "TO" 1500 mm.
Inside Diameter 700 mm.
Element Thickness 20 mm.
Internal Corrosion Allowance 3 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °C
Design External Pressure 1.034 bars
Design Temperature External Pressure 100 °C
Effective Diameter Multiplier 1.2
Material Name SA-516 70 [Normalized]
Efficiency, Longitudinal Seam 1.0
Efficiency, Circumferential Seam 1.0
Weld is pre-Heated No

Element From Node 100
Detail Type Packing
Detail ID Pack: [1 of 1]
Dist. from "FROM" Node / Offset dist 0 mm.
Height of Packed Section 1500 mm.
Density 350 kg/m³

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Percent Volume Holdup 30.0
Specific Gravity of Packing Liquid 1.0

Element From Node 100
Detail Type Insulation
Detail ID Ins: 30
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 1500 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 110
Element To Node 120
Element Type Cylinder
Description
Distance "FROM" to "TO" 1600 mm.
Inside Diameter 700 mm.
Element Thickness 20 mm.
Internal Corrosion Allowance 3 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °C
Design External Pressure 1.034 bars
Design Temperature External Pressure 100 °C
Effective Diameter Multiplier 1.2
Material Name SA-516 70 [Normalized]
Efficiency, Longitudinal Seam 1.0
Efficiency, Circumferential Seam 1.0
Weld is pre-Heated No

Element From Node 110
Detail Type Platform
Detail ID PLAT:[1 OF 1]
Dist. from "FROM" Node / Offset dist 800 mm.
Platform Start Angle (degrees) 0.0
Platform End Angle (degrees) 360.0
Platform Wind Area 27720 cm²
Platform Weight 20.966 kN
Platform Railing Weight 0 kN/mm.
Platform Grating Weight 0.025 Kgs/cm²
Platform Width 1100 mm.
Platform Height 1050 mm.
Platform Clearance or End Offset 100 mm.
Platform Force Coefficient 1.2
Ladder Layout Angle 0.0
Ladder Start Elevation 0 mm.
Ladder End Elevation 10500 mm.
Unit Weight of Ladder 0.00035 kN/mm.
Platform Length (top head platform) 0 mm.

Element From Node 110
Detail Type Packing

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Detail ID Pack: [1 of 1]
Dist. from "FROM" Node / Offset dist 0 mm.
Height of Packed Section 1380 mm.
Density 350 kg/m³
Percent Volume Holdup 30.0
Specific Gravity of Packing Liquid 1.0

Element From Node 110
Detail Type Insulation
Detail ID Ins: 30
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 1600 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 110
Detail Type Nozzle
Detail ID K10B (2in)
Dist. from "FROM" Node / Offset dist 1493 mm.
Nozzle Diameter 2 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 90.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1025 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 110
Detail Type Weight
Detail ID BED LIMMITER
Dist. from "FROM" Node / Offset dist 1380 mm.
Miscellaneous Weight 0.4903 kN
Offset from Element Centerline 0 mm.

Element From Node 120
Element To Node 130
Element Type Flange
Description
Distance "FROM" to "TO" 175 mm.
Flange Inside Diameter 700 mm.
Element Thickness 115 mm.
Internal Corrosion Allowance 3 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °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

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Allowable Stress, Hydrotest	223.4	N./mm ²
Material Density	7750.4	kg/m ³
P Number Thickness	30.988	mm.
Yield Stress, Operating	219.4	N./mm ²
UCS-66 Chart Curve Designation	B	
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	120	
Detail Type	Insulation	
Detail ID	Ins: 120	
Dist. from "FROM" Node / Offset dist	0	mm.
Height/Length of Insulation	175	mm.
Thickness of Insulation	50	mm.
Density	125	kg/m ³

Element From Node	130	
Element To Node	140	
Element Type	Flange	
Description		
Distance "FROM" to "TO"	175	mm.
Flange Inside Diameter	700	mm.
Element Thickness	115	mm.
Internal Corrosion Allowance	3	mm.
Nominal Thickness	0	mm.
External Corrosion Allowance	0	mm.
Design Internal Pressure	62	bars
Design Temperature Internal Pressure	148	°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	130	
Detail Type	Insulation	
Detail ID	Ins: 130	
Dist. from "FROM" Node / Offset dist	0	mm.
Height/Length of Insulation	175	mm.
Thickness of Insulation	50	mm.
Density	125	kg/m ³

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Element From Node 140
Element To Node 150
Element Type Cylinder
Description
Distance "FROM" to "TO" 863 mm.
Inside Diameter 700 mm.
Element Thickness 20 mm.
Internal Corrosion Allowance 3 mm.
Nominal Thickness 0 mm.
External Corrosion Allowance 0 mm.
Design Internal Pressure 62 bars
Design Temperature Internal Pressure 148 °C
Design External Pressure 1.034 bars
Design Temperature External Pressure 100 °C
Effective Diameter Multiplier 1.2
Material Name SA-516 70 [Normalized]
Allowable Stress, Ambient 137.9 N./mm²
Allowable Stress, Operating 137.9 N./mm²
Allowable Stress, Hydrotest 235.8 N./mm²
Material Density 7750.4 kg/m³
P Number Thickness 30.988 mm.
Yield Stress, Operating 231.8 N./mm²
UCS-66 Chart Curve Designation D
External Pressure Chart Name CS-2
UNS Number K02700
Product Form Plate
Efficiency, Longitudinal Seam 1.0
Efficiency, Circumferential Seam 1.0
Weld is pre-Heated No

Element From Node 140
Detail Type Insulation
Detail ID Ins: 140
Dist. from "FROM" Node / Offset dist 0 mm.
Height/Length of Insulation 863 mm.
Thickness of Insulation 50 mm.
Density 125 kg/m³

Element From Node 140
Detail Type Nozzle
Detail ID K1 (2in)
Dist. from "FROM" Node / Offset dist 207 mm.
Nozzle Diameter 2 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 225.0
Blind Flange (Y/N) N
Weight of Nozzle (Used if > 0) 0.1025 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 140
Detail Type Nozzle
Detail ID N06 (2in)

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Dist. from "FROM" Node / Offset dist 207 mm.
 Nozzle Diameter 2 in.
 Nozzle Schedule None
 Nozzle Class 600
 Layout Angle 270.0
 Blind Flange (Y/N) N
 Weight of Nozzle (Used if > 0) 0.1025 kN
 Grade of Attached Flange GR 1.1
 Nozzle Matl SA-105

Element From Node 140
 Detail Type Nozzle
 Detail ID K6A (2in)
 Dist. from "FROM" Node / Offset dist 250 mm.
 Nozzle Diameter 2 in.
 Nozzle Schedule None
 Nozzle Class 600
 Layout Angle 0.0
 Blind Flange (Y/N) N
 Weight of Nozzle (Used if > 0) 0.1025 kN
 Grade of Attached Flange GR 1.1
 Nozzle Matl SA-105

Element From Node 140
 Detail Type Nozzle
 Detail ID K6B (2in)
 Dist. from "FROM" Node / Offset dist 550 mm.
 Nozzle Diameter 2 in.
 Nozzle Schedule None
 Nozzle Class 600
 Layout Angle 0.0
 Blind Flange (Y/N) N
 Weight of Nozzle (Used if > 0) 0.1025 kN
 Grade of Attached Flange GR 1.1
 Nozzle Matl SA-105

Element From Node 140
 Detail Type Nozzle
 Detail ID N03 (2in)
 Dist. from "FROM" Node / Offset dist 110 mm.
 Nozzle Diameter 1 in.
 Nozzle Schedule None
 Nozzle Class 600
 Layout Angle 90.0
 Blind Flange (Y/N) N
 Weight of Nozzle (Used if > 0) 0.04871 kN
 Grade of Attached Flange GR 1.1
 Nozzle Matl SA-105

Element From Node 140
 Detail Type Nozzle
 Detail ID N10C (8in)
 Dist. from "FROM" Node / Offset dist 250 mm.
 Nozzle Diameter 8 in.
 Nozzle Schedule 80

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	BK	GCS	MF	120	ME	CN	0001		V01

Nozzle Class	600
Layout Angle	180.0
Blind Flange (Y/N)	Y
Weight of Nozzle (Used if > 0)	1.4249 kN
Grade of Attached Flange	GR 1.1
Nozzle Matl	SA-105 [Impact Tested]

Element From Node	140
Detail Type	Weight
Detail ID	DEMISTER PAD 2
Dist. from "FROM" Node / Offset dist	400 mm.
Miscellaneous Weight	0.9806 kN
Offset from Element Centerline	0 mm.

Element From Node	150
Element To Node	160
Element Type	Elliptical
Description	Top Head
Distance "FROM" to "TO"	50 mm.
Inside Diameter	700 mm.
Element Thickness	20 mm.
Internal Corrosion Allowance	3 mm.
Nominal Thickness	25 mm.
External Corrosion Allowance	0 mm.
Design Internal Pressure	62 bars
Design Temperature Internal Pressure	148 °C
Design External Pressure	1.034 bars
Design Temperature External Pressure	100 °C
Effective Diameter Multiplier	1.2
Material Name	SA-516 70 [Normalized]
Efficiency, Longitudinal Seam	1.0
Efficiency, Circumferential Seam	1.0
Elliptical Head Factor	2.0
Weld is pre-Heated	No

Element From Node	150
Detail Type	Insulation
Detail ID	Ins: 30
Dist. from "FROM" Node / Offset dist	0 mm.
Height/Length of Insulation	225 mm.
Thickness of Insulation	50 mm.
Density	125 kg/m³

Element From Node	150
Detail Type	Nozzle
Detail ID	N02 (6in)
Dist. from "FROM" Node / Offset dist	0 mm.
Nozzle Diameter	6 in.
Nozzle Schedule	80
Nozzle Class	600
Layout Angle	0.0
Blind Flange (Y/N)	N
Weight of Nozzle (Used if > 0)	0.5493 kN

	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0001	V01	

Grade of Attached Flange GR 1.1
Nozzle Matl SA-105 [Impact Tested]

Element From Node 150
Detail Type Nozzle
Detail ID N08 (1.5in)
Dist. from "FROM" Node / Offset dist 280 mm.
Nozzle Diameter 1.5 in.
Nozzle Schedule None
Nozzle Class 600
Layout Angle 0.0
Blind Flange (Y/N) Y
Weight of Nozzle (Used if > 0) 0.1129 kN
Grade of Attached Flange GR 1.1
Nozzle Matl SA-105

Element From Node 150
Detail Type Weight
Detail ID PIPING
Dist. from "FROM" Node / Offset dist 0 mm.
Miscellaneous Weight 9.806 kN
Offset from Element Centerline 970 mm.

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V01	0001	CN	ME	120	MF	GCS	BK																			

XY Coordinate Calculations:

From	To	X (Horiz.) mm.	Y (Vert.) mm.	DX (Horiz.) mm.	DY (Vert.) mm.

Skirt		...	1500	...	1500
Bottom Head		...	1550	...	50
30	40	...	3550	...	2000
40	50	...	3720	...	170
50	60	...	3899.53	...	170
60	70	...	5899.52	...	2000
70	80	...	6069.53	...	170
80	90	...	6254.05	...	175
90	100	...	7754.05	...	1500
100	110	...	9254.05	...	1500
110	120	...	10854	...	1600
120	130	...	11029	...	175
130	140	...	11213.6	...	175
140	150	...	12076.6	...	863
Top Head		...	12126.6	...	50

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	BK	GCS	MF	120	ME	CN	0001		V01

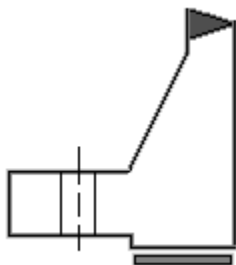
Flange Input Data Values

Description: New Flange :

Item: Node 40 to 50

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.10	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	0.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	706.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	110.0000	mm.
Thickness of Hub at Small End	go	18.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts	22		
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	706.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.
Axial Force on Flange		68.00	kN
Bending Moment on Flange		0.00	N-m

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ASME Code, Section VIII Division 1, 2019

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.1 \cdot (706.0/2 + 0.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.1) + C_a \\
 &= 16.3397 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 18.0) / (353.0 + 0.6 \cdot 18.0) \\
 &= 68.226 \text{ bars}
 \end{aligned}$$

Corroded Flange ID,	Bcor = B+2*Fcor	706.000	mm.
Corroded Large Hub,	glCor = gl-ci	35.000	mm.
Corroded Small Hub,	g0Cor = go-ci	18.000	mm.
Code R Dimension,	R = (C-B)/2 - gl	62.000	mm.
Gasket Contact Width,	N = (Go - Gi) / 2	25.400	mm.
Basic Gasket Width,	bo = N / 2	12.700	mm.
Effective Gasket Width,	b = Cb sqrt (bo)	8.980	mm.
Gasket Reaction Diameter,	G = Go - 2 * b	769.440	mm.
Original Design Pressure for Flange		62.103	bars
Axial Force Equiv. Pressure (4*max(F,0)/(pi*G^2))		1.462	bars
Bending Moment Equiv. Pressure (16*abs(M)/(pi*G^3))		0.000	bars
Final Equivalent Design Pressure		63.565	bars

Note:

Per ASME NC-3658.1(b), the equivalent pressure is used only to compute the Hydrostatic End Load H. The original design pressure is used in the remaining calculations.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 769.4395^2 \cdot 63.565 \\
 &= 2955.614 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot \pi \cdot G \cdot m \cdot P \\
 &= 2 \cdot 8.9803 \cdot 3.1416 \cdot 769.4395 \cdot 3.0 \cdot 62.1
 \end{aligned}$$

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$$= 808.844 \text{ kN}$$

Hydrostatic End Load at Flange ID [Hd]:

$$= \pi \cdot B_{cor}^2 \cdot P / 4$$

$$= 3.1416 \cdot 706.0^2 \cdot 62.1029 / 4$$

$$= 2431.082 \text{ kN}$$

Pressure Force on Flange Face [Ht]:

$$= H - H_d$$

$$= 2956 - 2431$$

$$= 524.532 \text{ kN}$$

Operating Bolt Load [Wm1]:

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

$$= \max(2956 + 809 + 0, 0)$$

$$= 3764.458 \text{ kN}$$

Gasket Seating Bolt Load [Wm2]:

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

$$= 68.95 \cdot 8.9803 \cdot 3.141 \cdot 769.44 + 0.0 \cdot 0.0 \cdot 0.0$$

$$= 1496.617 \text{ kN}$$

Required Bolt Area [Am]:

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

$$= \text{Maximum of } 3764/138, 1497/138$$

$$= 273.008 \text{ cm}^2$$

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

$$= 2a + 6t / (m + 0.5)$$

$$= 2 \cdot 44.45 + 6 \cdot 110.0 / (3.0 + 0.5)$$

$$= 277.471 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= C \cdot \sin(\pi / n)$$

$$= 900.0 \cdot \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\sqrt{Bs / (2a + t)}, 1)$$

$$= \max(\sqrt{128.083 / (2 \cdot 44.45 + 110.0)}, 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	273.008	281.032	
Radial Distance between Hub and Bolts:	57.150	62.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	277.471

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

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

$$= 281.032 \cdot 137.9 / (68.95 \cdot 3.14 \cdot (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

$$= 25.000 \text{ mm.}$$

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
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Flange Design Bolt Load, Gasket Seating [W]:

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

$$= 137.9 * (273.0079 + 281.0317) / 2$$

$$= 3819.78 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= W_{m1} - H$$

$$= 3764 - 2956$$

$$= 808.84 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

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

$$= (62.0 + 35.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

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

$$= 62.0 + (35.0 / 2.0)$$

$$= 79.5000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2431.	79.5000	1.0000	193349.
Face Pressure, Mt	525.	81.1401	1.0000	42578.
Gasket Load, Mg	809.	65.2802	1.0000	52823.
Gasket Seating, Matm	3820.	65.2802	1.0000	249457.
Total Moment for Operation, Mop				288750. N-m
Total Moment for Gasket seating, Matm				249457. N-m

Effective Hub Length, $h_o = \sqrt{B_{cor} * g_{oCor}}$ 112.730 mm.

Hub Ratio, $h/h_o = H_L / H_0$ 0.532

Thickness Ratio, $g_1/g_0 = (g_{1Cor}/g_{oCor})$ 1.944

Flange Factors for Integral Flange:

Factor F	0.820
Factor V	0.225
Factor f	1.051
Factors from Figure 2-7.1	K = 1.402
T = 1.753	U = 6.492
Y = 5.908	Z = 3.070
d = 0.10517E+07 mm. ³	e = 0.0073 mm. ⁻¹
Stress Factors	ALPHA = 1.801
BETA = 2.067	GAMMA = 1.027
DELTA = 1.266	Lamda = 2.293

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * M_{op} / B_{cor}) / (L * g_1^2)$$

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$$= (1.0511 \times 288750 / 706.0) / (2.2925 \times 35.0^2)$$

$$= 153.03 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f \times \text{Matm} / \text{Bcor}) / (L \times g1^2)$$

$$= (1.0511 \times 249457 / 706.0) / (2.2925 \times 35.0^2)$$

$$= 132.21 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (\text{Beta} \times \text{Mop} / \text{Bcor}) / (L \times t^2)$$

$$= (2.0674 \times 288750 / 706.0) / (2.2925 \times 110.0^2)$$

$$= 30.47 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (\text{Beta} \times \text{Matm} / \text{Bcor}) / (L \times t^2)$$

$$= (2.0674 \times 249457 / 706.0) / (2.2925 \times 110.0^2)$$

$$= 26.33 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y \times \text{Mo} / (t^2 \times \text{Bcor})) - Z \times \text{SRo}$$

$$= (5.9078 \times 288750 / (110.0^2 \times 706.0)) - 3.0696 \times 30$$

$$= 106.09 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

$$= (y \times \text{Matm} / (t^2 \times \text{Bcor})) - Z \times \text{SRa}$$

$$= (5.9078 \times 249457 / (110.0^2 \times 706.0)) - 3.0696 \times 26$$

$$= 91.65 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (\text{SHo} + \max(\text{SRo}, \text{STo})) / 2$$

$$= (153 + \max(30, 106)) / 2$$

$$= 129.56 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (\text{SHa} + \max(\text{SRa}, \text{STa})) / 2$$

$$= (132 + \max(26, 92)) / 2$$

$$= 111.93 \text{ N./mm}^2$$

Bolt Stress, Operating [BSo]:

$$= \text{Wm1} / \text{Ab}$$

$$= 3764 / 281.0317$$

$$= 133.96 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (\text{Wm2} / \text{Ab})$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Gasket Seating Allowed
Longitudinal Hub	153.03	206.85	132.21	206.85
Radial Flange	30.47	137.90	26.33	137.90
Tangential Flange	106.09	137.90	91.65	137.90
Maximum Average	129.56	137.90	111.93	137.90
Bolting	133.96	137.90	53.26	137.90

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	BK	GCS	MF	120	ME	CN	0001		V01

Minimum Required Flange Thickness	105.232 mm.
Estimated M.A.W.P. (Operating)	64 bars
Estimated M.A.W.P. (Gasket Seating)	64 bars
Estimated Finished Weight of Flange at given Thk.	350.9 kg.
Estimated Unfinished Weight of Forging at given Thk	498.4 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 249457.1 / 1.0 * 999.68 * 0.225 / (2.115 * 202713 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.624 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 288750.2 / 1.0 * 999.68 * 0.225 / (2.115 * 195184 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.750 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 249457.1 / 1.0 * 999.68 * 0.225 / (2.293 * 202713 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.576 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 288750.2 / 1.0 * 999.68 * 0.225 / (2.293 * 195184 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.692 \quad (\text{should be } \leq 1)$$

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.834, Temperature Reduction per Fig. UCS 66.1 = 9 °C

Min Metal Temp. w/o impact per UCS-66, Curve B	-11 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-20 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

Note: UCS-66(b)-(c) was considered in the flange MDMT calculation.

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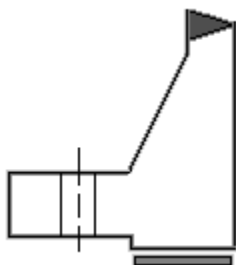
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Input Data Values

Description: New Flange :

Item: Node 50 to 60

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.10	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	0.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	706.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	110.0000	mm.
Thickness of Hub at Small End	go	18.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts	22		
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	706.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.



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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 52 از 383
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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

ASME Code, Section VIII Division 1, 2019

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + Ca)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.1 \cdot (706.0/2 + 0.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.1) + Ca \\
 &= 16.3397 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 18.0) / (353.0 + 0.6 \cdot 18.0) \\
 &= 68.226 \text{ bars}
 \end{aligned}$$

Corroded Flange ID,	Bcor = B + 2 * Fcor	706.000	mm.
Corroded Large Hub,	g1Cor = g1 - ci	35.000	mm.
Corroded Small Hub,	g0Cor = go - ci	18.000	mm.
Code R Dimension,	R = (C - B) / 2 - g1	62.000	mm.
Gasket Contact Width,	N = (Go - Gi) / 2	25.400	mm.
Basic Gasket Width,	bo = N / 2	12.700	mm.
Effective Gasket Width,	b = Cb sqrt(bo)	8.980	mm.
Gasket Reaction Diameter,	G = Go - 2 * b	769.440	mm.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot Peq \\
 &= 0.785 \cdot 769.4395^2 \cdot 62.103 \\
 &= 2887.614 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot Pi \cdot G \cdot m \cdot P \\
 &= 2 \cdot 8.9803 \cdot 3.1416 \cdot 769.4395 \cdot 3.0 \cdot 62.1 \\
 &= 808.844 \text{ kN}
 \end{aligned}$$

Hydrostatic End Load at Flange ID [Hd]:

$$\begin{aligned}
 &= Pi \cdot Bcor^2 \cdot P / 4 \\
 &= 3.1416 \cdot 706.0^2 \cdot 62.1029 / 4 \\
 &= 2431.082 \text{ kN}
 \end{aligned}$$

Pressure Force on Flange Face [Ht]:

$$\begin{aligned}
 &= H - Hd \\
 &= 2888 - 2431 \\
 &= 456.532 \text{ kN}
 \end{aligned}$$

Operating Bolt Load [Wm1]:

$$\begin{aligned}
 &= \max(H + Hp + H'p, 0) \\
 &= \max(2888 + 809 + 0, 0) \\
 &= 3696.458 \text{ kN}
 \end{aligned}$$

Gasket Seating Bolt Load [Wm2]:

$$\begin{aligned}
 &= y \cdot b \cdot Pi \cdot G + yPart \cdot bPart \cdot lp \\
 &= 68.95 \cdot 8.9803 \cdot 3.1416 \cdot 769.44 + 0.0 \cdot 0.0 \cdot 0.0 \\
 &= 1496.617 \text{ kN}
 \end{aligned}$$

Required Bolt Area [Am]:

$$\begin{aligned}
 &= \text{Maximum of } Wm1/Sb, Wm2/Sa \\
 &= \text{Maximum of } 3696/138, 1497/138 \\
 &= 268.076 \text{ cm}^2
 \end{aligned}$$

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

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$$= 2a + 6t / (m + 0.5)$$

$$= 2 * 44.45 + 6 * 110.0 / (3.0 + 0.5)$$

$$= 277.471 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= C * \sin(\pi / n)$$

$$= 900.0 * \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\sqrt{Bs / (2a + t)}, 1)$$

$$= \max(\sqrt{128.083 / (2 * 44.45 + 110.0)}, 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	268.076	281.032	
Radial Distance between Hub and Bolts:	57.150	62.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	277.471

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

$$= Ab * Sa / (y * \pi * (Go + Gi))$$

$$= 281.032 * 137.9 / (68.95 * 3.14 * (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

$$= 25.000 \text{ mm.}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$= Sa * (Am + Ab) / 2$$

$$= 137.9 * (268.0764 + 281.0317) / 2$$

$$= 3785.78 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= Wm1 - H$$

$$= 3696 - 2888$$

$$= 808.84 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

$$= (R + g1 + hg) / 2$$

$$= (62.0 + 35.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

$$= R + (g1 / 2)$$

$$= 62.0 + (35.0 / 2.0)$$

$$= 79.5000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2431.	79.5000	1.0000	193349.
Face Pressure, Mt	457.	81.1401	1.0000	37058.
Gasket Load, Mg	809.	65.2802	1.0000	52823.
Gasket Seating, Matm	3786.	65.2802	1.0000	247237.
Total Moment for Operation, Mop				283230. N-m
Total Moment for Gasket seating, Matm				247237. N-m
Effective Hub Length, ho = sqrt(Bcor*goCor)				112.730 mm.
Hub Ratio, h/h0 = HL / H0				0.532
Thickness Ratio, gl/g0 = (glCor/goCor)				1.944

Flange Factors for Integral Flange:

Factor F	0.820
Factor V	0.225
Factor f	1.051
Factors from Figure 2-7.1	K = 1.402
T = 1.753	U = 6.492
Y = 5.908	Z = 3.070
d = 0.10517E+07 mm. ³	e = 0.0073 mm. ⁻¹
Stress Factors	ALPHA = 1.801
BETA = 2.067	GAMMA = 1.027
DELTA = 1.266	Lamda = 2.293

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * Mop / Bcor) / (L * gl^2)$$

$$= (1.0511 * 283230 / 706.0) / (2.2925 * 35.0^2)$$

$$= 150.10 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f * Matm / Bcor) / (L * gl^2)$$

$$= (1.0511 * 247237 / 706.0) / (2.2925 * 35.0^2)$$

$$= 131.03 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (Beta * Mop / Bcor) / (L * t^2)$$

$$= (2.0674 * 283230 / 706.0) / (2.2925 * 110.0^2)$$

$$= 29.89 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (Beta * Matm / Bcor) / (L * t^2)$$

$$= (2.0674 * 247237 / 706.0) / (2.2925 * 110.0^2)$$

$$= 26.09 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y * Mo / (t^2 * Bcor)) - Z * SRo$$

$$= (5.9078 * 283230 / (110.0^2 * 706.0)) - 3.0696 * 30$$

$$= 104.06 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

$$= (y * Matm / (t^2 * Bcor)) - Z * SRa$$

$$= (5.9078 * 247237 / (110.0^2 * 706.0)) - 3.0696 * 26$$

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$$= 90.84 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (SHo + \max(SRo, STo)) / 2$$

$$= (150 + \max(30, 104)) / 2$$

$$= 127.08 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (SHa + \max(SRa, STa)) / 2$$

$$= (131 + \max(26, 91)) / 2$$

$$= 110.93 \text{ N./mm}^2$$

Bolt Stress, Operating [BSO]:

$$= Wm1 / Ab$$

$$= 3696 / 281.0317$$

$$= 131.54 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (Wm2 / Ab)$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Gasket Seating Allowed
Longitudinal Hub	150.10	206.85	131.03	206.85
Radial Flange	29.89	137.90	26.09	137.90
Tangential Flange	104.06	137.90	90.84	137.90
Maximum Average	127.08	137.90	110.93	137.90
Bolting	131.54	137.90	53.26	137.90

Minimum Required Flange Thickness	103.734 mm.
Estimated M.A.W.P. (Operating)	65 bars
Estimated M.A.W.P. (Gasket Seating)	65 bars
Estimated Finished Weight of Flange at given Thk.	350.9 kg.
Estimated Unfinished Weight of Forging at given Thk	498.4 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247236.7 / 1.0 * 999.68 * 0.225 / (2.062 * 202713 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.634 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 283230.4 / 1.0 * 999.68 * 0.225 / (2.062 * 195184 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.755 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247236.7 / 1.0 * 999.68 * 0.225 / (2.293 * 202713 * 18.0^2 * 112.73 * 0.3)$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 56 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

= 0.571 (should be <= 1)

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 283230.4 / 1.0 * 999.68 * 0.225 / (2.293 * 195184 * 18.0^2 * 112.73 * 0.3)$$

= 0.679 (should be <= 1)

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.834, Temperature Reduction per Fig. UCS 66.1 = 9 °C

Min Metal Temp. w/o impact per UCS-66, Curve B -11 °C

Min Metal Temp. at Required thickness (UCS 66.1) -20 °C

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

Note: UCS-66(b)-(c) was considered in the flange MDMT calculation.

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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)																									
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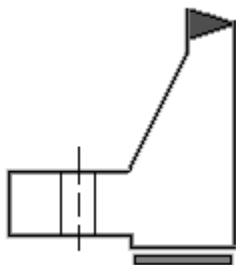
Flange Input Data Values

Description: New Flange :

Item: Node 70 to 80

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.00	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	0.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	706.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	110.0000	mm.
Thickness of Hub at Small End	go	18.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts	22		
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	706.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.
Axial Force on Flange		48.00	kN
Bending Moment on Flange		0.00	N-m

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ASME Code, Section VIII Division 1, 2019

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot (706.0/2 + 0.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) + C_a \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 18.0) / (353.0 + 0.6 \cdot 18.0) \\
 &= 68.226 \text{ bars}
 \end{aligned}$$

Corroded Flange ID,	Bcor = B + 2 * Fcor	706.000	mm.
Corroded Large Hub,	glCor = gl - ci	35.000	mm.
Corroded Small Hub,	g0Cor = go - ci	18.000	mm.
Code R Dimension,	R = (C - B) / 2 - gl	62.000	mm.
Gasket Contact Width,	N = (Go - Gi) / 2	25.400	mm.
Basic Gasket Width,	bo = N / 2	12.700	mm.
Effective Gasket Width,	b = Cb sqrt(bo)	8.980	mm.
Gasket Reaction Diameter,	G = Go - 2 * b	769.440	mm.
Original Design Pressure for Flange		62.000	bars
Axial Force Equiv. Pressure (4 * max(F, 0) / (pi * G^2))		1.032	bars
Bending Moment Equiv. Pressure (16 * abs(M) / (pi * G^3))		0.000	bars
Final Equivalent Design Pressure		63.032	bars

Note:

Per ASME NC-3658.1(b), the equivalent pressure is used only to compute the Hydrostatic End Load H. The original design pressure is used in the remaining calculations.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 769.4395^2 \cdot 63.032 \\
 &= 2930.829 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot \pi \cdot G \cdot m \cdot P \\
 &= 2 \cdot 8.9803 \cdot 3.1416 \cdot 769.4395 \cdot 3.0 \cdot 62.0
 \end{aligned}$$

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$$= 807.504 \text{ kN}$$

Hydrostatic End Load at Flange ID [Hd]:

$$= \pi \cdot B_{cor}^2 \cdot P / 4$$

$$= 3.1416 \cdot 706.0^2 \cdot 62.0 / 4$$

$$= 2427.053 \text{ kN}$$

Pressure Force on Flange Face [Ht]:

$$= H - H_d$$

$$= 2931 - 2427$$

$$= 503.775 \text{ kN}$$

Operating Bolt Load [Wm1]:

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

$$= \max(2931 + 808 + 0, 0)$$

$$= 3738.332 \text{ kN}$$

Gasket Seating Bolt Load [Wm2]:

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

$$= 68.95 \cdot 8.9803 \cdot 3.141 \cdot 769.44 + 0.0 \cdot 0.0 \cdot 0.0$$

$$= 1496.617 \text{ kN}$$

Required Bolt Area [Am]:

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

$$= \text{Maximum of } 3738/138, 1497/138$$

$$= 271.113 \text{ cm}^2$$

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

$$= 2a + 6t / (m + 0.5)$$

$$= 2 \cdot 44.45 + 6 \cdot 110.0 / (3.0 + 0.5)$$

$$= 277.471 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= C \cdot \sin(\pi / n)$$

$$= 900.0 \cdot \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\sqrt{Bs / (2a + t)}, 1)$$

$$= \max(\sqrt{128.083 / (2 \cdot 44.45 + 110.0)}, 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	271.113	281.032	
Radial Distance between Hub and Bolts:	57.150	62.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	277.471

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

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

$$= 281.032 \cdot 137.9 / (68.95 \cdot 3.14 \cdot (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

$$= 25.000 \text{ mm.}$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 60 از 383	
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Design Bolt Load, Gasket Seating [W]:

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

$$= 137.9 * (271.1132 + 281.0317) / 2$$

$$= 3806.72 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= W_{m1} - H$$

$$= 3738 - 2931$$

$$= 807.50 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

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

$$= (62.0 + 35.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

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

$$= 62.0 + (35.0 / 2.0)$$

$$= 79.5000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2427.	79.5000	1.0000	193029.
Face Pressure, Mt	504.	81.1401	1.0000	40893.
Gasket Load, Mg	808.	65.2802	1.0000	52735.
Gasket Seating, Matm	3807.	65.2802	1.0000	248604.

Total Moment for Operation, Mop 286657. N-m

Total Moment for Gasket seating, Matm 248604. N-m

Effective Hub Length, $h_o = \sqrt{B_{cor} * g_{oCor}}$ 112.730 mm.

Hub Ratio, $h/h_o = H_L / H_0$ 0.532

Thickness Ratio, $g_1/g_o = (g_{1Cor}/g_{oCor})$ 1.944

Flange Factors for Integral Flange:

Factor F 0.820

Factor V 0.225

Factor f 1.051

Factors from Figure 2-7.1 K = 1.402

T = 1.753 U = 6.492

Y = 5.908 Z = 3.070

d = 0.10517E+07 mm.³ e = 0.0073 mm.⁻¹

Stress Factors ALPHA = 1.801

BETA = 2.067 GAMMA = 1.027

DELTA = 1.266 Lamda = 2.293

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * M_{op} / B_{cor}) / (L * g_1^2)$$

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$$= (1.0511 \times 286657 / 706.0) / (2.2925 \times 35.0^2)$$

$$= 151.92 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f \times \text{Matm} / \text{Bcor}) / (L \times g1^2)$$

$$= (1.0511 \times 248604 / 706.0) / (2.2925 \times 35.0^2)$$

$$= 131.75 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (\text{Beta} \times \text{Mop} / \text{Bcor}) / (L \times t^2)$$

$$= (2.0674 \times 286657 / 706.0) / (2.2925 \times 110.0^2)$$

$$= 30.25 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (\text{Beta} \times \text{Matm} / \text{Bcor}) / (L \times t^2)$$

$$= (2.0674 \times 248604 / 706.0) / (2.2925 \times 110.0^2)$$

$$= 26.24 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y \times \text{Mo} / (t^2 \times \text{Bcor})) - Z \times \text{SRo}$$

$$= (5.9078 \times 286657 / (110.0^2 \times 706.0)) - 3.0696 \times 30$$

$$= 105.32 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

$$= (y \times \text{Matm} / (t^2 \times \text{Bcor})) - Z \times \text{SRa}$$

$$= (5.9078 \times 248604 / (110.0^2 \times 706.0)) - 3.0696 \times 26$$

$$= 91.34 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (\text{SHo} + \max(\text{SRo}, \text{STo})) / 2$$

$$= (152 + \max(30, 105)) / 2$$

$$= 128.62 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (\text{SHa} + \max(\text{SRa}, \text{STa})) / 2$$

$$= (132 + \max(26, 91)) / 2$$

$$= 111.55 \text{ N./mm}^2$$

Bolt Stress, Operating [BSo]:

$$= \text{Wm1} / \text{Ab}$$

$$= 3738 / 281.0317$$

$$= 133.03 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (\text{Wm2} / \text{Ab})$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Gasket Seating Allowed
Longitudinal Hub	151.92	206.85	131.75	206.85
Radial Flange	30.25	137.90	26.24	137.90
Tangential Flange	105.32	137.90	91.34	137.90
Maximum Average	128.62	137.90	111.55	137.90
Bolting	133.03	137.90	53.26	137.90

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	BK	GCS	MF	120	ME	CN	0001		V01

Minimum Required Flange Thickness	104.648 mm.
Estimated M.A.W.P. (Operating)	64 bars
Estimated M.A.W.P. (Gasket Seating)	64 bars
Estimated Finished Weight of Flange at given Thk.	350.9 kg.
Estimated Unfinished Weight of Forging at given Thk	498.4 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 248604.0 / 1.0 * 999.68 * 0.225 / (2.094 * 201334 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.632 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 286657.3 / 1.0 * 999.68 * 0.225 / (2.094 * 193805 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.757 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 248604.0 / 1.0 * 999.68 * 0.225 / (2.293 * 201334 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.578 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 286657.3 / 1.0 * 999.68 * 0.225 / (2.293 * 193805 * 18.0^2 * 112.73 * 0.3)$$

$$= 0.692 \quad (\text{should be } \leq 1)$$

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.832, Temperature Reduction per Fig. UCS 66.1 = 9 °C

Min Metal Temp. w/o impact per UCS-66, Curve B	-11 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-20 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

Note: UCS-66(b)(-c) was considered in the flange MDMT calculation.

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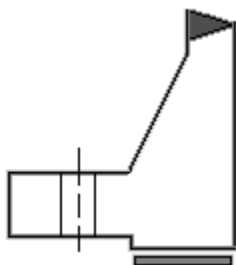
 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																									
شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 63 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

Flange Input Data Values

Description: New Flange :

Item: Node 80 to 90

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.00	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	3.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	700.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	115.0000	mm.
Thickness of Hub at Small End	go	20.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts		22	
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	700.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.



 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

ASME Code, Section VIII Division 1, 2019

Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot (700.0/2 + 3.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) + C_a \\
 &= 19.3119 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0) \\
 &= 64.542 \text{ bars}
 \end{aligned}$$

Corroded Flange Thickness, $t_c = T - c_i$	112.000	mm.
Corroded Flange ID, $B_{cor} = B + 2 \cdot F_{cor}$	706.000	mm.
Corroded Large Hub, $g1_{cor} = g1 - c_i$	32.000	mm.
Corroded Small Hub, $g0_{cor} = g0 - c_i$	17.000	mm.
Code R Dimension, $R = ((C - B_{cor})/2) - g1_{cor}$	65.000	mm.
Gasket Contact Width, $N = (G_o - G_i) / 2$	25.400	mm.
Basic Gasket Width, $b_o = N / 2$	12.700	mm.
Effective Gasket Width, $b = C_b \cdot \sqrt{b_o}$	8.980	mm.
Gasket Reaction Diameter, $G = G_o - 2 \cdot b$	769.440	mm.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 769.4395^2 \cdot 62.0 \\
 &= 2882.829 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot P_i \cdot G \cdot m \cdot P \\
 &= 2 \cdot 8.9803 \cdot 3.1416 \cdot 769.4395 \cdot 3.0 \cdot 62.0 \\
 &= 807.504 \text{ kN}
 \end{aligned}$$

Hydrostatic End Load at Flange ID [Hd]:

$$\begin{aligned}
 &= P_i \cdot B_{cor}^2 \cdot P / 4 \\
 &= 3.1416 \cdot 706.0^2 \cdot 62.0 / 4 \\
 &= 2427.053 \text{ kN}
 \end{aligned}$$

Pressure Force on Flange Face [Ht]:

$$\begin{aligned}
 &= H - H_d \\
 &= 2883 - 2427 \\
 &= 455.776 \text{ kN}
 \end{aligned}$$

Operating Bolt Load [Wm1]:

$$\begin{aligned}
 &= \max(H + H_p + H'p, 0) \\
 &= \max(2883 + 808 + 0, 0) \\
 &= 3690.333 \text{ kN}
 \end{aligned}$$

Gasket Seating Bolt Load [Wm2]:

$$\begin{aligned}
 &= y \cdot b \cdot P_i \cdot G + y_{Part} \cdot b_{Part} \cdot l_p \\
 &= 68.95 \cdot 8.9803 \cdot 3.1416 \cdot 769.44 + 0.0 \cdot 0.0 \cdot 0.0 \\
 &= 1496.617 \text{ kN}
 \end{aligned}$$

Required Bolt Area [Am]:

$$\begin{aligned}
 &= \text{Maximum of } W_{m1}/S_b, W_{m2}/S_a \\
 &= \text{Maximum of } 3690/138, 1497/138 \\
 &= 267.632 \text{ cm}^2
 \end{aligned}$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 65 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

$$= 2a + 6t / (m + 0.5)$$

$$= 2 * 44.45 + 6 * 112.0 / (3.0 + 0.5)$$

$$= 280.900 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= C * \sin(\pi / n)$$

$$= 900.0 * \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\sqrt{Bs / (2a + t)}, 1)$$

$$= \max(\sqrt{128.083 / (2 * 44.45 + 112.0)}, 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	267.632	281.032	
Radial Distance between Hub and Bolts:	57.150	65.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	280.900

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

$$= Ab * Sa / (y * \pi * (Go + Gi))$$

$$= 281.032 * 137.9 / (68.95 * 3.14 * (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

$$= 25.000 \text{ mm.}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$= Sa * (Am + Ab) / 2$$

$$= 137.9 * (267.6321 + 281.0317) / 2$$

$$= 3782.72 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= Wm1 - H$$

$$= 3690 - 2883$$

$$= 807.50 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

$$= (R + g1 + hg) / 2$$

$$= (65.0 + 32.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

$$= R + (g1 / 2)$$

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	BK	GCS	MF	120	ME	CN	0001		V01

$$= 65.0 + (32.0/2.0)$$

$$= 81.0000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2427.	81.0000	1.0000	196671.
Face Pressure, Mt	456.	81.1401	1.0000	36997.
Gasket Load, Mg	808.	65.2802	1.0000	52735.
Gasket Seating, Matm	3783.	65.2802	1.0000	247037.
Total Moment for Operation, Mop				286403. N-m
Total Moment for Gasket seating, Matm				247037. N-m

$$\text{Effective Hub Length, } h_o = \sqrt{Bcor * goCor} \quad 109.554 \text{ mm.}$$

$$\text{Hub Ratio, } h/h_o = HL / H0 \quad 0.548$$

$$\text{Thickness Ratio, } g1/g0 = (g1Cor/goCor) \quad 1.882$$

Flange Factors for Integral Flange:

Factor F	0.820
Factor V	0.230
Factor f	1.000
Factors from Figure 2-7.1	K = 1.402
T = 1.753	U = 6.492
Y = 5.908	Z = 3.070
d = 0.89401E+06 mm. ³	e = 0.0075 mm. ⁻¹
Stress Factors	ALPHA = 1.838
BETA = 2.117	GAMMA = 1.048
DELTA = 1.571	Lamda = 2.620

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * Mop / Bcor) / (L * g1^2)$$

$$= (1.0 * 286403 / 706.0) / (2.6198 * 32.0^2)$$

$$= 151.17 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f * Matm / Bcor) / (L * g1^2)$$

$$= (1.0 * 247037 / 706.0) / (2.6198 * 32.0^2)$$

$$= 130.39 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (Beta * Mop / Bcor) / (L * t^2)$$

$$= (2.1172 * 286403 / 706.0) / (2.6198 * 112.0^2)$$

$$= 26.13 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (Beta * Matm / Bcor) / (L * t^2)$$

$$= (2.1172 * 247037 / 706.0) / (2.6198 * 112.0^2)$$

$$= 22.54 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y * Mo / (t^2 * Bcor)) - Z * SRo$$

$$= (5.9078 * 286403 / (112.0^2 * 706.0)) - 3.0696 * 26$$

$$= 110.79 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

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$$= (y * Matm / (t^2 * Bcor)) - Z * SRa$$

$$= (5.9078 * 247037 / (112.0^2 * 706.0)) - 3.0696 * 23$$

$$= 95.56 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (SHo + \max(SRo, STo)) / 2$$

$$= (151 + \max(26, 111)) / 2$$

$$= 130.98 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (SHa + \max(SRa, STa)) / 2$$

$$= (130 + \max(23, 96)) / 2$$

$$= 112.98 \text{ N./mm}^2$$

Bolt Stress, Operating [BSo]:

$$= Wm1 / Ab$$

$$= 3690 / 281.0317$$

$$= 131.32 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (Wm2 / Ab)$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Gasket Seating Allowed
Longitudinal Hub	151.17	206.85	130.39	206.85
Radial Flange	26.13	137.90	22.54	137.90
Tangential Flange	110.79	137.90	95.56	137.90
Maximum Average	130.98	137.90	112.98	137.90
Bolting	131.32	137.90	53.26	137.90

Minimum Required Flange Thickness 111.303 mm.
 Estimated M.A.W.P. (Operating) 65 bars
 Estimated Finished Weight of Flange at given Thk. 372.3 kg.
 Estimated Unfinished Weight of Forging at given Thk 522.1 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247036.7 / 1.0 * 999.68 * 0.23 / (2.453 * 201334 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.631 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 286403.1 / 1.0 * 999.68 * 0.23 / (2.453 * 193805 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.760 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

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	BK	GCS	MF	120	ME	CN	0001		V01

$$= 52.14 * 247036.7 / 1.0 * 999.68 * 0.23 / (2.62 * 201334 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.591 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 286403.1 / 1.0 * 999.68 * 0.23 / (2.62 * 193805 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.712 \quad (\text{should be } \leq 1)$$

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.966, Temperature Reduction per Fig. UCS 66.1 = 2 °C

Min Metal Temp. w/o impact per UCS-66, Curve B	-7 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-9 °C
Min Metal Temp. w/o impact per UG-20 (f)	-29 °C

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	BK	GCS	MF	120	ME	CN	0001		V01

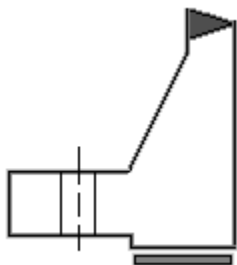
Flange Input Data Values

Description: New Flange :

Item: Node 120 to 130

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.00	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	3.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	700.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	115.0000	mm.
Thickness of Hub at Small End	go	20.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts		22	
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	700.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.
Axial Force on Flange		10.00	kN
Bending Moment on Flange		0.00	N-m

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادرکننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 70 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot (700.0/2 + 3.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) + C_a \\
 &= 19.3119 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0) \\
 &= 64.542 \text{ bars}
 \end{aligned}$$

Corroded Flange Thickness, t_c	= $T - c_i$	112.000	mm.
Corroded Flange ID, B_{cor}	= $B + 2 \cdot F_{cor}$	706.000	mm.
Corroded Large Hub, $g1_{cor}$	= $g1 - c_i$	32.000	mm.
Corroded Small Hub, $g0_{cor}$	= $g0 - c_i$	17.000	mm.
Code R Dimension, R	= $((C - B_{cor}) / 2) - g1_{cor}$	65.000	mm.
Gasket Contact Width, N	= $(G_o - G_i) / 2$	25.400	mm.
Basic Gasket Width, b_o	= $N / 2$	12.700	mm.
Effective Gasket Width, b	= $C_b \cdot \sqrt{b_o}$	8.980	mm.
Gasket Reaction Diameter, G	= $G_o - 2 \cdot b$	769.440	mm.
Original Design Pressure for Flange		62.000	bars
Axial Force Equiv. Pressure $(4 \cdot \max(F, 0) / (\pi \cdot G^2))$		0.215	bars
Bending Moment Equiv. Pressure $(16 \cdot \max(M, 0) / (\pi \cdot G^3))$		0.000	bars
Final Equivalent Design Pressure		62.215	bars

Note:

Per ASME NC-3658.1(b), the equivalent pressure is used only to compute the Hydrostatic End Load H. The original design pressure is used in the remaining calculations.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 769.4395^2 \cdot 62.215 \\
 &= 2892.829 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$= 2 \cdot b \cdot \pi \cdot G \cdot m \cdot P$$

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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 2 * 8.9803 * 3.1416 * 769.4395 * 3.0 * 62.0$$

$$= 807.504 \text{ kN}$$

Hydrostatic End Load at Flange ID [Hd]:

$$= \text{Pi} * \text{Bcor}^2 * \text{P} / 4$$

$$= 3.1416 * 706.0^2 * 62.0 / 4$$

$$= 2427.053 \text{ kN}$$

Pressure Force on Flange Face [Ht]:

$$= \text{H} - \text{Hd}$$

$$= 2893 - 2427$$

$$= 465.776 \text{ kN}$$

Operating Bolt Load [Wm1]:

$$= \max(\text{H} + \text{Hp} + \text{H}'\text{p}, 0)$$

$$= \max(2893 + 808 + 0, 0)$$

$$= 3700.333 \text{ kN}$$

Gasket Seating Bolt Load [Wm2]:

$$= \text{y} * \text{b} * \text{Pi} * \text{G} + \text{yPart} * \text{bPart} * \text{lp}$$

$$= 68.95 * 8.9803 * 3.141 * 769.44 + 0.0 * 0.0 * 0.0$$

$$= 1496.617 \text{ kN}$$

Required Bolt Area [Am]:

$$= \text{Maximum of } \text{Wm1/Sb}, \text{ Wm2/Sa}$$

$$= \text{Maximum of } 3700/138, 1497/138$$

$$= 268.357 \text{ cm}^2$$

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

$$= 2a + 6t / (m + 0.5)$$

$$= 2 * 44.45 + 6 * 112.0 / (3.0 + 0.5)$$

$$= 280.900 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= \text{C} * \sin(\text{pi} / \text{n})$$

$$= 900.0 * \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\text{sqrt}(\text{Bs} / (2a + t)), 1)$$

$$= \max(\text{sqrt}(128.083 / (2 * 44.45 + 112.0)), 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	268.357	281.032	
Radial Distance between Hub and Bolts:	57.150	65.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	280.900

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

$$= \text{Ab} * \text{Sa} / (\text{y} * \text{Pi} * (\text{Go} + \text{Gi}))$$

$$= 281.032 * 137.9 / (68.95 * 3.14 * (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

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= 25.000 mm.

Flange Design Bolt Load, Gasket Seating [W]:

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

$$= 137.9 * (268.3573 + 281.0317) / 2$$

$$= 3787.72 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= W_{m1} - H$$

$$= 3700 - 2893$$

$$= 807.50 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

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

$$= (65.0 + 32.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

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

$$= 65.0 + (32.0 / 2.0)$$

$$= 81.0000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2427.	81.0000	1.0000	196671.
Face Pressure, Mt	466.	81.1401	1.0000	37808.
Gasket Load, Mg	808.	65.2802	1.0000	52735.
Gasket Seating, Matm	3788.	65.2802	1.0000	247363.
Total Moment for Operation, Mop				287215. N-m
Total Moment for Gasket seating, Matm				247363. N-m

Effective Hub Length, $h_o = \sqrt{B_{cor} * g_{oCor}}$ 109.554 mm.

Hub Ratio, $h/h_o = H_L / H_O$ 0.548

Thickness Ratio, $g_1/g_o = (g_{1Cor}/g_{oCor})$ 1.882

Flange Factors for Integral Flange:

Factor F	0.820
Factor V	0.230
Factor f	1.000
Factors from Figure 2-7.1	K = 1.402
T = 1.753	U = 6.492
Y = 5.908	Z = 3.070
d = 0.89401E+06 mm. ³	e = 0.0075 mm. ⁻¹
Stress Factors	ALPHA = 1.838
BETA = 2.117	GAMMA = 1.048
DELTA = 1.571	Lamda = 2.620

Longitudinal Hub Stress, Operating [SHo]:

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	BK	GCS	MF	120	ME	CN	0001		V01

$$= (f * Mop / Bcor) / (L * g1^2)$$

$$= (1.0 * 287215 / 706.0) / (2.6198 * 32.0^2)$$

$$= 151.60 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f * Matm / Bcor) / (L * g1^2)$$

$$= (1.0 * 247363 / 706.0) / (2.6198 * 32.0^2)$$

$$= 130.56 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (Beta * Mop / Bcor) / (L * t^2)$$

$$= (2.1172 * 287215 / 706.0) / (2.6198 * 112.0^2)$$

$$= 26.20 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (Beta * Matm / Bcor) / (L * t^2)$$

$$= (2.1172 * 247363 / 706.0) / (2.6198 * 112.0^2)$$

$$= 22.57 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y * Mo / (t^2 * Bcor)) - Z * SRO$$

$$= (5.9078 * 287215 / (112.0^2 * 706.0)) - 3.0696 * 26$$

$$= 111.11 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

$$= (y * Matm / (t^2 * Bcor)) - Z * SRA$$

$$= (5.9078 * 247363 / (112.0^2 * 706.0)) - 3.0696 * 23$$

$$= 95.69 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (SHo + \max(SRO, STo)) / 2$$

$$= (152 + \max(26, 111)) / 2$$

$$= 131.35 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (SHa + \max(SRA, STa)) / 2$$

$$= (131 + \max(23, 96)) / 2$$

$$= 113.13 \text{ N./mm}^2$$

Bolt Stress, Operating [BSO]:

$$= Wm1 / Ab$$

$$= 3700 / 281.0317$$

$$= 131.68 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (Wm2 / Ab)$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Gasket Seating Allowed
Longitudinal Hub	151.60	206.85	130.56	206.85
Radial Flange	26.20	137.90	22.57	137.90
Tangential Flange	111.11	137.90	95.69	137.90
Maximum Average	131.35	137.90	113.13	137.90
Bolting	131.68	137.90	53.26	137.90

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	BK	GCS	MF	120	ME	CN	0001		V01

Minimum Required Flange Thickness 111.506 mm.
Estimated M.A.W.P. (Operating) 65 bars
Estimated Finished Weight of Flange at given Thk. 372.3 kg.
Estimated Unfinished Weight of Forging at given Thk 522.1 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247363.2 / 1.0 * 999.68 * 0.23 / (2.462 * 202713 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.625 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 287214.8 / 1.0 * 999.68 * 0.23 / (2.462 * 195184 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.754 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247363.2 / 1.0 * 999.68 * 0.23 / (2.62 * 202713 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.588 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 287214.8 / 1.0 * 999.68 * 0.23 / (2.62 * 195184 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.709 \quad (\text{should be } \leq 1)$$

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.968, Temperature Reduction per Fig. UCS 66.1 = 2 °C

Min Metal Temp. w/o impact per UCS-66, Curve B -7 °C
Min Metal Temp. at Required thickness (UCS 66.1) -9 °C
Min Metal Temp. w/o impact per UG-20(f) -29 °C

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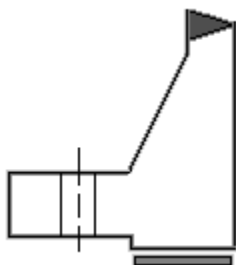
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Flange Input Data Values

Description: New Flange :

Item: Node 130 to 140

Description of Flange Geometry (Type)		Integral Weld Neck	
Design Pressure	P	62.00	bars
Design Temperature		148	°C
Internal Corrosion Allowance	ci	3.0000	mm.
External Corrosion Allowance	ce	0.0000	mm.
Use Corrosion Allowance in Thickness Calcs.		Yes	
Flange Inside Diameter	B	700.000	mm.
Flange Outside Diameter	A	990.000	mm.
Flange Thickness	t	115.0000	mm.
Thickness of Hub at Small End	go	20.0000	mm.
Thickness of Hub at Large End	gl	35.0000	mm.
Length of Hub	h	60.0000	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	900.000	mm.
Nominal Bolt Diameter	a	44.4500	mm.
Type of Threads	TEMA Thread Series		
Number of Bolts		22	
Flange Face Outside Diameter	Fod	800.000	mm.
Flange Face Inside Diameter	Fid	700.000	mm.
Flange Facing Sketch	1, Code Sketch 1a		
Gasket Outside Diameter	Go	787.400	mm.
Gasket Inside Diameter	Gi	736.600	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.



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Hub Small End Required Thickness due to Internal Pressure:

$$\begin{aligned}
 &= (P \cdot (D/2 + C_a)) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot (700.0/2 + 3.0)) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) + C_a \\
 &= 19.3119 \text{ mm.}
 \end{aligned}$$

Hub Small End Hub MAWP:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0) \\
 &= 64.542 \text{ bars}
 \end{aligned}$$

Corroded Flange Thickness, $t_c = T - c_i$	112.000	mm.
Corroded Flange ID, $B_{cor} = B + 2 \cdot F_{cor}$	706.000	mm.
Corroded Large Hub, $g1_{cor} = g1 - c_i$	32.000	mm.
Corroded Small Hub, $g0_{cor} = g0 - c_i$	17.000	mm.
Code R Dimension, $R = ((C - B_{cor})/2) - g1_{cor}$	65.000	mm.
Gasket Contact Width, $N = (G_o - G_i) / 2$	25.400	mm.
Basic Gasket Width, $b_o = N / 2$	12.700	mm.
Effective Gasket Width, $b = C_b \cdot \sqrt{b_o}$	8.980	mm.
Gasket Reaction Diameter, $G = G_o - 2 \cdot b$	769.440	mm.

Basic Flange and Bolt Loads:

Hydrostatic End Load due to Pressure [H]:

$$\begin{aligned}
 &= 0.785 \cdot G^2 \cdot P_{eq} \\
 &= 0.785 \cdot 769.4395^2 \cdot 62.0 \\
 &= 2882.829 \text{ kN}
 \end{aligned}$$

Contact Load on Gasket Surfaces [Hp]:

$$\begin{aligned}
 &= 2 \cdot b \cdot P_i \cdot G \cdot m \cdot P \\
 &= 2 \cdot 8.9803 \cdot 3.1416 \cdot 769.4395 \cdot 3.0 \cdot 62.0 \\
 &= 807.504 \text{ kN}
 \end{aligned}$$

Hydrostatic End Load at Flange ID [Hd]:

$$\begin{aligned}
 &= P_i \cdot B_{cor}^2 \cdot P / 4 \\
 &= 3.1416 \cdot 706.0^2 \cdot 62.0 / 4 \\
 &= 2427.053 \text{ kN}
 \end{aligned}$$

Pressure Force on Flange Face [Ht]:

$$\begin{aligned}
 &= H - H_d \\
 &= 2883 - 2427 \\
 &= 455.776 \text{ kN}
 \end{aligned}$$

Operating Bolt Load [Wm1]:

$$\begin{aligned}
 &= \max(H + H_p + H'p, 0) \\
 &= \max(2883 + 808 + 0, 0) \\
 &= 3690.333 \text{ kN}
 \end{aligned}$$

Gasket Seating Bolt Load [Wm2]:

$$\begin{aligned}
 &= y \cdot b \cdot P_i \cdot G + y_{Part} \cdot b_{Part} \cdot l_p \\
 &= 68.95 \cdot 8.9803 \cdot 3.1416 \cdot 769.44 + 0.0 \cdot 0.0 \cdot 0.0 \\
 &= 1496.617 \text{ kN}
 \end{aligned}$$

Required Bolt Area [Am]:

$$\begin{aligned}
 &= \text{Maximum of } W_{m1}/S_b, W_{m2}/S_a \\
 &= \text{Maximum of } 3690/138, 1497/138 \\
 &= 267.632 \text{ cm}^2
 \end{aligned}$$

 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	0001		V01

ASME Maximum Circumferential Spacing between Bolts per App. 2 eq. (3) [Bsmax]:

$$= 2a + 6t / (m + 0.5)$$

$$= 2 * 44.45 + 6 * 112.0 / (3.0 + 0.5)$$

$$= 280.900 \text{ mm.}$$

Actual Circumferential Bolt Spacing [Bs]:

$$= C * \sin(\pi / n)$$

$$= 900.0 * \sin(3.142/22)$$

$$= 128.083 \text{ mm.}$$

ASME Moment Multiplier for Bolt Spacing per App. 2 eq. (7) [Bsc]:

$$= \max(\sqrt{Bs / (2a + t)}, 1)$$

$$= \max(\sqrt{128.083 / (2 * 44.45 + 112.0)}, 1)$$

$$= 1.0000$$

Bolting Information for TEMA Imperial Thread Series (Non Mandatory):

	Minimum	Actual	Maximum
Bolt Area, cm ²	267.632	281.032	
Radial Distance between Hub and Bolts:	57.150	65.000	
Radial Distance between Bolts and Edge:	44.450	45.000	
Circ. Spacing between the Bolts:	95.250	128.083	280.900

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

$$= Ab * Sa / (y * \pi * (Go + Gi))$$

$$= 281.032 * 137.9 / (68.95 * 3.14 * (787.4 + 736.6))$$

$$= 11.740 \text{ mm.}$$

Note: Recommended Min. Width for Sheet and Composite Gaskets per table 2-4 :

$$= 25.000 \text{ mm.}$$

Flange Design Bolt Load, Gasket Seating [W]:

$$= Sa * (Am + Ab) / 2$$

$$= 137.9 * (267.6321 + 281.0317) / 2$$

$$= 3782.72 \text{ kN}$$

Gasket Load for the Operating Condition [HG]:

$$= Wm1 - H$$

$$= 3690 - 2883$$

$$= 807.50 \text{ kN}$$

Moment Arm Calculations:

Distance to Gasket Load Reaction [hg]:

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

$$= (900.0 - 769.4395) / 2$$

$$= 65.2802 \text{ mm.}$$

Distance to Face Pressure Reaction [ht]:

$$= (R + g1 + hg) / 2$$

$$= (65.0 + 32.0 + 65.2802) / 2$$

$$= 81.1401 \text{ mm.}$$

Distance to End Pressure Reaction [hd]:

$$= R + (g1 / 2)$$

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$$= 65.0 + (32.0/2.0)$$

$$= 81.0000 \text{ mm.}$$

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

Loading	Force	Distance	Bolt Corr	Moment
End Pressure, Md	2427.	81.0000	1.0000	196671.
Face Pressure, Mt	456.	81.1401	1.0000	36997.
Gasket Load, Mg	808.	65.2802	1.0000	52735.
Gasket Seating, Matm	3783.	65.2802	1.0000	247037.
Total Moment for Operation, Mop				286403. N-m
Total Moment for Gasket seating, Matm				247037. N-m

Effective Hub Length, $h_o = \sqrt{Bcor * goCor}$ 109.554 mm.

Hub Ratio, $h/h_o = HL / H_0$ 0.548

Thickness Ratio, $g_1/g_0 = (g_1Cor/goCor)$ 1.882

Flange Factors for Integral Flange:

Factor F	0.820
Factor V	0.230
Factor f	1.000
Factors from Figure 2-7.1	K = 1.402
T = 1.753	U = 6.492
Y = 5.908	Z = 3.070
d = 0.89401E+06 mm. ³	e = 0.0075 mm. ⁻¹
Stress Factors	ALPHA = 1.838
BETA = 2.117	GAMMA = 1.048
DELTA = 1.571	Lamda = 2.620

Longitudinal Hub Stress, Operating [SHo]:

$$= (f * Mop / Bcor) / (L * g_1^2)$$

$$= (1.0 * 286403 / 706.0) / (2.6198 * 32.0^2)$$

$$= 151.17 \text{ N./mm}^2$$

Longitudinal Hub Stress, Seating [SHa]:

$$= (f * Matm / Bcor) / (L * g_1^2)$$

$$= (1.0 * 247037 / 706.0) / (2.6198 * 32.0^2)$$

$$= 130.39 \text{ N./mm}^2$$

Radial Flange Stress, Operating [SRo]:

$$= (Beta * Mop / Bcor) / (L * t^2)$$

$$= (2.1172 * 286403 / 706.0) / (2.6198 * 112.0^2)$$

$$= 26.13 \text{ N./mm}^2$$

Radial Flange Stress, Seating [SRa]:

$$= (Beta * Matm / Bcor) / (L * t^2)$$

$$= (2.1172 * 247037 / 706.0) / (2.6198 * 112.0^2)$$

$$= 22.54 \text{ N./mm}^2$$

Tangential Flange Stress, Operating [STo]:

$$= (Y * Mo / (t^2 * Bcor)) - Z * SRo$$

$$= (5.9078 * 286403 / (112.0^2 * 706.0)) - 3.0696 * 26$$

$$= 110.79 \text{ N./mm}^2$$

Tangential Flange Stress, Seating [STa]:

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

$$= (y * Matm / (t^2 * Bcor)) - Z * SRa$$

$$= (5.9078 * 247037 / (112.0^2 * 706.0)) - 3.0696 * 23$$

$$= 95.56 \text{ N./mm}^2$$

Average Flange Stress, Operating [SAo]:

$$= (SHo + \max(SRo, STo)) / 2$$

$$= (151 + \max(26, 111)) / 2$$

$$= 130.98 \text{ N./mm}^2$$

Average Flange Stress, Seating [SAa]:

$$= (SHA + \max(SRa, STa)) / 2$$

$$= (130 + \max(23, 96)) / 2$$

$$= 112.98 \text{ N./mm}^2$$

Bolt Stress, Operating [BSo]:

$$= Wm1 / Ab$$

$$= 3690 / 281.0317$$

$$= 131.32 \text{ N./mm}^2$$

Bolt Stress, Seating [BSa]:

$$= (Wm2 / Ab)$$

$$= (1497 / 281.0317)$$

$$= 53.26 \text{ N./mm}^2$$

Flange Stress Analysis Results: N./mm²

	Actual	Operating Allowed	Gasket Seating Actual	Allowed
Longitudinal Hub	151.17	206.85	130.39	206.85
Radial Flange	26.13	137.90	22.54	137.90
Tangential Flange	110.79	137.90	95.56	137.90
Maximum Average	130.98	137.90	112.98	137.90
Bolting	131.32	137.90	53.26	137.90

Minimum Required Flange Thickness 111.303 mm.
 Estimated M.A.W.P. (Operating) 65 bars
 Estimated Finished Weight of Flange at given Thk. 372.3 kg.
 Estimated Unfinished Weight of Forging at given Thk 522.1 kg.

Flange Rigidity Based on Required Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

$$= 52.14 * 247036.7 / 1.0 * 999.68 * 0.23 / (2.453 * 202713 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.627 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 * Mo / Bsc * Cnv\_fac * V / (Lambda * Eop * goc^2 * ho * Ki)$$

$$= 52.14 * 286403.1 / 1.0 * 999.68 * 0.23 / (2.453 * 195184 * 17.0^2 * 109.554 * 0.3)$$

$$= 0.755 \quad (\text{should be } \leq 1)$$

Flange Rigidity Based on Given Thickness [ASME]:

Flange Rigidity Index, Seating (rotation check) per APP. 2 [Js]:

$$= 52.14 * Ma / Bsc * Cnv\_fac * V / (Lambda * Eamb * go^2 * ho * Ki)$$

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$$= 52.14 \times 247036.7 / 1.0 \times 999.68 \times 0.23 / (2.62 \times 202713 \times 17.0^2 \times 109.554 \times 0.3)$$

$$= 0.587 \quad (\text{should be } \leq 1)$$

Flange Rigidity Index Operating (rotation check) per APP. 2 [J]:

$$= 52.14 \times Mo / Bsc \times Cnv\_fac \times V / (\text{Lambda} \times Eop \times goc^2 \times ho \times Ki)$$

$$= 52.14 \times 286403.1 / 1.0 \times 999.68 \times 0.23 / (2.62 \times 195184 \times 17.0^2 \times 109.554 \times 0.3)$$

$$= 0.707 \quad (\text{should be } \leq 1)$$

Minimum Design Metal Temperature Results:

Thickness Ratio = 0.966, Temperature Reduction per Fig. UCS 66.1 = 2 °C

Min Metal Temp. w/o impact per UCS-66, Curve B	-7 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-9 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

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	BK	GCS	MF	120	ME	CN	0001		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

Skirt		...	...	...	736	...
Bottom Head		62.189	25	...	706	137.9
30	40	62.167	...	...	746	137.9
40	50	62.103	...	...	706	137.9
50	60	62.103	...	...	706	137.9
60	70	62.103	...	...	706	137.9
70	80	62	...	...	706	137.9
80	90	62	...	3	700	137.9
90	100	62	...	3	700	137.9
100	110	62	...	3	700	137.9
110	120	62	...	3	700	137.9
120	130	62	...	3	700	137.9
130	140	62	...	3	700	137.9
140	150	62	...	3	700	137.9
Top Head		62	25	3	700	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.

Skirt		...	No Calc	No Calc	25	No Calc
Bottom Head		62	77.4969	77.6856	20	15.9923
30	40	62	75.3906	75.5572	20	16.5183
40	50	62	63.8679	63.9709	110	105.232
50	60	62	65.0007	65.1036	110	103.734
60	70	62	75.4543	75.5572	20	16.3397
70	80	62	64.3059	64.3059	110	104.648
80	90	62	64.5419	65.1036	115	111.303
90	100	62	64.5419	76.1834	20	19.3119
100	110	62	64.5419	76.1834	20	19.3119
110	120	62	64.5419	76.1834	20	19.3119
120	130	62	64.5419	64.9382	115	111.506
130	140	62	64.5419	65.1036	115	111.303
140	150	62	64.5419	76.1834	20	19.3119
Top Head		62	66.8328	78.3477	20	18.7651

Minimum			64	64		

MAWP: 63 bars, limited by: Nozzle Reinforcement.

Elements Suitable for Design Internal Pressure.

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Internal Pressure Calculation Results:

ASME Code, Section VIII Division 1, 2019

Elliptical Head From 20 To 30 SA-516 70 , UCS-66 Crv. D at 148 °C

Bottom Head

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P \cdot D \cdot K_{cor}) / (2 \cdot S \cdot E - 0.2 \cdot P) \text{ Appendix 1-4 (c)} \\
 &= (62.189 \cdot 706.0 \cdot 1.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.189) \\
 &= 15.9923 + 0.0000 = 15.9923 \text{ mm.}
 \end{aligned}$$

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

Less Operating Hydrostatic Head Pressure of 0.189 bars

$$\begin{aligned}
 &= (2 \cdot S \cdot E \cdot t) / (K_{cor} \cdot D + 0.2 \cdot t) \text{ per Appendix 1-4 (c)} \\
 &= (2 \cdot 137.9 \cdot 1.0 \cdot 20.0) / (1.0 \cdot 706.0 + 0.2 \cdot 20.0) \\
 &= 78 - 0 = 77 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (2 \cdot S \cdot E \cdot t) / (K \cdot D + 0.2 \cdot t) \text{ per Appendix 1-4 (c)} \\
 &= (2 \cdot 137.9 \cdot 1.0 \cdot 20.0) / (1.0 \cdot 706.0 + 0.2 \cdot 20.0) \\
 &= 78 \text{ bars}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot (K_{cor} \cdot D + 0.2 \cdot t)) / (2 \cdot E \cdot t) \\
 &= (62.189 \cdot (1.0 \cdot 706.0 + 0.2 \cdot 20.0)) / (2 \cdot 1.0 \cdot 20.0) \\
 &= 110.391 \text{ N./mm}^2
 \end{aligned}$$

Straight Flange Required Thickness:

$$\begin{aligned}
 &= (P \cdot R) / (S \cdot E - 0.6 \cdot P) + c \text{ per UG-27 (c) (1)} \\
 &= (62.189 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.189) + 0.0 \\
 &= 16.363 \text{ mm.}
 \end{aligned}$$

Straight Flange Maximum Allowable Working Pressure:

Less Operating Hydrostatic Head Pressure of 0.171 bars

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 25.0) / (353.0 + 0.6 \cdot 25.0) \\
 &= 94 - 0 = 94 \text{ bars}
 \end{aligned}$$

Percent Elong. per UCS-79, VIII-1-01-57 $(75 \cdot t_{nom} / R_f) \cdot (1 - R_f / R_o)$ 14.149 %

Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govern. thk, $t_g = 20.0$, $t_r = 16.219$, $c = 0.0$ mm., $E^* = 1.0$

Thickness Ratio = $t_r \cdot (E^*) / (t_g - c) = 0.811$, Temp. Reduction = 11 °C

Min Metal Temp. w/o impact per UCS-66, Curve D

-40 °C

Min Metal Temp. at Required thickness (UCS 66.1)

-48 °C

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	BK	GCS	MF	120	ME	CN	0001		V01

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 25.0, tr = 16.601, c = 0.0 mm., E* = 1.0
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.664$, Temp. Reduction = 19 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -35 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Note:

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

Cylindrical Shell From 30 To 40 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$= (P \cdot Ro) / (S \cdot E + 0.4 \cdot P) \text{ per Appendix 1-1 (a) (1)}$$

$$= (62.167 \cdot 373.0) / (137.9 \cdot 1.0 + 0.4 \cdot 62.167)$$

$$= 16.5183 + 0.0000 = 16.5183 \text{ mm.}$$

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

Less Operating Hydrostatic Head Pressure of 0.167 bars

$$= (S \cdot E \cdot t) / (Ro - 0.4 \cdot t) \text{ per Appendix 1-1 (a) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 20.0) / (373.0 - 0.4 \cdot 20.0)$$

$$= 76 - 0 = 75 \text{ bars}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$= (S \cdot E \cdot t) / (Ro - 0.4 \cdot t) \text{ per Appendix 1-1 (a) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 20.0) / (373.0 - 0.4 \cdot 20.0)$$

$$= 76 \text{ bars}$$

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

$$= (P \cdot (Ro - 0.4 \cdot t)) / (E \cdot t)$$

$$= (62.167 \cdot ((373.0 - 0.4 \cdot 20.0)) / (1.0 \cdot 20.0)$$

$$= 113.461 \text{ N./mm}^2$$

% Elongation per Table UG-79-1 ($50 \cdot t_{nom} / R_f \cdot (1 - R_f / Ro)$) 2.755 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 20.0, tr = 16.748, c = 0.0 mm., E* = 1.0
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.837$, Temp. Reduction = 9 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Note:

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

Cylindrical Shell From 60 To 70 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 84 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (62.103 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.103)$$

$$= 16.3397 + 0.0000 = 16.3397 \text{ mm.}$$

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

Less Operating Hydrostatic Head Pressure of 0.103 bars

$$= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 20.0) / (353.0 + 0.6 \cdot 20.0)$$

$$= 76 - 0 = 75 \text{ bars}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 20.0) / (353.0 + 0.6 \cdot 20.0)$$

$$= 76 \text{ bars}$$

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

$$= (P \cdot (R + 0.6 \cdot t)) / (E \cdot t)$$

$$= (62.103 \cdot (353.0 + 0.6 \cdot 20.0)) / (1.0 \cdot 20.0)$$

$$= 113.344 \text{ N./mm}^2$$

% Elongation per Table UG-79-1 (50 * tnom / Rf * (1 - Rf / Ro)) 2.755 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 20.0, tr = 16.578, c = 0.0 mm., E* = 1.0
Thickness Ratio = tr * (E*) / (tg - c) = 0.829, Temp. Reduction = 10 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Note:

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

Cylindrical Shell From 90 To 100 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

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

$$= (62.0 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0)$$

$$= 16.3119 + 3.0000 = 19.3119 \text{ mm.}$$

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

$$= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0)$$

$$= 65 \text{ bars}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 \cdot 1.0 \cdot 20.0) / (350.0 + 0.6 \cdot 20.0)$$

$$= 76 \text{ bars}$$

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

$$= (P \cdot (R + 0.6 \cdot t)) / (E \cdot t)$$

 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 CONTACTOR (C-100)							شماره صفحه : 85 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

$$= (62.0 * (353.0 + 0.6 * 17.0)) / (1.0 * 17.0)$$

$$= 132.469 \text{ N./mm}^2$$

% Elongation per Table UG-79-1 (50*tnom/Rf*(1-Rf/Ro)) 2.778 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 20.0, tr = 16.55, c = 3.0 mm., E* = 1.0
Thickness Ratio = tr * (E*)/(tg - c) = 0.974, Temp. Reduction = 1 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -41 °C

Note:

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

Cylindrical Shell From 100 To 110 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

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

$$= (62.0 * 353.0) / (137.9 * 1.0 - 0.6 * 62.0)$$

$$= 16.3119 + 3.0000 = 19.3119 \text{ mm.}$$

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

$$= (S * E * t) / (R + 0.6 * t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 * 1.0 * 17.0) / (353.0 + 0.6 * 17.0)$$

$$= 65 \text{ bars}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$= (S * E * t) / (R + 0.6 * t) \text{ per UG-27 (c) (1)}$$

$$= (137.9 * 1.0 * 20.0) / (350.0 + 0.6 * 20.0)$$

$$= 76 \text{ bars}$$

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

$$= (P * (R + 0.6 * t)) / (E * t)$$

$$= (62.0 * (353.0 + 0.6 * 17.0)) / (1.0 * 17.0)$$

$$= 132.469 \text{ N./mm}^2$$

% Elongation per Table UG-79-1 (50*tnom/Rf*(1-Rf/Ro)) 2.778 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 20.0, tr = 16.55, c = 3.0 mm., E* = 1.0
Thickness Ratio = tr * (E*)/(tg - c) = 0.974, Temp. Reduction = 1 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -41 °C

Note:

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

 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 CONTACTOR (C-100)							شماره صفحه : 86 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Cylindrical Shell From 110 To 120 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P \cdot R) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 + 3.0000 = 19.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0) \\
 &= 65 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 20.0) / (350.0 + 0.6 \cdot 20.0) \\
 &= 76 \text{ bars}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot (R + 0.6 \cdot t)) / (E \cdot t) \\
 &= (62.0 \cdot (353.0 + 0.6 \cdot 17.0)) / (1.0 \cdot 17.0) \\
 &= 132.469 \text{ N./mm}^2
 \end{aligned}$$

% Elongation per Table UG-79-1 (50*tnom/Rf*(1-Rf/Ro)) 2.778 %

Minimum Design Metal Temperature Results:

Govrn. thk, tg = 20.0, tr = 16.55, c = 3.0 mm., E* = 1.0

Thickness Ratio = tr * (E*) / (tg - c) = 0.974, Temp. Reduction = 1 °C

Min Metal Temp. w/o impact per UCS-66, Curve D	-40 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-41 °C

Note:

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

Cylindrical Shell From 140 To 150 SA-516 70 , UCS-66 Crv. D at 148 °C

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P \cdot R) / (S \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 + 3.0000 = 19.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 17.0) / (353.0 + 0.6 \cdot 17.0) \\
 &= 65 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (S \cdot E \cdot t) / (R + 0.6 \cdot t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 \cdot 1.0 \cdot 20.0) / (350.0 + 0.6 \cdot 20.0) \\
 &= 76 \text{ bars}
 \end{aligned}$$

 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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 87 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

$$\begin{aligned}
 &= (P * (R + 0.6 * t)) / (E * t) \\
 &= (62.0 * (353.0 + 0.6 * 17.0)) / (1.0 * 17.0) \\
 &= 132.469 \text{ N./mm}^2
 \end{aligned}$$

% Elongation per Table UG-79-1 $(50 * t_{nom} / R_f * (1 - R_f / R_o))$ 2.778 %

Minimum Design Metal Temperature Results:

Govrn. thk, $t_g = 20.0$, $t_r = 16.55$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$

Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.974$, Temp. Reduction = $1 \text{ } ^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve D $-40 \text{ } ^\circ\text{C}$

Min Metal Temp. at Required thickness (UCS 66.1) $-41 \text{ } ^\circ\text{C}$

Note:

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

Elliptical Head From 150 To 160 SA-516 70 , UCS-66 Crv. D at $148 \text{ } ^\circ\text{C}$

Top Head

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P * D * K_{cor}) / (2 * S * E - 0.2 * P) \text{ Appendix 1-4 (c)} \\
 &= (62.0 * 706.0 * 0.989) / (2 * 137.9 * 1.0 - 0.2 * 62.0) \\
 &= 15.7651 + 3.0000 = 18.7651 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (2 * S * E * t) / (K_{cor} * D + 0.2 * t) \text{ per Appendix 1-4 (c)} \\
 &= (2 * 137.9 * 1.0 * 17.0) / (0.989 * 706.0 + 0.2 * 17.0) \\
 &= 67 \text{ bars}
 \end{aligned}$$

Maximum Allowable Pressure, New and Cold [MAPNC]:

$$\begin{aligned}
 &= (2 * S * E * t) / (K * D + 0.2 * t) \text{ per Appendix 1-4 (c)} \\
 &= (2 * 137.9 * 1.0 * 20.0) / (1.0 * 700.0 + 0.2 * 20.0) \\
 &= 78 \text{ bars}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P * (K_{cor} * D + 0.2 * t)) / (2 * E * t) \\
 &= (62.0 * (0.989 * 706.0 + 0.2 * 17.0)) / (2 * 1.0 * 17.0) \\
 &= 127.928 \text{ N./mm}^2
 \end{aligned}$$

Straight Flange Required Thickness:

$$\begin{aligned}
 &= (P * R) / (S * E - 0.6 * P) + c \text{ per UG-27 (c) (1)} \\
 &= (62.0 * 353.0) / (137.9 * 1.0 - 0.6 * 62.0) + 3.0 \\
 &= 19.312 \text{ mm.}
 \end{aligned}$$

Straight Flange Maximum Allowable Working Pressure:

$$\begin{aligned}
 &= (S * E * t) / (R + 0.6 * t) \text{ per UG-27 (c) (1)} \\
 &= (137.9 * 1.0 * 22.0) / (353.0 + 0.6 * 22.0) \\
 &= 83 \text{ bars}
 \end{aligned}$$

 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)																									
شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادرکننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 88 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

Factor K, corroded condition [Kcor]:

$$= (2 + (\text{Inside Diameter} / (2 * \text{Inside Head Depth}))^2) / 6$$

$$= (2 + (706.0 / (2 * 178.0))^2) / 6$$

$$= 0.988811$$

Percent Elong. per UCS-79, VIII-1-01-57 $(75 * t_{nom} / R_f) * (1 - R_f / R_o)$ 14.259 %

Note: Please Check Requirements of UCS-79 as Elongation is > 5%.

MDMT Calculations in the Knuckle Portion:

Govrn. thk, tg = 20.0, tr = 15.99, c = 3.0 mm., E* = 1.0

Thickness Ratio = $tr * (E^*) / (tg - c) = 0.941$, Temp. Reduction = 3 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C

Min Metal Temp. at Required thickness (UCS 66.1) -43 °C

MDMT Calculations in the Head Straight Flange:

Govrn. thk, tg = 25.0, tr = 16.55, c = 3.0 mm., E* = 1.0

Thickness Ratio = $tr * (E^*) / (tg - c) = 0.752$, Temp. Reduction = 14 °C

Min Metal Temp. w/o impact per UCS-66, Curve D -35 °C

Min Metal Temp. at Required thickness (UCS 66.1) -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 -20F (-29C) by paragraph UG-20F

Hydrostatic Test Pressure Results:

Pressure per UG99b	= 1.30 * M.A.W.P. * Sa/S	81.743 bars
Pressure per UG99b[36]	= 1.30 * Design Pres * Sa/S	80.600 bars
Pressure per UG99c	= 1.30 * M.A.P. - Head(Hyd)	82.307 bars
Pressure per UG100	= 1.10 * M.A.W.P. * Sa/S	69.167 bars
Pressure per PED	= max(1.43*DP, 1.25*DP*ratio)	88.660 bars
Pressure per App 27-4	= M.A.W.P.	62.879 bars

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

$$= \text{Test Factor} * \text{Design Pressure} * \text{Stress Ratio}$$

$$= 1.3 * 62.0 * 1.0$$

$$= 80.600 \text{ bars}$$

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.

 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 CONTACTOR (C-100)	شماره صفحه : 89 از 383																
	<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>0001</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01
	پروژه		بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0001	V01											

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

From To	Stress	Allowable	Ratio	Pressure
Bottom Head	145.0	235.8	0.615	81.67
30 40	149.0	235.8	0.632	81.65
60 70	148.6	235.8	0.630	81.42
90 100	173.5	235.8	0.736	81.19
100 110	173.2	235.8	0.734	81.04
110 120	172.8	235.8	0.733	80.90
140 150	172.4	235.8	0.731	80.71
Top Head	166.4	235.8	0.705	80.62

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

Description	Pad/Nozzle	Ambient	Operating	Ratio
N07 (1.5in)	Nozzle	117.90	117.90	1.000
K07A (3in)	Nozzle	137.90	137.90	1.000
K09A (2in)	Nozzle	117.90	117.90	1.000
N01 (6in)	Nozzle	137.90	137.90	1.000
N09 (1in)	Nozzle	137.90	137.90	1.000
K07B (3in)	Nozzle	137.90	137.90	1.000
K08B (2in)	Nozzle	137.90	137.90	1.000
K08A (2in)	Nozzle	137.90	137.90	1.000
K09B (2in)	Nozzle	137.90	137.90	1.000
N10A (8in)	Nozzle	137.90	137.90	1.000
N05 (2in)	Nozzle	137.90	137.90	1.000
N04 (1in)	Nozzle	137.90	137.90	1.000
N10B (8in)	Nozzle	137.90	137.90	1.000
K2B (2in)	Nozzle	137.90	137.90	1.000
K2A (2in)	Nozzle	137.90	137.90	1.000
K3A (2in)	Nozzle	137.90	137.90	1.000
K3B (2in)	Nozzle	137.90	137.90	1.000
K4B (3in)	Nozzle	137.90	137.90	1.000
K4A (3in)	Nozzle	137.90	137.90	1.000
K05 (2in)	Nozzle	137.90	137.90	1.000
K10A (2in)	Nozzle	137.90	137.90	1.000
K10B (2in)	Nozzle	137.90	137.90	1.000
K1 (2in)	Nozzle	137.90	137.90	1.000
N06 (2in)	Nozzle	137.90	137.90	1.000
K6A (2in)	Nozzle	137.90	137.90	1.000
K6B (2in)	Nozzle	137.90	137.90	1.000
N03 (2in)	Nozzle	137.90	137.90	1.000
N10C (8in)	Nozzle	137.90	137.90	1.000
N02 (6in)	Nozzle	137.90	137.90	1.000
N08 (1.5in)	Nozzle	137.90	137.90	1.000
Minimum				1.000

 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 CONTACTOR (C-100)							شماره صفحه : 90 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

Description	Ambient	Operating	Ratio
Bottom Head	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
	137.90	137.90	1.000
Top Head	137.90	137.90	1.000
Minimum			1.000

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 91 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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

Description	Ambient	Operating	Ratio
N07 (1.5in)	18.90	217.19	0.087
K07A (3in)	72.36	223.40	0.324
K09A (2in)	22.16	217.19	0.102
N01 (6in)	106.96	223.40	0.479
N09 (1in)	12.15	223.40	0.054
K07B (3in)	20.12	223.40	0.090
K08B (2in)	17.38	223.40	0.078
K08A (2in)	17.38	223.40	0.078
K09B (2in)	17.39	223.40	0.078
N10A (8in)	121.48	223.40	0.544
N05 (2in)	17.27	223.40	0.077
N04 (1in)	12.12	223.40	0.054
N10B (8in)	121.16	223.40	0.542
K2B (2in)	17.32	223.40	0.078
K2A (2in)	17.32	223.40	0.078
K3A (2in)	17.34	223.40	0.078
K3B (2in)	17.33	223.40	0.078
K4B (3in)	20.05	223.40	0.090
K4A (3in)	20.09	223.40	0.090
K05 (2in)	21.84	223.40	0.098
K10A (2in)	21.82	223.40	0.098
K10B (2in)	21.71	223.40	0.097
K1 (2in)	21.69	223.40	0.097
N06 (2in)	21.69	223.40	0.097
K6A (2in)	21.69	223.40	0.097
K6B (2in)	21.68	223.40	0.097
N03 (2in)	16.05	223.40	0.072
N10C (8in)	105.72	223.40	0.473
N02 (6in)	99.54	223.40	0.446
N08 (1.5in)	18.51	223.40	0.083

Elements Suitable for Test Pressure.

PV Elite is a trademark of Intergraph CADWorx & Analysis Solutions, Inc. 2020

 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 CONTACTOR (C-100) <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>0001</td><td>V01</td></tr></table>	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 92 از 383
پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه											
BK	GCS	MF	120	ME	CN	0001	V01											

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	1500	...	...	No Calc	No Calc
20	30	No Calc	746	20	0.0037236	115.451
30	40	2108.83	746	20	0.0019348	103.004
40	50	No Calc	...	110	No Calc	No Calc
50	60	No Calc	...	110	No Calc	No Calc
60	70	2000	746	20	0.0020523	104.333
70	80	No Calc	...	110	No Calc	No Calc
80	90	No Calc	...	112	No Calc	No Calc
90	100	4600	740	17	0.00069324	69.308
100	110	4600	740	17	0.00069324	69.308
110	120	4600	740	17	0.00069324	69.308
120	130	No Calc	...	112	No Calc	No Calc
130	140	No Calc	...	112	No Calc	No Calc
140	150	971.333	740	17	0.0035578	114.75
150	160	No Calc	740	17	0.0031907	112.973

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	...	No Calc	...	No Calc
20	30	20	1.93136	1.034	34.3891
30	40	20	3.6997	1.034	36.818
40	50	110	65.786	1.034	No Calc
50	60	110	65.786	1.034	No Calc
60	70	20	3.61282	1.034	37.2929
70	80	110	65.786	1.034	No Calc
80	90	115	74.8538	1.034	No Calc
90	100	20	8.15391	1.034	21.2282
100	110	20	8.15391	1.034	21.2282
110	120	20	8.15391	1.034	21.2282
120	130	115	74.8538	1.034	No Calc
130	140	115	74.8538	1.034	No Calc
140	150	20	5.65651	1.034	35.1466
150	160	20	4.91581	1.034	28.8354

Minimum

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 93 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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	1500	No Calc	No Calc	No Calc
20	30	No Calc	No Calc	No Calc	No Calc
30	40	2108.83	65704.5	No Calc	No Calc
40	50	No Calc	No Calc	No Calc	No Calc
50	60	No Calc	No Calc	No Calc	No Calc
60	70	2000	62721.3	No Calc	No Calc
70	80	No Calc	No Calc	No Calc	No Calc
80	90	No Calc	No Calc	No Calc	No Calc
90	100	4600	365050	No Calc	No Calc
100	110	4600	365050	No Calc	No Calc
110	120	4600	365050	No Calc	No Calc
120	130	No Calc	No Calc	No Calc	No Calc
130	140	No Calc	No Calc	No Calc	No Calc
140	150	971.333	24657.5	No Calc	No Calc
150	160	No Calc	No Calc	No Calc	No Calc

Elements Suitable for External Pressure.

ASME Code, Section VIII Division 1, 2019

Elliptical Head From 20 to 30 Ext. Chart: CS-2 at 100 °C

Bottom Head

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
20.000	746.00	37.30	0.0037236	115.45

$$MAEP = B / (K0 * Do / t) = 115.4508 / (0.9 * 37.3) = 34.3891 \text{ bars}$$

Results for Required Thickness				Tca
Tca	Outer Dia	Do/t	Factor A	Factor B
1.931	746.00	386.26	0.0003596	35.95

$$MAEP = B / (K0 * Do / t) = 35.9496 / (0.9 * 386.2569) = 1.0341 \text{ bars}$$

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

Material UNS Number: K02700



$$\text{MAEP} = (4 \cdot B) / (3 \cdot (D_o / t)) = (4 \cdot 78.6059) / (3 \cdot 37.3) = 28.097 \text{ bars}$$

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 95 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

Cylindrical Shell From 60 to 70 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	
20.000	746.00	2000.00	37.30	2.6810	0.0020523	104.33	

$$MAEP = (4*B)/(3*(Do/t)) = (4*104.3331)/(3*37.3) = 37.2929 \text{ bars}$$

Results for Required Thickness							Tca
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
3.613	746.00	2000.00	206.49	2.6810	0.0001602	16.01	

$$MAEP = (4*B)/(3*(Do/t)) = (4*16.0147)/(3*206.487) = 1.034 \text{ bars}$$

Results for Maximum Stiffened Length							Slen
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
20.000	746.00	62721.31	37.30	50.0000	0.0008112	78.61	

$$MAEP = (4*B)/(3*(Do/t)) = (4*78.6059)/(3*37.3) = 28.097 \text{ bars}$$

Cylindrical Shell From 90 to 100 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	
17.000	740.00	4600.00	43.53	6.2162	0.0006932	69.31	

$$MAEP = (4*B)/(3*(Do/t)) = (4*69.308)/(3*43.5294) = 21.2282 \text{ bars}$$

Results for Required Thickness							Tca
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
5.154	740.00	4600.00	143.58	6.2162	0.0001114	11.14	

$$MAEP = (4*B)/(3*(Do/t)) = (4*11.136)/(3*143.5802) = 1.0341 \text{ bars}$$

Results for Maximum Stiffened Length							Slen
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

17.000 | 740.00 | 365050.28 | 43.53 | 50.0000 | 0.0005906 | 59.05 |

$$MAEP = (4*B) / (3*(Do/t)) = (4*59.05) / (3*43.5294) = 18.0863 \text{ bars}$$

Cylindrical Shell From 100 to 110 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
17.000	740.00	4600.00	43.53	6.2162	0.0006932	69.31

$$MAEP = (4*B) / (3*(Do/t)) = (4*69.308) / (3*43.5294) = 21.2282 \text{ bars}$$

Results for Required Thickness	Tca

Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B
5.154	740.00	4600.00	143.58	6.2162	0.0001114	11.14

$$MAEP = (4*B) / (3*(Do/t)) = (4*11.136) / (3*143.5802) = 1.0341 \text{ bars}$$

Results for Maximum Stiffened Length	Slen

Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B
17.000	740.00	365050.28	43.53	50.0000	0.0005906	59.05

$$MAEP = (4*B) / (3*(Do/t)) = (4*59.05) / (3*43.5294) = 18.0863 \text{ bars}$$

Cylindrical Shell From 110 to 120 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
17.000	740.00	4600.00	43.53	6.2162	0.0006932	69.31

$$MAEP = (4*B) / (3*(Do/t)) = (4*69.308) / (3*43.5294) = 21.2282 \text{ bars}$$

Results for Required Thickness	Tca

Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B
5.154	740.00	4600.00	143.58	6.2162	0.0001114	11.14

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 97 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

$$MAEP = (4*B)/(3*(Do/t)) = (4*11.136)/(3*143.5802) = 1.0341 \text{ bars}$$

Results for Maximum Stiffened Length							Slen
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
17.000	740.00	365050.28	43.53	50.0000	0.0005906	59.05	

$$MAEP = (4*B)/(3*(Do/t)) = (4*59.05)/(3*43.5294) = 18.0863 \text{ bars}$$

Cylindrical Shell From 140 to 150 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	
17.000	740.00	971.33	43.53	1.3126	0.0035578	114.75	

$$MAEP = (4*B)/(3*(Do/t)) = (4*114.7499)/(3*43.5294) = 35.1466 \text{ bars}$$

Results for Required Thickness							Tca
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
2.657	740.00	971.33	278.56	1.3126	0.0002161	21.61	

$$MAEP = (4*B)/(3*(Do/t)) = (4*21.6051)/(3*278.5605) = 1.0341 \text{ bars}$$

Results for Maximum Stiffened Length							Slen
Tca	Outer Dia	Slen	Do/t	L/D	Factor A	Factor B	
17.000	740.00	24657.50	43.53	33.3209	0.0005914	59.13	

$$MAEP = (4*B)/(3*(Do/t)) = (4*59.1305)/(3*43.5294) = 18.111 \text{ bars}$$

Elliptical Head From 150 to 160 Ext. Chart: CS-2 at 100 °C

Top Head

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	
17.000	740.00	43.53	0.0031907	112.97	

 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 CONTACTOR (C-100)							شماره صفحه : 98 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

$$MAEP = B / (K0 * Do / t) = 112.9734 / (0.9 * 43.5294) = 28.8354 \text{ bars}$$

Results for Required Thickness					Tca	
Tca	Outer Dia	Do/t	Factor A	Factor B		
1.916	740.00	386.26	0.0003596	35.95		

$$MAEP = B / (K0 * Do / t) = 35.9494 / (0.9 * 386.2588) = 1.0341 \text{ bars}$$

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

Material UNS Number: K02700

Required Thickness due to Internal Pressure [tr]:

$$\begin{aligned}
 &= (P * D * K_{cor}) / (2 * S * E - 0.2 * P) \text{ Appendix 1-4 (c)} \\
 &= (1.727 * 706.0 * 0.989) / (2 * 137.9 * 1.0 - 0.2 * 1.727) \\
 &= 0.4372 + 3.0000 = 3.4372 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= ((2 * S * E * t) / (K_{cor} * D + 0.2 * t)) / 1.67 \text{ per Appendix 1-4 (c)} \\
 &= ((2 * 137.9 * 1.0 * 17.0) / (0.989 * 706.0 + 0.2 * 17.0)) / 1.67 \\
 &= 40 \text{ bars}
 \end{aligned}$$

Maximum Allowable External Pressure [MAEP]:

$$\begin{aligned}
 &= \min(MAEP, MAWP) \\
 &= \min(28.84, 40.0196) \\
 &= 28.835 \text{ bars}
 \end{aligned}$$

Thickness requirements per UG-33(a)(1) do not govern the required thickness of this head.

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 99 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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 %
10	20	1264.54	...	1264.54	...	63.2269
20	30	146.17	65648.4	146.17	65648.4	7.3085
30	40	707.093	783082	707.093	783082	35.3546
40	50	350.879	66561.9	350.879	66561.9	17.5439
50	60	350.879	66561.9	350.879	66561.9	17.5439
60	70	707.093	783082	707.093	783082	35.3546
70	80	350.879	66561.9	350.879	66561.9	17.5439
80	90	372.313	68122	363.327	68519.7	18.6157
90	100	525.937	577371	448.909	587311	26.2968
100	110	525.937	577371	448.909	587311	26.2968
110	120	560.999	615862	478.836	626465	28.05
120	130	372.313	68122	363.327	68519.7	18.6157
130	140	372.313	68122	363.327	68519.7	18.6157
140	150	302.589	332181	258.272	337900	15.1295
150	160	143.961	64152.3	126.686	65648.4	7.19807
Total		7053	4202801.00	6729	4241693.00	352

Weight of Details:

From	Type	Weight of Detail kg.	X Offset, Dtl. Cent. mm.	Y Offset, Dtl. Cent. mm.	Description
10	Ins1	463.005	...	750	FIREPROOF
20	Liqd	68.5864	...	-87.5	Liquid: 20
20	Ins1	6.46199	...	-62.5	Ins: 30
20	Lini	16.9035	...	-56.25	CLAD
20	Noz1	10.2662	...	-326.5	N07 (1.5in)
20	Noz1	23.447	...	-295.438	K07A (3in)
20	Noz1	15.1496	...	-646.331	K09A (2in)
20	Wght	50	...	-162.5	VORTEX BREAKER
30	Liqd	250.042	...	325	Liquid: 30
30	Ins1	31.2597	...	1000	Ins: 30
30	Lini	106.37	...	1000	CLAD
30	Noz1	81.2937	430.914	1350	N01 (6in)
30	Noz1	9.93279	365.7	150	N09 (1in)
30	Noz1	19.8152	391.1	1050	K07B (3in)
30	Noz1	10.9749	378.4	778	K08B (2in)
30	Noz1	10.9749	378.4	422	K08A (2in)
30	Noz1	10.9749	378.4	250	K09B (2in)
30	Noz1	150.448	455.381	1600	N10A (8in)
30	Noz1	11.0455	378.4	150	N05 (2in)
30	Wght	100	...	1800	DEMISTER PAD 1
30	Wght	100	...	1350	N01 INLET
40	Ins1	3.23054	...	87.5	Ins: 40
50	Ins1	3.23054	...	85	Ins: 50
60	Liqd	403.913	...	525	Liquid: 40

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 100 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

60 Insl	31.2597	...	1000	Ins: 30
60 Lini	106.37	...	1000	CLAD
60 Nozl	5.59574	365.7	100	N04 (1in)
60 Nozl	150.448	455.381	1493.7	N10B (8in)
60 Nozl	10.9749	378.4	1381.65	K2B (2in)
60 Nozl	10.9749	378.4	1025.65	K2A (2in)
60 Nozl	10.9749	378.4	303.65	K3A (2in)
60 Nozl	10.9749	378.4	659.65	K3B (2in)
60 Nozl	19.8152	391.1	1853.65	K4B (3in)
60 Nozl	19.8152	391.1	303.65	K4A (3in)
60 Nozl	10.9749	378.4	1700	K05 (2in)
60 Wght	250	...	193	CHIMNEY
70 Insl	3.23054	...	85	Ins: 70
80 Insl	3.29633	...	87.5	Ins: 80
90 Pack	171.068	...	865	Pack: [1 of 1]
90 Insl	23.2681	...	750	Ins: 30
90 Nozl	10.9749	375.4	120	K10A (2in)
90 Wght	100	...	230	SUPPORT GRID
90 Wght	1254	...	...	ATTACHMENTS
100 Pack	202.049	...	750	Pack: [1 of 1]
100 Insl	23.2681	...	750	Ins: 30
110 Plat	2245.02	0.14697E-04	800	PLAT:[1 OF 1]
110 Pack	185.885	...	690	Pack: [1 of 1]
110 Insl	24.8193	...	800	Ins: 30
110 Nozl	10.9749	375.4	1493	K10B (2in)
110 Wght	50	...	1380	BED LIMITER
120 Insl	3.29633	...	87.5	Ins: 120
130 Insl	3.29633	...	87.5	Ins: 130
140 Insl	13.3869	...	431.5	Ins: 140
140 Nozl	10.9749	375.4	207	K1 (2in)
140 Nozl	10.9749	375.4	207	N06 (2in)
140 Nozl	10.9749	375.4	250	K6A (2in)
140 Nozl	10.9749	375.4	550	K6B (2in)
140 Nozl	5.21564	362.7	110	N03 (2in)
140 Nozl	152.572	448.425	250	N10C (8in)
140 Wght	100	...	400	DEMISTER PAD 2
150 Insl	6.36902	...	112.5	Ins: 30
150 Nozl	58.8148	...	325	N02 (6in)
150 Nozl	12.0839	...	255	N08 (1.5in)
150 Wght	1000	970	...	PIPING

90 Pliq	146.56	...	865.000	
100 Pliq	173.11	...	750.000	
110 Pliq	159.26	...	690.000	

Total Weight of Each Detail Type:

Platforms	2245.0
Packing	559.0
Packing Liquid	478.9
Liquid	722.5
Insulation	642.7
Lining	229.6
Nozzles	899.4
Weights	3004.0

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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Sum of the Detail Weights 8781.2 kg.

Weight Summation Results: (kg.)

	Fabricated	Shop Test	Shipping	Erected	Empty	Operating
Main Elements	7406.6	7406.6	7406.6	7406.6	7406.6	7406.6
Nozzles	899.4	899.4	899.4	899.4	899.4	899.4
Wld Weights	50.0	50.0	50.0	50.0	50.0	50.0
Platforms	...	...	...	...	2245.0	2245.0 *
Packing	...	...	...	...	559.0	559.0 *
Insulation	...	...	...	...	642.7	642.7 *
Lining	...	...	...	229.6	229.6	229.6
Empty Weights	...	...	...	700.0	700.0	...
Ope Weights	...	...	...	...	...	2854.0
Ope. Liquid	...	...	...	...	...	722.5
Packing Liq	...	...	...	...	...	478.9
Test Liquid	...	4200.2	...	...	...	...
Totals	8356.0	12556.2	8585.6	9285.6	12732.3	16087.8

Field Installation Options:

- * Platforms installed after lifting.
- * Packing installed after lifting.
- * Insulation installed after lifting.

Miscellaneous Weight Percent: 5.0 %

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	8356.0 kg.
Shop Test Wt.	- Fabricated Weight + Water (Full)	12556.2 kg.
Shipping Wt.	- Fab. Weight + removable Intls.+ Shipping App.	8585.6 kg.
Erected Wt.	- Fab. Wt + or - loose items (trays,platforms etc.)	9285.6 kg.
Ope. Wt. no Liq	- Fab. Weight + Internals. + Details + Weights	12732.3 kg.
Operating Wt.	- Empty Weight + Operating Liq. Uncorroded	16087.8 kg.
Field Test Wt.	- Empty Weight + Water (Full)	15342.8 kg.
Mass of the Upper 1/3 of the Vertical Vessel		6423.1 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	34683.2
20	30	7382.89

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	BK	GCS	MF	120	ME	CN	0001		V01

30	40	46872.6
40	50	8666.9
50	60	8666.9
60	70	46872.6
70	80	8666.9
80	90	8877.36
90	100	34871.7
100	110	34871.7
110	120	37196.5
120	130	8877.36
130	140	8877.36
140	150	20062.8
150	160	7275.52

Total 322722.125 cm²

Element and Detail Weights:

From	To	Total Ele. Empty Wgt.	Total. Ele. Oper. Wgt.	Total. Ele. Hydro. Wgt.	Total Dtl. Offset Mom.	Oper. Wgt. No Liquid
		kg.	kg.	kg.	N-m	kg.
10	20	1327.76	1790.77	1790.77	...	1790.77
20	30	269.245	344.293	341.315	...	275.707
30	40	1354.28	1635.58	1968.14	1290.62	1385.54
40	50	368.423	371.653	438.174	...	371.653
50	60	368.423	371.653	438.174	...	371.653
60	70	1349.37	1784.54	1913.23	1047.92	1380.63
70	80	368.423	371.653	438.174	...	371.653
80	90	390.929	394.225	453.267	...	394.225
90	100	663.208	2258.11	1092.55	40.4169	2111.54
100	110	552.233	950.656	1081.58	...	777.551
110	120	650.024	3265	3409.67	40.4172	3105.74
120	130	390.929	394.225	453.267	...	394.225
130	140	390.929	394.225	453.267	...	394.225
140	150	619.406	532.793	823.954	851.397	532.793
150	160	222.058	1228.43	275.896	9515.67	1228.43

Cumulative Vessel Weight

From	To	Cumulative Ope Wgt. No Liquid	Cumulative Oper. Wgt.	Cumulative Hydro. Wgt.
		kg.	kg.	kg.
10	20	14886.3	16087.8	15371.4
20	30	13095.6	14297	13580.7
30	40	12819.9	13952.7	13239.3
40	50	11434.3	12317.2	11271.2
50	60	11062.7	11945.5	10833
60	70	10691	11573.9	10394.9
70	80	9310.39	9789.32	8481.62
80	90	8938.74	9417.66	8043.45
90	100	8544.51	9023.44	7590.18
100	110	6432.97	6765.33	6497.63

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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

110 120	5655.42	5814.67	5416.06
120 130	2549.67	2549.67	2006.38
130 140	2155.45	2155.45	1553.12
140 150	1761.22	1761.22	1099.85
150 160	1228.43	1228.43	275.896

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	12786.4	12786.4	12786.4
20	30	12786.4	12786.4	12786.4
30	40	12786.4	12786.4	12786.4
40	50	11495.8	11495.8	11495.8
50	60	11495.8	11495.8	11495.8
60	70	11495.8	11495.8	11495.8
70	80	10447.9	10447.9	10447.9
80	90	10447.9	10447.9	10447.9
90	100	10447.9	10447.9	10447.9
100	110	10407.5	10407.5	10407.5
110	120	10407.5	10407.5	10407.5
120	130	10367.1	10367.1	10367.1
130	140	10367.1	10367.1	10367.1
140	150	10367.1	10367.1	10367.1
150	160	9515.67	9515.67	9515.67

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 104 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Nozzle Flange MAWP Results: (bars & °C)

Nozzle Description	Flange Rating Ope.	Flange Rating Ambient	Design Temp	Class	Grade/Group	Equiv. Press	UG-44 (b)	Max Pressure 50%	DNV
N07 (1.5in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K07A (3in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K09A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N01 (6in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N09 (1in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K07B (3in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K08B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K08A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K09B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N10A (8in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N05 (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N04 (1in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N10B (8in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K2B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K2A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K3A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K3B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K4B (3in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K4A (3in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K05 (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K10A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K10B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K1 (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N06 (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K6A (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
K6B (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N03 (2in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N10C (8in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N02 (6in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
N08 (1.5in)	90.32	102.10	148	600	GR 1.1	...	...	...	...
Min Rating	90.320	102.100 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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	BK	GCS	MF	120	ME	CN	0001		V01

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 2.3677 Hz.

The Natural Frequency for the Vessel (Ope...) is 2.32003 Hz.

The Natural Frequency for the Vessel (Filled) is 2.52417 Hz.

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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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]:

$$\begin{aligned}
 &= \min(0.85, 0.925((1 + 1.7 * gQ * Izbar * Q) / (1 + 1.7 * gV * Izbar))) \\
 &= \min(0.85, 0.925((1 + 1.7 * 3.4 * 0.211 * 0.937) / (1 + 1.7 * 3.4 * 0.211))) \\
 &= \min(0.85, 0.893) \\
 &= 0.850
 \end{aligned}$$

Natural Frequency of Vessel (Operating)	2.320 Hz
Natural Frequency of Vessel (Empty)	2.368 Hz
Natural Frequency of Vessel (Test)	2.524 Hz

Force Coefficient	[Cf] 0.644
Structure Height to Diameter ratio	14.915
Height to top of Structure	12371.574 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]:

$$\begin{aligned}
 &= \text{Centroid Height} + \text{Vessel Base Elevation} \\
 &= 750.0 + 100.0 = 850.0 \text{ mm.} \\
 &= 2.789 \text{ ft. Imperial Units}
 \end{aligned}$$

Velocity Pressure coefficient evaluated at height z [Kz]:

Because z (2.789 ft.) < 15 ft.

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 2.01 * (15 / Z_g) ^ { 2 / \text{Alpha} }$$

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

$$= 0.849$$

Type of Hill: No Hill

Wind Directionality Factor [Kd]:

$$= 0.95, \text{ per Table 26.6-1}$$

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]:

$$= \max (16, 0.00256 * Kz * Kzt * Kd * V(\text{mph}) ^ 2)$$

$$= \max (16, 0.00256 * 0.849 * 1.0 * 0.95 * 144.162 ^ 2)$$

$$= 42.9 \text{ psf } [209.487] \text{ Kgs/m}^2$$

Force on the first element [F]:

$$= qz * G * Cf * \text{WindArea}$$

$$= 42.906 * 0.85 * 0.644 * 16.198$$

$$= 380.4 \text{ lbs. } [1.7] \text{ kN}$$

Element	Hgt (z) mm.	K1	K2	K3	Kz	Kzt	qz Kgs/m ²
Skirt	850.0	0.000	0.000	0.000	0.849	1.000	209.487
Bottom Head	1625.0	0.000	0.000	0.000	0.849	1.000	209.487
Node 30 to 40	2650.0	0.000	0.000	0.000	0.849	1.000	209.487
Node 40 to 50	3735.0	0.000	0.000	0.000	0.849	1.000	209.487
Node 50 to 60	3914.5	0.000	0.000	0.000	0.849	1.000	209.487
Node 60 to 70	4999.5	0.000	0.000	0.000	0.865	1.000	213.466
Node 70 to 80	6084.5	0.000	0.000	0.000	0.902	1.000	222.478
Node 80 to 90	6266.5	0.000	0.000	0.000	0.907	1.000	223.863
Node 90 to 100	7104.0	0.000	0.000	0.000	0.931	1.000	229.853
Node 100 to 110	8604.0	0.000	0.000	0.000	0.970	1.000	239.313
Node 110 to 120	10154.0	0.000	0.000	0.000	1.004	1.000	247.805
Node 120 to 130	11041.5	0.000	0.000	0.000	1.022	1.000	252.215
Node 130 to 140	11226.1	0.000	0.000	0.000	1.026	1.000	253.097
Node 140 to 150	11745.1	0.000	0.000	0.000	1.035	1.000	255.517
Top Head	12304.0	0.000	0.000	0.000	1.046	1.000	258.030

Note:

The height/(avg. diameter) ratio [14.5], was less than or equal to 15, therefore no wind vibration calculations have been performed.

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	BK	GCS	MF	120	ME	CN	0001		V01

Platform Load Calculations

ID	Wind Area cm ²	Elevation mm.	Pressure Kgs/m ²	Force kN	Cf
PLAT:[1 OF 1]	27720.00	10154.05	247.81	6.74	1.20

Wind Loads on Masses/Equipment/Piping

ID	Wind Area cm ²	Elevation mm.	Pressure Kgs/m ²	Force kN
VORTEX BREAKER	0.00	1437.50	209.49	0.00
DEMISTER PAD	0.00	3450.00	209.49	0.00
N01 INLET	0.00	3000.00	209.49	0.00
CHIMNEY	0.00	4192.53	210.51	0.00
SUPPORT GRID	0.00	6584.05	226.13	0.00
ATTACHMENTS	0.00	6354.05	224.49	0.00
BED LIMMITER	0.00	10734.05	250.69	0.00
DEMISTER PAD	0.00	11713.57	255.37	0.00
PIPING	0.00	12176.57	257.46	0.00

The Natural Frequency for the Vessel (Ope...) is 2.32003 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	850	1003.2	15048	209.487	1.01523
20	30	1625	1015.2	507.6	209.487	0.034246
30	40	2650	1015.2	20304	209.487	1.36984
40	50	3735	967.2	1644.24	209.487	0.11093
50	60	3914.53	967.2	1644.24	209.487	0.11093
60	70	4999.52	1015.2	20304	213.466	1.39586
70	80	6084.52	967.2	1644.24	222.478	0.11781
80	90	6266.55	960	1680	223.863	0.12112
90	100	7104.05	1008	15120	229.853	1.11927
100	110	8604.05	1008	15120	239.313	1.16533
110	120	10154	1008	16128	247.805	5.32868
120	130	11041.5	960	1680	252.215	0.13646
130	140	11226.1	960	1680	253.097	0.13694
140	150	11745.1	1008	8699.04	255.517	0.71585
150	160	12304	1008	2443.62	258.03	0.20306

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	BK	GCS	MF	120	ME	CN	0001	
								V01

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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	BK	GCS	MF	120	ME	CN	0001		V01

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		2.000
Site Class		D
Component Elevation Ratio	z/h	0.000
Amplification Factor	Ap	0.000
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]:

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

$$= 0.020 * (40.3595^{0.75})$$

$$= 0.320 \text{ seconds}$$

The Coefficient Cu from Table 12.8-1 is : 1.400

Fundamental Period (1/Frequency) [T]:

$$= (1/\text{Natural Frequency}) = (1/2.32)$$

$$= 0.431$$

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

$$= \text{Minimum Value of } (1.4 * 0.32, 0.431) \text{ per 12.8.2}$$

$$= 0.431$$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Compute the Seismic Response Coefficient per equation 12.8-2 [Cs]:

$$\begin{aligned}
 &= S_{ds} / (R / I) \\
 &= 1.02 / (2.0 / 1.25) \\
 &= 0.637
 \end{aligned}$$

Check the Maximum value of Cs per equation 12.8-3 [Cs]:

$$\begin{aligned}
 &= S_{d1} / (T * (R / I_e)) \\
 &= 0.385 / (0.431 * (2.0 / 1.25)) \\
 &= 0.558
 \end{aligned}$$

Check the Minimum value of Cs per equation 15.4-1 [Cs]:

$$\begin{aligned}
 &= \max((0.044 * S_{DS} * I_e), 0.030) \\
 &= \max((0.044 * 1.02 * 1.25), 0.030) \\
 &= 0.056
 \end{aligned}$$

Total Base Shear [V]:

$$\begin{aligned}
 &= C_s * W \text{ (Equation 12.8-1) :} \\
 &= 0.5583 * 157.8 \\
 &= 88.069 \text{ kN}
 \end{aligned}$$

Vertical load per 12.4-4, [YEq]:

$$\begin{aligned}
 &= 0.2 * S_{ds} * W \\
 &= 0.2 * 1.02 * 158 \\
 &= 32.2 \text{ kN}
 \end{aligned}$$

Final Base Shear, $V = 61.65 \text{ kN}$
Final Vertical Load, $YEq = 22.53 \text{ kN}$

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 2.32003 Hz.

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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	750	17.5603	0.76169	0.67929	22.5277
20	30	1525	3.37614	0.29777	0.28008	20.0201
30	40	2550	16.0385	2.36533	2.3557	19.538
40	50	3635	3.64443	0.76616	0.91353	17.2477
50	60	3814.53	3.64443	0.804	0.95865	16.7272
60	70	4899.53	17.4992	4.9586	4.50978	16.2068
70	80	5984.53	3.64443	1.26138	1.504	13.7079
80	90	6166.55	3.86577	1.37869	1.64442	13.1875
90	100	7004.05	22.143	8.9696	3.16862	12.6355
100	110	8504.05	9.32213	4.58489	3.20346	9.47347
110	120	10054	32.0166	18.6167	4.45802	8.14227
120	130	10941.5	3.86577	2.44626	2.91775	3.57029
130	140	11126.1	3.86577	2.48751	2.96696	3.01826
140	150	11645.1	5.22457	3.51868	4.92027	2.46623
150	160	12101.6	12.046	8.43084	1.83308	1.72016

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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	BK	GCS	MF	120	ME	CN	0001		V01

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	750	13.0816	61.6481	98619.3	540768
20	30	1525	12.0663	60.8865	79750.8	448829
30	40	2550	12.0321	60.5887	79148.1	445791
40	50	3635	10.6622	58.2234	56444.5	326931
50	60	3814.53	10.5513	57.4572	54540.1	316547
60	70	4899.53	10.4404	56.6532	52755.1	306843
70	80	5984.53	9.04452	51.6946	33262.3	198452
80	90	6166.55	8.92671	50.4332	31649	189287
90	100	7004.05	8.80559	49.0545	30096.8	180578
100	110	8504.05	7.68632	40.0849	17722.9	113696
110	120	10054	6.52099	35.5	7063.07	56984.6
120	130	10941.5	1.19232	16.8833	889.924	15061
130	140	11126.1	1.05585	14.437	683.068	12181.8
140	150	11645.1	0.91891	11.9495	510.206	9872.03
150	160	12101.6	0.20306	8.43084	25.8768	1074.35

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.

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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>0001</td><td>V01</td></tr></table>		پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01
	پروژه		بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه									
BK	GCS	MF	120	ME	CN	0001	V01											

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	13.0816	0.038888	0.15037	0.00019366
20	30	12.0663	0.15526	0.16022	0.00020042
30	40	12.0321	0.42467	0.80408	0.00043054
40	50	10.6622	0.84072	0.87744	0.00043256
50	60	10.5513	0.91425	0.95115	0.00043452
60	70	10.4404	1.42767	1.97694	0.0005802
70	80	9.04452	2.02628	2.07567	0.00058139
80	90	8.92671	2.12657	2.17752	0.00058253
90	100	8.80559	2.63035	3.11027	0.00065487
100	110	7.68632	3.61046	4.12458	0.00069214
110	120	6.52099	4.68187	5.24316	0.00070274
120	130	1.19232	5.30466	5.36615	0.00070277
130	140	1.05585	5.42764	5.48913	0.00070279
140	150	0.91891	5.79246	6.09587	0.00070317
150	160	0.20306	6.11345	6.13103	0.00070317

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Critical Wind Velocity for Tower Vibration:

From	To	1st Crit.	2nd Crit.
		Wind Speed Km/hr	Wind Speed Km/hr
10	20	41.7812	261.133
20	30	42.281	264.256
30	40	42.281	264.256
40	50	40.2819	251.762
50	60	40.2819	251.762
60	70	42.281	264.256
70	80	40.2819	251.762
80	90	39.9821	249.888
90	100	41.9812	262.382
100	110	41.9812	262.382
110	120	41.9812	262.382
120	130	39.9821	249.888
130	140	39.9821	249.888
140	150	41.9812	262.382
150	160	41.9812	262.382

Allowable deflection at the Tower Top (Ope) (6.000"/100ft. Criteria)
Allowable deflection : 60.633 Actual deflection : 6.131 mm.

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 116 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Longitudinal Stress Constants:

From	To	Metal Area		Section Modulus	
		New cm ²	Corroded cm ²	New mm. ³	Corroded mm. ³
10	20	558.418	558.418	9600579	9600579
20	30	456.159	456.159	8063436	8063436
30	40	456.159	456.159	8063436	8063436
40	50	456.159	456.159	8063436	8063436
50	60	456.159	456.159	8063436	8063436
60	70	456.159	456.159	8063436	8063436
70	80	456.159	456.159	8063436	8063436
80	90	452.389	386.133	7929036	6822780
90	100	452.389	386.133	7929036	6822780
100	110	452.389	386.133	7929036	6822780
110	120	452.389	386.133	7929036	6822780
120	130	452.389	386.133	7929036	6822780
130	140	452.389	386.133	7929036	6822780
140	150	452.389	386.133	7929036	6822780
150	160	452.389	386.133	7929036	6822780

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Longitudinal Allowable Stresses:

From	To	Tensile		Hydrotest Compressive	
		N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	75.845	129.695	-122.731	-147.277
20	30	137.9	235.8	-122.287	-146.745
30	40	137.9	235.8	-122.287	-146.745
40	50	137.9	223.4	-122.287	-146.745
50	60	137.9	223.4	-122.287	-146.745
60	70	137.9	235.8	-122.287	-146.745
70	80	137.9	223.4	-122.287	-146.745
80	90	137.9	223.4	-120.888	-145.066
90	100	137.9	235.8	-120.888	-145.066
100	110	137.9	235.8	-120.888	-145.066
110	120	137.9	235.8	-120.888	-145.066
120	130	137.9	223.4	-120.888	-145.066
130	140	137.9	223.4	-120.888	-145.066
140	150	137.9	235.8	-120.888	-145.066
150	160	137.9	235.8	-120.888	-145.066

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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:

From	To	Longitudinal Stress Internal Pressure N./mm ²	Longitudinal Stress External Pressure N./mm ²	Longitudinal Stress Hydrotest Pressure N./mm ²
10	20	...	...	...
20	30	53.4781	-0.99082	69.5215
30	40	53.4781	-0.99082	69.5215
40	50	...	...	...
50	60	...	...	...
60	70	53.4781	-0.99082	69.5215
70	80	...	...	...
80	90	...	...	...
90	100	63.1343	-1.15176	82.0745
100	110	63.1343	-1.15176	82.0745
110	120	63.1343	-1.15176	82.0745
120	130	...	...	...
130	140	...	...	...
140	150	63.1343	-1.15176	82.0745
150	160	63.1343	-1.15176	82.0745

Longitudinal Stresses due to Weight Loads for these Conditions:

From	To	Wght. Str. Empty N./mm ²	Wght. Str. Operating N./mm ²	Wght. Str. Hydrotest N./mm ²	Wght. Str. Emp. Mom. N./mm ²	Wght. Str. Opr. Mom. N./mm ²
10	20	-2.61431	-2.82531	-2.6995	1.33141	1.33141
20	30	-2.81538	-2.91834	-2.81538	1.58522	1.58522
30	40	-2.7561	-2.85907	-2.7561	1.58522	1.58522
40	50	-2.45823	-2.56119	-2.45823	1.42522	1.42522
50	60	-2.37833	-2.48129	-2.37833	1.42522	1.42522
60	70	-2.29843	-2.40139	-2.29843	1.42522	1.42522
70	80	-2.00161	-2.10458	-2.00161	1.2953	1.2953
80	90	-2.27022	-2.39186	-2.27022	1.53084	1.53084
90	100	-2.1701	-2.29173	-2.1701	1.53084	1.53084
100	110	-1.63382	-1.71823	-1.63382	1.52491	1.52491
110	120	-1.43634	-1.47678	-1.43634	1.52491	1.52491
120	130	-0.64755	-0.64755	-0.64755	1.51899	1.51899
130	140	-0.54743	-0.54743	-0.54743	1.51899	1.51899
140	150	-0.44731	-0.44731	-0.44731	1.51899	1.51899
150	160	-0.31199	-0.31199	-0.31199	1.39424	1.39424

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

From	To	Wght. Str. Hyd. Mom. N./mm ²	Bend. Str. Oper. Wind N./mm ²	Bend. Str. Oper. Equ. N./mm ²	Bend. Str. Hyd. Wind N./mm ²	Bend. Str. Hyd. Equ. N./mm ²
10	20	1.33141	10.2689	56.3085	3.38875	...
20	30	1.58522	9.88725	55.6445	3.26279	...
30	40	1.58522	9.81253	55.2678	3.23813	...
40	50	1.42522	6.99782	40.5319	2.30928	...
50	60	1.42522	6.76171	39.2445	2.23136	...
60	70	1.42522	6.54041	38.0415	2.15834	...
70	80	1.2953	4.12375	24.6034	1.36084	...
80	90	1.53084	4.63724	27.7345	1.53029	...
90	100	1.53084	4.40981	26.4585	1.45524	...
100	110	1.52491	2.59677	16.6589	0.85693	...
110	120	1.52491	1.03489	8.34944	0.34151	...
120	130	1.51899	0.13039	2.20675	0.043029	...
130	140	1.51899	0.10008	1.78489	0.033028	...
140	150	1.51899	0.074756	1.44646	0.024669	...
150	160	1.39424	0.0037915	0.15741	0.0012512	...

Longitudinal Stresses due to these Conditions:

From	To	Vortex Shedding Operating Case N./mm ²	Vortex Shedding Empty Case N./mm ²	Vortex Shedding Test Case N./mm ²	Earthquake Empty Case N./mm ²
10	20	...	...	...	30.6276
20	30	...	...	...	29.7736
30	40	...	...	...	29.5535
40	50	...	...	...	21.0759
50	60	...	...	...	20.3518
60	70	...	...	...	19.6854
70	80	...	...	...	12.5237
80	90	...	...	...	14.1215
90	100	...	...	...	13.4984
100	110	...	...	...	8.68678
110	120	...	...	...	4.57568
120	130	...	...	...	1.08893
130	140	...	...	...	0.7886
140	150	...	...	...	0.57731
150	160	...	...	...	0.034226

Longitudinal Stresses due to Applied Axial Forces:

From	To	Longitudinal Stress Y Forces Wind N./mm ²	Longitudinal Stress Y Forces Seismic N./mm ²
10	20	...	0.40345
20	30	...	0.43892
30	40	...	0.42835

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40	50	...	0.37814
50	60	...	0.36673
60	70	...	0.35532
70	80	...	0.30053
80	90	...	0.34156
90	100	...	0.32726
100	110	...	0.24536
110	120	...	0.21088
120	130	...	0.092471
130	140	...	0.078173
140	150	...	0.063875
150	160	...	0.044552

Longitudinal Stresses due to User Forces and Moments:

		Wind For/Mom	Earthquake For/Mom	Wind For/Mom	Earthquake For/Mom
From	To	Corroded	Corroded	No Corrosion	No Corrosion
		N./mm ²	N./mm ²	N./mm ²	N./mm ²
10	20	...	...	...	...
20	30	...	...	...	...
30	40	...	...	...	...
40	50	...	...	...	...
50	60	...	...	...	...
60	70	...	...	...	...
70	80	...	...	...	...
80	90	...	...	...	...
90	100	...	...	...	...
100	110	...	...	...	...
110	120	...	...	...	...
120	130	...	...	...	...
130	140	...	...	...	...
140	150	...	...	...	...
150	160	...	...	...	...

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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	8.99	75.85	-14.21	122.73	0.1185	0.1158
20	8.66	137.90	-14.29	122.29	0.0628	0.1168
30	8.64	137.90	-14.15	122.29	0.0627	0.1157
60	5.67	137.90	-10.26	122.29	0.0411	0.0839
90	3.77	137.90	-8.11	120.89	0.0273	0.0671
100	2.49	137.90	-5.76	120.89	0.0180	0.0476
110	1.12	137.90	-4.00	120.89	0.0081	0.0331
140	1.15	137.90	-2.04	120.89	0.0083	0.0169

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150 1.09 137.90 -1.71 120.89 0.0079 0.0141

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

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	29.75	75.85	-34.17	122.73	0.3922	0.2784
20	28.98	137.90	-33.74	122.29	0.2102	0.2759
30	28.81	137.90	-33.47	122.29	0.2089	0.2737
60	19.17	137.90	-23.05	122.29	0.1390	0.1885
90	13.19	137.90	-16.87	120.89	0.0956	0.1396
100	8.82	137.90	-11.60	120.89	0.0640	0.0960
110	4.88	137.90	-7.33	120.89	0.0354	0.0606
140	1.71	137.90	-2.48	120.89	0.0124	0.0205
150	1.16	137.90	-1.70	120.89	0.0084	0.0140

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	8.78	75.85	-14.43	122.73	0.1157	0.1175
20	8.55	137.90	-14.39	122.29	0.0620	0.1177
30	8.54	137.90	-14.26	122.29	0.0619	0.1166
60	5.56	137.90	-10.37	122.29	0.0403	0.0848
90	3.65	137.90	-8.23	120.89	0.0265	0.0681
100	2.40	137.90	-5.84	120.89	0.0174	0.0483
110	1.08	137.90	-4.04	120.89	0.0079	0.0334
140	1.15	137.90	-2.04	120.89	0.0083	0.0169
150	1.09	137.90	-1.71	120.89	0.0079	0.0141

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	55.22	75.85	-60.06	122.73	0.7280	0.4894
20	54.75	137.90	-59.71	122.29	0.3970	0.4883
30	54.42	137.90	-59.28	122.29	0.3947	0.4848
60	37.42	137.90	-41.51	122.29	0.2714	0.3395
90	26.02	137.90	-29.95	120.89	0.1887	0.2478
100	16.71	137.90	-19.66	120.89	0.1212	0.1626
110	8.61	137.90	-11.14	120.89	0.0624	0.0922
140	2.58	137.90	-3.35	120.89	0.0187	0.0277
150	1.28	137.90	-1.82	120.89	0.0093	0.0150

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	2.02	129.69	-7.42	147.28	0.0156	0.0504
20	2.03	235.80	-7.66	146.74	0.0086	0.0522
30	2.07	235.80	-7.58	146.74	0.0088	0.0517
60	1.29	235.80	-5.88	146.74	0.0055	0.0401
90	0.82	235.80	-5.16	145.07	0.0035	0.0355
100	0.75	235.80	-4.02	145.07	0.0032	0.0277

 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 08_0010_CO-GCS-BK-HD)								
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	BK	GCS	MF	120	ME	CN	0001		V01

110	0.43	235.80	-3.30	145.07	0.0018	0.0228
140	1.10	235.80	-1.99	145.07	0.0046	0.0137
150	1.08	235.80	-1.71	145.07	0.0046	0.0118

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		129.69	-4.03	147.28		0.0274
20		235.80	-4.40	146.74		0.0300
30		235.80	-4.34	146.74		0.0296
60		235.80	-3.72	146.74		0.0254
90		235.80	-3.70	145.07		0.0255
100		235.80	-3.16	145.07		0.0218
110	0.09	235.80	-2.96	145.07	0.0004	0.0204
140	1.07	235.80	-1.97	145.07	0.0045	0.0136
150	1.08	235.80	-1.71	145.07	0.0046	0.0118

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	8.78	75.85	-14.43	122.73	0.1157	0.1175
20	62.03	137.90		122.29	0.4498	
30	62.02	137.90		122.29	0.4497	
60	59.04	137.90		122.29	0.4282	
90	66.78	137.90		120.89	0.4843	
100	65.54	137.90		120.89	0.4753	
110	64.22	137.90		120.89	0.4657	
140	64.28	137.90		120.89	0.4661	
150	64.22	137.90		120.89	0.4657	

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	55.22	75.85	-60.06	122.73	0.7280	0.4894
20	108.23	137.90	-6.23	122.29	0.7848	0.0510
30	107.90	137.90	-5.81	122.29	0.7825	0.0475
60	90.90	137.90		122.29	0.6592	
90	89.16	137.90		120.89	0.6465	
100	79.85	137.90		120.89	0.5790	
110	71.74	137.90		120.89	0.5203	
140	65.72	137.90		120.89	0.4766	
150	64.42	137.90		120.89	0.4671	

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

From Node	Tensile Stress	All. Tens. Stress	Comp. Stress	All. Comp. Stress	Tens. Ratio	Comp. Ratio
10	8.78	75.85	-14.43	122.73	0.1157	0.1175
20	7.56	137.90	-15.38	122.29	0.0548	0.1258
30	7.55	137.90	-15.25	122.29	0.0547	0.1247
60	4.57	137.90	-11.36	122.29	0.0332	0.0929

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	BK	GCS	MF	120	ME	CN	0001		V01

90	2.50	137.90	-9.38	120.89	0.0181	0.0776
100	1.25	137.90	-6.99	120.89	0.0091	0.0578
110		137.90	-5.19	120.89		0.0429
140		137.90	-3.19	120.89		0.0264
150		137.90	-2.86	120.89		0.0237

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	55.22	75.85	-60.06	122.73	0.7280	0.4894
20	53.76	137.90	-60.70	122.29	0.3898	0.4964
30	53.43	137.90	-60.27	122.29	0.3875	0.4929
60	36.43	137.90	-42.50	122.29	0.2642	0.3476
90	24.87	137.90	-31.11	120.89	0.1804	0.2573
100	15.56	137.90	-20.81	120.89	0.1128	0.1721
110	7.46	137.90	-12.29	120.89	0.0541	0.1017
140	1.43	137.90	-4.50	120.89	0.0104	0.0372
150	0.13	137.90	-2.97	120.89	0.0010	0.0246

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	2.02	129.69	-7.42	147.28	0.0156	0.0504
20	71.55	235.80		146.74	0.3035	
30	71.59	235.80		146.74	0.3036	
60	70.81	235.80		146.74	0.3003	
90	82.89	235.80		145.07	0.3515	
100	82.82	235.80		145.07	0.3512	
110	82.50	235.80		145.07	0.3499	
140	83.17	235.80		145.07	0.3527	
150	83.16	235.80		145.07	0.3527	

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		129.69	-4.03	147.28		0.0274
20	68.29	235.80		146.74	0.2896	
30	68.35	235.80		146.74	0.2899	
60	68.65	235.80		146.74	0.2911	
90	81.44	235.80		145.07	0.3454	
100	81.97	235.80		145.07	0.3476	
110	82.16	235.80		145.07	0.3484	
140	83.15	235.80		145.07	0.3526	
150	83.16	235.80		145.07	0.3527	

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		75.85	-3.95	122.73		0.0321
20	52.25	137.90		122.29	0.3789	

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	BK	GCS	MF	120	ME	CN	0001		V01

30	52.31	137.90	122.29	0.3793
60	52.60	137.90	122.29	0.3815
90	62.49	137.90	120.89	0.4532
100	63.03	137.90	120.89	0.4570
110	63.22	137.90	120.89	0.4585
140	64.21	137.90	120.89	0.4656
150	64.22	137.90	120.89	0.4657

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		75.85	-2.83	122.73		0.0230
20	50.56	137.90		122.29	0.3666	
30	50.62	137.90		122.29	0.3671	
60	51.08	137.90		122.29	0.3704	
90	61.18	137.90		120.89	0.4436	
100	61.67	137.90		120.89	0.4472	
110	61.87	137.90		120.89	0.4487	
140	62.75	137.90		120.89	0.4551	
150	62.87	137.90		120.89	0.4559	

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		75.85	-4.16	122.73		0.0339
20	52.14	137.90		122.29	0.3781	
30	52.20	137.90		122.29	0.3786	
60	52.50	137.90		122.29	0.3807	
90	62.37	137.90		120.89	0.4523	
100	62.94	137.90		120.89	0.4564	
110	63.18	137.90		120.89	0.4582	
140	64.21	137.90		120.89	0.4656	
150	64.22	137.90		120.89	0.4657	

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		75.85	-3.95	122.73		0.0321
20	52.25	137.90		122.29	0.3789	
30	52.31	137.90		122.29	0.3793	
60	52.60	137.90		122.29	0.3815	
90	62.49	137.90		120.89	0.4532	
100	63.03	137.90		120.89	0.4570	
110	63.22	137.90		120.89	0.4585	
140	64.21	137.90		120.89	0.4656	
150	64.22	137.90		120.89	0.4657	

Analysis of Load Case 17 : NP+VO+OW

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	0001		V01

10		75.85	-4.16	122.73		0.0339
20		137.90	-4.50	122.29		0.0368
30		137.90	-4.44	122.29		0.0363
60		137.90	-3.83	122.29		0.0313
90		137.90	-3.82	120.89		0.0316
100		137.90	-3.24	120.89		0.0268
110	0.05	137.90	-3.00	120.89	0.0003	0.0248
140	1.07	137.90	-1.97	120.89	0.0078	0.0163
150	1.08	137.90	-1.71	120.89	0.0078	0.0141

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		75.85	-3.75	122.73		0.0306
20	52.58	137.90		122.29	0.3813	
30	52.63	137.90		122.29	0.3817	
60	52.86	137.90		122.29	0.3833	
90	62.70	137.90		120.89	0.4547	
100	63.19	137.90		120.89	0.4582	
110	63.39	137.90		120.89	0.4597	
140	64.27	137.90		120.89	0.4661	
150	64.26	137.90		120.89	0.4660	

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		75.85	-3.75	122.73		0.0306
20		137.90	-5.06	122.29		0.0413
30		137.90	-5.01	122.29		0.0409
60		137.90	-4.46	122.29		0.0365
90		137.90	-4.65	120.89		0.0384
100		137.90	-4.15	120.89		0.0343
110		137.90	-3.94	120.89		0.0326
140		137.90	-3.05	120.89		0.0253
150		137.90	-2.81	120.89		0.0233

Absolute Maximum of the all of the Stress Ratio's

0.7848

Governing Element: Bottom Head

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
Skirt	...	-2.4	1.3	56.3	55.2	+ Tens
Skirt	...	-2.4	-1.3	-56.3	-60.1	- Comp
Bottom Head	53.5	-2.5	1.6	55.6	108.2	+ Tens
Bottom Head	53.5	-2.5	-1.6	-55.6	-6.2	- Comp
Element # 3	53.5	-2.4	1.6	55.3	107.9	+ Tens
Element # 3	53.5	-2.4	-1.6	-55.3	-5.8	- Comp

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Element # 6	53.5	-2.0	1.4	38.0	90.9	+ Tens
Element # 6	53.5	-2.0	-1.4	-38.0	...	- Comp
Element # 9	63.1	-2.0	1.5	26.5	89.2	+ Tens
Element # 9	63.1	-2.0	-1.5	-26.5	...	- Comp
Element # 10	63.1	-1.5	1.5	16.7	79.8	+ Tens
Element # 10	63.1	-1.5	-1.5	-16.7	...	- Comp
Element # 11	63.1	-1.3	1.5	8.3	71.7	+ Tens
Element # 11	63.1	-1.3	-1.5	-8.3	...	- Comp
Element # 14	63.1	-0.4	1.5	1.4	65.7	+ Tens
Element # 14	63.1	-0.4	-1.5	-1.4	...	- Comp
Top Head	63.1	-0.3	1.4	0.2	64.4	+ Tens
Top Head	63.1	-0.3	-1.4	-0.2	...	- Comp

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	BK	GCS	MF	120	ME	CN	0001		V01

Skirt Support Analysis Per EN 13445-3: 2009(E) Issue 1 (2009-07):

Item: Skirt

Type B Skirt per EN-13445 Figure 16.12-2:

Design Pressure	P	62.000	bars
Total vessel (empty) weight	Fg	91.055	kN
Head Weight below section 2-2	DeltaFg	2.640	kN
Weight of vessel contents (liquid)	Ff	66.702	kN
Vessel Gross Weight	Fg + Ff = F4	157.757	kN
Skirt Mean Diameter	Dz	711.000	mm.
Skirt Analysis Thickness (Corroded)	ez	25.000	mm.
Skirt Height	H	1500.000	mm.
Force at section 1-1	F1	155.117	kN
Moment at section 1-1	M1	448829.406	N-m
Applied Moment - Bottom of Skirt	Mb	540767.688	N-m
Weight Above the Skirt	W	157.757	kN

Access No	Diameter mm.	Layout Angle Deg	Cntr. Dist. From Bottom mm.	Obround Cntr-Cntr mm.
1	202.0000	0.0000	800.0000	0.0000
2	202.0000	90.0000	800.0000	0.0000
3	255.0000	180.0000	800.0000	0.0000
4	400.0000	280.0000	800.0000	200.0000

Access Opening Frame Dimension

Access No	Width mm.	Thick mm.
1	150.0000	8.2000
2	150.0000	8.2000
3	150.0000	9.3000
4	150.0000	10.0000

Interference check:

Access	Access	Pitch mm.	Ligament mm.
1	2	558.4182	353.5970
2	3	558.4182	325.6026
3	4	620.4647	277.6440
1	4	1737.3009	1422.4745

INTERFERENCE CHECK: No Interference Detected between Openings

Minimum Pitch between openings is: 558.4182 mm.

Minimum Ligament between Openings is: 277.6440 mm.

Recommended minimum Ligament:

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 129 از 383	
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	BK	GCS	MF	120	ME	CN	0001		V01

$= 2 * \text{Sqrt}(D * t)$
 $= 2 * \text{Sqrt}(711.0 * 25.0) = 266.646 \text{ mm.}$
 Please evaluate the suitability of this result

Section properties at least metal area [A]:

Number of Openings At Critical Height = 4

Access No	Layout Angle 1 Deg.	Layout Angle 2 Deg.
1	-16.5055	16.5055
2	73.4945	106.5055
3	158.9827	201.0173
4	245.7650	314.2350

The points for integrating Ixx, Iyy is as follows:

FROM THETA1 Deg	TO THETA2 Deg
16.505	73.495
106.505	158.983
201.017	245.765
-45.765	-16.505

Height of Weakest Section	H	800.067	mm.
Rotation of Principle Axes	a	18.095	Deg.
Centroid Position in X direction	g	-2.056	mm.
Centroid Position in Y direction	h	42.785	mm.
Principle Moment of Inertia	Ixx	217626.703	cm**4
Principle Moment of Inertia	Iyy	270912.688	cm**4
Distance to Extreme Fiber	ybar	409.308	mm.
Distance to Extreme Fiber	xbar	379.334	mm.
Minimum Section Modulus	W4	5316947.000	mm.^3
Metal Area at the Cutting Plane	A4	391.697	cm ²

Half Opening Width Subtended Angle at Weakest Section: [Delta]:

$= \text{Asin}(\text{Largest}(\text{Opening Width}) / D_z)$
 $= \text{Asin}(400.0/711.0) = 0.5975 \text{ rad } (34.235 \text{ deg})$

Skirt Mean Radius at Section 4-4 [r]:

$= D_z/2 = 711.0/2 = 355.5 \text{ mm.}$

Opening Ratio At Weakest Section: EN 13445 Equation 16.12-76 [ratio]:

$= \text{Delta} * \text{Sqrt}(r/ez)$
 $= 0.598 * \text{Sqrt}(355.5/25.0) = 2.2532$
 WARNING: ratio Exceeds 2 - See EN 13445 16.12.76(a).

This equation is a precaution against radial buckling at the opening.

The frame (if there is one), may prevent this. The code does not say what size this frame should be. Your judgement is required.

Analysis of the Section at Weakest Section Modulus [Section 4-4]:

Skirt Corroded Thickness [ez]:

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شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 130 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

$$= ex(new) - ci - cext = 25.0 - 0.0 - 0.0 = 25.0 \text{ mm.}$$

Please note:

There is more than one opening in the skirt

EN-13445 and AD-2000 considers only one opening per Figure 16.12-4

this skirt has 4 openings. Please check results

Find the moment acting at the Critical Height [M4]:

$$\begin{aligned}
 &= (M_{bottom} - M_{top}) * (H - CutHeight) / H + M_{top} \\
 &= (540768 - 448829.438) * (18000.0 - 9600.799) / 18000.0 + 448829.438 \\
 &= 491729.812 \text{ N-m}
 \end{aligned}$$

Compute the section modulus [Zxx and Zyy]

$$Z_{xx} = I_{xx} / y_{bar} = 217626.703 / 409.308 = 5316947 \text{ mm.}^3$$

$$Z_{yy} = I_{yy} / x_{bar} = 270912.688 / 379.334 = 7141803 \text{ mm.}^3$$

$$Z = \text{Min}(Z_{xx}, Z_{yy}) = \text{Min}(5316947, 7141803) = 5316947 \text{ mm.}^3$$

The balance of the calculations are per EN-13445, and they may be treated as academic if the designated code is not EN-13445

Radius of Gyration of Skirt at 4-4 [rg]:

$$\begin{aligned}
 &(\text{rg is not included in the analysis of EN 13445}) \\
 &= \sqrt{\text{Min}(I_{xx}, I_{yy}) / \text{Area}(A4)} \\
 &= \sqrt{\text{Min}(217626.703, 270912.688) / 391.697} \\
 &= 235.712 \text{ mm.}
 \end{aligned}$$

Skirt Slenderness Ratio [r/L]:

$$= 235.712 / 1500.0 = 0.157$$

Location of the Skirt Centroid at critical height [e]:

$$\begin{aligned}
 &ex = -2.056 : ey = 42.785 \\
 &e = \sqrt{ex^2 + ey^2} = \sqrt{(-2.056)^2 + 42.785^2} \\
 &= 42.835 \text{ mm.}
 \end{aligned}$$

Moment Increment at Centroid [DeltaM4]:

$$\begin{aligned}
 &= (F_g + F_f) * e = F_4 * e \\
 &= (91.05 + 66.7) * 42.83471 = 6760.211 \text{ N-m}
 \end{aligned}$$

Nomenclature per EN-13445 (not AD-2000)

For the skirt at the opening/weakest part: Equations 16.12-70 & 71:

Actual Stresses:

$$\begin{aligned}
 Sm_{4p} &= (M_4 + \Delta M_4) / W_4 - F_4 / A_4 \\
 &= (491729.844 + 6760.211) / 7141803 - 157.757 / 391.697 \\
 &= 65.75 \text{ N./mm}^2 - \text{Equation 16.12-70}
 \end{aligned}$$

$$\begin{aligned}
 Sm_{4q} &= -(M_4 + \Delta M_4) / W_4 - F_4 / A_4 \\
 &= -(491729.844 + 6760.211) / 7141803 - 157.757 / 391.697 \\
 &= -73.8 \text{ N./mm}^2 - \text{Equation 16.12-71}
 \end{aligned}$$

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Allowable stresses at the opening/weakest part: Equations 16.12-72 & 73:

Max stress for Sm4p and Sm4q: Equations 16.12 72 & 73:

$$= f_z = 137.9 \text{ N./mm}^2$$

Skirt stress at the openings / critical section:

Sm4p	65.75	137.90	Pass	70
Sm4q	-73.80	137.90	Pass	71

The stresses are satisfactory in the region with the opening(s).

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Shop/Field Installation Options :

Platform(s) installed in the Field after being lifted.
Packing is installed in the Field after being lifted.
Insulation is installed in the Field after being lifted.
Lining is installed in the Shop.

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

Center of Gravity of the Platforms	10054.050 mm.
Center of Gravity of the Packing	8559.051 mm.
Center of Gravity of the Liquid	3256.327 mm.
Center of Gravity of the Insulation	2442.576 mm.
Center of Gravity of the Lining	3556.864 mm.
Center of Gravity of the Nozzles	6223.772 mm.
Center of Gravity of the Added Weights (Operating)	7856.153 mm.
Center of Gravity of the Added Weights (Empty)	5408.629 mm.
Center of Gravity of Bare Shell New and Cold	5895.865 mm.
Center of Gravity of Bare Shell Corroded	5734.581 mm.
Vessel CG in the Operating Condition	6616.875 mm.
Vessel CG in the Fabricated (Shop/Empty) Condition	5830.426 mm.
Vessel CG in the Test Condition	6129.386 mm.

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Skirt Data :

Skirt Outside Diameter at Base	SOD	736.0000	mm.
Skirt Thickness	STHK	25.0000	mm.
Skirt Internal Corrosion Allowance	SCA	0.0000	mm.
Skirt External Corrosion Allowance		0.0000	mm.
Skirt Material		SA-516 70	

Basering Input: Type of Geometry: Continuous Top Ring W/Gussets

Thickness of Basering	TBA	80.0000	mm.
Design Temperature of the Basering		85.00	°C
Basering Matl		SA-283 C	
Basering Operating All. Stress	BASOPE	108.25	N./mm ²
Basering Yield Stress		191.06	N./mm ²
Inside Diameter of Basering	DI	620.0000	mm.
Outside Diameter of Basering	DOU	1060.0000	mm.
Nominal Diameter of Bolts	BND	48.0000	mm.
Bolt Corrosion Allowance	BCA	0.0000	mm.
Bolt Material		SA-193 B7	
Bolt Material Class/Thickness Range		<= 2 1/2	
Bolt Operating Allowable Stress	SA	135.00	N./mm ²
Number of Bolts	RN	12	
Diameter of Bolt Circle	DC	960.0000	mm.
Bolt Allowable Shear Stress		81.000	N./mm ²
Thickness of Gusset Plates	TGA	12.0000	mm.
Width of Gussets at Top Plate	TWDT	200.0000	mm.
Width of Gussets at Base Plate	BWDT	162.0000	mm.
Gusset Plate Elastic Modulus	E	199042000.0	KPa.
Gusset Plate Yield Stress	SY	191.1	N./mm ²
Height of Gussets	HG	265.0000	mm.
Distance between Gussets	RG	100.0000	mm.
Dist. from Bolt Center to Gusset (Rg/2)	CG	50.0000	mm.
Number of Gussets per bolt	NG	2	
Thickness of Top Plate or Ring	TTA	35.0000	mm.
Radial Width of the Top Plate	TOPWTH	200.0000	mm.
Anchor Bolt Hole Dia. in Top Plate	BHOLE	60.0000	mm.
External Corrosion Allowance	CA	1.6000	mm.
Dead Weight of Vessel	DW	124.9	kN
Operating Weight of Vessel	ROW	157.8	kN
Test Weight of Vessel	TW	150.5	kN
Earthquake Moment on Basering	EQMOM	550283.3	N-m
Wind Moment on Basering	WIMOM	108135.0	N-m
Test Moment on Basering	TM	42060.1	N-m
Percent Bolt Preload	ppl	100.0	
Use AISC A5.2 Increase in Fc and Bolt Stress		No	
Use Allowable Weld Stress per AISC J2.5		No	
Factor for Increase of Allowables	Fact	1.0000	

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شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 134 از 383
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V01	0001	CN	ME	120	MF	GCS	BK																			

Results for Basering Analysis : Analyze Option

Basering Thickness Calculation method used : Simplified (Steel on Steel)

Calculation of Bolt Loads for Multiple Loading Conditions:

Operating Bolt Load, Earthquake Operating Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 550283/960.0) - 158) / 12$$

$$= 179.7 \text{ kN}$$

Operating Bolt Load, Windload Empty Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 108135/960.0) - 125) / 12$$

$$= 27.1 \text{ kN}$$

Operating Bolt Load, Windload Vortex Shedding Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 0/960.0) - 158) / 12$$

$$= -13.1 \text{ kN}$$

Operating Bolt Load, Test Moment Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 42060/960.0) - 150) / 12$$

$$= 2.1 \text{ kN}$$

Calculation of Maximum Load per Bolt [W/Bolt], Earthquake + Operating Condition:

W = ROW - Yforce (from gy Acceleration or user force), M = EQMOM

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 550283/960.0) - 135) / 12$$

$$= 179.7 \text{ kN}$$

Required Area for Each Bolt, Based on Max Load	13.3140	cm ²
Area Available in a Single Bolt (Corr)	13.4296	cm ²
Area Available in all the Bolts (Corr)	161.1551	cm ²
Bolt Stress Based on Simplified Analysis	133.8	N./mm ²
Allowable Bolt Stress	135.0 [Fact]	135.00 N./mm ²

Shear Stress in a Single Bolt [taub]:

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

$$= 62 / (2 * 13.43 * 12)$$

$$= 1.9 \text{ N./mm}^2. \text{ Must be less than } 81.0 \text{ N./mm}^2.$$

Concrete Contact Area of Base Ring	CCA	5805.66	cm ²
Concrete Contact Section Modulus of Base Ring		0.1032E+09	mm. ³

Concrete Load (Simplified method), Earthquake in Operating Condition [Sc]:

$$= ((ppl/100 * (Abt * Sa) + W) / Cca) + M/CZ \quad \text{per Jawad \& Farr Eq. 12.1}$$

$$= (1.0(161.1551 * 135 + 180) / 5805.66) + 550283 / .10324E+09$$

$$= 9.39 \text{ N./mm}^2$$

Concrete Allowable Stress

8.27 N./mm²

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Determine Maximum Bending Width of Basing Section [Rw1,Rw2]:

$$Rw1 = (Dou - SkirtOD)/2, \quad Rw2 = (SkirtID - Di + 2*Sca)/2$$

$$Rw1 = (1060.0-736.0)/2, \quad Rw2 = (686.0-620.0 + 2*0.0)/2$$

$$Rw1 = 162.0, \quad Rw2 = 33.0 \text{ mm.}$$

Calculation of required Basing Thickness, (Simplified) [Tb]:

Allowable Bending Stress 1.5 Basope = 162.377 N./mm²

$$= \text{Max}(Rw1, Rw2) * (3 * Sc / S)^{1/2} + CA \text{ per Jawad \& Farr Eq. 12.12}$$

$$= \text{Max}(162.0, 33.0) * (3 * 9.386/162.377)^{1/2} + 1.6$$

$$= 69.0619 \text{ mm.}$$

Basing Stress at given Thickness [Sb]

$$= 3 * Sc * (\text{Max}[Rw1, Rw2]/(Tb - Ca))^2$$

$$= 3 * 9.386 * (\text{Max}[162.0, 33.0]/(80.0 - 1.6))^2$$

$$= 120.229, \text{ must be less than } 162.377 \text{ N./mm}^2$$

Required Thickness of Top Plate in Tension:

(Calculated as a fixed beam per Megyesy)

$$P = W_{max} \quad \text{Bolt Load}$$

$$Rm = (Ft * 2 * Cg)/8, \quad \text{Bending Moment}$$

$$Sb \quad \text{Allowable Bending Stress}$$

$$Wt = (Topwth - Bnd), \quad \text{Width of Section}$$

$$T = (6 * Rm / (Sb * Wt))^{1/2} + CA$$

$$T = (6 * 2247 / (162 * 152.0))^{1/2} + 1.6$$

$$T = 24.9705 \text{ mm.}$$

Required Thickness of Continuous Top Ring per Moss:

$$a = (Dc - SkirtOD)/2 \quad \text{Skirt Distance to Bolt Circle}$$

$$P = W_{max} \quad \text{Bolt Load}$$

$$l = Avgwdt \quad \text{Average Gusset Width}$$

$$g1 = \text{Gamma } 1 \quad \text{Constant Term } f(b/l)$$

$$g2 = \text{Gamma } 2 \quad \text{Constant Term } f(b/l)$$

$$g = \text{Flat distance} / 2 \quad \text{Nut } 1/2 \text{ Dimension (from Tema)}$$

$$Fb = \quad \text{Allowable Bending Stress}$$

$$Mo = P/(4\pi) [1.3(\ln((2l\sin(\pi a/l)/(\pi g))) + 1) - [(0.7 - g2)P/(4\pi)]] \quad \text{Moment Term}$$

$$Tc = (6 * \text{Abs}(Mo) / Fb)^{1/2} + CA \quad \text{Required Thickness}$$

$$Tc = (6 * 589/162)^{1/2} + 1.6$$

$$Tc = 30.8744 \text{ mm.}$$

Required Thickness of Gusset in Compression, per AISC E2-1:

1. Allowed Compression at Given Thickness:

$$\text{Factor } Kl/r \text{ Per E2-1} \quad 76.4976$$

$$\text{Factor } Cc \text{ Per E2-1} \quad 143.4044$$

$$\text{Allowable Buckling Str. per E2-1} \quad 88.69 \text{ N./mm}^2$$

$$\text{Actual Buckling Str. at Given Thickness} \quad 41.38 \text{ N./mm}^2$$

$$\text{Required Gusset thickness, + CA} \quad 9.2393 \text{ mm.}$$

2. Allowed Compression at Calculated Thickness:

$$\text{Factor } Kl/r \text{ Per E2-1} \quad 120.1636$$

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Factor Cc Per E2-1	143.4044	
Allowable Buckling Str. per E2-1	65.00	N./mm ²
Act. Buckling Str. at Calculated Thickness	64.99	N./mm ²

Summary of Basing Thickness Calculations:

Required Basing Thickness (simplified)	69.0619	mm.
Actual Basing Thickness as entered by user	80.0000	mm.
Required Top Ring/Plate Thickness as a Fixed Beam	24.9705	mm.
Required Thickness of Continuous Top Ring (Moss)	30.8744	mm.
Actual Top Ring Thickness as entered by user	35.0000	mm.
Required Gusset thickness, + CA	9.2393	mm.
Actual Gusset Thickness as entered by user	12.0000	mm.

Weld Size Calculations per Steel Plate Engineering Data - Vol. 2

Compute the Weld load at the Skirt/Base Junction [W]

$= \text{SkirtStress} * (\text{SkirtThickness} - \text{CA})$
 $= 60.062 * (25.0 - 0.0)$
 $= 1.5 \text{ kN/mm.}$

Results for Computed Minimum Basing Weld Size [BWeld]

$= W / [(0.4 * \text{Yield}) * 2 * 0.707]$
 $= 2 / [(0.4 * 191) * 2 * 0.707]$
 $= 13.895 \text{ mm.}$

Results for Computed Minimum Gusset and Top Plate to Skirt Weld Size

Vertical Plate Load [Wv]

$= \text{Bolt Load} / (\text{Cmwth} + 2 * (\text{Hg} + \text{Tta}))$
 $= 179.7 / (124.0 + 2 * (265.0 + 35.0))$
 $= 0.248 \text{ kN/mm.}$

Horizontal Plate Load [Wh]

$= \text{Bolt Load} * e / (\text{Cmwth} * (\text{Hg} + \text{Tta}) + 0.6667 * (\text{Hg} + \text{Tta})^2)$
 $= 179.7 * 112.0 / (124.0 * (300.0) + 0.6667 * (300.0)^2)$
 $= 0.207 \text{ kN/mm.}$

Resultant Weld Load [Wr]

$= (\text{Wv}^2 + \text{Wh}^2)^{1/2}$
 $= (0.25^2 + 0.21^2)^{1/2}$
 $= 0.323 \text{ kN/mm.}$

Results for Computed Min Gusset and Top Plate to Skirt Weld Size [GsWeld]

$= \text{Wr} / [(0.4 * \text{Yield}) * 2 * 0.707]$
 $= 0.32 / [(0.4 * 191) * 2 * 0.707]$
 $= 2.992 \text{ mm.}$

Results for Computed Minimum Gusset to Top Plate Weld Size

Weld Load [Wv]

$= \text{Bolt Load} / (2 * \text{TopWth})$
 $= 179.7 / (2 * 200.0)$

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$$= 0.449 \text{ kN/mm.}$$

Weld Load [Wh]

$$= \text{Bolt Load} * e / (2 * \text{Hgt} * \text{TopWth})$$

$$= 179.7 * 112.0 / (2 * 300.0 * 200.0)$$

$$= 0.168 \text{ kN/mm.}$$

Resultant Weld Load [Wr]

$$= (W_v^2 + W_h^2)^{1/2}$$

$$= (0.45^2 + 0.17^2)^{1/2}$$

$$= 0.48 \text{ kN/mm.}$$

Results for Computed Min Gusset to Top Plate Weld Size [GtpWeld]

$$= W_r / [(0.4 * \text{Yield}) * 2 * 0.707]$$

$$= 0.48 / [(0.4 * 191) * 2 * 0.707]$$

$$= 4.438 \text{ mm.}$$

Note: The calculated weld sizes need not exceed the component thickness framing into the weld. At the same time, the weld must meet a minimum size specification which is 3/16 in. (4.76 mm) or 1/4 in. (6.35 mm), depending on the component thickness.

Summary of Required Weld Sizes:

Required Basing to Skirt Double Fillet Weld Size	13.8949	mm.
Required Gusset to Skirt Double Fillet Weld Size	4.7625	mm.
Required Top Plate to Skirt Weld Size	6.3500	mm.
Required Gusset to Top Plate Double Fillet Weld Size	4.4385	mm.

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Input, Nozzle Desc: N07 (1.5in)

From: 20

Pressure for Reinforcement Calculations	P	62.189	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Elliptical Head	D	706.00	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	20.0000	mm.
Head Internal Corrosion Allowance	c	0.0000	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

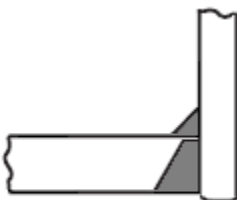
Type of Element Connected to the Shell : Nozzle

Material		SA-106	B
Material UNS Number		K03006	
Material Specification/Type		Smls. pipe	
Allowable Stress at Temperature	Sn	117.90	N./mm ²
Allowable Stress At Ambient	Sna	117.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		1.5000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	XXS	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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	0001		V01

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



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

Reinforcement CALCULATION, Description: N07 (1.5in)

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

Actual Inside Diameter Used in Calculation	1.200 in.
Actual Thickness Used in Calculation	0.350 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]

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

$$= (62.19 \cdot 0.9 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.19)$$

$$= 14.3930 \text{ mm.}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)}$$

$$= 15.24 \left(\exp \left(\frac{62.19}{117.9 \cdot 1.0} \right) - 1 \right)$$

$$= 0.8255 \text{ mm.}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2795 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	88.2600 mm.
Parallel to Vessel Wall	Rn+tn+t	44.1300 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	22.2250 mm.

Weld Strength Reduction Factor [fr1]:

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

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

$$= 0.855$$

Weld Strength Reduction Factor [fr2]:

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

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

 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 CONTACTOR (C-100)							شماره صفحه : 140 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

$$= 0.855$$

Weld Strength Reduction Factor [fr3]:

$$= \min(fr2, fr4)$$

$$= \min(0.855, 1.0)$$

$$= 0.855$$

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	4.758	0.319	NA
Area in Shell	A1	3.095	9.974	NA
Area in Nozzle Wall	A2	3.065	3.272	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds	A41+A42+A43	0.855	0.855	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	7.015	14.102	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (30.48 \cdot 14.393 \cdot 1.0 + 2 \cdot 8.89 \cdot 14.393 \cdot 1.0 \cdot (1 - 0.86))$$

$$= 4.758 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 57.78(1.0 \cdot 20.0 - 1.0 \cdot 14.393) - 2 \cdot 8.89$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 14.393) \cdot (1 - 0.855)$$

$$= 3.095 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 22.23)(8.89 - 0.83) \cdot 0.855$$

$$= 3.065 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 0.855 + (0.0)^2 \cdot 0.855$$

$$= 0.855 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures	ta = 0.8255 mm.
Wall Thickness per UG16(b),	tr16b = 1.5000 mm.
Wall Thickness, shell/head, internal pressure	trb1 = 15.9923 mm.
Wall Thickness	tbt = max(trb1, tr16b) = 15.9923 mm.
Wall Thickness, shell/head, external pressure	trb2 = 0.2647 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	0001		V01

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 3.2200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[3.22, \max(15.9923, 1.5)]$
 $= 3.2200 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(0.8255, 3.22)$
 $= 3.2200 \text{ mm.}$

Available Nozzle Neck Thickness = 8.8900 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, min(Curve:B, Curve:A)

Govrn. thk, $tg = 8.89$, $tr = 0.825$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.093$, 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

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

Govrn. thk, $tg = 8.89$, $tr = 0.825$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.093$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve B	-29 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-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)	-39 °C

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

Design Pressure/Ambient Rating = $62.19 / 102.10 = 0.609$

Weld Size Calculations, Description: N07 (1.5in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 8.8900 \text{ mm.}$

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	$6.0000 = \text{Min per Code}$	$7.0700 = 0.7 * W_o \text{ mm.}$

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

 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	0001		V01

Weld Load [W]:

$$\begin{aligned}
 &= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv) \\
 &= \max(0, (4.7581 - 3.0951 + 2 * 8.89 * 0.855 * (1.0 * 20.0 - 14.393))138) \\
 &= 34.68 \text{ kN}
 \end{aligned}$$

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

Weld Load [W1]:

$$\begin{aligned}
 &= (A2+A5+A4-(Wi-Can/.707)^2*fr2)*Sv \\
 &= (3.0649 + 0.0 + 0.855 - 0.0 * 0.86) * 138 \\
 &= 54.05 \text{ kN}
 \end{aligned}$$

Weld Load [W2]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv \\
 &= (3.0649 + 0.0 + 0.855 + (3.0404)) * 138 \\
 &= 95.97 \text{ kN}
 \end{aligned}$$

Weld Load [W3]:

$$\begin{aligned}
 &= (A2+A3+A4+A5+(2*tn*t*fr1))*S \\
 &= (3.0649 + 0.0 + 0.855 + 0.0 + (3.0404)) * 138 \\
 &= 95.97 \text{ kN}
 \end{aligned}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$\begin{aligned}
 &= (\pi/2) * Dlo * Wo * 0.49 * Snw \\
 &= (3.1416/2.0) * 48.26 * 10.0 * 0.49 * 118 \\
 &= 44. \text{ kN}
 \end{aligned}$$

Shear, Nozzle Wall [Snw]:

$$\begin{aligned}
 &= (\pi * (Dlr + Dlo) / 4) * (Thk - Can) * 0.7 * Sn \\
 &= (3.1416 * 19.685) * (8.89 - 0.0) * 0.7 * 118 \\
 &= 45. \text{ kN}
 \end{aligned}$$

Tension, Shell Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng \\
 &= (3.1416/2.0) * 48.26 * (18.0 - 0.0) * 0.74 * 138 \\
 &= 139. \text{ kN}
 \end{aligned}$$

Strength of Failure Paths:

$$\begin{aligned}
 \text{PATH11} &= (\text{SONW} + \text{SNW}) = (44 + 45) = 89 \text{ kN} \\
 \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\
 &= (44 + 0 + 139 + 0) = 183 \text{ kN} \\
 \text{PATH33} &= (\text{Sonw} + \text{Tngw} + \text{Sinw}) \\
 &= (44 + 139 + 0) = 183 \text{ kN}
 \end{aligned}$$

Summary of Failure Path Calculations:

Path 1-1 = 89 kN , must exceed W = 34 kN or W1 = 54 kN
 Path 2-2 = 183 kN , must exceed W = 34 kN or W2 = 95 kN
 Path 3-3 = 183 kN , must exceed W = 34 kN or W3 = 95 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K07A (3in)

From: 20

Pressure for Reinforcement Calculations	P	62.186	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Elliptical Head	D	706.00	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	20.0000	mm.
Head Internal Corrosion Allowance	c	0.0000	mm.
Head External Corrosion Allowance	co	0.0000	mm.
Distance from Head Centerline	L1	200.0000	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		180.00	deg
Diameter		3.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	STD	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	50.0000	mm.
Height of Beveled Transition	L'	10.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		20.0000	mm.
Style of FVC Nozzle		Heavy Barrel	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.

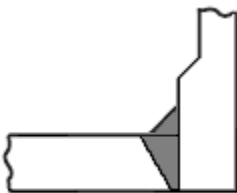
 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Class
Flange Grade

600
GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Note : Checking Nozzle in the Meridional direction.

Reinforcement CALCULATION, Description: K07A (3in)

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

Actual Inside Diameter Used in Calculation	3.122 in.
Actual Thickness Used in Calculation	0.189 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]
 $= (P \cdot K_1 \cdot D) / (2 \cdot S_v \cdot E - 0.2 \cdot P)$ per UG-37 (a) (3)
 $= (62.19 \cdot 0.9 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.19)$
 $= 14.3923 \text{ mm.}$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]
 $= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P)$ per UG-27 (c) (1)
 $= (62.19 \cdot 39.65) / (138 \cdot 1.0 - 0.6 \cdot 62.19)$
 $= 1.8378 \text{ mm.}$

Required Nozzle thickness under External Pressure per UG-28 : 0.3989 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):
 $= 2.5 \cdot \text{Corroded Hub Thickness}$
 $= 2.5 \cdot 20.0$ Note: less than the hub height, use (e-2)
 $= 50.0000 \text{ mm.}$

 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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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

Parallel to Vessel Wall (Diameter Limit) D1 168.1903 mm.
Parallel to Vessel Wall, opening length d 84.0951 mm.
Normal to Vessel Wall (Thickness Limit), no pad Tlnp 50.0000 mm.

Note: Hub Height was >= 2.5 times Hub Thickness, using sketch UG-40 (e-2).

Weld Strength Reduction Factor [fr1]:

= min(1, Sn/Sv)
= min(1, 137.9/137.9)
= 1.000

Weld Strength Reduction Factor [fr2]:

= min(1, Sn/Sv)
= 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	12.103	0.812	NA
Area in Shell	A1	4.716	15.195	NA
Area in Nozzle Wall	A2	18.670	20.149	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	24.386	36.344	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 70.56 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

= (d * tr*F + 2 * tn * tr*F * (1-fr1)) UG-37(c)
= (84.0951*14.3923*1.0+2*20.0*14.3923*1.0*(1-1.0))
= 12.103 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)
= 84.095(1.0 * 20.0 - 1.0 * 14.392) - 2 * 20.0
(1.0 * 20.0 - 1.0 * 14.3923) * (1 - 1.0)
= 4.716 cm²

 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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Area Available in Nozzle Projecting Outward [A2]:

$$= (2 * t_{lnp}) (t_n - t_{rn}) fr_2 / \sin(\alpha_3)$$

$$= (2 * 50.0) (20.0 - 1.84) 1.0 / \sin(76.6)$$

$$= 18.670 \text{ cm}^2$$

Note: See ASME VIII-1 2011(a) Appendix L, L-7.7.7(b) for more information.

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

$$= W_o^2 * fr_2 + (W_i - c_{an} / 0.707)^2 * fr_2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Note: There are no hub area calculations because Figure UG-40 (e-2) was used.

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, Curve: A

Govrn. thk, $t_g = 4.801$, $t_r = 1.838$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
 Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.383$, Temp. Reduction = 55 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-48 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

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

Govrn. thk, $t_g = 20.0$, $t_r = 14.392$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
 Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.72$, Temp. Reduction = 16 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	12 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-3 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -3 °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)	-39 °C

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

$$\text{Design Pressure/Ambient Rating} = 62.19 / 102.10 = 0.609$$

Weld Size Calculations, Description: K07A (3in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 19.0000 \text{ mm.}$

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = $0.7 * W_o \text{ mm.}$

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

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 148 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Weld Load [W]:

$$\begin{aligned}
 &= \max(0, (A - A1 + 2 \cdot t_n \cdot f_{r1} \cdot (E1 \cdot t - t_r)) \cdot S_v) \\
 &= \max(0, (12.1033 - 4.7158 + 2 \cdot 20.0 \cdot 1.0 \cdot (1.0 \cdot 20.0 - 14.3923)) \cdot 138) \\
 &= 132.79 \text{ kN}
 \end{aligned}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

$$\begin{aligned}
 &= (A2 + A4 - (W_i - C_{an} / .707)^2 \cdot f_{r2}) \cdot S_v \\
 &= (18.6698 + 1. - 0.0 \cdot 1.0) \cdot 138 \\
 &= 271.22 \text{ kN}
 \end{aligned}$$

Weld Load [W2]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + (2 \cdot (\text{Hub Thickness}) \cdot t \cdot f_{r1})) \cdot S_v \\
 &= (18.6698 + 0.0 + 1. + (8.0)) \cdot 138 \\
 &= 381.53 \text{ kN}
 \end{aligned}$$

Weld Load [W3]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + (2 \cdot (\text{Hub Thickness}) \cdot t \cdot f_{r1})) \cdot S_v \\
 &= (18.6698 + 0.0 + 1. + 0.0) \cdot 138 \\
 &= 381.53 \text{ kN}
 \end{aligned}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$\begin{aligned}
 &= (\pi/2) \cdot D_{lo} \cdot W_o \cdot 0.49 \cdot S_{nw} \\
 &= (3.1416/2.0) \cdot 126.5145 \cdot 10.0 \cdot 0.49 \cdot 138 \\
 &= 134. \text{ kN}
 \end{aligned}$$

Shear, Nozzle Wall [Snw]:

$$\begin{aligned}
 &= (\pi \cdot (D_{lr} + D_{lo}) / 4) \cdot (Thk - C_{an}) \cdot 0.7 \cdot S_n \\
 &= (3.1416 \cdot 52.6524) \cdot (20.0 - 0.0) \cdot 0.7 \cdot 138 \\
 &= 319. \text{ kN}
 \end{aligned}$$

Tension, Shell Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi/2) \cdot D_{lo} \cdot (W_{gnvi} - C_{as}) \cdot 0.74 \cdot S_{ng} \\
 &= (3.1416/2.0) \cdot 126.5145 \cdot (18.0 - 0.0) \cdot 0.74 \cdot 138 \\
 &= 365. \text{ kN}
 \end{aligned}$$

Strength of Failure Paths:

$$\begin{aligned}
 \text{PATH11} &= (\text{SONW} + \text{SNW}) = (134 + 319) = 454 \text{ kN} \\
 \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\
 &= (134 + 0 + 365 + 0) = 499 \text{ kN} \\
 \text{PATH33} &= (\text{Sonw} + \text{Tngw} + \text{Sinw}) \\
 &= (134 + 365 + 0) = 499 \text{ kN}
 \end{aligned}$$

Summary of Failure Path Calculations:

$$\begin{aligned}
 \text{Path 1-1} &= 453 \text{ kN}, \text{ must exceed } W = 132 \text{ kN} \quad \text{or } W1 = 271 \text{ kN} \\
 \text{Path 2-2} &= 499 \text{ kN}, \text{ must exceed } W = 132 \text{ kN} \quad \text{or } W2 = 381 \text{ kN} \\
 \text{Path 3-3} &= 499 \text{ kN}, \text{ must exceed } W = 132 \text{ kN} \quad \text{or } W3 = 381 \text{ kN}
 \end{aligned}$$

 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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 149 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 78 bars

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

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

Note : Checking Nozzle in the Latitudinal direction.

Reinforcement CALCULATION, Description: K07A (3in)

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

Actual Inside Diameter Used in Calculation 3.122 in.
Actual Thickness Used in Calculation 0.189 in.

Nozzle input data check completed without errors.

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

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

$$= (62.19 \cdot 0.9 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.19)$$

$$= 14.3923 \text{ mm.}$$

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

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

$$= (62.19 \cdot 39.65) / (138 \cdot 1.0 - 0.6 \cdot 62.19)$$

$$= 1.8378 \text{ mm.}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3989 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):

$$= 2.5 \cdot \text{Corroded Hub Thickness}$$

$$= 2.5 \cdot 20.0 \text{ Note: less than the hub height, use (e-2)}$$

$$= 50.0000 \text{ mm.}$$

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

Parallel to Vessel Wall (Diameter Limit)	D1	159.2988	mm.
Parallel to Vessel Wall	Rn+tn+t	79.6494	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000	mm.

Note: Hub Height was >= 2.5 times Hub Thickness, using sketch UG-40 (e-2).

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	11.413	0.766	NA
Area in Shell	A1	4.486	14.455	NA
Area in Nozzle Wall	A2	18.162	19.601	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds	A41+A42+A43	1.000	1.000	NA

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V01	0001	CN	ME	120	MF	GCS	BK																			

Area in Element	A5		0.000		0.000		NA
Area in Hub	A6		0.000		0.000		NA
TOTAL AREA AVAILABLE	Atot		23.648		35.056		NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (79.2988 \cdot 14.3923 \cdot 1.0 + 2 \cdot 20.0 \cdot 14.3923 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 11.413 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d \cdot (E1 \cdot t - F \cdot tr) - 2 \cdot tn \cdot (E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 80.0 \cdot (1.0 \cdot 20.0 - 1.0 \cdot 14.392) - 2 \cdot 20.0 \cdot (1.0 \cdot 20.0 - 1.0 \cdot 14.3923) \cdot (1 - 1.0)$$

$$= 4.486 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp) \cdot (tn - trn) \cdot fr2$$

$$= (2 \cdot 50.0) \cdot (20.0 - 1.84) \cdot 1.0$$

$$= 18.162 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

Note: There are no hub area calculations because Figure UG-40 (e-2) was used.

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

Wall Thickness for Internal/External pressures	ta = 1.8378 mm.
Wall Thickness per UG16(b),	tr16b = 1.5000 mm.
Wall Thickness, shell/head, internal pressure	trb1 = 15.9915 mm.
Wall Thickness	tb1 = max(trb1, tr16b) = 15.9915 mm.
Wall Thickness, shell/head, external pressure	trb2 = 0.2647 mm.
Wall Thickness	tb2 = max(trb2, tr16b) = 1.5000 mm.
Wall Thickness per table UG-45	tb3 = 4.8000 mm.

Determine Nozzle Thickness candidate [tb]:

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

$$= \min[4.8, \max(15.9915, 1.5)]$$

$$= 4.8000 \text{ mm.}$$

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

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

$$= \max(1.8378, 4.8)$$

$$= 4.8000 \text{ mm.}$$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Available Nozzle Neck Thickness = 4.8006 mm. --> OK

Weld Size Calculations, Description: K07A (3in)

Intermediate Calc. for nozzle/shell Welds T_{min} 19.0000 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * W _o mm.

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

Weld Load [W]:

$$\begin{aligned}
 &= \max(0, (A - A_1 + 2 \cdot t_n \cdot f_{r1} \cdot (E_1 \cdot t - t_r)) \cdot S_v) \\
 &= \max(0, (11.413 - 4.4861 + 2 \cdot 20.0 \cdot 1.0 \cdot (1.0 \cdot 20.0 - 14.3923)) \cdot 138) \\
 &= 126.44 \text{ kN}
 \end{aligned}$$

For hub type nozzles, A₂ includes the area of the hub.

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

Weld Load [W1]:

$$\begin{aligned}
 &= (A_2 + A_4 - (W_i - C_{an} / .707)^2 \cdot f_{r2}) \cdot S_v \\
 &= (18.1622 + 1. - 0.0 \cdot 1.0) \cdot 138 \\
 &= 264.22 \text{ kN}
 \end{aligned}$$

Weld Load [W2]:

$$\begin{aligned}
 &= (A_2 + A_3 + A_4 + (2 \cdot (\text{Hub Thickness}) \cdot t \cdot f_{r1})) \cdot S_v \\
 &= (18.1622 + 0.0 + 1. + (8.0)) \cdot 138 \\
 &= 374.53 \text{ kN}
 \end{aligned}$$

Weld Load [W3]:

$$\begin{aligned}
 &= (A_2 + A_3 + A_4 + (2 \cdot (\text{Hub Thickness}) \cdot t \cdot f_{r1})) \cdot S_v \\
 &= (18.1622 + 0.0 + 1. + 0.0) \cdot 138 \\
 &= 374.53 \text{ kN}
 \end{aligned}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$\begin{aligned}
 &= (\pi / 2) \cdot D_{lo} \cdot W_o \cdot 0.49 \cdot S_{nw} \\
 &= (3.1416 / 2.0) \cdot 119.2988 \cdot 10.0 \cdot 0.49 \cdot 138 \\
 &= 127. \text{ kN}
 \end{aligned}$$

Shear, Nozzle Wall [Snw]:

$$\begin{aligned}
 &= (\pi \cdot (D_{lr} + D_{lo}) / 4) \cdot (Thk - C_{an}) \cdot 0.7 \cdot S_n \\
 &= (3.1416 \cdot 49.6494) \cdot (20.0 - 0.0) \cdot 0.7 \cdot 138 \\
 &= 301. \text{ kN}
 \end{aligned}$$

Tension, Shell Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi / 2) \cdot D_{lo} \cdot (W_{gnvi} - C_{as}) \cdot 0.74 \cdot S_{ng} \\
 &= (3.1416 / 2.0) \cdot 119.2988 \cdot (18.0 - 0.0) \cdot 0.74 \cdot 138 \\
 &= 344. \text{ kN}
 \end{aligned}$$

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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Strength of Failure Paths:

$$\begin{aligned} \text{PATH11} &= (\text{SONW} + \text{SNW}) = (127 + 301) = 428 \text{ kN} \\ \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\ &= (127 + 0 + 344 + 0) = 471 \text{ kN} \\ \text{PATH33} &= (\text{Sonw} + \text{Tngw} + \text{Sinw}) \\ &= (127 + 344 + 0) = 471 \text{ kN} \end{aligned}$$

Summary of Failure Path Calculations:

Path 1-1 = 427 kN , must exceed W = 126 kN or W1 = 264 kN
 Path 2-2 = 470 kN , must exceed W = 126 kN or W2 = 374 kN
 Path 3-3 = 470 kN , must exceed W = 126 kN or W3 = 374 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 78 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 : 22.5225 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 243.5051 mm.

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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)																									
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V01	0001	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: K09A (2in)

From: 20

Pressure for Reinforcement Calculations	P	62.187	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Elliptical Head	D	706.00	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	20.0000	mm.
Head Internal Corrosion Allowance	c	0.0000	mm.
Head External Corrosion Allowance	co	0.0000	mm.
Distance from Head Centerline	L1	150.0000	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

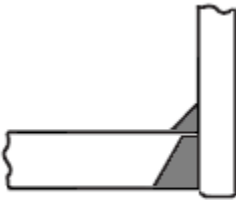
Type of Element Connected to the Shell : Nozzle

Material		SA-106	B
Material UNS Number		K03006	
Material Specification/Type		Smls. pipe	
Allowable Stress at Temperature	Sn	117.90	N./mm ²
Allowable Stress At Ambient	Sna	117.90	N./mm ²
Diameter Basis (for tr calc only)		ID	
Layout Angle		0.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	XXS	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Corrosion Allowance	can	0.0000	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	12.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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V01	0001	CN	ME	120	MF	GCS	BK																			

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



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

Note : Checking Nozzle in the Meridional direction.

Reinforcement CALCULATION, Description: K09A (2in)

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

Actual Inside Diameter Used in Calculation	1.612 in.
Actual Thickness Used in Calculation	0.382 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]
 $= (P \cdot K_1 \cdot D) / (2 \cdot S_v \cdot E - 0.2 \cdot P)$ per UG-37 (a) (3)
 $= (62.19 \cdot 0.9 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.19)$
 $= 14.3927 \text{ mm.}$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]
 $= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P)$ per UG-27 (c) (1)
 $= (62.19 \cdot 20.47) / (118 \cdot 1.0 - 0.6 \cdot 62.19)$
 $= 1.1151 \text{ mm.}$

Required Nozzle thickness under External Pressure per UG-28 : 0.3185 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	101.4553 mm.
Parallel to Vessel Wall	Rn+tn+t	50.7276 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	24.2253 mm.

Weld Strength Reduction Factor [fr1]:

$= \min(1, S_n / S_v)$
 $= \min(1, 117.9 / 137.9)$
 $= 0.855$

Weld Strength Reduction Factor [fr2]:

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 155 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

$= \min(1, S_n/S_v)$
 $= \min(1, 117.9/137.9)$
 $= 0.855$

Weld Strength Reduction Factor [fr3]:

$= \min(fr2, fr4)$
 $= \min(0.855, 1.0)$
 $= 0.855$

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	6.460	0.433	NA
Area in Shell	A1	3.172	10.221	NA
Area in Nozzle Wall	A2	3.613	3.948	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.231	1.231	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	8.016	15.401	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 76.69 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$= (d \cdot tr \cdot F + 2 \cdot t_n \cdot tr \cdot F \cdot (1 - fr1)) \text{ UG-37(c)}$
 $= (42.0751 \cdot 14.3927 \cdot 1.0 + 2 \cdot 9.6901 \cdot 14.3927 \cdot 1.0 \cdot (1 - 0.86))$
 $= 6.460 \text{ cm}^2$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$= d(E1 \cdot t - F \cdot tr) - 2 \cdot t_n(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$
 $= 59.38(1.0 \cdot 20.0 - 1.0 \cdot 14.393) - 2 \cdot 9.69$
 $(1.0 \cdot 20.0 - 1.0 \cdot 14.3927) \cdot (1 - 0.855)$
 $= 3.172 \text{ cm}^2$

Area Available in Nozzle Projecting Outward [A2]:

$= (2 \cdot t_{lnp})(t_n - t_{rn})fr2/\sin(\alpha3)$
 $= (2 \cdot 24.23)(9.69 - 1.12)0.855/\sin(79.5)$
 $= 3.613 \text{ cm}^2$

Note: See ASME VIII-1 2011(a) Appendix L, L-7.7.7(b) for more information.

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

$= W_o^2 \cdot fr2 + (W_i - can/0.707)^2 \cdot fr2$
 $= 12.0^2 \cdot 0.855 + (0.0)^2 \cdot 0.855$
 $= 1.231 \text{ cm}^2$

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BK	GCS	MF	120	ME	CN	0001	V01																			

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, min(Curve:B, Curve:A)

Govrn. thk, $t_g = 9.69$, $t_r = 1.115$, $c = 0.0$ mm., $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.115$, 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

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

Govrn. thk, $t_g = 9.69$, $t_r = 1.115$, $c = 0.0$ mm., $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.115$, Temp. Reduction = 78°C

Min Metal Temp. w/o impact per UCS-66, Curve B -29°C
Min Metal Temp. at Required thickness (UCS 66.1) -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) -39°C

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

Design Pressure/Ambient Rating = $62.19/102.10 = 0.609$

Weld Size Calculations, Description: K09A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 9.6901$ mm.

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $8.4840 = 0.7 * W_o$ mm.

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

Weld Load [W]:

$$= \max(0, (A - A_1 + 2 * t_n * f_{r1} * (E_1 * t - t_r)) * S_v)$$

$$= \max(0, (6.4602 - 3.1721 + 2 * 9.6901 * 0.855 * (1.0 * 20.0 - 14.3927)) * 138)$$

$$= 58.15 \text{ kN}$$

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

Weld Load [W1]:

$$= (A_2 + A_5 + A_4 - (W_i - C_{an} / .707)^2 * f_{r2}) * S_v$$

$$= (3.6126 + 0.0 + 1.2312 - 0.0 * 0.86) * 138$$

$$= 66.79 \text{ kN}$$

Weld Load [W2]:

$$= (A_2 + A_3 + A_4 + (2 * t_n * t * f_{r1})) * S_v$$

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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= (3.6126 + 0.0 + 1.2312 + (3.314)) * 138$$

$$= 112.49 \text{ kN}$$

Weld Load [W3]:

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

$$= (3.6126 + 0.0 + 1.2312 + 0.0 + (3.314)) * 138$$

$$= 112.49 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 61.9903 * 12.0 * 0.49 * 118$$

$$= 68. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 26.0163) * (9.6901 - 0.0) * 0.7 * 118$$

$$= 65. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 61.9903 * (18.0 - 0.0) * 0.74 * 138$$

$$= 179. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (68 + 65) = 133 \text{ kN}$$

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

$$= (68 + 0 + 179 + 0) = 246 \text{ kN}$$

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

$$= (68 + 179 + 0) = 246 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 132 kN , must exceed W = 58 kN or W1 = 66 kN
 Path 2-2 = 246 kN , must exceed W = 58 kN or W2 = 112 kN
 Path 3-3 = 246 kN , must exceed W = 58 kN or W3 = 112 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 69 bars

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

Note : Checking Nozzle in the Latitudinal direction.

Reinforcement CALCULATION, Description: K09A (2in)

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

Actual Inside Diameter Used in Calculation 1.612 in.
 Actual Thickness Used in Calculation 0.382 in.

Nozzle input data check completed without errors.

 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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Reqd thk per UG-37(a) of Elliptical Head, Tr [Int. Press]
 $= (P \cdot K_1 \cdot D) / (2 \cdot S_v \cdot E - 0.2 \cdot P)$ per UG-37(a) (3)
 $= (62.19 \cdot 0.9 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.19)$
 $= 14.3927 \text{ mm.}$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]
 $= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P)$ per UG-27 (c) (1)
 $= (62.19 \cdot 20.47) / (118 \cdot 1.0 - 0.6 \cdot 62.19)$
 $= 1.1151 \text{ mm.}$

Required Nozzle thickness under External Pressure per UG-28 : 0.3185 mm.

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

Parallel to Vessel Wall (Diameter Limit)	Dl	100.3250	mm.
Parallel to Vessel Wall	Rn+tn+t	50.1625	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	24.2253	mm.

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	6.297	0.423	NA
Area in Shell	A1	3.172	10.221	NA
Area in Nozzle Wall	A2	3.552	3.882	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.231	1.231	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	7.955	15.335	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr_1))$ UG-37(c)
 $= (40.9448 \cdot 14.3927 \cdot 1.0 + 2 \cdot 9.6901 \cdot 14.3927 \cdot 1.0 \cdot (1 - 0.86))$
 $= 6.297 \text{ cm}^2$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$= d (E_1 \cdot t - F \cdot tr) - 2 \cdot tn (E_1 \cdot t - F \cdot tr) \cdot (1 - fr_1)$
 $= 59.38 (1.0 \cdot 20.0 - 1.0 \cdot 14.393) - 2 \cdot 9.69$
 $(1.0 \cdot 20.0 - 1.0 \cdot 14.3927) \cdot (1 - 0.855)$
 $= 3.172 \text{ cm}^2$

Area Available in Nozzle Projecting Outward [A2]:

$= (2 \cdot tlnp) (tn - trn) fr_2$
 $= (2 \cdot 24.23) (9.69 - 1.12) \cdot 0.855$
 $= 3.552 \text{ cm}^2$

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

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	BK	GCS	MF	120	ME	CN	0001		V01

$$= W_o^2 * fr2 + (W_i - can / 0.707)^2 * fr2$$

$$= 12.0^2 * 0.855 + (0.0)^2 * 0.855$$

$$= 1.231 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $t_a = 1.1151 \text{ mm.}$
 Wall Thickness per UG16(b), $t_{r16b} = 1.5000 \text{ mm.}$
 Wall Thickness, shell/head, internal pressure $t_{rb1} = 15.9918 \text{ mm.}$
 Wall Thickness $t_{b1} = \max(t_{rb1}, t_{r16b}) = 15.9918 \text{ mm.}$
 Wall Thickness, shell/head, external pressure $t_{rb2} = 0.2647 \text{ mm.}$
 Wall Thickness $t_{b2} = \max(t_{rb2}, t_{r16b}) = 1.5000 \text{ mm.}$
 Wall Thickness per table UG-45 $t_{b3} = 3.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$$= \min[t_{b3}, \max(t_{b1}, t_{b2})]$$

$$= \min[3.42, \max(15.9918, 1.5)]$$

$$= 3.4200 \text{ mm.}$$

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

$$= \max(t_a, t_b)$$

$$= \max(1.1151, 3.42)$$

$$= 3.4200 \text{ mm.}$$

Available Nozzle Neck Thickness = 9.6901 mm. --> OK

Weld Size Calculations, Description: K09A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 9.6901 \text{ mm.}$

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	8.4840 = $0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$$= \max(0, (A - A1 + 2 * t_n * fr1 * (E1 * t - t_r)) * S_v)$$

$$= \max(0, (6.2975 - 3.1721 + 2 * 9.6901 * 0.855 * (1.0 * 20.0 - 14.3927)) * 138)$$

$$= 55.91 \text{ kN}$$

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

Weld Load [W1]:

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

$$= (3.5522 + 0.0 + 1.2312 - 0.0 * 0.86) * 138$$

$$= 65.96 \text{ kN}$$

Weld Load [W2]:

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

$$= (3.5522 + 0.0 + 1.2312 + (3.314)) * 138$$

$$= 111.65 \text{ kN}$$

Weld Load [W3]:

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

$$= (3.5522 + 0.0 + 1.2312 + 0.0 + (3.314)) * 138$$

$$= 111.65 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 60.325 * 12.0 * 0.49 * 118$$

$$= 66. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 25.3174) * (9.6901 - 0.0) * 0.7 * 118$$

$$= 64. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 60.325 * (18.0 - 0.0) * 0.74 * 138$$

$$= 174. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (66 + 64) = 129 \text{ kN}$$

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

$$= (66 + 0 + 174 + 0) = 240 \text{ kN}$$

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

$$= (66 + 174 + 0) = 240 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 129 kN , must exceed W = 55 kN or W1 = 65 kN
 Path 2-2 = 239 kN , must exceed W = 55 kN or W2 = 111 kN
 Path 3-3 = 239 kN , must exceed W = 55 kN or W3 = 111 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 69 bars

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

The Drop for this Nozzle is : 7.9043 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 228.4395 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N01 (6in)

From: 30

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1400.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

Type of Element Connected to the Shell : Nozzle

Material [Impact Tested]		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		90.00	deg
Diameter		6.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	STD	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	90.0000	mm.
Height of Beveled Transition	L'	18.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		35.0000	mm.
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	15.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	

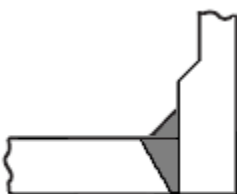
 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Grade

GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Reinforcement CALCULATION, Description: N01 (6in)

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

Actual Inside Diameter Used in Calculation	6.135 in.
Actual Thickness Used in Calculation	0.245 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 77.91) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 3.6004 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.5804 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):

$$\begin{aligned}
 &= 2.5 \cdot \text{Corroded Hub Thickness} \\
 &= 2.5 \cdot 35.0 \text{ Note: less than the hub height, use (e-2)} \\
 &= 87.5000 \text{ mm.}
 \end{aligned}$$

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

Parallel to Vessel Wall (Diameter Limit)	D1	311.6580 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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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Parallel to Vessel Wall, opening length d 155.8290 mm.
Normal to Vessel Wall (Thickness Limit), no pad Tlnp 50.0000 mm.

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 [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	25.419	2.883	NA
Area in Shell	A1	5.747	25.401	NA
Area in Nozzle Wall	A2	31.400	34.420	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	38.147	60.820	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * t_n * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (155.829 * 16.3119 * 1.0 + 2 * 35.0 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 25.419 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 * t - F * tr) - 2 * t_n(E1 * t - F * tr) * (1 - fr1)$$

$$= 155.829(1.0 * 20.0 - 1.0 * 16.312) - 2 * 35.0$$

$$(1.0 * 20.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 5.747 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 * tlnp)(t_n - trn)fr2$$

$$= (2 * 50.0)(35.0 - 3.6)1.0$$

$$= 31.400 \text{ cm}^2$$

 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	0001		V01

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

$$= W_o^2 * fr2 + (W_i - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Note: There are no hub area calculations because Figure UG-40 (e-2) was used.

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

Wall Thickness for Internal/External pressures $t_a = 3.6004 \text{ mm.}$
Wall Thickness per UG16(b), $tr_{16b} = 1.5000 \text{ mm.}$
Wall Thickness, shell/head, internal pressure $tr_{b1} = 16.3119 \text{ mm.}$
Wall Thickness $tb_1 = \max(tr_{b1}, tr_{16b}) = 16.3119 \text{ mm.}$
Wall Thickness, shell/head, external pressure $tr_{b2} = 0.2648 \text{ mm.}$
Wall Thickness $tb_2 = \max(tr_{b2}, tr_{16b}) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb_3 = 6.2200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$$= \min[tb_3, \max(tb_1, tb_2)]$$

$$= \min[6.22, \max(16.3119, 1.5)]$$

$$= 6.2200 \text{ mm.}$$

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

$$= \max(t_a, t_b)$$

$$= \max(3.6004, 6.22)$$

$$= 6.2200 \text{ mm.}$$

Available Nozzle Neck Thickness = 6.2230 mm. --> OK

Stresses on Nozzle due to External and Pressure Loads per the ASME

B31.3 Piping Code (see 319.4.4 and 302.3.5):

Sustained	: 78.5,	Allowable	: 137.9 N./mm ²	Passed
Expansion	: 0.0,	Allowable	: 266.3 N./mm ²	Passed
Occasional	: 37.3,	Allowable	: 183.4 N./mm ²	Passed
Shear	: 7.9,	Allowable	: 96.5 N./mm ²	Passed

Note : The number of cycles on this nozzle was assumed to be 7000 or less for the determination of the expansion stress allowable.

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, Curve: A

Govrn. thk, $t_g = 6.223$, $t_r = 3.6$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.579$, Temp. Reduction = 24 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-32 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

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

Govrn. thk, $t_g = 20.0$, $t_r = 16.312$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.816$, Temp. Reduction = 10 °C

 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	0001		V01

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -32 °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) -40 °C

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

Design Pressure/Ambient Rating = 62.00/102.10 = 0.607

Weld Size Calculations, Description: N01 (6in)

Intermediate Calc. for nozzle/shell Welds Tmin 19.0000 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm.

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

Weld Load [W]:

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

$$= \max(0, (25.4187 - 5.7471 + 2 * 35.0 * 1.0 * (1.0 * 20.0 - 16.3119)) * 138)$$

$$= 306.85 \text{ kN}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

$$= (A2 + A4 - (W_i - C_{an} / .707)^2 * f_{r2}) * S_v$$

$$= (31.3996 + 1. - 0.0 * 1.0) * 138$$

$$= 446.75 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * (\text{Hub Thickness}) * t * f_{r1})) * S_v$$

$$= (31.3996 + 0.0 + 1. + (14.0)) * 138$$

$$= 639.80 \text{ kN}$$

Weld Load [W3]:

$$= (A2 + A3 + A4 + (2 * (\text{Hub Thickness}) * t * f_{r1})) * S_v$$

$$= (31.3996 + 0.0 + 1. + 0.0) * 138$$

$$= 639.80 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416 / 2.0) * 225.829 * 10.0 * 0.49 * 138$$

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 166 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
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= 240. kN

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 95.4145) * (35.0 - 0.0) * 0.7 * 138$$

$$= 1013. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 225.829 * (15.0 - 0.0) * 0.74 * 138$$

$$= 543. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (240 + 1013) = 1252 \text{ kN}$$

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

$$= (240 + 0 + 543 + 0) = 783 \text{ kN}$$

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

$$= (240 + 543 + 0) = 783 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 1252 kN , must exceed W = 306 kN or W1 = 446 kN
 Path 2-2 = 782 kN , must exceed W = 306 kN or W2 = 639 kN
 Path 3-3 = 782 kN , must exceed W = 306 kN or W3 = 639 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 18.5463 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 238.5462 mm.

Input Echo, WRC107/537 Item 1, Description: N01 (6in) :

Diameter Basis for Vessel	Vbasis	ID
Cylindrical or Spherical Vessel	Cylsph	Cylindrical
Internal Corrosion Allowance	Cas	0.0000 mm.
Vessel Diameter	Dv	706.000 mm.
Vessel Thickness	Tv	20.000 mm.
Design Temperature	T1	148.0 °C
Vessel Material		SA-516 70
Vessel UNS Number		K02700
Vessel Cold S.I. Allowable	Smc	137.90 N./mm ²
Vessel Hot S.I. Allowable	Smh	137.90 N./mm ²

Note:

Using 2 * Yield for Discontinuity Stress Allowable (Div 2, 4.1.6.3), Sps.

Make sure that material properties at this temperature are not time-dependent for Material: SA-516 70

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	BK	GCS	MF	120	ME	CN	0001		V01

Attachment Type	Type	Round
Diameter Basis for Nozzle	Nbasis	ID
Corrosion Allowance for Nozzle	Can	0.0000 mm.
Nozzle Diameter	Dn	155.829 mm.
Nozzle Thickness	Tn	35.000 mm.
Nozzle Material		SA-105
Nozzle UNS Number		K03504
Nozzle Cold S.I. Allowable	SNmc	137.90 N./mm ²
Nozzle Hot S.I. Allowable	SNmh	137.90 N./mm ²
Design Internal Pressure	Dp	62.000 bars
Include Pressure Thrust		No

External Forces and Moments in WRC 107/537 Convention:

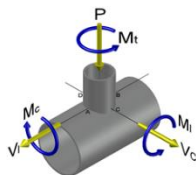
Radial Load	(SUS)	P	9.6	kN
Longitudinal Shear	(SUS)	Vl	9.6	kN
Circumferential Shear	(SUS)	Vc	-7.2	kN
Circumferential Moment	(SUS)	Mc	-2880.0	N-m
Longitudinal Moment	(SUS)	Ml	-3740.0	N-m
Torsional Moment	(SUS)	Mt	-4320.0	N-m

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".



Stress Attenuation Diameter (for Insert Plates) per WRC 297:

$$\begin{aligned}
 &= \text{NozzleOD} + 2 * 1.65 * \text{sqrt}(\text{Rmean}(\text{t} - \text{ca})) \\
 &= 225.829 + 2 * 1.65 * \text{sqrt}(363.0 (20.0 - 0.0)) \\
 &= 507.008 \text{ mm.}
 \end{aligned}$$

WRC 107 Stress Calculation for SUS tained loads:

Radial Load	P	9.6	kN
Circumferential Shear	VC	-7.2	kN
Longitudinal Shear	VL	9.6	kN
Circumferential Moment	MC	-2880.0	N-m

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Longitudinal Moment ML -3740.0 N-m
Torsional Moment MT -4320.0 N-m

Dimensionless Parameters used : Gamma = 18.15

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979	Beta	Figure	Value	Location
N (PHI) / (P/Rm)	0.272	4C	2.613	(A,B)
N (PHI) / (P/Rm)	0.272	3C	1.798	(C,D)
M (PHI) / (P)	0.272	2C1	0.038	(A,B)
M (PHI) / (P)	0.272	1C !	0.067	(C,D)
N (PHI) / (MC/ (Rm**2 * Beta))	0.272	3A	0.771	(A,B,C,D)
M (PHI) / (MC/ (Rm * Beta))	0.272	1A	0.082	(A,B,C,D)
N (PHI) / (ML/ (Rm**2 * Beta))	0.272	3B	1.908	(A,B,C,D)
M (PHI) / (ML/ (Rm * Beta))	0.272	1B	0.028	(A,B,C,D)
N (x) / (P/Rm)	0.272	3C	1.798	(A,B)
N (x) / (P/Rm)	0.272	4C	2.613	(C,D)
M (x) / (P)	0.272	1C1	0.067	(A,B)
M (x) / (P)	0.272	2C !	0.038	(C,D)
N (x) / (MC/ (Rm**2 * Beta))	0.272	4A	1.416	(A,B,C,D)
M (x) / (MC/ (Rm * Beta))	0.272	2A	0.041	(A,B,C,D)
N (x) / (ML/ (Rm**2 * Beta))	0.272	4B	0.742	(A,B,C,D)
M (x) / (ML/ (Rm * Beta))	0.272	2B	0.046	(A,B,C,D)

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

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

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

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-3.5	-3.5	-3.5	-3.5	-2.4	-2.4	-2.4	-2.4
Circ. Bend. P		-5.5	5.5	-5.5	5.5	-9.6	9.6	-9.6	9.6
Circ. Memb. MC		0.0	0.0	0.0	0.0	3.1	3.1	-3.1	-3.1
Circ. Memb. MC		0.0	0.0	0.0	0.0	36.0	-36.0	-36.0	36.0
Circ. Memb. ML		9.9	9.9	-9.9	-9.9	0.0	0.0	0.0	0.0
Circ. Bend. ML		15.7	-15.7	-15.7	15.7	0.0	0.0	0.0	0.0
Tot. Circ. Str.		16.7	-3.8	-34.6	7.8	27.1	-25.7	-51.1	40.2
Long. Memb. P		-2.4	-2.4	-2.4	-2.4	-3.5	-3.5	-3.5	-3.5
Long. Bend. P		-9.6	9.6	-9.6	9.6	-5.5	5.5	-5.5	5.5
Long. Memb. MC		0.0	0.0	0.0	0.0	5.7	5.7	-5.7	-5.7
Long. Bend. MC		0.0	0.0	0.0	0.0	17.9	-17.9	-17.9	17.9
Long. Memb. ML		3.9	3.9	-3.9	-3.9	0.0	0.0	0.0	0.0
Long. Bend. ML		26.0	-26.0	-26.0	26.0	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 CONTACTOR (C-100)							شماره صفحه : 169 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Tot. Long. Str.	17.9	-14.9	-41.8	29.3	14.6	-10.1	-32.5	14.2
Shear VC	-1.0	-1.0	1.0	1.0	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
Shear MT	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7
Tot. Shear	-3.7	-3.7	-1.7	-1.7	-4.0	-4.0	-1.3	-1.3
Str. Int.	21.1	16.0	42.2	29.5	28.3	26.7	51.2	40.2

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)		106.4	112.6	106.4	112.6	106.4	112.6	106.4	112.6
Circ. Pl (SUS)		6.5	6.5	-13.4	-13.4	0.7	0.7	-5.5	-5.5
Circ. Q (SUS)		10.2	-10.2	-21.2	21.2	26.4	-26.4	-45.6	45.6
Long. Pm (SUS)		53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2
Long. Pl (SUS)		1.5	1.5	-6.2	-6.2	2.2	2.2	-9.1	-9.1
Long. Q (SUS)		16.4	-16.4	-35.6	35.6	12.4	-12.4	-23.4	23.4
Shear Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pl (SUS)		-1.0	-1.0	1.0	1.0	-1.4	-1.4	1.4	1.4
Shear Q (SUS)		-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7	-2.7
Pm (SUS)		106.4	112.6	106.4	112.6	106.4	112.6	106.4	112.6
Pm+Pl (SUS)		112.9	119.1	93.0	99.2	107.2	113.4	101.0	107.2
Pm+Pl+Q (Total)		123.4	109.1	71.9	120.5	133.8	87.3	55.4	152.8

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	112.62	137.90	Passed
Pm+Pl (SUS)	119.13	206.85	Passed
Pm+Pl+Q (TOTAL)	152.81	413.70	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

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شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 170 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: N09 (1in)

From: 30

Pressure for Reinforcement Calculations	P	62.152	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		200.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

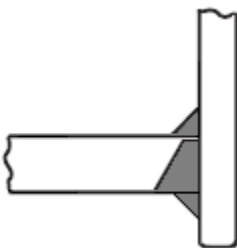
Type of Element Connected to the Shell : Nozzle

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		90.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	14.3000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	325.0000	mm.
Weld leg size, Inside Element to Shell	Wi	15.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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



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

Reinforcement CALCULATION, Description: N09 (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	0.563 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.15 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.15) \\
 &= 16.3530 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 12.7 \left(\exp \left(\frac{62.15}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 0.5855 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2982 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	94.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	47.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	35.7500	mm.
Normal to Vessel Wall, Inward		35.7500	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= 1.000$$

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	4.154	0.470	NA
Area in Shell	A1	2.502	11.182	NA
Area in Nozzle Wall	A2	9.806	10.011	NA
Area in Inward Nozzle	A3	10.225	10.225	NA
Area in Welds	A41+A42+A43	3.250	3.250	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	25.782	34.668	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (25.4 * 16.353 * 1.0 + 2 * 14.3 * 16.353 * 1.0 * (1 - 1.0))$$

$$= 4.154 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d (E1 * t - F * tr) - 2 * tn (E1 * t - F * tr) * (1 - fr1)$$

$$= 68.6 (1.0 * 20.0 - 1.0 * 16.353) - 2 * 14.3$$

$$(1.0 * 20.0 - 1.0 * 16.353) * (1 - 1.0)$$

$$= 2.502 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 35.75) (14.3 - 0.59) 1.0$$

$$= 9.806 \text{ cm}^2$$

Area Available in Inward Nozzle [A3]:

$$= 2 * ti * \min(h, Tl, 2.5 * ti) * fr2$$

$$= 2 * 14.3 * (35.75) * 1.0$$

$$= 10.225 \text{ cm}^2$$

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

$$= Wo^2 * fr2 + (Wi - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (15.0)^2 * 1.0$$

$$= 3.250 \text{ cm}^2$$

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	BK	GCS	MF	120	ME	CN	0001		V01

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

Wall Thickness for Internal/External pressures $t_a = 0.5855 \text{ mm.}$
 Wall Thickness per UG16(b), $t_{r16b} = 1.5000 \text{ mm.}$
 Wall Thickness, shell/head, internal pressure $t_{rb1} = 16.3530 \text{ mm.}$
 Wall Thickness $t_{b1} = \max(t_{rb1}, t_{r16b}) = 16.3530 \text{ mm.}$
 Wall Thickness, shell/head, external pressure $t_{rb2} = 0.2648 \text{ mm.}$
 Wall Thickness $t_{b2} = \max(t_{rb2}, t_{r16b}) = 1.5000 \text{ mm.}$
 Wall Thickness per table UG-45 $t_{b3} = 3.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[t_{b3}, \max(t_{b1}, t_{b2})]$
 $= \min[3.42, \max(16.353, 1.5)]$
 $= 3.4200 \text{ mm.}$

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

$= \max(t_a, t_b)$
 $= \max(0.5855, 3.42)$
 $= 3.4200 \text{ mm.}$

Available Nozzle Neck Thickness = 14.3000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $t_g = 14.3$, $t_r = 0.586$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
 Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.041$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve A 3 °C
 Min Metal Temp. at Required thickness (UCS 66.1) -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) -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 = $62.15/102.10 = 0.609$

Weld Size Calculations, Description: N09 (1in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 14.3000 \text{ mm.}$
 Intermediate Calc. for Inward Weld $T_{minIns} = 14.3000 \text{ mm.}$

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * W_o mm.
Inward Weld	6.0000 = Min per Code	10.6050 = 0.7 * W_i -Can mm.

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

Weld Load [W]:

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$$= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$$

$$= \max(0, (4.1537 - 2.5019 + 2 * 14.3 * 1.0 * (1.0 * 20.0 - 16.353)) 138)$$

$$= 37.16 \text{ kN}$$

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

Weld Load [W1]:

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

$$= (9.8059 + 0.0 + 3.25 - 8.8583 * 1.0) * 138$$

$$= 149.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (9.8059 + 10.2245 + 3.25 + (5.72)) * 138$$

$$= 399.88 \text{ kN}$$

Weld Load [W3]:

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

$$= (9.8059 + 10.2245 + 3.25 + 0.0 + (5.72)) * 138$$

$$= 399.88 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 54.0 * 10.0 * 0.49 * 138$$

$$= 57. \text{ kN}$$

Shear, Inward Nozzle Weld [Sinw]:

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

$$= (3.1416/2.0) * 54.0 * 15.0 * 0.49 * 138$$

$$= 86. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 19.85) * (14.3 - 0.0) * 0.7 * 138$$

$$= 86. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 54.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 156. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (57 + 86) = 143 \text{ kN}$$

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

$$= (57 + 0 + 156 + 86) = 299 \text{ kN}$$

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

$$= (57 + 156 + 86) = 299 \text{ kN}$$

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	BK	GCS	MF	120	ME	CN	0001		V01

Summary of Failure Path Calculations:

Path 1-1 = 143 kN , must exceed $W = 37 \text{ kN}$ or $W1 = 149 \text{ kN}$
 Path 2-2 = 299 kN , must exceed $W = 37 \text{ kN}$ or $W2 = 399 \text{ kN}$
 Path 3-3 = 299 kN , must exceed $W = 37 \text{ kN}$ or $W3 = 399 \text{ kN}$

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 1.0341 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 545.0000 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K07B (3in)

From: 30

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1100.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

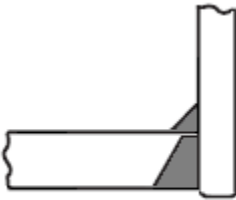
Type of Element Connected to the Shell : Nozzle

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		3.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	20.4000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)																									
شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 177 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	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: K07B (3in)

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

Actual Inside Diameter Used in Calculation	3.000 in.
Actual Thickness Used in Calculation	0.803 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 38.1 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.7522 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.4698 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	157.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	78.5000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 178 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		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	12.430	1.410	NA
Area in Shell	A1	2.980	13.171	NA
Area in Nozzle Wall	A2	18.648	19.930	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	22.628	34.101	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (76.2 \cdot 16.3119 \cdot 1.0 + 2 \cdot 20.4 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 12.430 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 80.8(1.0 \cdot 20.0 - 1.0 \cdot 16.312) - 2 \cdot 20.4$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 2.980 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 50.0)(20.4 - 1.75)1.0$$

$$= 18.648 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.7522 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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 CONTACTOR (C-100)							شماره صفحه : 179 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 5.7300 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[5.73, \max(16.3119, 1.5)]$
 $= 5.7300 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(1.7522, 5.73)$
 $= 5.7300 \text{ mm.}$

Available Nozzle Neck Thickness = 20.4000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 20.0$, $tr = 16.312$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.816$, Temp. Reduction = 10 °C

Min Metal Temp. w/o impact per UCS-66, Curve A $12 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $2 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $2 \text{ }^{\circ}\text{C}$

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 = $62.00 / 102.10 = 0.607$

Weld Size Calculations, Description: K07B (3in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 19.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (12.4297 - 2.98 + 2 * 20.4 * 1.0 * (1.0 * 20.0 - 16.3119)) 138)$
 $= 151.05 \text{ kN}$

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

Weld Load [W1]:

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 180 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (18.6478 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 270.92 \text{ kN}$$

Weld Load [W2]:

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

$$= (18.6478 + 0.0 + 1. + (8.16)) * 138$$

$$= 383.44 \text{ kN}$$

Weld Load [W3]:

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

$$= (18.6478 + 0.0 + 1. + 0.0 + (8.16)) * 138$$

$$= 383.44 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 117.0 * 10.0 * 0.49 * 138$$

$$= 124. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 48.3) * (20.4 - 0.0) * 0.7 * 138$$

$$= 299. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 117.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 338. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (124 + 299) = 423 \text{ kN}$$

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

$$= (124 + 0 + 338 + 0) = 462 \text{ kN}$$

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

$$= (124 + 338 + 0) = 462 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 422 kN , must exceed W = 151 kN or W1 = 270 kN

Path 2-2 = 461 kN , must exceed W = 151 kN or W2 = 383 kN

Path 3-3 = 461 kN , must exceed W = 151 kN or W3 = 383 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 4.8811 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 224.8811 mm.

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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K08B (2in)

From: 30

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		828.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

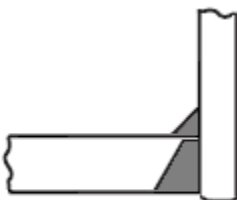
Type of Element Connected to the Shell : Nozzle

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		45.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: K08B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.1681 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 184 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		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	8.286	0.940	NA
Area in Shell	A1	2.700	11.932	NA
Area in Nozzle Wall	A2	12.808	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.508	26.389	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.286 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.312) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 2.700 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.808 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1681 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 185 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3119, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1681, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.168$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

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 = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K08B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (8.2864 - 2.6997 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3119)) 138)$
 $= 93.92 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8085 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.40 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8085 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8085 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 93 kN or W1 = 190 kN

Path 2-2 = 331 kN , must exceed W = 93 kN or W2 = 281 kN

Path 3-3 = 331 kN , must exceed W = 93 kN or W3 = 281 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K08A (2in)

From: 30

Pressure for Reinforcement Calculations	P	62.125	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		472.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

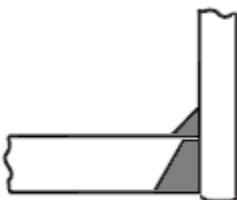
Type of Element Connected to the Shell : Nozzle

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		45.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: K08A (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

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

$$= (62.13 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.13)$$

$$= 16.3458 \text{ mm.}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)}$$

$$= 25.4 \left(\exp \left(\frac{62.13}{137.9 \cdot 1.0} \right) - 1 \right)$$

$$= 1.1705 \text{ mm.}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000	mm.

Weld Strength Reduction Factor [fr1]:

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

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

$$= 1.000$$

Weld Strength Reduction Factor [fr2]:

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

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

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	BK	GCS	MF	120	ME	CN	0001		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	8.304	0.940	NA
Area in Shell	A1	2.675	11.932	NA
Area in Nozzle Wall	A2	12.806	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.481	26.389	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3458 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3458 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.304 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.346) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3458) \cdot (1 - 1.0)$$

$$= 2.675 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.806 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1705 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3458 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3458 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(trb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3458, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1705, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.171$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.071$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

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 = $62.13 / 102.10 = 0.608$

Weld Size Calculations, Description: K08A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (8.3037 - 2.6749 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3458)) 138)$
 $= 94.34 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8065 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.37 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8065 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.93 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8065 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.93 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 94 kN or W1 = 190 kN
 Path 2-2 = 331 kN , must exceed W = 94 kN or W2 = 281 kN
 Path 3-3 = 331 kN , must exceed W = 94 kN or W3 = 281 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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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 CONTACTOR (C-100)							شماره صفحه : 194 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K09B (2in)

From: 30

Pressure for Reinforcement Calculations	P	62.142	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		300.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

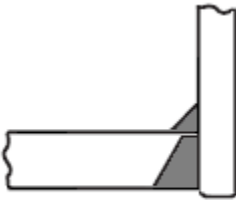
Type of Element Connected to the Shell : Nozzle

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		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)																									
شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 195 از 383
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Nozzle Sketch (may not represent actual weld type/configuration)



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

Reinforcement CALCULATION, Description: K09B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.14 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.14) \\
 &= 16.3503 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 \left(\exp \left(\frac{62.14}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.1709 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	8.306	0.940	NA
Area in Shell	A1	2.672	11.932	NA
Area in Nozzle Wall	A2	12.806	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.478	26.389	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (50.8 * 16.3503 * 1.0 + 2 * 16.6 * 16.3503 * 1.0 * (1 - 1.0))$$

$$= 8.306 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 * t - F * tr) - 2 * tn(E1 * t - F * tr) * (1 - fr1)$$

$$= 73.2(1.0 * 20.0 - 1.0 * 16.35) - 2 * 16.6$$

$$(1.0 * 20.0 - 1.0 * 16.3503) * (1 - 1.0)$$

$$= 2.672 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 41.5)(16.6 - 1.17)1.0$$

$$= 12.806 \text{ cm}^2$$

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

$$= Wo^2 * fr2 + (Wi - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1709 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3503 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3503 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3503, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1709, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.171$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.071$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

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 = $62.14 / 102.10 = 0.609$

Weld Size Calculations, Description: K09B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (8.306 - 2.6716 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3503)) 138)$
 $= 94.40 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8062 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.37 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8062 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.93 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8062 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.93 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 94 kN or W1 = 190 kN
 Path 2-2 = 331 kN , must exceed W = 94 kN or W2 = 281 kN
 Path 3-3 = 331 kN , must exceed W = 94 kN or W3 = 281 kN

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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N10A (8in)

From: 30

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		1650.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

Type of Element Connected to the Shell : Nozzle

Material [Impact Tested]		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		8.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	STD	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	80.0000	mm.
Height of Beveled Transition	L'	22.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		45.0000	mm.
Style of FVC Nozzle		Heavy Barrel	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
This is a Manway or Access Opening.			

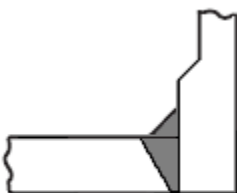
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Class
Flange Grade

600
GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Reinforcement CALCULATION, Description: N10A (8in)

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

Actual Inside Diameter Used in Calculation	8.061 in.
Actual Thickness Used in Calculation	0.282 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 102.38) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 4.7310 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.6750 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):

Height value from sketch (e-1) [te]:

$$\begin{aligned}
 &= (\text{Hub Thickness} - \text{Neck Thickness}) / \tan(30) \\
 &= 37.844 / 0.5773
 \end{aligned}$$

 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)																									
شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 202 از 383
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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

= 65.5470 mm.

Note: Hub Height was < 2.5 times Hub Thickness, use sketch UG-40 (e-1).

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

Parallel to Vessel Wall (Diameter Limit)	D1	409.5242	mm.
Parallel to Vessel Wall, opening length	d	204.7621	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000	mm.

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 [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	33.401	3.788	NA
Area in Shell	A1	7.552	33.377	NA
Area in Nozzle Wall	A2	2.425	6.481	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43	A4	1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	37.844	37.844	NA
TOTAL AREA AVAILABLE	Atot	48.821	78.702	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * t_n * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (204.7621 * 16.3119 * 1.0 + 2 * 45.0 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 33.401 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 * t - F * tr) - 2 * t_n(E1 * t - F * tr) * (1 - fr1)$$

$$= 204.762(1.0 * 20.0 - 1.0 * 16.312) - 2 * 45.0$$

$$(1.0 * 20.0 - 1.0 * 16.3119) * (1 - 1.0)$$

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$$= 7.552 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 * t_{lnp}) (t_n - t_{rn}) fr^2$$

$$= (2 * 50.0) (7.16 - 4.73) 1.0$$

$$= 2.425 \text{ cm}^2$$

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

$$= W_o^2 * fr^2 + (W_i - can / 0.707)^2 * fr^2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Area Available in the Hub Section [A6]:

$$= (2 * \min(t_{lnp}, h_o, \text{Hubht})) * (\text{Hubtk} - t_n) * fr^2$$

$$= (2 * \min(50.0, 200.0, 80.0)) * (45.0 - 7.2) * 1.0$$

$$= 37.844 \text{ cm}^2$$

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, Curve: A

Govrn. thk, tg = 7.156, tr = 4.731, c = 0.0 mm., E* = 1.0
Thickness Ratio = tr * (E*) / (tg - c) = 0.661, Temp. Reduction = 19 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-27 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

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

Govrn. thk, tg = 20.0, tr = 16.312, c = 0.0 mm., E* = 1.0
Thickness Ratio = tr * (E*) / (tg - c) = 0.816, Temp. Reduction = 10 °C

Min Metal Temp. w/o impact per UCS-66, Curve D	-40 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-48 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -29 °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 :

$$\text{Design Pressure/Ambient Rating} = 62.00/102.10 = 0.607$$

Weld Size Calculations, Description: N10A (8in)

Intermediate Calc. for nozzle/shell Welds Tmin 19.0000 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm.

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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

Weld Load [W]:

$$\begin{aligned}
 &= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv) \\
 &= \max(0, (33.4006 - 7.5518 + 2 * 45.0 * 1.0 * (1.0 * 20.0 - 16.3119))138) \\
 &= 402.19 \text{ kN}
 \end{aligned}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

$$\begin{aligned}
 &= (A2+A4-(Wi-Can/.707)^2*fr2)*Sv \\
 &= (40.269 + 1. - 0.0 * 1.0) * 138 \\
 &= 569.05 \text{ kN}
 \end{aligned}$$

Weld Load [W2]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv \\
 &= (40.269 + 0.0 + 1. + (18.0)) * 138 \\
 &= 817.25 \text{ kN}
 \end{aligned}$$

Weld Load [W3]:

$$\begin{aligned}
 &= (A2+A3+A4+A5+(2*tn*t*fr1))*S \\
 &= (40.269 + 0.0 + 1. + 0.0 + (18.0)) * 138 \\
 &= 817.25 \text{ kN}
 \end{aligned}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

$$\begin{aligned}
 &= (\pi/2) * Dlo * Wo * 0.49 * Snw \\
 &= (3.1416/2.0) * 294.7621 * 10.0 * 0.49 * 138 \\
 &= 313. \text{ kN}
 \end{aligned}$$

Shear, Nozzle Wall [Snw]:

$$\begin{aligned}
 &= (\pi * (Dlr + Dlo) / 4) * (Thk - Can) * 0.7 * Sn \\
 &= (3.1416 * 124.881) * (45.0 - 0.0) * 0.7 * 138 \\
 &= 1704. \text{ kN}
 \end{aligned}$$

Tension, Shell Groove Weld [Tngw]:

$$\begin{aligned}
 &= (\pi/2) * Dlo * (Wgnvi-Cas) * 0.74 * Sng \\
 &= (3.1416/2.0) * 294.7621 * (18.0 - 0.0) * 0.74 * 138 \\
 &= 850. \text{ kN}
 \end{aligned}$$

Strength of Failure Paths:

$$\begin{aligned}
 \text{PATH11} &= (\text{SONW} + \text{SNW}) = (313 + 1704) = 2017 \text{ kN} \\
 \text{PATH22} &= (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw}) \\
 &= (313 + 0 + 850 + 0) = 1163 \text{ kN} \\
 \text{PATH33} &= (\text{Sonw} + \text{Tngw} + \text{Sinw}) \\
 &= (313 + 850 + 0) = 1163 \text{ kN}
 \end{aligned}$$

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	BK	GCS	MF	120	ME	CN	0001		V01

Summary of Failure Path Calculations:

Path 1-1 = 2016 kN , must exceed W = 402 kN or W1 = 569 kN
 Path 2-2 = 1163 kN , must exceed W = 402 kN or W2 = 817 kN
 Path 3-3 = 1163 kN , must exceed W = 402 kN or W3 = 817 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 bars

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

The Drop for this Nozzle is : 32.2387 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 252.2386 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N05 (2in)

From: 30

Pressure for Reinforcement Calculations	P	62.152	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2108.8333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		200.00	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

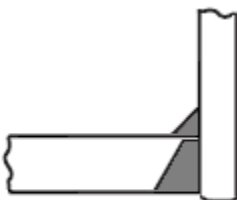
Type of Element Connected to the Shell : Nozzle

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		270.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.7640	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: N05 (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.660 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.15 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.15) \\
 &= 16.3530 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R (\exp([P / (S_n \cdot E)] - 1)) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 (\exp([62.15 / (137.9 \cdot 1.0)] - 1)) \\
 &= 1.1710 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3870 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.3280 mm.
Parallel to Vessel Wall	Rn+tn+t	62.1640 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.9100 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	8.307	0.940	NA
Area in Shell	A1	2.682	11.985	NA
Area in Nozzle Wall	A2	13.070	13.727	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds	A41+A42+A43	1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.752	26.712	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.353 \cdot 1.0 + 2 \cdot 16.764 \cdot 16.353 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.307 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.528(1.0 \cdot 20.0 - 1.0 \cdot 16.353) - 2 \cdot 16.764$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.353) \cdot (1 - 1.0)$$

$$= 2.682 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.91)(16.76 - 1.17)1.0$$

$$= 13.070 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1710 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3530 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3530 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.353, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.171, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.7640 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.764$, $tr = 1.171$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

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 = $62.15/102.10 = 0.609$

Weld Size Calculations, Description: N05 (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.7640 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * tn * fr1 * (E1 * t - tr)) Sv)$
 $= \max(0, (8.3073 - 2.6816 + 2 * 16.764 * 1.0 * (1.0 * 20.0 - 16.353)) 138)$
 $= 94.43 \text{ kN}$

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

Weld Load [W1]:

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 210 از 383	
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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (13.07 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 194.01 \text{ kN}$$

Weld Load [W2]:

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

$$= (13.07 + 0.0 + 1. + (6.7056)) * 138$$

$$= 286.47 \text{ kN}$$

Weld Load [W3]:

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

$$= (13.07 + 0.0 + 1. + 0.0 + (6.7056)) * 138$$

$$= 286.47 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.328 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.782) * (16.764 - 0.0) * 0.7 * 138$$

$$= 172. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.328 * (18.0 - 0.0) * 0.74 * 138$$

$$= 243. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 172) = 261 \text{ kN}$$

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

$$= (89 + 0 + 243 + 0) = 333 \text{ kN}$$

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

$$= (89 + 243 + 0) = 333 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 261 kN , must exceed W = 94 kN or W1 = 194 kN
 Path 2-2 = 332 kN , must exceed W = 94 kN or W2 = 286 kN
 Path 3-3 = 332 kN , must exceed W = 94 kN or W3 = 286 kN

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 211 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 2.5272 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5272 mm.

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 212 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N04 (1in)

From: 60

Pressure for Reinforcement Calculations	P	62.093	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		2499.53	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

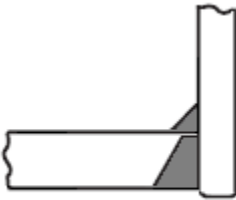
Type of Element Connected to the Shell : Nozzle

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		90.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	14.3000	mm.
Flange Material		SA-106 B	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	mm.
Joint Efficiency of Shell Seam at Nozzle	E1	1.00	
Joint Efficiency of Nozzle Neck	En	1.00	
Outside Projection	ho	226.1880	mm.
Weld leg size between Nozzle and Pad/Shell	Wo	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 213 از 383
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	
	V01	0001	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: 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	0.563 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.09 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.09) \\
 &= 16.3371 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R (\exp([P / (S_n \cdot E)] - 1)) \text{ per Appendix 1-2 (a) (1)} \\
 &= 12.7 (\exp([62.09 / (137.9 \cdot 1.0)] - 1)) \\
 &= 0.5850 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3143 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	94.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	47.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	35.7500 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 214 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		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	4.150	0.459	NA
Area in Shell	A1	2.513	11.242	NA
Area in Nozzle Wall	A2	9.806	10.000	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	13.319	22.241	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (25.4 \cdot 16.3371 \cdot 1.0 + 2 \cdot 14.3 \cdot 16.3371 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 4.150 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 68.6(1.0 \cdot 20.0 - 1.0 \cdot 16.337) - 2 \cdot 14.3$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3371) \cdot (1 - 1.0)$$

$$= 2.513 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 35.75)(14.3 - 0.58)1.0$$

$$= 9.806 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 0.5850 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3371 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3371 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>MF</td><td>120</td><td>ME</td><td>CN</td><td>0001</td><td>V01</td></tr></table>	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)								پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	BK	GCS	MF	120	ME	CN	0001	V01	شماره صفحه : 215 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه																			
BK	GCS	MF	120	ME	CN	0001	V01																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 3.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[3.42, \max(16.3371, 1.5)]$
 $= 3.4200 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(0.585, 3.42)$
 $= 3.4200 \text{ mm.}$

Available Nozzle Neck Thickness = 14.3000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 14.3$, $tr = 0.585$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.041$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve A $3 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^{\circ}\text{C}$

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

Design Pressure/Ambient Rating = $62.09/102.10 = 0.608$

Weld Size Calculations, Description: N04 (1in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 14.3000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * tn * fr1 * (E1 * t - tr)) Sv)$
 $= \max(0, (4.1496 - 2.5128 + 2 * 14.3 * 1.0 * (1.0 * 20.0 - 16.3371)) 138)$
 $= 37.02 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (9.8063 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 149.01 \text{ kN}$$

Weld Load [W2]:

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

$$= (9.8063 + 0.0 + 1. + (5.72)) * 138$$

$$= 227.88 \text{ kN}$$

Weld Load [W3]:

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

$$= (9.8063 + 0.0 + 1. + 0.0 + (5.72)) * 138$$

$$= 227.88 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 54.0 * 10.0 * 0.49 * 138$$

$$= 57. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 19.85) * (14.3 - 0.0) * 0.7 * 138$$

$$= 86. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 54.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 156. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (57 + 86) = 143 \text{ kN}$$

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

$$= (57 + 0 + 156 + 0) = 213 \text{ kN}$$

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

$$= (57 + 156 + 0) = 213 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 143 kN , must exceed W = 37 kN or W1 = 149 kN

Path 2-2 = 213 kN , must exceed W = 37 kN or W2 = 227 kN

Path 3-3 = 213 kN , must exceed W = 37 kN or W3 = 227 kN

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	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 1.0341 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 247.2221 mm.

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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 CONTACTOR (C-100)							شماره صفحه : 218 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N10B (8in)

From: 60

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		3893.23	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

Type of Element Connected to the Shell : Nozzle

Material [Impact Tested]		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		8.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	STD	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	80.0000	mm.
Height of Beveled Transition	L'	22.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		45.0000	mm.
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
This is a Manway or Access Opening.			

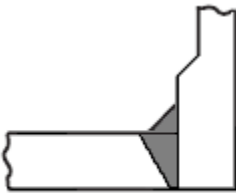
 NISOC	نگهداشت و افزایش تولید میدان نفتی بینک سطح الارض و ابنیه تحت الارض خرید بسته نم زدای گاز ایستگاه تقویت فشار گاز بینک (قرارداد BK-HD-GCS-CO-0010_08)																									
شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 219 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Flange Class
Flange Grade

600
GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Reinforcement CALCULATION, Description: N10B (8in)

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

Actual Inside Diameter Used in Calculation	8.061 in.
Actual Thickness Used in Calculation	0.282 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 102.38) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 4.7310 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.6750 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):

Height value from sketch (e-1) [te]:

$$\begin{aligned}
 &= (\text{Hub Thickness} - \text{Neck Thickness}) / \tan(30) \\
 &= 37.844 / 0.5773 \\
 &= 65.5470 \text{ mm.}
 \end{aligned}$$

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 220 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Note: Hub Height was < 2.5 times Hub Thickness, use sketch UG-40 (e-1).

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

Parallel to Vessel Wall (Diameter Limit)	D1	409.5242	mm.
Parallel to Vessel Wall, opening length	d	204.7621	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000	mm.

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 [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	33.401	3.699	NA
Area in Shell	A1	7.552	33.555	NA
Area in Nozzle Wall	A2	2.425	6.481	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	37.844	37.844	NA
TOTAL AREA AVAILABLE	Atot	48.821	78.880	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * t_n * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (204.7621 * 16.3119 * 1.0 + 2 * 45.0 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 33.401 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d (E1 * t - F * tr) - 2 * t_n (E1 * t - F * tr) * (1 - fr1)$$

$$= 204.762 (1.0 * 20.0 - 1.0 * 16.312) - 2 * 45.0$$

$$(1.0 * 20.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 7.552 \text{ cm}^2$$

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 * t_{lnp}) (t_n - t_{rn}) fr_2$$

$$= (2 * 50.0) (7.16 - 4.73) 1.0$$

$$= 2.425 \text{ cm}^2$$

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

$$= W_o^2 * fr_2 + (W_i - c_{an}/0.707)^2 * fr_2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Area Available in the Hub Section [A6]:

$$= (2 * \min(t_{lnp}, h_o, H_{ubht})) * (H_{ubtk} - t_n) * fr_2$$

$$= (2 * \min(50.0, 200.0, 80.0)) * (45.0 - 7.2) * 1.0$$

$$= 37.844 \text{ cm}^2$$

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld (Impact tested) :

Note: This Element/Detail was specified as being Impact Tested.

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

Govern. $t_h, t_g = 20.0, t_r = 16.312, c = 0.0 \text{ mm.}, E^* = 1.0$

Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.816$, Temp. Reduction = 10°C

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -14 °C

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

MDMT of ANSI B16.5/47 flange per Matl. Specification -18 °C
Flange MDMT with Temp reduction per UCS-66(i) (2) -40 °C

Where the Stress Reduction Ratio per UCS-66(i)(2) is :

$$\text{Design Pressure/Ambient Rating} = 62.00/102.10 = 0.607$$

Weld Size Calculations, Description: N10B (8in)

Intermediate Calc. for nozzle/shell Welds $T_{min} \quad 19.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld 6.0000 = Min per Code 7.0700 = 0.7 * W_o mm.

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

Weld Load [W]:

$$= \max(0, (A - A_1 + 2 * t_n * fr_1 * (E_1 * t - t_r)) S_v)$$

$$= \max(0, (33.4006 - 7.5518 + 2 * 45.0 * 1.0 *)$$

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	BK	GCS	MF	120	ME	CN	0001		V01

$$(1.0 * 20.0 - 16.3119) * 138 = 402.19 \text{ kN}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

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

$$= (40.269 + 1. - 0.0 * 1.0) * 138$$

$$= 569.05 \text{ kN}$$

Weld Load [W2]:

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

$$= (40.269 + 0.0 + 1. + (18.0)) * 138$$

$$= 817.25 \text{ kN}$$

Weld Load [W3]:

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

$$= (40.269 + 0.0 + 1. + 0.0 + (18.0)) * 138$$

$$= 817.25 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416 / 2.0) * 294.7621 * 10.0 * 0.49 * 138$$

$$= 313. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 124.881) * (45.0 - 0.0) * 0.7 * 138$$

$$= 1704. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416 / 2.0) * 294.7621 * (18.0 - 0.0) * 0.74 * 138$$

$$= 850. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (313 + 1704) = 2017 \text{ kN}$$

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

$$= (313 + 0 + 850 + 0) = 1163 \text{ kN}$$

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

$$= (313 + 850 + 0) = 1163 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 2016 kN , must exceed W = 402 kN or W1 = 569 kN
 Path 2-2 = 1163 kN , must exceed W = 402 kN or W2 = 817 kN
 Path 3-3 = 1163 kN , must exceed W = 402 kN or W3 = 817 kN

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 223 از 383	
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 bars

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

The Drop for this Nozzle is : 32.2387 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 252.2386 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K2B (2in)

From: 60

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		3781.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

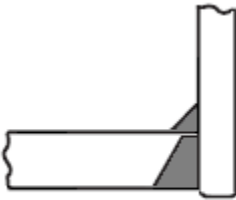
Type of Element Connected to the Shell : Nozzle

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		45.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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Nozzle Sketch (may not represent actual weld type/configuration)



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

Reinforcement CALCULATION, Description: K2B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.1681 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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	BK	GCS	MF	120	ME	CN	0001		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	8.286	0.918	NA
Area in Shell	A1	2.700	11.995	NA
Area in Nozzle Wall	A2	12.808	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.508	26.453	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.286 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.312) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 2.700 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.808 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1681 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 227 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(trb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3119, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1681, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.168$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^{\circ}\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^{\circ}\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K2B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (8.2864 - 2.6997 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3119))138)$
 $= 93.92 \text{ kN}$

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

Weld Load [W1]:

 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	0001		V01

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

$$= (12.8085 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.40 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8085 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8085 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 93 kN or W1 = 190 kN
 Path 2-2 = 331 kN , must exceed W = 93 kN or W2 = 281 kN
 Path 3-3 = 331 kN , must exceed W = 93 kN or W3 = 281 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K2A (2in)

From: 60

Pressure for Reinforcement Calculations	P	62.002	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		3425.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

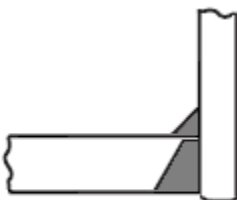
Type of Element Connected to the Shell : Nozzle

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		45.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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	0001		V01

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



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

Reinforcement CALCULATION, Description: K2A (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (137.9 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3125 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.1682 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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	0001		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	8.287	0.918	NA
Area in Shell	A1	2.699	11.995	NA
Area in Nozzle Wall	A2	12.808	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.508	26.453	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3125 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3125 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.287 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.313) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3125) \cdot (1 - 1.0)$$

$$= 2.699 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.808 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1682 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3125 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3125 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(trb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3125, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1682, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.168$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K2A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (8.2868 - 2.6992 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3125))138)$
 $= 93.93 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8084 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.40 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8084 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8084 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.96 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 93 kN or W1 = 190 kN
 Path 2-2 = 331 kN , must exceed W = 93 kN or W2 = 281 kN
 Path 3-3 = 331 kN , must exceed W = 93 kN or W3 = 281 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 CONTACTOR (C-100)							شماره صفحه : 235 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K3A (2in)

From: 60

Pressure for Reinforcement Calculations	P	62.073	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		2703.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

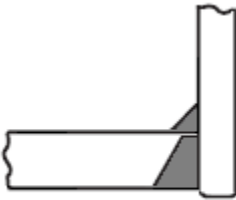
Type of Element Connected to the Shell : Nozzle

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		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	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: K3A (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.07 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.07) \\
 &= 16.3317 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R (\exp([P / (S_n \cdot E)] - 1)) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 (\exp([62.07 / (137.9 \cdot 1.0)] - 1)) \\
 &= 1.1695 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		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	8.296	0.918	NA
Area in Shell	A1	2.685	11.995	NA
Area in Nozzle Wall	A2	12.807	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.493	26.453	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3317 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3317 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.296 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.332) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3317) \cdot (1 - 1.0)$$

$$= 2.685 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.807 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1695 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3317 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3317 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(trb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3317, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1695, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.17$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.07/102.10 = 0.608$

Weld Size Calculations, Description: K3A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (8.2965 - 2.6852 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3317)) 138)$
 $= 94.17 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8073 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.39 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8073 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.94 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8073 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.94 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 94 kN or W1 = 190 kN

Path 2-2 = 331 kN , must exceed W = 94 kN or W2 = 281 kN

Path 3-3 = 331 kN , must exceed W = 94 kN or W3 = 281 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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K3B (2in)

From: 60

Pressure for Reinforcement Calculations	P	62.038	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		3059.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

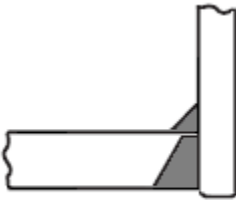
Type of Element Connected to the Shell : Nozzle

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		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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	V01	0001	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: K3B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.04 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.04) \\
 &= 16.3222 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 25.4 \left(\exp \left(\frac{62.04}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.1689 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	41.5000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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)																									
شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 244 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	8.292	0.918	NA
Area in Shell	A1	2.692	11.995	NA
Area in Nozzle Wall	A2	12.808	13.457	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	16.500	26.453	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (50.8 \cdot 16.3222 \cdot 1.0 + 2 \cdot 16.6 \cdot 16.3222 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 8.292 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 73.2(1.0 \cdot 20.0 - 1.0 \cdot 16.322) - 2 \cdot 16.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3222) \cdot (1 - 1.0)$$

$$= 2.692 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 41.5)(16.6 - 1.17)1.0$$

$$= 12.808 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.1689 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3222 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3222 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(trb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 4.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[4.8, \max(16.3222, 1.5)]$
 $= 4.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(1.1689, 4.8)$
 $= 4.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.169$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.07$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66 (b) (1) (-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.04/102.10 = 0.608$

Weld Size Calculations, Description: K3B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 16.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * tn * fr1 * (E1 * t - tr)) Sv)$
 $= \max(0, (8.2917 - 2.6921 + 2 * 16.6 * 1.0 * (1.0 * 20.0 - 16.3222)) 138)$
 $= 94.05 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (12.8079 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 190.39 \text{ kN}$$

Weld Load [W2]:

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

$$= (12.8079 + 0.0 + 1. + (6.64)) * 138$$

$$= 281.95 \text{ kN}$$

Weld Load [W3]:

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

$$= (12.8079 + 0.0 + 1. + 0.0 + (6.64)) * 138$$

$$= 281.95 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 33.7) * (16.6 - 0.0) * 0.7 * 138$$

$$= 170. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 170) = 259 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 258 kN , must exceed W = 94 kN or W1 = 190 kN
 Path 2-2 = 331 kN , must exceed W = 94 kN or W2 = 281 kN
 Path 3-3 = 331 kN , must exceed W = 94 kN or W3 = 281 kN

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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K4B (3in)

From: 60

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		4253.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

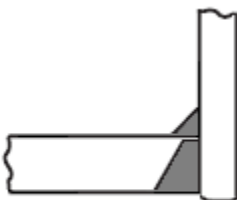
Type of Element Connected to the Shell : Nozzle

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		315.00	deg
Diameter		3.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	20.4000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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	BK	GCS	MF	120	ME	CN	0001	V01

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



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

Reinforcement CALCULATION, Description: K4B (3in)

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

Actual Inside Diameter Used in Calculation	3.000 in.
Actual Thickness Used in Calculation	0.803 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 38.1 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.7522 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.4698 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	157.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	78.5000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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	BK	GCS	MF	120	ME	CN	0001		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	12.430	1.376	NA
Area in Shell	A1	2.980	13.241	NA
Area in Nozzle Wall	A2	18.648	19.930	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	22.628	34.171	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (76.2 \cdot 16.3119 \cdot 1.0 + 2 \cdot 20.4 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 12.430 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 80.8(1.0 \cdot 20.0 - 1.0 \cdot 16.312) - 2 \cdot 20.4$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 2.980 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 50.0)(20.4 - 1.75)1.0$$

$$= 18.648 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.7522 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 5.7300 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[5.73, \max(16.3119, 1.5)]$
 $= 5.7300 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(1.7522, 5.73)$
 $= 5.7300 \text{ mm.}$

Available Nozzle Neck Thickness = 20.4000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 20.0$, $tr = 16.312$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.816$, Temp. Reduction = 10 °C

Min Metal Temp. w/o impact per UCS-66, Curve A $12 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $2 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $2 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^{\circ}\text{C}$

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

Design Pressure/Ambient Rating = $62.00 / 102.10 = 0.607$

Weld Size Calculations, Description: K4B (3in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 19.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (12.4297 - 2.98 + 2 * 20.4 * 1.0 * (1.0 * 20.0 - 16.3119)) 138)$
 $= 151.05 \text{ kN}$

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

Weld Load [W1]:

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شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 252 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (18.6478 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 270.92 \text{ kN}$$

Weld Load [W2]:

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

$$= (18.6478 + 0.0 + 1. + (8.16)) * 138$$

$$= 383.44 \text{ kN}$$

Weld Load [W3]:

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

$$= (18.6478 + 0.0 + 1. + 0.0 + (8.16)) * 138$$

$$= 383.44 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 117.0 * 10.0 * 0.49 * 138$$

$$= 124. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 48.3) * (20.4 - 0.0) * 0.7 * 138$$

$$= 299. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 117.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 338. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (124 + 299) = 423 \text{ kN}$$

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

$$= (124 + 0 + 338 + 0) = 462 \text{ kN}$$

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

$$= (124 + 338 + 0) = 462 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 422 kN , must exceed W = 151 kN or W1 = 270 kN

Path 2-2 = 461 kN , must exceed W = 151 kN or W2 = 383 kN

Path 3-3 = 461 kN , must exceed W = 151 kN or W3 = 383 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 CONTACTOR (C-100)							شماره صفحه : 253 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 75 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 : 4.8811 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 224.8811 mm.

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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)								
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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K4A (3in)

From: 60

Pressure for Reinforcement Calculations	P	62.073	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		2703.18	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

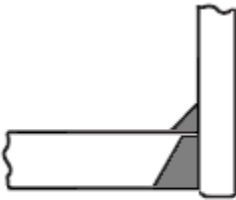
Type of Element Connected to the Shell : Nozzle

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		315.00	deg
Diameter		3.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	20.4000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	0.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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V01	0001	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: K4A (3in)

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

Actual Inside Diameter Used in Calculation	3.000 in.
Actual Thickness Used in Calculation	0.803 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.07 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.07) \\
 &= 16.3317 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 38.1 \left(\exp \left(\frac{62.07}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.7543 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.4698 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	157.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	78.5000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	50.0000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	12.445	1.376	NA
Area in Shell	A1	2.964	13.241	NA
Area in Nozzle Wall	A2	18.646	19.930	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	22.610	34.171	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (76.2 \cdot 16.3317 \cdot 1.0 + 2 \cdot 20.4 \cdot 16.3317 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 12.445 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 80.8(1.0 \cdot 20.0 - 1.0 \cdot 16.332) - 2 \cdot 20.4$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3317) \cdot (1 - 1.0)$$

$$= 2.964 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 50.0)(20.4 - 1.75)1.0$$

$$= 18.646 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 1.7543 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 1.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3317 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3317 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 1.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 5.7300 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[5.73, \max(16.3317, 1.5)]$
 $= 5.7300 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(1.7543, 5.73)$
 $= 5.7300 \text{ mm.}$

Available Nozzle Neck Thickness = 20.4000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 20.0$, $tr = 16.332$, $c = 0.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.817$, Temp. Reduction = $10 \text{ }^{\circ}\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $12 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $2 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $2 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^{\circ}\text{C}$

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

Design Pressure/Ambient Rating = $62.07/102.10 = 0.608$

Weld Size Calculations, Description: K4A (3in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 19.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (12.4447 - 2.964 + 2 * 20.4 * 1.0 * (1.0 * 20.0 - 16.3317)) 138)$
 $= 151.37 \text{ kN}$

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

Weld Load [W1]:

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	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= (18.6457 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 270.89 \text{ kN}$$

Weld Load [W2]:

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

$$= (18.6457 + 0.0 + 1. + (8.16)) * 138$$

$$= 383.41 \text{ kN}$$

Weld Load [W3]:

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

$$= (18.6457 + 0.0 + 1. + 0.0 + (8.16)) * 138$$

$$= 383.41 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 117.0 * 10.0 * 0.49 * 138$$

$$= 124. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 48.3) * (20.4 - 0.0) * 0.7 * 138$$

$$= 299. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 117.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 338. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (124 + 299) = 423 \text{ kN}$$

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

$$= (124 + 0 + 338 + 0) = 462 \text{ kN}$$

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

$$= (124 + 338 + 0) = 462 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 422 kN , must exceed W = 151 kN or W1 = 270 kN
 Path 2-2 = 461 kN , must exceed W = 151 kN or W2 = 383 kN
 Path 3-3 = 461 kN , must exceed W = 151 kN or W3 = 383 kN

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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 76 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 : 4.8811 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 224.8811 mm.

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V01	0001	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: K05 (2in)

From: 60

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	706.00	mm.
Design Length of Section	L	2000.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	0.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		4099.53	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

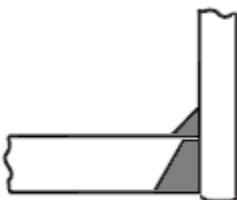
Type of Element Connected to the Shell : Nozzle

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		270.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 261 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: K05 (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	124.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	62.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	9.265	1.026	NA
Area in Shell	A1	2.478	11.012	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	11.834	20.998	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (56.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 13.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 67.2(1.0 \cdot 20.0 - 1.0 \cdot 16.312) - 2 \cdot 13.6$$

$$(1.0 \cdot 20.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 2.478 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 34.0)(13.6 - 1.31)1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 4.3123 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 16.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 16.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 0.2648 \text{ mm.}$

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Wall Thickness $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(16.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K05 (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 2.4784 + 2 * 13.6 * 1.0 * (1.0 * 20.0 - 16.3119)) 138)$
 $= 107.41 \text{ kN}$

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

Weld Load [W1]:

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (5.44)) * 138$$

$$= 204.01 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (5.44)) * 138$$

$$= 204.01 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 0.0) * 0.74 * 138$$

$$= 242. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 242 + 0) = 331 \text{ kN}$$

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

$$= (89 + 242 + 0) = 331 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 107 kN or W1 = 129 kN
 Path 2-2 = 331 kN , must exceed W = 107 kN or W2 = 204 kN
 Path 3-3 = 331 kN , must exceed W = 107 kN or W3 = 204 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 69 bars

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

The Drop for this Nozzle is : 2.5075 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5075 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: K10A (2in)

From: 90

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	4600.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		4874.05	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

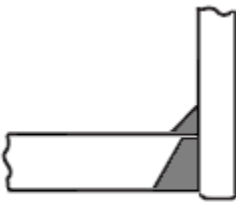
Type of Element Connected to the Shell : Nozzle

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		90.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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Nozzle Sketch (may not represent actual weld type/configuration)



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

Reinforcement CALCULATION, Description: K10A (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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)																									
شماره پیمان: 053 – 073 – 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 267 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

= 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	9.265	1.464	NA
Area in Shell	A1	0.421	7.250	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	17.235	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

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

= (56.8*16.3119*1.0+2*13.6*16.3119*1.0*(1-1.0))

= 9.265 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)

= 61.2(1.0 * 17.0 - 1.0 * 16.312) - 2 * 13.6

(1.0 * 17.0 - 1.0 * 16.3119) * (1 - 1.0)

= 0.421 cm²

Area Available in Nozzle Projecting Outward [A2]:

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

= (2 * 34.0) (13.6 - 1.31) 1.0

= 8.356 cm²

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

= Wo² * fr2 + (Wi-can/0.707)² * fr2

= 10.0² * 1.0 + (0.0)² * 1.0

= 1.000 cm²

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

Wall Thickness for Internal/External pressures ta = 4.3123 mm.

Wall Thickness per UG16(b), tr16b = 4.5000 mm.

Wall Thickness, shell/head, internal pressure trb1 = 19.3119 mm.

Wall Thickness tbt = max(trb1, tr16b) = 19.3119 mm.

Wall Thickness, shell/head, external pressure trb2 = 3.2648 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 $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^{\circ}\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^{\circ}\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^{\circ}\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^{\circ}\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^{\circ}\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^{\circ}\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K10A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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

Weld Load [W1]:

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 3.0) * 0.74 * 138$$

$$= 202. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 202 + 0) = 291 \text{ kN}$$

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

$$= (89 + 202 + 0) = 291 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 291 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 291 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 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 CONTACTOR (C-100)							شماره صفحه : 270 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K10B (2in)

From: 110

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	4600.0000	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9247.05	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

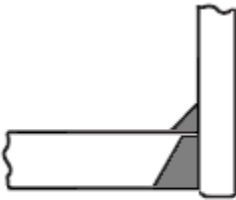
Type of Element Connected to the Shell : Nozzle

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		90.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	18.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 271 از 383	
	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری		پروژه
	V01	0001	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: K10B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	9.265	1.464	NA
Area in Shell	A1	0.421	7.250	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	17.235	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) UG-37(c)$$

$$= (56.8 * 16.3119 * 1.0 + 2 * 13.6 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 * t - F * tr) - 2 * tn(E1 * t - F * tr) * (1 - fr1)$$

$$= 61.2(1.0 * 17.0 - 1.0 * 16.312) - 2 * 13.6$$

$$(1.0 * 17.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 0.421 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 34.0) (13.6 - 1.31) 1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 * fr2 + (Wi - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures ta = 4.3123 mm.

Wall Thickness per UG16(b), tr16b = 4.5000 mm.

Wall Thickness, shell/head, internal pressure trb1 = 19.3119 mm.

Wall Thickness tbt = max(trb1, tr16b) = 19.3119 mm.

Wall Thickness, shell/head, external pressure trb2 = 3.2648 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K10B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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

Weld Load [W1]:

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 274 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (18.0 - 3.0) * 0.74 * 138$$

$$= 202. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 202 + 0) = 291 \text{ kN}$$

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

$$= (89 + 202 + 0) = 291 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 291 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 291 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 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 CONTACTOR (C-100)							شماره صفحه : 275 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K1 (2in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9920.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

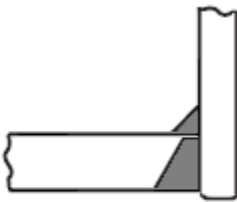
Type of Element Connected to the Shell : Nozzle

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		225.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 276 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: K1 (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

$$= 1.000$$

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	9.265	0.754	NA
Area in Shell	A1	0.421	8.778	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	18.764	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (56.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 13.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 61.2(1.0 \cdot 17.0 - 1.0 \cdot 16.312) - 2 \cdot 13.6$$

$$(1.0 \cdot 17.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 0.421 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 34.0)(13.6 - 1.31)1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can/0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 4.3123 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 19.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 19.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 3.2648 \text{ mm.}$

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K1 (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * tn * fr1 * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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

Weld Load [W1]:

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (20.0 - 3.0) * 0.74 * 138$$

$$= 229. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 229 + 0) = 318 \text{ kN}$$

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

$$= (89 + 229 + 0) = 318 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 318 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 318 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 280 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Input, Nozzle Desc: N06 (2in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9920.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

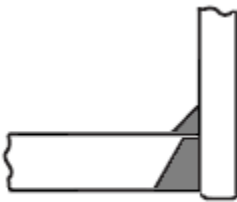
Type of Element Connected to the Shell : Nozzle

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		270.00	deg
Diameter		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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)								
شماره پیمان: 053 - 073 - 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 281 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال	نسخه	
	BK	GCS	MF	120	ME	CN	0001	V01	

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



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

Reinforcement CALCULATION, Description: N06 (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000	mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000	mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		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	9.265	0.754	NA
Area in Shell	A1	0.421	8.778	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	18.764	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (56.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 13.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 61.2(1.0 \cdot 17.0 - 1.0 \cdot 16.312) - 2 \cdot 13.6$$

$$(1.0 \cdot 17.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 0.421 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 34.0)(13.6 - 1.31)1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 4.3123 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 19.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 19.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 3.2648 \text{ mm.}$

 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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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66(b)(1)(-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: N06 (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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

Weld Load [W1]:

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (20.0 - 3.0) * 0.74 * 138$$

$$= 229. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 229 + 0) = 318 \text{ kN}$$

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

$$= (89 + 229 + 0) = 318 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 318 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 318 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K6A (2in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9963.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

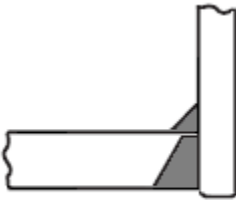
Type of Element Connected to the Shell : Nozzle

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		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
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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	نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	
	V01	0001	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: K6A (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

 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	0001		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	9.265	0.754	NA
Area in Shell	A1	0.421	8.778	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	18.764	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \cdot UG-37(c)$$

$$= (56.8 \cdot 16.3119 \cdot 1.0 + 2 \cdot 13.6 \cdot 16.3119 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 61.2(1.0 \cdot 17.0 - 1.0 \cdot 16.312) - 2 \cdot 13.6$$

$$(1.0 \cdot 17.0 - 1.0 \cdot 16.3119) \cdot (1 - 1.0)$$

$$= 0.421 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp)(tn - trn)fr2$$

$$= (2 \cdot 34.0)(13.6 - 1.31)1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 4.3123 \text{ mm.}$

Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$

Wall Thickness, shell/head, internal pressure $trb1 = 19.3119 \text{ mm.}$

Wall Thickness $tbl = \max(trb1, tr16b) = 19.3119 \text{ mm.}$

Wall Thickness, shell/head, external pressure $trb2 = 3.2648 \text{ mm.}$

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 288 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness $tb2 = \max(tb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:
 $= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

Minimum Wall Thickness of Nozzle Necks [tUG-45]:
 $= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = $78 \text{ }^\circ\text{C}$

Min Metal Temp. w/o impact per UCS-66, Curve A $7 \text{ }^\circ\text{C}$
Min Metal Temp. at Required thickness (UCS 66.1) $-104 \text{ }^\circ\text{C}$

Gov. MDMT of the nozzle to shell joint welded assembly : $-104 \text{ }^\circ\text{C}$

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

Unadjusted MDMT of ANSI B16.5/47 flanges per UCS-66(c) $-18 \text{ }^\circ\text{C}$
Flange MDMT with Temp reduction per UCS-66 (b) (1) (-b) $-40 \text{ }^\circ\text{C}$

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: K6A (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:
 $= \max(0, (A - A1 + 2 * tn * fr1 * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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

Weld Load [W1]:

 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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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (20.0 - 3.0) * 0.74 * 138$$

$$= 229. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 229 + 0) = 318 \text{ kN}$$

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

$$= (89 + 229 + 0) = 318 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 318 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 318 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 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 CONTACTOR (C-100)							شماره صفحه : 290 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: K6B (2in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		10263.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

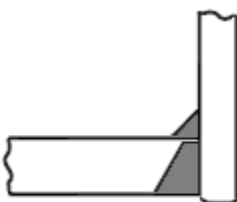
Type of Element Connected to the Shell : Nozzle

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		2.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.6000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	
Flange Series	Series	@	

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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 291 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: K6B (2in)

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

Actual Inside Diameter Used in Calculation	2.000 in.
Actual Thickness Used in Calculation	0.654 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 28.4) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 1.3123 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3862 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	118.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	59.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	34.0000 mm.

Weld Strength Reduction Factor [fr1]:

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

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)								
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	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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

$$= 1.000$$

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	9.265	0.754	NA
Area in Shell	A1	0.421	8.778	NA
Area in Nozzle Wall	A2	8.356	8.985	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds	A41+A42+A43	1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.777	18.764	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (56.8 * 16.3119 * 1.0 + 2 * 13.6 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 9.265 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d (E1 * t - F * tr) - 2 * tn (E1 * t - F * tr) * (1 - fr1)$$

$$= 61.2 (1.0 * 17.0 - 1.0 * 16.312) - 2 * 13.6$$

$$(1.0 * 17.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 0.421 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 34.0) (13.6 - 1.31) 1.0$$

$$= 8.356 \text{ cm}^2$$

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

$$= Wo^2 * fr2 + (Wi - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 4.3123 \text{ mm.}$
 Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$
 Wall Thickness, shell/head, internal pressure $trb1 = 19.3119 \text{ mm.}$
 Wall Thickness $tb1 = \max(trb1, tr16b) = 19.3119 \text{ mm.}$

 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 CONTACTOR (C-100)							شماره صفحه : 293 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Wall Thickness, shell/head, external pressure $trb2 = 3.2648 \text{ mm.}$
Wall Thickness $tb2 = \max(trb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 7.8000 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.8, \max(19.3119, 4.5)]$
 $= 7.8000 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(4.3123, 7.8)$
 $= 7.8000 \text{ mm.}$

Available Nozzle Neck Thickness = 16.6000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 16.6$, $tr = 1.312$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.096$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve A 7 °C
Min Metal Temp. at Required thickness (UCS 66.1) -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) -40 °C

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

Design Pressure/Ambient Rating = $62.00 / 102.10 = 0.607$

Weld Size Calculations, Description: K6B (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.6000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (9.2652 - 0.4211 + 2 * 13.6 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 124.53 \text{ kN}$

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)																									
شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 294 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Weld Load [W1]:

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

$$= (8.3556 + 0.0 + 1. - 0.0 * 1.0) * 138$$

$$= 129.00 \text{ kN}$$

Weld Load [W2]:

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

$$= (8.3556 + 0.0 + 1. + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Weld Load [W3]:

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

$$= (8.3556 + 0.0 + 1. + 0.0 + (4.624)) * 138$$

$$= 192.76 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.0 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 35.2) * (16.6 - 3.0) * 0.7 * 138$$

$$= 145. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.0 * (20.0 - 3.0) * 0.74 * 138$$

$$= 229. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 145) = 234 \text{ kN}$$

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

$$= (89 + 0 + 229 + 0) = 318 \text{ kN}$$

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

$$= (89 + 229 + 0) = 318 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 234 kN , must exceed W = 124 kN or W1 = 129 kN
 Path 2-2 = 318 kN , must exceed W = 124 kN or W2 = 192 kN
 Path 3-3 = 318 kN , must exceed W = 124 kN or W3 = 192 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 64 bars

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

The Drop for this Nozzle is : 2.5291 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 222.5291 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	0001		V01

Input, Nozzle Desc: N03 (2in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9823.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

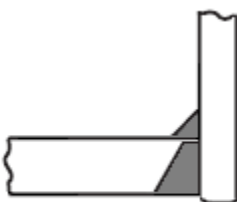
Type of Element Connected to the Shell : Nozzle

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		90.00	deg
Diameter		1.0000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	14.3000	mm.
Flange Material		SA-106 B	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	
Flange Series	Series	D	

The Pressure Design option was Design Pressure + static head.

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	BK	GCS	MF	120	ME	CN	0001		V01

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



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

Reinforcement CALCULATION, Description: N03 (2in)

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	0.563 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]

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{(S_n \cdot E)} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 15.7 \left(\exp \left(\frac{62.0}{(137.9 \cdot 1.0)} \right) - 1 \right) \\
 &= 0.7220 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.2982 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	88.0000 mm.
Parallel to Vessel Wall	Rn+tn+t	44.0000 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	28.2500 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
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V01	0001	CN	ME	120	MF	GCS	BK																			

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

$$= 1.000$$

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	5.122	0.417	NA
Area in Shell	A1	0.389	8.118	NA
Area in Nozzle Wall	A2	5.977	6.216	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds	A41+A42+A43	1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	7.366	15.334	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (31.4 * 16.3119 * 1.0 + 2 * 11.3 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 5.122 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d (E1 * t - F * tr) - 2 * tn (E1 * t - F * tr) * (1 - fr1)$$

$$= 56.6 (1.0 * 17.0 - 1.0 * 16.312) - 2 * 11.3$$

$$(1.0 * 17.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 0.389 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 28.25) (11.3 - 0.72) 1.0$$

$$= 5.977 \text{ cm}^2$$

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

$$= Wo^2 * fr2 + (Wi - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $ta = 3.7220 \text{ mm.}$
 Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$
 Wall Thickness, shell/head, internal pressure $trb1 = 19.3119 \text{ mm.}$
 Wall Thickness $tb1 = \max(trb1, tr16b) = 19.3119 \text{ mm.}$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Wall Thickness, shell/head, external pressure $trb2 = 3.2648 \text{ mm.}$
Wall Thickness $tb2 = \max(trb2, tr16b) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb3 = 6.4200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[6.42, \max(19.3119, 4.5)]$
 $= 6.4200 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(3.722, 6.42)$
 $= 6.4200 \text{ mm.}$

Available Nozzle Neck Thickness = 14.3000 mm. --> OK

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $tg = 14.3$, $tr = 0.722$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio $= tr * (E^*) / (tg - c) = 0.064$, Temp. Reduction = 78 °C

Min Metal Temp. w/o impact per UCS-66, Curve A 3 °C
Min Metal Temp. at Required thickness (UCS 66.1) -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) -40 °C

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

Design Pressure/Ambient Rating = $62.00 / 102.10 = 0.607$

Weld Size Calculations, Description: N03 (2in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 11.3000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - tr)) Sv)$
 $= \max(0, (5.1219 - 0.3895 + 2 * 11.3 * 1.0 * (1.0 * 17.0 - 16.3119)) 138)$
 $= 67.40 \text{ kN}$

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

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	BK	GCS	MF	120	ME	CN	0001		V01

Weld Load [W1]:

$$= (A2+A5+A4-(W_i-\text{Can}/.707)^2 \cdot fr2) \cdot Sv$$

$$= (5.9766 + 0.0 + 1. - 0.0 \cdot 1.0) \cdot 138$$

$$= 96.20 \text{ kN}$$

Weld Load [W2]:

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

$$= (5.9766 + 0.0 + 1. + (3.842)) \cdot 138$$

$$= 149.18 \text{ kN}$$

Weld Load [W3]:

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

$$= (5.9766 + 0.0 + 1. + 0.0 + (3.842)) \cdot 138$$

$$= 149.18 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) \cdot 54.0 \cdot 10.0 \cdot 0.49 \cdot 138$$

$$= 57. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 \cdot 21.35) \cdot (14.3 - 3.0) \cdot 0.7 \cdot 138$$

$$= 73. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) \cdot 54.0 \cdot (20.0 - 3.0) \cdot 0.74 \cdot 138$$

$$= 147. \text{ kN}$$

Strength of Failure Paths:

$$\text{PATH11} = (\text{SONW} + \text{SNW}) = (57 + 73) = 130 \text{ kN}$$

$$\text{PATH22} = (\text{Sonw} + \text{Tpgw} + \text{Tngw} + \text{Sinw})$$

$$= (57 + 0 + 147 + 0) = 204 \text{ kN}$$

$$\text{PATH33} = (\text{Sonw} + \text{Tngw} + \text{Sinw})$$

$$= (57 + 147 + 0) = 204 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 130 kN , must exceed W = 67 kN or W1 = 96 kN

Path 2-2 = 204 kN , must exceed W = 67 kN or W2 = 149 kN

Path 3-3 = 204 kN , must exceed W = 67 kN or W3 = 149 kN

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	BK	GCS	MF	120	ME	CN	0001		V01

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 65 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 : 1.0430 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 221.0430 mm.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N10C (8in)

From: 140

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516 70	
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Cylindrical Shell	D	700.00	mm.
Design Length of Section	L	971.3333	mm.
Shell Finished (Minimum) Thickness	t	20.0000	mm.
Shell Internal Corrosion Allowance	c	3.0000	mm.
Shell External Corrosion Allowance	co	0.0000	mm.
Distance from Bottom/Left Tangent		9963.57	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

Type of Element Connected to the Shell : Nozzle

Material [Impact Tested]		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		8.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	80	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	80.0000	mm.
Height of Beveled Transition	L'	22.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		45.0000	mm.
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
This is a Manway or Access Opening.			

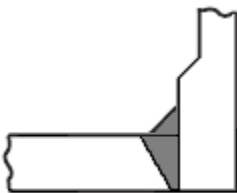
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	BK	GCS	MF	120	ME	CN	0001		V01

Flange Class
Flange Grade

600
GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Reinforcement CALCULATION, Description: N10C (8in)

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

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

$$\begin{aligned}
 &= (P \cdot R) / (S_v \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 353.0) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 16.3119 \text{ mm.}
 \end{aligned}$$

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

$$\begin{aligned}
 &= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P) \text{ per UG-27 (c) (1)} \\
 &= (62.0 \cdot 101.42) / (138 \cdot 1.0 - 0.6 \cdot 62.0) \\
 &= 4.6868 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.6751 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):

Height value from sketch (e-1) [te]:

$$\begin{aligned}
 &= (\text{Hub Thickness} - \text{Neck Thickness}) / \tan(30) \\
 &= 33.888 / 0.5773 \\
 &= 58.6949 \text{ mm.}
 \end{aligned}$$

 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	0001		V01

Note: Hub Height was < 2.5 times Hub Thickness, use sketch UG-40 (e-1).

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

Parallel to Vessel Wall (Diameter Limit)	D1	405.7000	mm.
Parallel to Vessel Wall, opening length	d	202.8500	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	42.5000	mm.

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 [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	33.089	2.694	NA
Area in Shell	A1	1.396	29.096	NA
Area in Nozzle Wall	A2	2.912	6.322	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	28.804	28.804	NA
TOTAL AREA AVAILABLE	Atot	34.112	65.222	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (202.85 * 16.3119 * 1.0 + 2 * 42.0 * 16.3119 * 1.0 * (1 - 1.0))$$

$$= 33.089 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d (E1 * t - F * tr) - 2 * tn (E1 * t - F * tr) * (1 - fr1)$$

$$= 202.85 (1.0 * 17.0 - 1.0 * 16.312) - 2 * 42.0$$

$$(1.0 * 17.0 - 1.0 * 16.3119) * (1 - 1.0)$$

$$= 1.396 \text{ cm}^2$$

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	BK	GCS	MF	120	ME	CN	0001		V01

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 * t_{lnp}) (t_n - t_{rn}) fr_2$$

$$= (2 * 42.5) (8.11 - 4.69) 1.0$$

$$= 2.912 \text{ cm}^2$$

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

$$= W_o^2 * fr_2 + (W_i - c_{an}/0.707)^2 * fr_2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Area Available in the Hub Section [A6]:

$$= (2 * \min(t_{lnp}, h_o, H_{ubht})) * (H_{ubtk} - t_n) * fr_2$$

$$= (2 * \min(42.5, 200.0, 80.0)) * (45.0 - 11.1) * 1.0$$

$$= 28.804 \text{ cm}^2$$

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld (Impact tested) :

Note: This Element/Detail was specified as being Impact Tested.

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

Govern. $t_h, t_g = 20.0, t_r = 16.312, c = 3.0 \text{ mm.}, E^* = 1.0$
 Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.96$, Temp. Reduction = 2°C

Min Metal Temp. w/o impact per UCS-66, Curve D -40°C
 Min Metal Temp. at Required thickness (UCS 66.1) -42°C

Gov. MDMT of the nozzle to shell joint welded assembly : -19°C

ANSI Flange MDMT including Temperature reduction per UCS-66.1:

MDMT of ANSI B16.5/47 flange per Matl. Specification -18°C
 Flange MDMT with Temp reduction per UCS-66(i) (2) -40°C

Where the Stress Reduction Ratio per UCS-66(i)(2) is :

$$\text{Design Pressure/Ambient Rating} = 62.00/102.10 = 0.607$$

Weld Size Calculations, Description: N10C (8in)

Intermediate Calc. for nozzle/shell Welds $T_{min} \quad 17.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
 Nozzle Weld $6.0000 = \text{Min per Code } 7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$$= \max(0, (A - A_1 + 2 * t_n * fr_1 * (E_1 * t - t_r)) S_v)$$

$$= \max(0, (33.0887 - 1.3958 + 2 * 42.0 * 1.0 *)$$

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$$(1.0 * 17.0 - 16.3119) * 138 = 444.98 \text{ kN}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

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

$$= (31.7162 + 1. - 0.0 * 1.0) * 138$$

$$= 451.12 \text{ kN}$$

Weld Load [W2]:

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

$$= (31.7162 + 0.0 + 1. + (14.28)) * 138$$

$$= 648.02 \text{ kN}$$

Weld Load [W3]:

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

$$= (31.7162 + 0.0 + 1. + 0.0 + (14.28)) * 138$$

$$= 648.02 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416 / 2.0) * 286.85 * 10.0 * 0.49 * 138$$

$$= 304. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 122.425) * (45.0 - 3.0) * 0.7 * 138$$

$$= 1559. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416 / 2.0) * 286.85 * (20.0 - 3.0) * 0.74 * 138$$

$$= 782. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (304 + 1559) = 1864 \text{ kN}$$

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

$$= (304 + 0 + 782 + 0) = 1086 \text{ kN}$$

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

$$= (304 + 782 + 0) = 1086 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 1863 kN , must exceed W = 444 kN or W1 = 451 kN
 Path 2-2 = 1086 kN , must exceed W = 444 kN or W2 = 648 kN
 Path 3-3 = 1086 kN , must exceed W = 444 kN or W3 = 648 kN

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N02 (6in)

From: 150

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Elliptical Head	D	700.00	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	20.0000	mm.
Head Internal Corrosion Allowance	c	3.0000	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 [Impact Tested]		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		6.0000	in.
Size and Thickness Basis		Minimum	
Nominal Thickness	tn	80	
Flange Material		SA-105	
Flange Type		Weld Neck Flange	
Hub Height of Integral Nozzle	h	90.0000	mm.
Height of Beveled Transition	L'	18.0000	mm.
Hub Thickness of Integral Nozzle (tn or x+tp)		35.0000	mm.
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	15.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	

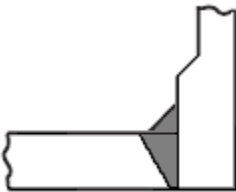
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	V01	0001	CN	ME	120	MF	GCS	
	BK							

Flange Grade

GR 1.1

The Pressure Design option was Design Pressure + static head.

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



Hub Nozzle (Set-in)

Reinforcement CALCULATION, Description: N02 (6in)

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

Actual Inside Diameter Used in Calculation	5.869 in.
Actual Thickness Used in Calculation	0.378 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]
 $= (P \cdot K_1 \cdot D) / (2 \cdot S_v \cdot E - 0.2 \cdot P)$ per UG-37 (a) (3)
 $= (62.0 \cdot 0.893 \cdot 706.0) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.0)$
 $= 14.2338 \text{ mm.}$

Reqd thk per UG-37(a) of Nozzle Wall, Trn [Int. Press]
 $= (P \cdot R) / (S_n \cdot E - 0.6 \cdot P)$ per UG-27 (c) (1)
 $= (62.0 \cdot 77.54) / (138 \cdot 1.0 - 0.6 \cdot 62.0)$
 $= 3.5829 \text{ mm.}$

Required Nozzle thickness under External Pressure per UG-28 : 0.5804 mm.

Intermediate Hub Nozzle Calculations:

Check to determine use of Sketch (e-1) or (e-2):
 $= 2.5 \cdot \text{Corroded Hub Thickness}$
 $= 2.5 \cdot 32.0$ Note: less than the hub height, use (e-2)
 $= 80.0000 \text{ mm.}$

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

Parallel to Vessel Wall (Diameter Limit)	D1 310.1452 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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Parallel to Vessel Wall, opening length d 155.0726 mm.
Normal to Vessel Wall (Thickness Limit), no pad Tlnp 42.5000 mm.

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 [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	22.073	1.485	NA
Area in Shell	A1	4.290	23.391	NA
Area in Nozzle Wall	A2	24.155	26.707	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
Area in Hub	A6	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	29.444	51.098	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d * tr * F + 2 * tn * tr * F * (1 - fr1)) \text{ UG-37(c)}$$

$$= (155.0726 * 14.2338 * 1.0 + 2 * 32.0 * 14.2338 * 1.0 * (1 - 1.0))$$

$$= 22.073 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 * t - F * tr) - 2 * tn(E1 * t - F * tr) * (1 - fr1)$$

$$= 155.073(1.0 * 17.0 - 1.0 * 14.234) - 2 * 32.0$$

$$(1.0 * 17.0 - 1.0 * 14.2338) * (1 - 1.0)$$

$$= 4.290 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

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

$$= (2 * 42.5)(32.0 - 3.58)1.0$$

$$= 24.155 \text{ cm}^2$$

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

$$= W_o^2 * fr2 + (W_i - can / 0.707)^2 * fr2$$

$$= 10.0^2 * 1.0 + (0.0)^2 * 1.0$$

$$= 1.000 \text{ cm}^2$$

Note: There are no hub area calculations because Figure UG-40 (e-2) was used.

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

Wall Thickness for Internal/External pressures $t_a = 6.5829 \text{ mm.}$
Wall Thickness per UG16(b), $tr_{16b} = 4.5000 \text{ mm.}$
Wall Thickness, shell/head, internal pressure $tr_{b1} = 18.7651 \text{ mm.}$
Wall Thickness $tb_1 = \max(tr_{b1}, tr_{16b}) = 18.7651 \text{ mm.}$
Wall Thickness, shell/head, external pressure $tr_{b2} = 3.2618 \text{ mm.}$
Wall Thickness $tb_2 = \max(tr_{b2}, tr_{16b}) = 4.5000 \text{ mm.}$
Wall Thickness per table UG-45 $tb_3 = 9.2200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$$= \min[tb_3, \max(tb_1, tb_2)]$$

$$= \min[9.22, \max(18.7651, 4.5)]$$

$$= 9.2200 \text{ mm.}$$

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

$$= \max(t_a, t_b)$$

$$= \max(6.5829, 9.22)$$

$$= 9.2200 \text{ mm.}$$

Available Nozzle Neck Thickness = 9.6012 mm. --> OK

Stresses on Nozzle due to External and Pressure Loads per the ASME

B31.3 Piping Code (see 319.4.4 and 302.3.5):

Sustained	: 78.3,	Allowable	: 137.9 N./mm ²	Passed
Expansion	: 0.0,	Allowable	: 266.4 N./mm ²	Passed
Occasional	: 34.9,	Allowable	: 183.4 N./mm ²	Passed
Shear	: 8.4,	Allowable	: 96.5 N./mm ²	Passed

Note : The number of cycles on this nozzle was assumed to be 7000 or less for the determination of the expansion stress allowable.

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

Nozzle Neck to Flange Weld, Curve: A

Govrn. thk, $t_g = 9.601$, $t_r = 3.583$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.543$, Temp. Reduction = 28 °C

Min Metal Temp. w/o impact per UCS-66, Curve A	-8 °C
Min Metal Temp. at Required thickness (UCS 66.1)	-35 °C
Min Metal Temp. w/o impact per UG-20(f)	-29 °C

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

Govrn. thk, $t_g = 20.0$, $t_r = 14.234$, $c = 3.0 \text{ mm.}$, $E^* = 1.0$
Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.837$, Temp. Reduction = 9 °C

 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	0001		V01

Min Metal Temp. w/o impact per UCS-66, Curve D -40 °C
Min Metal Temp. at Required thickness (UCS 66.1) -48 °C

Gov. MDMT of the nozzle to shell joint welded assembly : -35 °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) -40 °C

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

Design Pressure/Ambient Rating = 62.00/102.10 = 0.607

Weld Size Calculations, Description: N02 (6in)

Intermediate Calc. for nozzle/shell Welds Tmin 19.0000 mm.

Results Per UW-16.1:

	Required Thickness	Actual Thickness
Nozzle Weld	6.0000 = Min per Code	7.0700 = 0.7 * Wo mm.

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

Weld Load [W]:

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

$$= \max(0, (22.0727 - 4.2897 + 2 * 32.0 * 1.0 * (1.0 * 17.0 - 14.2338)) 138)$$

$$= 269.62 \text{ kN}$$

For hub type nozzles, A2 includes the area of the hub.

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

Weld Load [W1]:

$$= (A2 + A4 - (W_i - C_{an} / .707)^2 * f_{r2}) * S_v$$

$$= (24.1545 + 1. - 0.0 * 1.0) * 138$$

$$= 346.85 \text{ kN}$$

Weld Load [W2]:

$$= (A2 + A3 + A4 + (2 * (\text{Hub Thickness}) * t * f_{r1})) * S_v$$

$$= (24.1545 + 0.0 + 1. + (10.88)) * 138$$

$$= 496.87 \text{ kN}$$

Weld Load [W3]:

$$= (A2 + A3 + A4 + (2 * (\text{Hub Thickness}) * t * f_{r1})) * S_v$$

$$= (24.1545 + 0.0 + 1. + 0.0) * 138$$

$$= 496.87 \text{ kN}$$

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416 / 2.0) * 219.0726 * 10.0 * 0.49 * 138$$

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= 233. kN

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 93.5363) * (35.0 - 3.0) * 0.7 * 138$$

$$= 908. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 219.0726 * (15.0 - 3.0) * 0.74 * 138$$

$$= 421. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (233 + 908) = 1140 \text{ kN}$$

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

$$= (233 + 0 + 421 + 0) = 654 \text{ kN}$$

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

$$= (233 + 421 + 0) = 654 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 1140 kN , must exceed W = 269 kN or W1 = 346 kN
 Path 2-2 = 653 kN , must exceed W = 269 kN or W2 = 496 kN
 Path 3-3 = 653 kN , must exceed W = 269 kN or W3 = 496 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 67 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 : 9.3543 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 229.3543 mm.

Input Echo, WRC107/537 Item 1, Description: N02 (6in) :

Diameter Basis for Vessel	Vbasis	ID	
Cylindrical or Spherical Vessel	Cylsph	Spherical	
Internal Corrosion Allowance	Cas	3.0000	mm.
Vessel Diameter	Dv	1260.000	mm.
Vessel Thickness	Tv	20.000	mm.
Design Temperature	T1	148.0	°C
Vessel Material		SA-516 70	
Vessel UNS Number		K02700	
Vessel Cold S.I. Allowable	Smc	137.90	N./mm ²
Vessel Hot S.I. Allowable	Smh	137.90	N./mm ²

Note:

Using 2 * Yield for Discontinuity Stress Allowable (Div 2, 4.1.6.3), Sps.

Make sure that material properties at this temperature are not time-dependent for Material: SA-516 70

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	BK	GCS	MF	120	ME	CN	0001		V01

Attachment Type	Type	Round
WRC107 Attachment Classification	Holsol	Hollow
Diameter Basis for Nozzle	Nbasis	ID
Corrosion Allowance for Nozzle	Can	3.0000 mm.
Nozzle Diameter	Dn	149.073 mm.
Nozzle Thickness	Tn	35.000 mm.
Nozzle Material		SA-105
Nozzle UNS Number		K03504
Nozzle Cold S.I. Allowable	SNmc	137.90 N./mm ²
Nozzle Hot S.I. Allowable	SNmh	137.90 N./mm ²
Design Internal Pressure	Dp	62.000 bars
Include Pressure Thrust		No

External Forces and Moments in WRC 107/537 Convention:

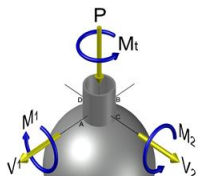
Radial Load	(SUS)	P	9.6	kN
Longitudinal Shear	(SUS)	(Vl) V1	9.6	kN
Circumferential Shear	(SUS)	(Vc) V2	-9.6	kN
Circumferential Moment	(SUS)	(Mc) M1	-3740.0	N-m
Longitudinal Moment	(SUS)	(Ml) M2	-3740.0	N-m
Torsional Moment	(SUS)	Mt	-4320.0	N-m

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".



Stress Attenuation Diameter (for Insert Plates) per WRC 297:

$$\begin{aligned}
 &= \text{NozzleOD} + 2 * 1.65 * \text{sqrt}(\text{Rmean}(\text{t} - \text{ca})) \\
 &= 219.073 + 2 * 1.65 * \text{sqrt}(641.5 (20.0 - 3.0)) \\
 &= 563.690 \text{ mm.}
 \end{aligned}$$

WRC 107 Stress Calculation for SUS tained loads:

Radial Load	P	9.6	kN
Circumferential Shear	(VC) V2	-9.6	kN
Longitudinal Shear	(VL) V1	9.6	kN

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Tot. Shear	-5.0	-5.0	-1.7	-1.7	-5.0	-5.0	-1.7	-1.7
Str. Int.	49.9	41.0	67.6	53.6	49.9	41.0	67.6	53.6

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
Rad. Pm (SUS)		115.5	115.5	115.5	115.5	115.5	115.5	115.5	115.5
Rad. Pl (SUS)		4.4	4.4	-7.0	-7.0	4.4	4.4	-7.0	-7.0
Rad. Q (SUS)		44.6	-44.6	-60.5	60.5	44.6	-44.6	-60.5	60.5
Long. Pm (SUS)		115.5	115.5	115.5	115.5	115.5	115.5	115.5	115.5
Long. Pl (SUS)		5.7	5.7	-9.9	-9.9	5.7	5.7	-9.9	-9.9
Long. Q (SUS)		15.1	-15.1	-19.8	19.8	15.1	-15.1	-19.8	19.8
Shear Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shear Pl (SUS)		-1.6	-1.6	1.6	1.6	-1.6	-1.6	1.6	1.6
Shear Q (SUS)		-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4	-3.4
Pm (SUS)		115.5	115.5	115.5	115.5	115.5	115.5	115.5	115.5
Pm+Pl (SUS)		122.3	122.3	109.2	109.2	122.3	122.3	109.2	109.2
Pm+Pl+Q (Total)		165.4	106.9	85.8	169.1	165.4	106.9	85.8	169.1

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	115.49	137.90	Passed
Pm+Pl (SUS)	122.32	206.85	Passed
Pm+Pl+Q (TOTAL)	169.07	413.70	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

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	BK	GCS	MF	120	ME	CN	0001		V01

Input, Nozzle Desc: N08 (1.5in)

From: 150

Pressure for Reinforcement Calculations	P	62.000	bars
Temperature for Internal Pressure	Temp	148	°C
Design External Pressure	Pext	1.03	bars
Temperature for External Pressure	Tempex	100	°C
Shell Material [Normalized]		SA-516	70
Shell Allowable Stress at Temperature	Sv	137.90	N./mm ²
Shell Allowable Stress At Ambient	Sva	137.90	N./mm ²
Inside Diameter of Elliptical Head	D	700.00	mm.
Aspect Ratio of Elliptical Head	Ar	2.00	
Head Finished (Minimum) Thickness	t	20.0000	mm.
Head Internal Corrosion Allowance	c	3.0000	mm.
Head External Corrosion Allowance	co	0.0000	mm.
Distance from Head Centerline	L1	280.0000	mm.
User Entered Minimum Design Metal Temperature		5.00	°C

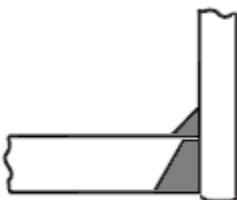
Type of Element Connected to the Shell : Nozzle

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		1.5000	in.
Size and Thickness Basis		Actual	
Actual Thickness	tn	16.0000	mm.
Flange Material		SA-105	
Flange Type		Long Weld Neck	
Corrosion Allowance	can	3.0000	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	10.0000	mm.
Groove weld depth between Nozzle and Vessel	Wgnv	20.0000	mm.
Inside Projection	h	0.0000	mm.
Weld leg size, Inside Element to Shell	Wi	0.0000	mm.
Flange Class		600	
Flange Grade		GR 1.1	

The Pressure Design option was Design Pressure + static head.

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



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

Note : Checking Nozzle in the Meridional direction.

Reinforcement CALCULATION, Description: N08 (1.5in)

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

Actual Inside Diameter Used in Calculation	1.500 in.
Actual Thickness Used in Calculation	0.630 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]

$$\begin{aligned}
 &= (P \cdot D \cdot K) / (2 \cdot S_v \cdot E - 0.2 \cdot P) \text{ Appendix 1-4 (c)} \\
 &= (62.0 \cdot 706.0 \cdot 0.989) / (2 \cdot 137.9 \cdot 1.0 - 0.2 \cdot 62.0) \\
 &= 15.7651 \text{ mm.}
 \end{aligned}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

$$\begin{aligned}
 &= R \left(\exp \left(\frac{P}{S_n \cdot E} \right) - 1 \right) \text{ per Appendix 1-2 (a) (1)} \\
 &= 22.05 \left(\exp \left(\frac{62.0}{137.9 \cdot 1.0} \right) - 1 \right) \\
 &= 1.0141 \text{ mm.}
 \end{aligned}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3491 mm.

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

Parallel to Vessel Wall (Diameter Limit)	D1	112.9429 mm.
Parallel to Vessel Wall	Rn+tn+t	56.4714 mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	32.5000 mm.

Weld Strength Reduction Factor [fr1]:

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

Weld Strength Reduction Factor [fr2]:

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$= \min(1, S_n/S_v)$
 $= \min(1, 137.9/137.9)$
 $= 1.000$

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	8.347	0.507	NA
Area in Shell	A1	0.741	9.051	NA
Area in Nozzle Wall	A2	8.663	9.144	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	10.404	19.194	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 56.41 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$= (d \cdot tr \cdot F + 2 \cdot t_n \cdot tr \cdot F \cdot (1 - fr1))$ UG-37(c)
 $= (52.9429 \cdot 15.7651 \cdot 1.0 + 2 \cdot 13.0 \cdot 15.7651 \cdot 1.0 \cdot (1 - 1.0))$
 $= 8.347 \text{ cm}^2$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$= d(E1 \cdot t - F \cdot tr) - 2 \cdot t_n(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$
 $= 60.0(1.0 \cdot 17.0 - 1.0 \cdot 15.765) - 2 \cdot 13.0$
 $(1.0 \cdot 17.0 - 1.0 \cdot 15.7651) \cdot (1 - 1.0)$
 $= 0.741 \text{ cm}^2$

Area Available in Nozzle Projecting Outward [A2]:

$= (2 \cdot t_{lnp})(t_n - t_{rn})fr2/\sin(\alpha3)$
 $= (2 \cdot 32.5)(13.0 - 1.01)1.0/\sin(64.1)$
 $= 8.663 \text{ cm}^2$

Note: See ASME VIII-1 2011(a) Appendix L, L-7.7.7(b) for more information.

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

$= W_o^2 \cdot fr2 + (W_i - can/0.707)^2 \cdot fr2$
 $= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$
 $= 1.000 \text{ cm}^2$

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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Nozzle Junction Minimum Design Metal Temperature (MDMT) Calculations:

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

Govrn. thk, $t_g = 16.0$, $t_r = 1.014$, $c = 3.0$ mm., $E^* = 1.0$
 Thickness Ratio = $t_r * (E^*) / (t_g - c) = 0.078$, Temp. Reduction = 78°C

Min Metal Temp. w/o impact per UCS-66, Curve A 6°C
 Min Metal Temp. at Required thickness (UCS 66.1) -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) -40°C

Where the Stress Reduction Ratio per UCS-66(b)(1)(-b) is :
 Design Pressure/Ambient Rating = $62.00/102.10 = 0.607$

Weld Size Calculations, Description: N08 (1.5in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.0000$ mm.

Results Per UW-16.1:

Required Thickness Actual Thickness
 Nozzle Weld $6.0000 = \text{Min per Code}$ $7.0700 = 0.7 * W_o$ mm.

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

Weld Load [W]:

$$\begin{aligned}
 &= \max(0, (A - A1 + 2 * t_n * f_{r1} * (E1 * t - t_r)) * S_v) \\
 &= \max(0, (8.3465 - 0.7409 + 2 * 13.0 * 1.0 * (1.0 * 17.0 - 15.7651)) * 138) \\
 &= 109.30 \text{ kN}
 \end{aligned}$$

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

Weld Load [W1]:

$$\begin{aligned}
 &= (A2 + A5 + A4 - (W_i - C_{an} / .707)^2 * f_{r2}) * S_v \\
 &= (8.663 + 0.0 + 1.0 - 0.0 * 1.0) * 138 \\
 &= 133.24 \text{ kN}
 \end{aligned}$$

Weld Load [W2]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + (2 * t_n * t * f_{r1})) * S_v \\
 &= (8.663 + 0.0 + 1.0 + (4.42)) * 138 \\
 &= 194.19 \text{ kN}
 \end{aligned}$$

Weld Load [W3]:

$$\begin{aligned}
 &= (A2 + A3 + A4 + A5 + (2 * t_n * t * f_{r1})) * S \\
 &= (8.663 + 0.0 + 1.0 + 0.0 + (4.42)) * 138 \\
 &= 194.19 \text{ kN}
 \end{aligned}$$

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	BK	GCS	MF	120	ME	CN	0001		V01

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 84.1564 * 10.0 * 0.49 * 138$$

$$= 89. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 34.2748) * (16.0 - 3.0) * 0.7 * 138$$

$$= 135. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 84.1564 * (20.0 - 3.0) * 0.74 * 138$$

$$= 229. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (89 + 135) = 224 \text{ kN}$$

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

$$= (89 + 0 + 229 + 0) = 319 \text{ kN}$$

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

$$= (89 + 229 + 0) = 319 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 224 kN , must exceed W = 109 kN or W1 = 133 kN
 Path 2-2 = 318 kN , must exceed W = 109 kN or W2 = 194 kN
 Path 3-3 = 318 kN , must exceed W = 109 kN or W3 = 194 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 67 bars

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

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

Note : Checking Nozzle in the Latitudinal direction.

Reinforcement CALCULATION, Description: N08 (1.5in)

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

Actual Inside Diameter Used in Calculation 1.500 in.
 Actual Thickness Used in Calculation 0.630 in.

Nozzle input data check completed without errors.

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

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

$$= (62.0 * 706.0 * 0.989) / (2 * 137.9 * 1.0 - 0.2 * 62.0)$$

$$= 15.7651 \text{ mm.}$$

Reqd thk per App. 1 of Nozzle Wall, Trn [Int. Press]

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$$= R(\exp([P/(Sn \cdot E)] - 1)) \text{ per Appendix 1-2 (a) (1)}$$

$$= 22.05(\exp([62.0/(137.9 \cdot 1.0)] - 1))$$

$$= 1.0141 \text{ mm.}$$

Required Nozzle thickness under External Pressure per UG-28 : 0.3491 mm.

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

Parallel to Vessel Wall (Diameter Limit)	Dl	104.1000	mm.
Parallel to Vessel Wall	Rn+tn+t	52.0500	mm.
Normal to Vessel Wall (Thickness Limit), no pad	Tlnp	32.5000	mm.

Results of Nozzle Reinforcement Area Calculations: (cm²)

AREA AVAILABLE, A1 to A5		Design	External	Mapnc
Area Required	Ar	6.952	0.422	NA
Area in Shell	A1	0.741	9.051	NA
Area in Nozzle Wall	A2	7.791	8.223	NA
Area in Inward Nozzle	A3	0.000	0.000	NA
Area in Welds A41+A42+A43		1.000	1.000	NA
Area in Element	A5	0.000	0.000	NA
TOTAL AREA AVAILABLE	Atot	9.532	18.274	NA

The Internal Pressure Case Governs the Analysis.

Nozzle Angle Used in Area Calculations 90.00 Degs.

The area available without a pad is Sufficient.

Area Required [A]:

$$= (d \cdot tr \cdot F + 2 \cdot tn \cdot tr \cdot F \cdot (1 - fr1)) \text{ UG-37(c)}$$

$$= (44.1 \cdot 15.7651 \cdot 1.0 + 2 \cdot 13.0 \cdot 15.7651 \cdot 1.0 \cdot (1 - 1.0))$$

$$= 6.952 \text{ cm}^2$$

Reinforcement Areas per Figure UG-37.1

Area Available in Shell [A1]:

$$= d(E1 \cdot t - F \cdot tr) - 2 \cdot tn(E1 \cdot t - F \cdot tr) \cdot (1 - fr1)$$

$$= 60.0(1.0 \cdot 17.0 - 1.0 \cdot 15.765) - 2 \cdot 13.0$$

$$(1.0 \cdot 17.0 - 1.0 \cdot 15.7651) \cdot (1 - 1.0)$$

$$= 0.741 \text{ cm}^2$$

Area Available in Nozzle Projecting Outward [A2]:

$$= (2 \cdot tlnp) (tn - trn) fr2$$

$$= (2 \cdot 32.5) (13.0 - 1.01) 1.0$$

$$= 7.791 \text{ cm}^2$$

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

$$= Wo^2 \cdot fr2 + (Wi - can / 0.707)^2 \cdot fr2$$

$$= 10.0^2 \cdot 1.0 + (0.0)^2 \cdot 1.0$$

$$= 1.000 \text{ cm}^2$$

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

Wall Thickness for Internal/External pressures $t_a = 4.0141 \text{ mm.}$

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Wall Thickness per UG16(b), $tr16b = 4.5000 \text{ mm.}$
 Wall Thickness, shell/head, internal pressure $trb1 = 18.7651 \text{ mm.}$
 Wall Thickness $tb1 = \max(trb1, tr16b) = 18.7651 \text{ mm.}$
 Wall Thickness, shell/head, external pressure $trb2 = 3.2618 \text{ mm.}$
 Wall Thickness $tb2 = \max(trb2, tr16b) = 4.5000 \text{ mm.}$
 Wall Thickness per table UG-45 $tb3 = 7.5200 \text{ mm.}$

Determine Nozzle Thickness candidate [tb]:

$= \min[tb3, \max(tb1, tb2)]$
 $= \min[7.52, \max(18.7651, 4.5)]$
 $= 7.5200 \text{ mm.}$

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

$= \max(ta, tb)$
 $= \max(4.0141, 7.52)$
 $= 7.5200 \text{ mm.}$

Available Nozzle Neck Thickness = 16.0000 mm. --> OK

Weld Size Calculations, Description: N08 (1.5in)

Intermediate Calc. for nozzle/shell Welds $T_{min} = 13.0000 \text{ mm.}$

Results Per UW-16.1:

Required Thickness Actual Thickness
 Nozzle Weld $6.0000 = \text{Min per Code } 7.0700 = 0.7 * W_o \text{ mm.}$

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

Weld Load [W]:

$= \max(0, (A-A1+2*tn*fr1*(E1*t-tr))Sv)$
 $= \max(0, (6.9524 - 0.7409 + 2 * 13.0 * 1.0 * (1.0 * 17.0 - 15.7651))138)$
 $= 90.08 \text{ kN}$

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

Weld Load [W1]:

$= (A2+A5+A4-(Wi-Can/.707)^2*fr2)*Sv$
 $= (7.7909 + 0.0 + 1. - 0.0 * 1.0) * 138$
 $= 121.22 \text{ kN}$

Weld Load [W2]:

$= (A2 + A3 + A4 + (2 * tn * t * fr1)) * Sv$
 $= (7.7909 + 0.0 + 1. + (4.42)) * 138$
 $= 182.16 \text{ kN}$

Weld Load [W3]:

$= (A2+A3+A4+A5+(2*tn*t*fr1))*S$
 $= (7.7909 + 0.0 + 1. + 0.0 + (4.42)) * 138$
 $= 182.16 \text{ kN}$

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V01	0001	CN	ME	120	MF	GCS	BK																			

Strength of Connection Elements for Failure Path Analysis

Shear, Outward Nozzle Weld [Sonw]:

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

$$= (3.1416/2.0) * 70.1 * 10.0 * 0.49 * 138$$

$$= 74. \text{ kN}$$

Shear, Nozzle Wall [Snw]:

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

$$= (3.1416 * 28.55) * (16.0 - 3.0) * 0.7 * 138$$

$$= 113. \text{ kN}$$

Tension, Shell Groove Weld [Tngw]:

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

$$= (3.1416/2.0) * 70.1 * (20.0 - 3.0) * 0.74 * 138$$

$$= 191. \text{ kN}$$

Strength of Failure Paths:

$$PATH11 = (SONW + SNW) = (74 + 113) = 187 \text{ kN}$$

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

$$= (74 + 0 + 191 + 0) = 265 \text{ kN}$$

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

$$= (74 + 191 + 0) = 265 \text{ kN}$$

Summary of Failure Path Calculations:

Path 1-1 = 186 kN , must exceed W = 90 kN or W1 = 121 kN
 Path 2-2 = 265 kN , must exceed W = 90 kN or W2 = 182 kN
 Path 3-3 = 265 kN , must exceed W = 90 kN or W3 = 182 kN

Maximum Allowable Pressure for this Nozzle at this Location:

Converged Max. Allow. Pressure in Operating case 67 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 : 18.1973 mm.

The Cut Length for this Nozzle is, Drop + Ho + H + T : 240.3138 mm.

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Listed below are the known problem areas for the current design. If one or more of the design flags are turned on, please re-run the analysis. Some of these issues may be resolved when using updated input values.

**** Warning: The Concrete was Overstressed!**

Please review all reports carefully!

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(B&Y) Case

Skirt Data :

Skirt Outside Diameter at Base	SOD	736.0000	mm.
Skirt Thickness	STHK	25.0000	mm.
Skirt Internal Corrosion Allowance	SCA	0.0000	mm.
Skirt External Corrosion Allowance		0.0000	mm.
Skirt Material		SA-516 70	

Basering Input: Type of Geometry: Continuous Top Ring W/Gussets

Thickness of Basering	TBA	80.0000	mm.
Design Temperature of the Basering		85.00	°C
Basering Matl		SA-283 C	
Basering Operating All. Stress	BASOPE	108.25	N./mm ²
Basering Yield Stress		191.06	N./mm ²
Inside Diameter of Basering	DI	620.0000	mm.
Outside Diameter of Basering	DOU	1060.0000	mm.
Nominal Diameter of Bolts	BND	48.0000	mm.
Bolt Corrosion Allowance	BCA	0.0000	mm.
Bolt Material		SA-193 B7	
Bolt Material Class/Thickness Range		<= 2 1/2	
Bolt Operating Allowable Stress	SA	135.00	N./mm ²
Number of Bolts	RN	12	
Diameter of Bolt Circle	DC	960.0000	mm.
Bolt Allowable Shear Stress		81.000	N./mm ²
Ultimate Comp. Strength of Concrete	FPC	20.7	N./mm ²
Allowable Comp. Strength of Concrete	FC	8.3	N./mm ²
Modular ratio Steel/Concrete		9.833	
Thickness of Gusset Plates	TGA	12.0000	mm.
Width of Gussets at Top Plate	TWDT	200.0000	mm.
Width of Gussets at Base Plate	BWDT	162.0000	mm.
Gusset Plate Elastic Modulus	E	199042000.0	KPa.
Gusset Plate Yield Stress	SY	191.1	N./mm ²
Height of Gussets	HG	265.0000	mm.
Distance between Gussets	RG	100.0000	mm.
Dist. from Bolt Center to Gusset (Rg/2)	CG	50.0000	mm.
Number of Gussets per bolt	NG	2	
Thickness of Top Plate or Ring	TTA	35.0000	mm.
Radial Width of the Top Plate	TOPWTH	200.0000	mm.
Anchor Bolt Hole Dia. in Top Plate	BHOLE	60.0000	mm.
External Corrosion Allowance	CA	1.6000	mm.
Dead Weight of Vessel	DW	147.0	kN
Operating Weight of Vessel	ROW	157.8	kN
Test Weight of Vessel	TW	150.4	kN

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Earthquake Moment on Basing	EQMOM	550282.1	N-m
Wind Moment on Basing	WIMOM	108121.0	N-m
Test Moment on Basing	TM	42055.4	N-m
Percent Bolt Preload	ppl	100.0	

Use AISC A5.2 Increase in Fc and Bolt Stress	No
Use Allowable Weld Stress per AISC J2.5	No
Factor for Increase of Allowables	Fact 1.0000

Results for Brownell and Young Basing Analysis : Analyze Option

Note: This analysis is based on Neutral Axis shift method for Steel on Concrete (or a material with significantly different Young's modulus).

Calculation of Bolt Loads for Multiple Load Conditions:

Operating Bolt Load, Earthquake Operating Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 550282/960.0) - 135) / 12$$

$$= 179.7 \text{ kN}$$

Operating Bolt Load, Windload Empty Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 108121/960.0) - 147) / 12$$

$$= 25.3 \text{ kN}$$

Operating Bolt Load, Windload Vortex Shedding Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 0/960.0) - 158) / 12$$

$$= -13.1 \text{ kN}$$

Operating Bolt Load, Test Moment Case:

$$= ((4 * M/DC) - W) / RN \quad \text{per Jawad \& Farr, Eq. 12.3}$$

$$= ((4 * 42055/960.0) - 150) / 12$$

$$= 2.1 \text{ kN}$$

Governing Bolt Load Condition, Earthquake + Operating Condition:

Area Available in one Bolt	Abss :	13.4296	cm ²
Area Available in all the Bolts	Abss * RN :	161.1551	cm ²

Trial#	k	knew	Cc	Ct	z	j	Ft	Fc
2	0.167	0.251	1.110	2.734	0.466	0.773	659.8	795.1
4	0.293	0.272	1.489	2.458	0.439	0.781	657.7	793.0
6	0.282	0.287	1.460	2.481	0.442	0.780	657.7	793.0
8	0.285	0.286	1.468	2.475	0.441	0.780	657.7	793.0
10	0.285	0.285	1.469	2.474	0.441	0.781	657.7	793.0

The Actual Stress in a Single Bolt [Sbolt]:

$$= 2 * Ft / (T1 * Dc * Ct)$$

$$= 2 * 657.7 / (5.343 * 960.0 * 2.474)$$

$$= 103.668 \text{ N./mm}^2, \text{ Should be less than } 135.0$$

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Thickness of the Band of Bolting Steel [T1]

$$= RN * Bolt Area / (3.14159 * Dc)$$

$$= 12 * 13.43 / (3.14159 * 960.0)$$

$$= 5.343 \text{ mm.}$$

Check the Bearing Stress in the Concrete [fc(max)]

$$= fc' [(2kd + t3) / (2kd)]$$

$$= 4.208 [(2 * 0.285 * 960.0 + 220.0) / (2 * 0.285 * 960.0)]$$

$$= 5.897 \text{ N./mm}^2, \text{ Should be less than } 8.3$$

Values for table 10.3, $l = 162.0$, $b = 125.664$, $l/b = 1.289155$

Maximum Moment per unit width [Mmax]:

$$= \text{Max} (Mx, My) = \text{Max} (10.441, 18.864) = 18.864 \text{ kN}$$

Reqd Thickness of Basing, Brownell & Young Method [T]:

$$= (6 * Mmax / fallow)^{1/2} + Ca$$

$$= (6 * 18.864 / 126.1)^{1/2} + 1.6$$

$$= 31.561 \text{ mm.}$$

Nomenclature:

a	= (Dc-Ds) / 2	Skirt Distance to Bolt Circle
P	= Sbolt * Abss = Wmax	Maximum Load on one Bolt
l		Radial Top Plate Width
lavg		Average Gusset Plate Width
g1	= Gamma 1	Constant Term f(b/l)
g2	= Gamma 2	Constant Term f(b/l)
g	= Flat distance / 2	Nut 1/2 Dimension (from Tema)
Fb		Allowable Bending Stress

Values for table 10.6, $l = 200.0$, $b = 100.0$, $b/l = 0.5$

As $b/l (0.5)$ is less than 1, inverting $b/l = 2.0$.

Moment Term, based on geometry [Mo]:

$$= P / (4\pi) [1.3 (\ln((2l \sin(\pi * a / l)) / (\pi * g))) + 1] - [(0.7 - g2) P / (4\pi)]$$

$$= 139.21 / (4 * 3.14) [1.3 (\ln((2 * 200.0 * \sin(3.14 * 112.0 / 200.0)) / (3.14 * 40.0))) + 1] - [(0.7 - 0.022) * 139.21 / (4 * 3.14)]$$

$$= 19.9818 \text{ kN}$$

Required Thickness of Continuous Top Ring [Tc]:

$$= (6 * \text{Abs}(Mo) / Fb)^{1/2} + Ca$$

$$= (6 * \text{Abs}(19.98) / 162.38)^{1/2} + 1.6$$

$$= 28.7737 \text{ mm.}$$

Required Gusset Plate Thickness [tg]:

$$= P / (\text{Stress Term} * lavg) + Ca$$

$$= 139.21 / (124.11 * 181.0) + 1.6$$

$$= 11.125 \text{ (not less than } 9.525 + 1.6) \text{ mm.}$$

Bolt spacing [m]:

$$= \pi * Bolt Circle Diameter / \text{number of Bolts}$$

$$= 3.142 * 960.0 / 12 = 251.327 \text{ mm.}$$

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Req. Skirt Thk. to withstand Local Bending, (Brownell and Young) [t]:

$$= 1.76 * (P*a / (m * (h + tba) * 1.5 * Sktope))^{2/3} * r^{1/3} + Ca$$

$$= 1.76 * (139 * 112.0 / (251.33 * 345.0 * 207))^{2/3} * 368.0^{1/3} + Ca$$

$$= 11.489 + 0.0 = 11.489 \text{ mm.}$$

Shear Stress in a Single Bolt [taub]:

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

$$= 62 / (2 * 13.43 * 12)$$

$$= 1.9 \text{ N./mm}^2. \text{ Must be less than } 81.0 \text{ N./mm}^2.$$

Summary of Basing Thickness Calculations

Required Basing Thickness (tension)	31.5606	mm.
Actual Basing Thickness as entered by user	80.0000	mm.
Required Thickness of Chair Cap	28.7737	mm.
Actual Top Ring Thickness as entered by user	35.0000	mm.
Required Gusset thickness, + CA	11.1250	mm.
Actual Gusset Thickness as entered by user	12.0000	mm.
Required Thickness of Skirt for Local Stress	11.4886	mm.
Given Thickness of Skirt	25.0000	mm.
Required Gusset Height to meet local stress	38.6854	mm.

Weld Size Calculations per Steel Plate Engineering Data - Vol. 2

Compute the Weld load at the Skirt/Base Junction [W]

$$= \text{SkirtStress} * (\text{SkirtThickness} - CA)$$

$$= 60.062 * (25.0 - 0.0)$$

$$= 1.5 \text{ kN/mm.}$$

Results for Computed Minimum Basing Weld Size [BWeld]

$$= W / [(0.4 * \text{Yield}) * 2 * 0.707]$$

$$= 2 / [(0.4 * 191) * 2 * 0.707]$$

$$= 13.895 \text{ mm.}$$

Results for Computed Minimum Gusset and Top Plate to Skirt Weld Size

Vertical Plate Load [Wv]

$$= \text{Bolt Load} / (\text{Cmwth} + 2 * (Hg + Tta))$$

$$= 139.2 / (170.5 + 2 * (265.0 + 35.0))$$

$$= 0.181 \text{ kN/mm.}$$

Horizontal Plate Load [Wh]

$$= \text{Bolt Load} * e / (\text{Cmwth} * (Hg + Tta) + 0.6667 * (Hg + Tta)^2)$$

$$= 139.2 * 112.0 / (170.5 * (300.0) + 0.6667 * (300.0)^2)$$

$$= 0.14 \text{ kN/mm.}$$

Resultant Weld Load [Wr]

$$= (Wv^2 + Wh^2)^{1/2}$$

$$= (0.18^2 + 0.14^2)^{1/2}$$

$$= 0.229 \text{ kN/mm.}$$

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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Results for Computed Min Gusset and Top Plate to Skirt Weld Size [GsWeld]

$$\begin{aligned}
 &= W_r / [(0.4 * Yield) * 2 * 0.707] \\
 &= 0.23 / [(0.4 * 191) * 2 * 0.707] \\
 &= 2.117 \text{ mm.}
 \end{aligned}$$

Results for Computed Minimum Gusset to Top Plate Weld Size

Weld Load [Wv]

$$\begin{aligned}
 &= Bolt \text{ Load} / (2 * TopWth) \\
 &= 139.2 / (2 * 200.0) \\
 &= 0.348 \text{ kN/mm.}
 \end{aligned}$$

Weld Load [Wh]

$$\begin{aligned}
 &= Bolt \text{ Load} * e / (2 * Hgt * TopWth) \\
 &= 139.2 * 112.0 / (2 * 300.0 * 200.0) \\
 &= 0.13 \text{ kN/mm.}
 \end{aligned}$$

Resultant Weld Load [Wr]

$$\begin{aligned}
 &= (W_v^2 + W_h^2)^{1/2} \\
 &= (0.35^2 + 0.13^2)^{1/2} \\
 &= 0.371 \text{ kN/mm.}
 \end{aligned}$$

Results for Computed Min Gusset to Top Plate Weld Size [GtpWeld]

$$\begin{aligned}
 &= W_r / [(0.4 * Yield) * 2 * 0.707] \\
 &= 0.37 / [(0.4 * 191) * 2 * 0.707] \\
 &= 3.438 \text{ mm.}
 \end{aligned}$$

Note: The calculated weld sizes need not exceed the component thickness framing into the weld. At the same time, the weld must meet a minimum size specification which is 3/16 in. (4.76 mm) or 1/4 in. (6.35 mm), depending on the component thickness.

Summary of Required Weld Sizes:

Required Basing to Skirt Double Fillet Weld Size	13.8948	mm.
Required Gusset to Skirt Double Fillet Weld Size	4.7625	mm.
Required Top Plate to Skirt Weld Size	6.3500	mm.
Required Gusset to Top Plate Double Fillet Weld Size	3.4379	mm.

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Hydrotest Case

Hydrostatic Test Pressure Results:

Pressure per UG99b	= 1.30 * M.A.W.P. * Sa/S	81.743	bars
Pressure per UG99b[36]	= 1.30 * Design Pres * Sa/S	80.600	bars
Pressure per UG99c	= 1.30 * M.A.P. - Head(Hyd)	83.089	bars
Pressure per UG100	= 1.10 * M.A.W.P. * Sa/S	69.167	bars
Pressure per PED	= max(1.43*DP, 1.25*DP*ratio)	88.660	bars
Pressure per App 27-4	= M.A.W.P.	62.879	bars

User Defined Hydrostatic Test Pressure at High Point 81.740 bars

Horizontal Test performed per: User Hydro Pressure

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.

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

From To	Stress	Allowable	Ratio	Pressure
Bottom Head	145.2	235.8	0.616	81.81
30 40	149.3	235.8	0.633	81.81
60 70	149.3	235.8	0.633	81.81
90 100	174.8	235.8	0.741	81.81
100 110	174.8	235.8	0.741	81.81
110 120	174.8	235.8	0.741	81.81
140 150	174.8	235.8	0.741	81.81
Top Head	168.8	235.8	0.716	81.81

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

Description	Pad/Nozzle	Ambient	Operating	Ratio
N07 (1.5in)	Nozzle	117.90	117.90	1.000
K07A (3in)	Nozzle	137.90	137.90	1.000
K09A (2in)	Nozzle	117.90	117.90	1.000
N01 (6in)	Nozzle	137.90	137.90	1.000
N09 (1in)	Nozzle	137.90	137.90	1.000
K07B (3in)	Nozzle	137.90	137.90	1.000
K08B (2in)	Nozzle	137.90	137.90	1.000
K08A (2in)	Nozzle	137.90	137.90	1.000
K09B (2in)	Nozzle	137.90	137.90	1.000
N10A (8in)	Nozzle	137.90	137.90	1.000
N05 (2in)	Nozzle	137.90	137.90	1.000
N04 (1in)	Nozzle	137.90	137.90	1.000
N10B (8in)	Nozzle	137.90	137.90	1.000
K2B (2in)	Nozzle	137.90	137.90	1.000

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N04 (1in)	12.17	223.40	0.054
N10B (8in)	121.95	223.40	0.546
K2B (2in)	17.43	223.40	0.078
K2A (2in)	17.43	223.40	0.078
K3A (2in)	17.43	223.40	0.078
K3B (2in)	17.43	223.40	0.078
K4B (3in)	20.19	223.40	0.090
K4A (3in)	20.19	223.40	0.090
K05 (2in)	21.99	223.40	0.098
K10A (2in)	21.99	223.40	0.098
K10B (2in)	21.99	223.40	0.098
K1 (2in)	21.99	223.40	0.098
N06 (2in)	21.99	223.40	0.098
K6A (2in)	21.99	223.40	0.098
K6B (2in)	21.99	223.40	0.098
N03 (2in)	16.28	223.40	0.073
N10C (8in)	107.19	223.40	0.480
N02 (6in)	101.01	223.40	0.452
N08 (1.5in)	18.79	223.40	0.084

Elements Suitable for Test Pressure.

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FEA N8 Nozzle

Results were generated with the finite element program FE/Pipe®. Stress results are post-processed in accordance with the rules specified in ASME Section III and ASME Section VIII, Division 2.

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- [Load Case Report](#)
- [Solution Data](#)
- [ASME Code Stress Output Plots](#)
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- [Highest Secondary Stress Ratios](#)
- [Highest Fatigue Stress Ratios](#)
- [Highest Stress Ratios Per Region](#)
- [Stress Intensification Factors](#)
- [Allowable Loads](#)
- [Compressive Stress Summary](#)
- [Flexibilities](#)
- [Graphical Results](#)

Model Notes
Model Notes

Input Echo:

Model Type : Elliptical Head

Parent Geometry

Parent Outside Diam. : 740.000 mm.
Thickness : 17.000 mm.
Ellipse Ratio : 0.000

Parent Properties:

Cold Allowable : 137.9 MPa
Hot Allowable : 137.9 MPa
Material DB # 1016422.
Ultimate Tensile (Amb) : 482.6 MPa
Yield Strength (Amb) : 262.0 MPa
Yield Strength (Hot) : 231.7 MPa
Elastic Modulus (Amb) : 202720.0 MPa
Poissons Ratio : 0.300
Expansion Coefficient : 0.1241E-04 mm./mm./deg.
Weight Density : 0.0000E+00 N /cu.mm. (NOT USED)

Nozzle Geometry

Nozzle Outside Diam. : 70.000 mm.
Thickness : 13.000 mm.

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Length : 300.000 mm.

Location perpendicular to the head centerline : 280.000 mm.

Nozzle Tilt Angle : 0.000 deg.

Nozzle Properties

Cold Allowable : 137.9 MPa

Hot Allowable : 137.9 MPa

Material DB # 1015022.

Ultimate Tensile (Amb) : 482.6 MPa

Yield Strength (Amb) : 248.2 MPa

Yield Strength (Hot) : 219.3 MPa

Elastic Modulus (Amb) : 201341.0 MPa

Poissons Ratio : 0.300

Expansion Coefficient : 0.1241E-04 mm./mm./deg.

Weight Density : 0.0000E+00 N /cu.mm. (NOT USED)

Design Operating Cycles : 7000.

Ambient Temperature (Deg.) : 21.10

Uniform thermal expansion produces no stress in this geometry.

Any thermal loads will come through operating forces and moments applied through the nozzle.

Nozzle Inside Temperature : 148.00 deg.

Nozzle Outside Temperature : 148.00 deg.

Vessel Inside Temperature : 148.00 deg.

Vessel Outside Temperature : 148.00 deg.

Nozzle Pressure : 6.200 MPa

Vessel Pressure : 6.200 MPa

No external forces or bending moments were included in this analysis.

Stresses ARE nodally AVERAGED.

No weld dimensions have been given for the nozzle connection to the shell. This will produce conservative results for external loads and may tend to produce more realistic inside surface pressure stresses.

Vessel Centerline Vector: 0.000 1.000 0.000

Nozzle Centerline Vector: 0.000 1.000 0.000

Zero Degree Orientation Vector: 1.000 0.000 0.000

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Load Case Report
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Load Case Report

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Inner and outer element temperatures are the same throughout the model. No thermal ratcheting calculations will be performed.

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THE 9 LOAD CASES ANALYZED ARE:

1 WEIGHT ONLY (Wgt Only)

Weight ONLY case run to get the stress range between the installed and the operating states.

/----- Loads in Case 1
Loads due to Weight

2 SUSTAINED (Wgt+Pr)

Sustained case run to satisfy local primary membrane and bending stress limits.

/----- Loads in Case 2
Loads due to Weight
Pressure Case 1

3 OPERATING

Case run to compute the operating stresses used in secondary, peak and range calculations as needed.

/----- Loads in Case 3
Pressure Case 1
Loads from (Operating)

4 RANGE (Fatigue Calc Performed)

Case run to get the RANGE of stresses. as described in NB-3222.2, 5.5.3.2, 5.5.5.2 or 5.5.6.1.

/----- Combinations in Range Case 4
Plus Stress Results from CASE 3
Minus Stress Results from CASE 1

5 Program Generated -- Force Only

Case run to compute sif's and flexibilities.
/----- Loads in Case 5
Loads from (Axial)

6 Program Generated -- Force Only

Case run to compute sif's and flexibilities.
/----- Loads in Case 6
Loads from (Inplane)

7 Program Generated -- Force Only

Case run to compute sif's and flexibilities.
/----- Loads in Case 7
Loads from (Outplane)

8 Program Generated -- Force Only

Case run to compute sif's and flexibilities.
/----- Loads in Case 8
Loads from (Torsion)

9 Program Generated -- Force Only

Case run to compute sif's and flexibilities.
/----- Loads in Case 9
Pressure Case 1

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Solution Data
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Solution Data

Maximum Solution Row Size = 876
Number of Nodes = 2101
Number of Elements = 708
Number of Solution Cases = 8

Summation of Loads per Case

Case #	FX	FY	FZ
1	0.	0.	0.
2	0.	2545408.	0.
3	0.	2545408.	0.
4	0.	321011.	0.
5	0.	0.	0.
6	0.	0.	0.
7	0.	0.	0.
8	0.	2545408.	0.

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ASME Code Stress Output Plots
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ASME Code Stress Output Plots

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- 1) $P_l < SPL$ (SUS,Membrane) Case 2
- 2) $Q_b < SPS$ (SUS,Bending) Case 2
- 3) $P_l+P_b+Q < SPS$ (SUS,Inside) Case 2
- 4) $P_l+P_b+Q < SPS$ (SUS,Outside) Case 2
- 5) $S_1+S_2+S_3 < 4S$ (SUS, $S_1+S_2+S_3$) Case 2
- 6) $P_l+P_b+Q < SPS$ (OPE,Inside) Case 3
- 7) $P_l+P_b+Q < SPS$ (OPE,Outside) Case 3
- 8) Membrane < User (OPE,Membrane) Case 3

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- 9) Bending < User (OPE,Bending) Case 3
- 10) Pl+Pb+Q+F < 2Sa (SIF,Outside) Case 5
- 11) Pl+Pb+Q+F < 2Sa (SIF,Outside) Case 6
- 12) Pl+Pb+Q+F < 2Sa (SIF,Outside) Case 7
- 13) Pl+Pb+Q+F < 2Sa (SIF,Outside) Case 8
- 14) Pl+Pb+Q+F < 2Sa (SIF,Outside) Case 9
- 15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
- 16) Pl+Pb+Q < SPS (EXP,Outside) Case 4
- 17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4
- 18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 4

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Stress Results - Notes
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Stress Results - Notes

- Results in this analysis were generated using the finite element solution method.
- Using 2019 ASME Section VIII Division 2
- Use Polished Bar fatigue curve.
- Ratio between Operating and Design Pressure = 1.000000
Range cases use operating pressure. Primary cases use design pressure.
- Assume free end displacements of attached pipe (e.g. thermal loads) are secondary loads.
- Primary bending stresses at discontinuities are treated like secondary stresses. (Pb=0)
- Use Equivalent Stress (Von Mises).
- TRIAXIAL Stress Guidelines:
S1+S2+S3 evaluation omitted from operating stress.
Include S1+S2+S3 evaluation in primary case evaluation.
Bending stress NOT included for all S1+S2+S3 calculations.
- Use local tensor values for averaged and not averaged stresses.

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ASME Overstressed Areas
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ASME Overstressed Areas

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*** NO OVERSTRESSED NODES IN THIS MODEL ***

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Highest Primary Stress Ratios
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Highest Primary Stress Ratios

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Shell Next to Nozzle 1

P1	SPL	Primary Membrane Load Case 2
132	232	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		1) P1 < SPL (SUS,Membrane) Case 2

56%

Nozzle 1 Next to Shell

P1	SPL	Primary Membrane Load Case 2
100	219	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		1) P1 < SPL (SUS,Membrane) Case 2

45%

Shell In Nozzle 1 Vicinity

P1	SPL	Primary Membrane Load Case 2
161	232	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		1) P1 < SPL (SUS,Membrane) Case 2

69%

Nozzle 1

P1	SPL	Primary Membrane Load Case 2
19	219	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		1) P1 < SPL (SUS,Membrane) Case 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 CONTACTOR (C-100)							شماره صفحه : 339 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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Highest Secondary Stress Ratios

FEPipe Version 15.0

Released Jan. 2021

Jobname: NOZZLE

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\$P

Highest Secondary Stress Ratios

\$X

In combination case 4 the max range stress divided by the max component stress is 1.00. The case tensor components are NEVER additive and so the combination case will have LOWER stresses than the largest of any of the individual cases by between 1 and 20%.

Load Case	Combined/Max (Inside)	Combined/Max (Outside)
4	1.000	1.000

Shell Next to Nozzle 1

Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
175	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2
35%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
175	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3
35%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4
175	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
35%		

Nozzle 1 Next to Shell

Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
162	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2
34%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
162	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3
34%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4
162	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:

 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 CONTACTOR (C-100)							شماره صفحه : 340 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

34% 15) Pl+Pb+Q < SPS (EXP,Inside) Case 4

Shell In Nozzle 1 Vicinity

Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2
46%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3
46%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
46%		

Nozzle 1

Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 2
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		4) Pl+Pb+Q < SPS (SUS,Outside) Case 2
7%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 3
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		7) Pl+Pb+Q < SPS (OPE,Outside) Case 3
7%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 4
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		16) Pl+Pb+Q < SPS (EXP,Outside) Case 4
7%		

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Highest Fatigue Stress Ratios

FEPipe Version 15.0
Released Jan. 2021

Jobname: NOZZLE
4:22pm MAR 3,2025

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Highest Fatigue Stress Ratios

\$X

Shell Next to Nozzle 1

Pl+Pb+Q+F	Damage Ratio	Primary+Secondary+Peak (Inner) Load Case 4
236	0.043 Life	Stress Concentration Factor = 1.350
MPa	0.407 Stress	Strain Concentration Factor = 1.000

 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 08_BK-HD-GCS-CO-0010)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 341 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Allowable 579.9 MPa 40%

Cycles Allowed for this Stress = 163,979.
 "B31" Fatigue Stress Allowable = 689.5
 Markl Fatigue Stress Allowable = 575.0
 WRC 474 Mean Cycles to Failure = 722,402.
 WRC 474 99% Probability Cycles = 167,821.
 WRC 474 95% Probability Cycles = 232,998.
 BS5500 Allowed Cycles(Curve F) = 129,385.
 Membrane-to-Bending Ratio = 2.367
 Bending-to-PL+PB+Q Ratio = 0.297
 Plot Reference:
 17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4

Nozzle 1 Next to Shell

Pl+Pb+Q+F 219 MPa 0.382 Stress

Damage Ratio 0.034 Life

Primary+Secondary+Peak (Inner) Load Case 4
 Stress Concentration Factor = 1.350
 Strain Concentration Factor = 1.000
 Cycles Allowed for this Stress = 208,425.
 "B31" Fatigue Stress Allowable = 689.5
 Markl Fatigue Stress Allowable = 575.0
 WRC 474 Mean Cycles to Failure = 1,078,886.
 WRC 474 99% Probability Cycles = 250,635.
 WRC 474 95% Probability Cycles = 347,975.
 BS5500 Allowed Cycles(Curve F) = 166,442.
 Membrane-to-Bending Ratio = 1.463
 Bending-to-PL+PB+Q Ratio = 0.406
 Plot Reference:
 17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4

Shell In Nozzle 1 Vicinity

Pl+Pb+Q+F 228 MPa 0.394 Stress

Damage Ratio 0.038 Life

Primary+Secondary+Peak (Inner) Load Case 4
 Stress Concentration Factor = 1.000
 Strain Concentration Factor = 1.000
 Cycles Allowed for this Stress = 184,716.
 "B31" Fatigue Stress Allowable = 689.5
 Markl Fatigue Stress Allowable = 575.0
 WRC 474 Mean Cycles to Failure = 316,600.
 WRC 474 99% Probability Cycles = 73,549.
 WRC 474 95% Probability Cycles = 102,114.
 BS5500 Allowed Cycles(Curve F) = 58,069.
 Membrane-to-Bending Ratio = 1.751
 Bending-to-PL+PB+Q Ratio = 0.363
 Plot Reference:
 17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4

Nozzle 1

Pl+Pb+Q+F 36 MPa 0.063 Stress

Damage Ratio 0.000 Life

Primary+Secondary+Peak (Outer) Load Case 4
 Stress Concentration Factor = 1.000
 Strain Concentration Factor = 1.000
 Cycles Allowed for this Stress = 1.0000E11
 "B31" Fatigue Stress Allowable = 689.5
 Markl Fatigue Stress Allowable = 575.0
 WRC 474 Mean Cycles to Failure = 1.2324E8
 WRC 474 99% Probability Cycles = 28,630,694.
 WRC 474 95% Probability Cycles = 39,750,116.
 BS5500 Allowed Cycles(Curve F) = 20,541,886.
 Membrane-to-Bending Ratio = 0.754
 Bending-to-PL+PB+Q Ratio = 0.570
 Plot Reference:
 18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 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 CONTACTOR (C-100)							شماره صفحه : 342 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
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Highest Stress Ratios Per Region

FEPipe Version 15.0

Jobname: NOZZLE

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Released Jan. 2021

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Highest Stress Ratios Per Region

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Shell Next to Nozzle 1

P1	SPL	Primary Membrane Load Case 2
132	232	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		1) P1 < SPL (SUS,Membrane) Case 2
56%		
Qb	SPS	Primary Bending Load Case 2
63	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		2) Qb < SPS (SUS,Bending) Case 2
12%		
P1+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
175	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		3) P1+Pb+Q < SPS (SUS,Inside) Case 2
35%		
P1+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 2
138	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		4) P1+Pb+Q < SPS (SUS,Outside) Case 2
28%		
S1+S2+S3	4S	Part 5 (5.3.2) Load Case 2
197	552	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		5) S1+S2+S3 < 4S (SUS,S1+S2+S3) Case 2
35%		
P1+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
175	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		6) P1+Pb+Q < SPS (OPE,Inside) Case 3
35%		
P1+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 3
138	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		7) P1+Pb+Q < SPS (OPE,Outside) Case 3
28%		
Membrane	User	Component Evaluation Load Case 3
132	494	Min Prin. Stress = -85. (77% Neg, 0% NegHi)
MPa	MPa	Plot Reference:
		8) Membrane < User (OPE,Membrane) Case 3
26%		

 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 08_0010-BK-HD-GCS-CO)							
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 343 از 383
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	
	BK	GCS	MF	120	ME	CN	0001	
							V01	

Bending 63 MPa	User 494 MPa	Component Evaluation Load Case 3 Min Prin. Stress = -85. (77% Neg, 0% NegHi) Plot Reference: 9) Bending < User (OPE,Bending) Case 3
12%		
Pl+Pb+Q 175 MPa	SPS 494 MPa	Primary+Secondary (Inner) Load Case 4 Min Prin. Stress = -85. (77% Neg, 0% NegHi) Plot Reference: 15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
35%		
Pl+Pb+Q 138 MPa	SPS 494 MPa	Primary+Secondary (Outer) Load Case 4 Min Prin. Stress = -85. (77% Neg, 0% NegHi) Plot Reference: 16) Pl+Pb+Q < SPS (EXP,Outside) Case 4
28%		
Pl+Pb+Q+F 236 MPa	Damage Ratio 0.043 Life 0.407 Stress	Primary+Secondary+Peak (Inner) Load Case 4 Stress Concentration Factor = 1.350 Strain Concentration Factor = 1.000 Cycles Allowed for this Stress = 163,979. "B31" Fatigue Stress Allowable = 689.5 Markl Fatigue Stress Allowable = 575.0 WRC 474 Mean Cycles to Failure = 722,402. WRC 474 99% Probability Cycles = 167,821. WRC 474 95% Probability Cycles = 232,998. BS5500 Allowed Cycles(Curve F) = 129,385. Membrane-to-Bending Ratio = 2.367 Bending-to-PL+PB+Q Ratio = 0.297 Plot Reference: 17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4
Allowable 579.9 MPa		
40%		
Pl+Pb+Q+F 187 MPa	Damage Ratio 0.016 Life 0.322 Stress	Primary+Secondary+Peak (Outer) Load Case 4 Stress Concentration Factor = 1.350 Strain Concentration Factor = 1.000 Cycles Allowed for this Stress = 451,059. "B31" Fatigue Stress Allowable = 689.5 Markl Fatigue Stress Allowable = 575.0 WRC 474 Mean Cycles to Failure = 1,497,967. WRC 474 99% Probability Cycles = 347,991. WRC 474 95% Probability Cycles = 483,142. BS5500 Allowed Cycles(Curve F) = 260,464. Membrane-to-Bending Ratio = 2.496 Bending-to-PL+PB+Q Ratio = 0.286 Plot Reference: 18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 4
Allowable 579.9 MPa		
32%		
Nozzle 1 Next to Shell		
Pl 100 MPa	SPL 219 MPa	Primary Membrane Load Case 2 Min Prin. Stress = -45. (88% Neg, 68% NegHi) Plot Reference: 1) Pl < SPL (SUS,Membrane) Case 2
45%		
Qb 69 MPa	SPS 468 MPa	Primary Bending Load Case 2 Min Prin. Stress = -45. (88% Neg, 68% NegHi) Plot Reference: 2) Qb < SPS (SUS,Bending) Case 2
14%		
Pl+Pb+Q 162 MPa	SPS 468 MPa	Primary+Secondary (Inner) Load Case 2 Min Prin. Stress = -45. (88% Neg, 68% NegHi) Plot Reference:

 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	0001	V01											

		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2
34%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 2
82	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		4) Pl+Pb+Q < SPS (SUS,Outside) Case 2
17%		
S1+S2+S3	4S	Part 5 (5.3.2) Load Case 2
123	552	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		5) S1+S2+S3 < 4S (SUS,S1+S2+S3) Case 2
22%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
162	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3
34%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 3
82	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		7) Pl+Pb+Q < SPS (OPE,Outside) Case 3
17%		
Membrane	User	Component Evaluation Load Case 3
100	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		8) Membrane < User (OPE,Membrane) Case 3
21%		
Bending	User	Component Evaluation Load Case 3
69	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		9) Bending < User (OPE,Bending) Case 3
14%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4
162	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
34%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 4
82	468	Min Prin. Stress = -45. (88% Neg, 68% NegHi)
MPa	MPa	Plot Reference:
		16) Pl+Pb+Q < SPS (EXP,Outside) Case 4
17%		
Pl+Pb+Q+F	Damage Ratio	Primary+Secondary+Peak (Inner) Load Case 4
219	0.034 Life	Stress Concentration Factor = 1.350
MPa	0.382 Stress	Strain Concentration Factor = 1.000
		Cycles Allowed for this Stress = 208,425.
Allowable		"B31" Fatigue Stress Allowable = 689.5
574.2		Mark1 Fatigue Stress Allowable = 575.0
MPa		WRC 474 Mean Cycles to Failure = 1,078,886.
		WRC 474 99% Probability Cycles = 250,635.
		WRC 474 95% Probability Cycles = 347,975.
38%		BS5500 Allowed Cycles(Curve F) = 166,442.
		Membrane-to-Bending Ratio = 1.463
		Bending-to-PL+PB+Q Ratio = 0.406
		Plot Reference:
		17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 345 از 383
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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Pl+Pb+Q+F Damage Ratio Primary+Secondary+Peak (Outer) Load Case 4
111 0.000 Life Stress Concentration Factor = 1.350
MPa 0.193 Stress Strain Concentration Factor = 1.000
Cycles Allowed for this Stress = 3.8307E9
Allowable "B31" Fatigue Stress Allowable = 689.5
574.2 Markl Fatigue Stress Allowable = 575.0
MPa WRC 474 Mean Cycles to Failure = 10,284,998.
19% WRC 474 99% Probability Cycles = 2,389,296.
WRC 474 95% Probability Cycles = 3,317,237.
BS5500 Allowed Cycles (Curve F) = 1,289,684.
Membrane-to-Bending Ratio = 1.444
Bending-to-PL+PB+Q Ratio = 0.409
Plot Reference:
18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 4

Shell In Nozzle 1 Vicinity

Pl	SPL	Primary Membrane Load Case 2
161	232	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		1) Pl < SPL (SUS,Membrane) Case 2
69%		
Qb	SPS	Primary Bending Load Case 2
89	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		2) Qb < SPS (SUS,Bending) Case 2
17%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2
46%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 2
143	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		4) Pl+Pb+Q < SPS (SUS,Outside) Case 2
28%		
S1+S2+S3	4S	Part 5 (5.3.2) Load Case 2
209	552	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		5) S1+S2+S3 < 4S (SUS,S1+S2+S3) Case 2
37%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3
46%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 3
143	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		7) Pl+Pb+Q < SPS (OPE,Outside) Case 3
28%		
Membrane	User	Component Evaluation Load Case 3
161	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		8) Membrane < User (OPE,Membrane) Case 3
32%		

 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	0001		V01

Bending	User	Component Evaluation Load Case 3
89	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		9) Bending < User (OPE,Bending) Case 3
17%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4
228	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		15) Pl+Pb+Q < SPS (EXP,Inside) Case 4
46%		
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 4
143	494	Min Prin. Stress = -144. (86% Neg, 71% NegHi)
MPa	MPa	Plot Reference:
		16) Pl+Pb+Q < SPS (EXP,Outside) Case 4
28%		
Pl+Pb+Q+F	Damage Ratio	Primary+Secondary+Peak (Inner) Load Case 4
228	0.038 Life	Stress Concentration Factor = 1.000
MPa	0.394 Stress	Strain Concentration Factor = 1.000
		Cycles Allowed for this Stress = 184,716.
Allowable		"B31" Fatigue Stress Allowable = 689.5
579.9		Markl Fatigue Stress Allowable = 575.0
MPa		WRC 474 Mean Cycles to Failure = 316,600.
		WRC 474 99% Probability Cycles = 73,549.
39%		WRC 474 95% Probability Cycles = 102,114.
		BS5500 Allowed Cycles(Curve F) = 58,069.
		Membrane-to-Bending Ratio = 1.751
		Bending-to-PL+PB+Q Ratio = 0.363
		Plot Reference:
		17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4
Pl+Pb+Q+F	Damage Ratio	Primary+Secondary+Peak (Outer) Load Case 4
143	0.000 Life	Stress Concentration Factor = 1.000
MPa	0.246 Stress	Strain Concentration Factor = 1.000
		Cycles Allowed for this Stress = 25,750,612.
Allowable		"B31" Fatigue Stress Allowable = 689.5
579.9		Markl Fatigue Stress Allowable = 575.0
MPa		WRC 474 Mean Cycles to Failure = 1,394,068.
		WRC 474 99% Probability Cycles = 323,855.
24%		WRC 474 95% Probability Cycles = 449,632.
		BS5500 Allowed Cycles(Curve F) = 236,693.
		Membrane-to-Bending Ratio = 2.239
		Bending-to-PL+PB+Q Ratio = 0.309
		Plot Reference:
		18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 4
Nozzle 1		
Pl	SPL	Primary Membrane Load Case 2
19	219	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		1) Pl < SPL (SUS,Membrane) Case 2
8%		
Qb	SPS	Primary Bending Load Case 2
21	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:
		2) Qb < SPS (SUS,Bending) Case 2
4%		
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 2
22	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)
MPa	MPa	Plot Reference:

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		3) Pl+Pb+Q < SPS (SUS,Inside) Case 2	
4%			
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 2	
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		4) Pl+Pb+Q < SPS (SUS,Outside) Case 2	
7%			
S1+S2+S3	4S	Part 5 (5.3.2) Load Case 2	
31	552	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		5) S1+S2+S3 < 4S (SUS,S1+S2+S3) Case 2	
5%			
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 3	
22	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		6) Pl+Pb+Q < SPS (OPE,Inside) Case 3	
4%			
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 3	
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		7) Pl+Pb+Q < SPS (OPE,Outside) Case 3	
7%			
Membrane	User	Component Evaluation Load Case 3	
19	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		8) Membrane < User (OPE,Membrane) Case 3	
4%			
Bending	User	Component Evaluation Load Case 3	
21	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		9) Bending < User (OPE,Bending) Case 3	
4%			
Pl+Pb+Q	SPS	Primary+Secondary (Inner) Load Case 4	
22	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		15) Pl+Pb+Q < SPS (EXP,Inside) Case 4	
4%			
Pl+Pb+Q	SPS	Primary+Secondary (Outer) Load Case 4	
36	468	Min Prin. Stress = -16. (61% Neg, 58% NegHi)	
MPa	MPa	Plot Reference:	
		16) Pl+Pb+Q < SPS (EXP,Outside) Case 4	
7%			
Pl+Pb+Q+F	Damage Ratio	Primary+Secondary+Peak (Inner) Load Case 4	
22	0.000 Life	Stress Concentration Factor = 1.000	
MPa	0.038 Stress	Strain Concentration Factor = 1.000	
		Cycles Allowed for this Stress = 1.0000E11	
Allowable		"B31" Fatigue Stress Allowable = 689.5	
574.2		Mark1 Fatigue Stress Allowable = 575.0	
MPa		WRC 474 Mean Cycles to Failure = 5.8505E8	
		WRC 474 99% Probability Cycles = 1.3591E8	
		WRC 474 95% Probability Cycles = 1.8870E8	
3%		BS5500 Allowed Cycles(Curve F) = 2.6567E8	
		Membrane-to-Bending Ratio = 1.935	
		Bending-to-PL+PB+Q Ratio = 0.341	
		Plot Reference:	
		17) Pl+Pb+Q+F < 2Sa (EXP,Inside) Case 4	

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Pl+Pb+Q+F Damage Ratio Primary+Secondary+Peak (Outer) Load Case 4
36 0.000 Life Stress Concentration Factor = 1.000
MPa 0.063 Stress Strain Concentration Factor = 1.000
Cycles Allowed for this Stress = 1.0000E11
Allowable "B31" Fatigue Stress Allowable = 689.5
574.2 Markl Fatigue Stress Allowable = 575.0
MPa WRC 474 Mean Cycles to Failure = 1.2324E8
WRC 474 99% Probability Cycles = 28,630,694.
6% WRC 474 95% Probability Cycles = 39,750,116.
BS5500 Allowed Cycles (Curve F) = 20,541,886.
Membrane-to-Bending Ratio = 0.754
Bending-to-PL+PB+Q Ratio = 0.570
Plot Reference:
18) Pl+Pb+Q+F < 2Sa (EXP,Outside) Case 4

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Stress Intensification Factors
FEPIPE Version 15.0 Jobname: NOZZLE \$P
Released Jan. 2021 4:22pm MAR 3, 2025

Stress Intensification Factors \$X

Branch/Nozzle Sif Summary

	Peak	Primary	Secondary	SSI
Axial :	2.658	1.969	3.938	1.252
Inplane :	1.540	1.141	2.281	1.155
Outplane:	1.438	1.065	2.130	1.087
Torsion :	0.891	0.997	1.320	0.944
Pressure:	0.874	1.193	1.692	0.970

The above stress intensification factors are to be used in a beam-type analysis of the piping system. Inplane, Outplane and Torsional sif's should be used with the matching branch pipe whose diameter and thickness is given below. The axial sif should be used to intensify the axial stress in the branch pipe calculated by F/A. The pressure sif should be used to intensify the nominal pressure stress in the PARENT or HEADER, calculated from PDo/2T. B31 calculations use mean diameters and Section VIII calculations use outside diameters. SSIs are based on peak stress factors and correlated test results.

Pipe OD : 70.000 mm.
Pipe Thk: 13.000 mm.
Z approx: 33172.836 cu.mm.
Z exact : 28417.230 cu.mm.

(SSI = SIF^x)	Axial	Inpl	Outpl	Tors	Pres
SIF/SSI Exponents:	0.693	0.305	0.173	0.028	-1.314

SIF/SSI exponent based on relationship between primary and peak stress factors from the finite element analysis.

B31.3 Branch Pressure i-factor = 17.359
Header Pressure i-factor = 1.790

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The B31.3 pressure i-factors should be used with with F/A, where F is the axial force due to pressure, and A is the area of the pipe wall. This is equivalent to finding the pressure stress from (ip) (PD/4T).

B31.3 (Branch)		
Peak Stress Sif	0.000	Axial
	4.153	Inplane
	5.283	Outplane
	1.000	Torsional
B31.1 (Branch)		
Peak Stress Sif	0.000	Axial
	2.013	Inplane
	2.013	Outplane
	2.013	Torsional
WRC 330 (Branch)		
Peak Stress Sif	0.000	Axial
	1.500	Inplane
	1.500	Outplane
	1.000	Torsional

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Allowable Loads
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Jobname: NOZZLE
4:22pm MAR 3,2025

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Allowable Loads \$X

SECONDARY		Maximum	Conservative	Realistic
Load Type (Range):		Individual	Simultaneous	Simultaneous
		Occuring	Occuring	Occuring
Axial Force	(N)	253960.	55949.	83924.
Inplane Moment	(mm. N)	5298220.	1008003.	2138298.
Outplane Moment	(mm. N)	5675270.	1020814.	2165473.
Torsional Moment	(mm. N)	9154114.	2236172.	3354259.
Pressure	(MPa)	13.41	6.20	6.20
PRIMARY		Maximum	Conservative	Realistic
Load Type:		Individual	Simultaneous	Simultaneous
		Occuring	Occuring	Occuring
Axial Force	(N)	263174.	38709.	58064.
Inplane Moment	(mm. N)	5463068.	703099.	1491498.
Outplane Moment	(mm. N)	5851848.	753135.	1597641.
Torsional Moment	(mm. N)	6251685.	1137868.	1706803.
Pressure	(MPa)	8.92	6.20	6.20

NOTES:

- 1) Maximum Individual Occuring Loads are the maximum allowed values of the respective loads if all other load components are zero, i.e. the listed axial force may be applied if the inplane, outplane and torsional moments, and the pressure are zero.
- 2) The Conservative Allowable Simultaneous loads are the maximum loads that can be applied simultaneously.

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A conservative stress combination equation is used that typically produces stresses within 50-70% of the allowable stress.

- 3) The Realistic Allowable Simultaneous loads are the maximum loads that can be applied simultaneously. A more realistic stress combination equation is used based on experience at Paulin Research. Stresses are typically produced within 80-105% of the allowable.
- 4) Secondary allowable loads are limits for expansion and operating piping loads.
- 5) Primary allowable loads are limits for weight, primary and sustained type piping loads.
- 6) High D/T low pressure systems may be subject to instability and should be checked when compressive stresses are present.

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Compressive Stress Summary
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Compressive Stress Summary (MPa)

\$X

Nomenclature:

Min Stress - Compressive Membrane and Bending Stress
Pts in Region - No. of nodes in the model region
>5% Compression - 5% or more of Compressive Stress Limit
>50% Compression - 50% or more of Compressive Stress Limit

Compressive Stress Limit = -0.55 Min(Sy, kEt/R), Section slenderness ratio (elastic buckling) not considered.

#	Load Type	Case	Min Stress	Pts in Region	Compression and Bending		Region
					>5%	>50%	
1	SUSTAINED	2	-45.	384	88%	68%	Nozzle 1 Next to Shell
2	OPERATING	3	-45.	384	88%	68%	Nozzle 1 Next to Shell
3	EXPANSION	4	-45.	384	88%	68%	Nozzle 1 Next to Shell
4	SUSTAINED	2	-16.	960	61%	58%	Nozzle 1
5	OPERATING	3	-16.	960	61%	58%	Nozzle 1
6	EXPANSION	4	-16.	960	61%	58%	Nozzle 1
7	SUSTAINED	2	-85.	834	77%	0%	Shell Next to Nozzle 1
8	OPERATING	3	-85.	834	77%	0%	Shell Next to Nozzle 1
9	EXPANSION	4	-85.	834	77%	0%	Shell Next to Nozzle 1
10	SUSTAINED	2	-144.	126	86%	71%	Shell In Nozzle 1 Vicinity
11	OPERATING	3	-144.	126	86%	71%	Shell In Nozzle 1 Vicinity
12	EXPANSION	4	-144.	126	86%	71%	Shell In Nozzle 1 Vicinity

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شماره پیمان: 053 - 073 - 9184	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 351 از 383
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Flexibilities
FEPipe Version 15.0
Released Jan. 2021

Jobname: NOZZLE
4:22pm MAR 3, 2025

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Flexibilities

\$X

The following stiffnesses should be used in a piping, "beam-type" analysis of the intersection. The stiffnesses should be inserted at the surface of the branch/header or nozzle/vessel junction. The general characteristics used for the branch pipe should be:

Outside Diameter = 70.000 mm.
Wall Thickness = 13.000 mm.

Axial Translational Stiffness = 649560. N /mm.
Inplane Rotational Stiffness = 20178536. mm. N /deg
Outplane Rotational Stiffness = 25976146. mm. N /deg
Torsional Rotational Stiffness = 66507284. mm. N /deg

Estimated Radial Shell Displacement due to Allowable Loads

SECONDARY:

Axial (mm.) = 0.391 In-Plane (mm.) = 0.131 Out-Plane (mm.) = 0.109

PRIMARY

Axial (mm.) = 0.405 In-Plane (mm.) = 0.135 Out-Plane (mm.) = 0.112

Secondary Conservative Displacement = 0.131 mm.

Secondary Realistic Displacement = 0.223 mm.

Primary Conservative Displacement = 0.091 mm.

Primary Realistic Displacement = 0.157 mm.

Intersection Flexibility Factors for Branch/Nozzle

:

Find axial stiffness: $K = 3EI/(kd)^3$ N /mm.
Find bending and torsional stiffnesses: $K = EI/(kd)$ mm. N per radian.
The EI product is 0.20190E+12 N mm.^2
The value of (d) to use is: 57.000 mm..
The resulting bending stiffness is in units of force x length per radian.

Axial Flexibility Factor (k) = 1.714
Inplane Flexibility Factor (k) = 3.064
Outplane Flexibility Factor (k) = 2.380
Torsional Flexibility Factor (k) = 0.930

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Finite Element Model

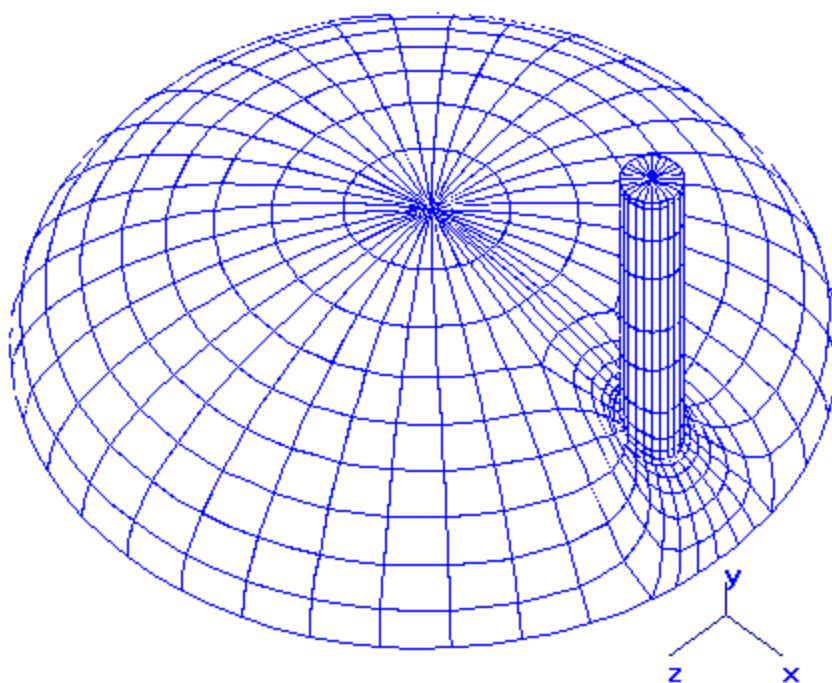
- [Finite Element Model](#)

Area of Discontinuity at Nozzle

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- [1\) \$Pl < SPL\$ \(SUS Membrane\) Case 2](#)
- [2\) \$Qb < SPS\$ \(SUS Bending\) Case 2](#)
- [3\) \$Pl+Pb+Q < SPS\$ \(SUS Inside\) Case 2](#)
- [4\) \$Pl+Pb+Q < SPS\$ \(SUS Outside\) Case 2](#)
- [5\) \$S1+S2+S3 < 4S\$ \(SUS \$S1+S2+S3\$ \) Case 2](#)
- [6\) \$Pl+Pb+Q < SPS\$ \(OPE Inside\) Case 3](#)
- [7\) \$Pl+Pb+Q < SPS\$ \(OPE Outside\) Case 3](#)
- [8\) \$Membrane < User\$ \(OPE Membrane\) Case 3](#)
- [9\) \$Bending < User\$ \(OPE Bending\) Case 3](#)
- [15\) \$Pl+Pb+Q < SPS\$ \(EXP Inside\) Case 4](#)
- [16\) \$Pl+Pb+Q < SPS\$ \(EXP Outside\) Case 4](#)
- [17\) \$Pl+Pb+Q+F < 2Sa\$ \(EXP Inside\) Case 4](#)
- [18\) \$Pl+Pb+Q+F < 2Sa\$ \(EXP Outside\) Case 4](#)
- [10\) \$Pl+Pb+Q+F < 2Sa\$ \(SIF Outside\) Case 5](#)
- [11\) \$Pl+Pb+Q+F < 2Sa\$ \(SIF Outside\) Case 6](#)
- [12\) \$Pl+Pb+Q+F < 2Sa\$ \(SIF Outside\) Case 7](#)
- [13\) \$Pl+Pb+Q+F < 2Sa\$ \(SIF Outside\) Case 8](#)
- [14\) \$Pl+Pb+Q+F < 2Sa\$ \(SIF Outside\) Case 9](#)

Finite Element Model





نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

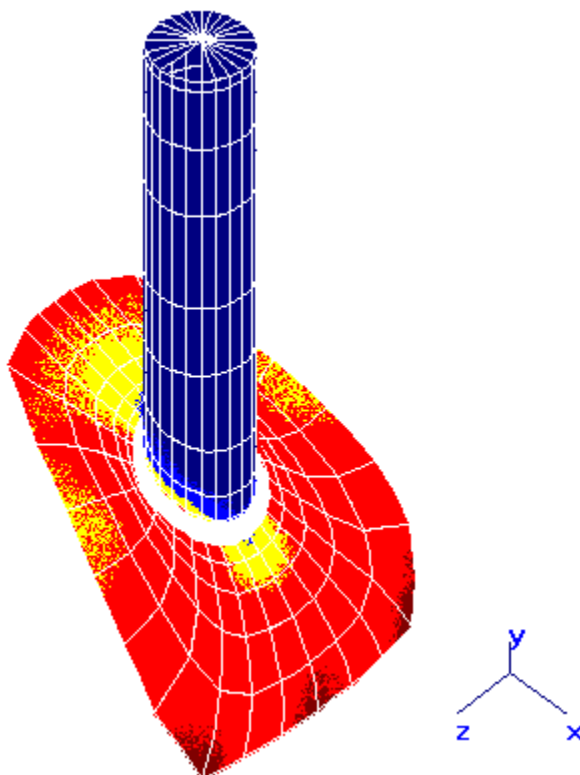
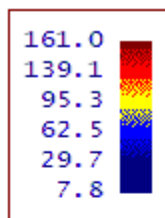
053-073-9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 353 از 383

1) P1 < SPL (SUS Membrane) Case 2



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

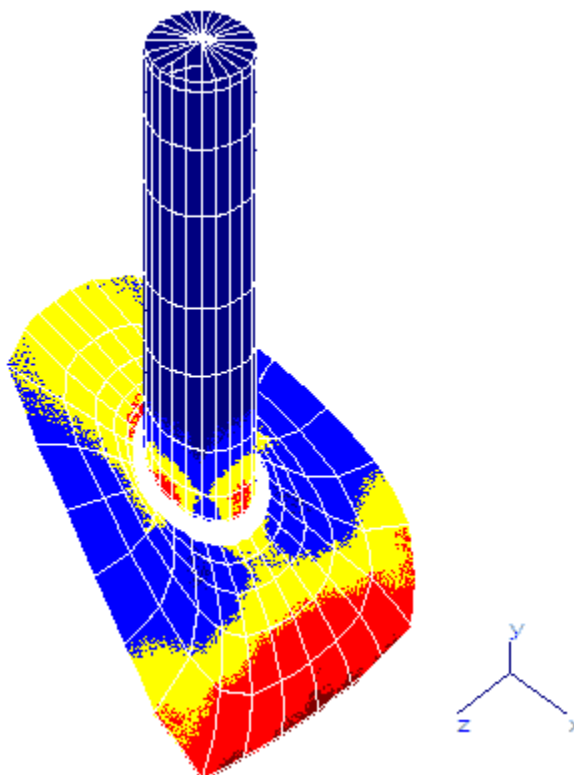
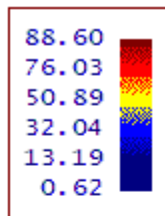
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

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V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 354 از 383

2) Qb < SPS (SUS Bending) Case 2



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

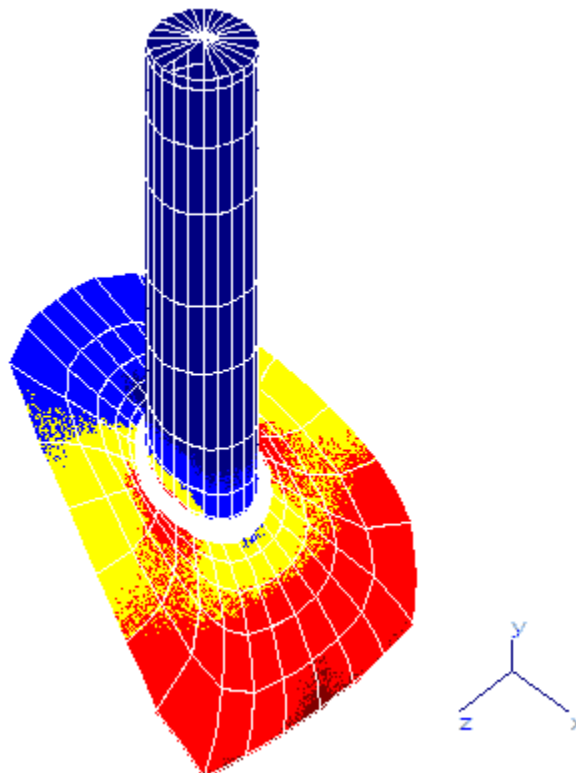
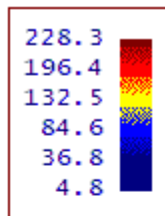
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 355 از 383

3) $P_l + P_b + Q < SPS$ (SUS Inside) Case 2



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

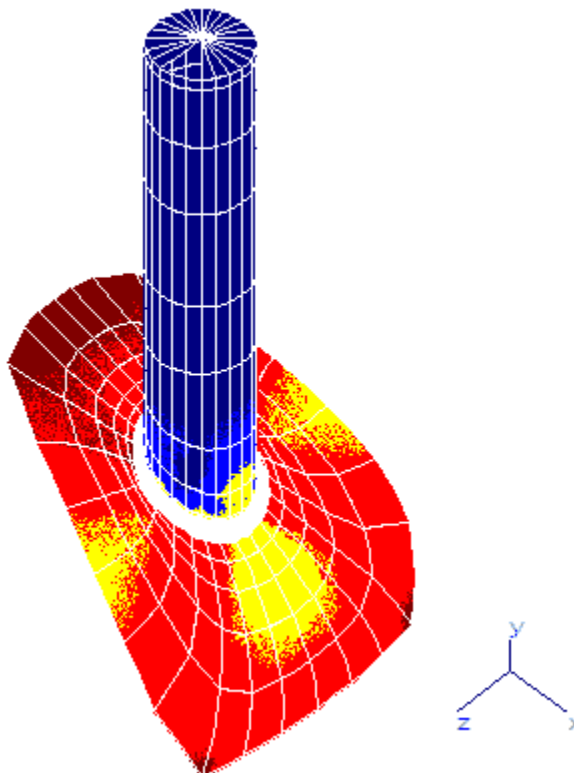
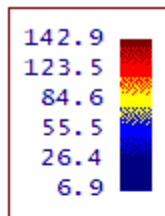
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 356 از 383

4) $P_l + P_b + Q < SPS$ (SUS Outside) Case 2



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



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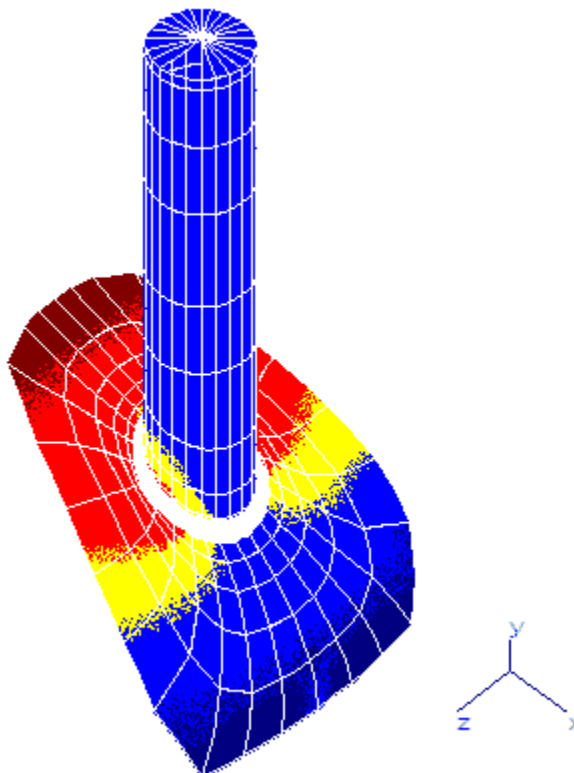
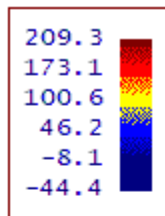
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 357 از 383

5) $S1+S2+S3 < 45$ (SUS $S1+S2+S3$) Case 2



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

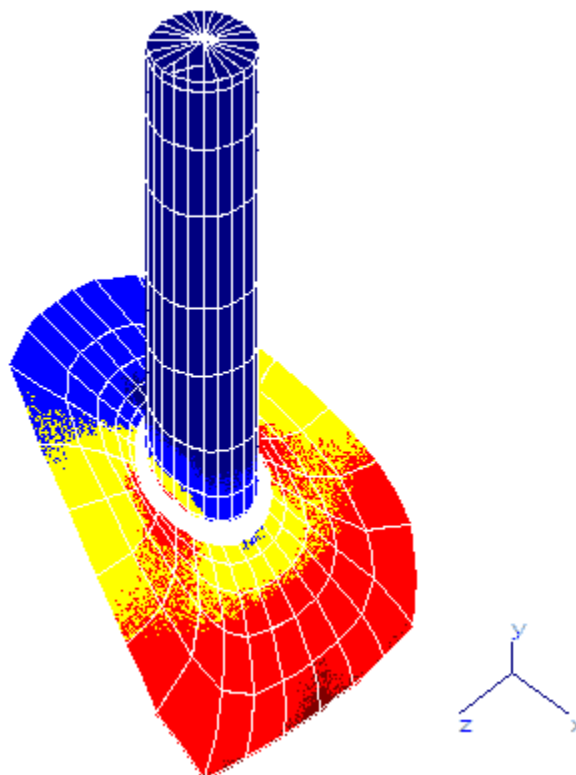
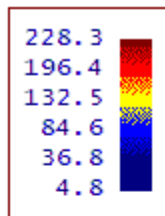
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 358 از 383

6) $P_l + P_b + Q < SPS$ (OPE Inside) Case 3



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



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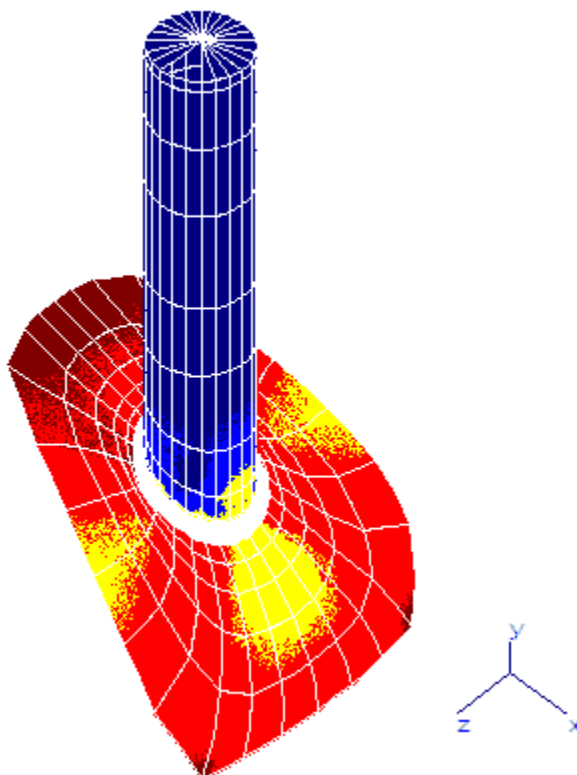
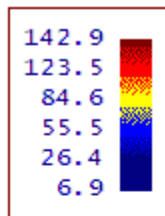
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 359 از 383

7) $P_l + P_b + Q < SPS$ (OPE Outside) Case 3



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

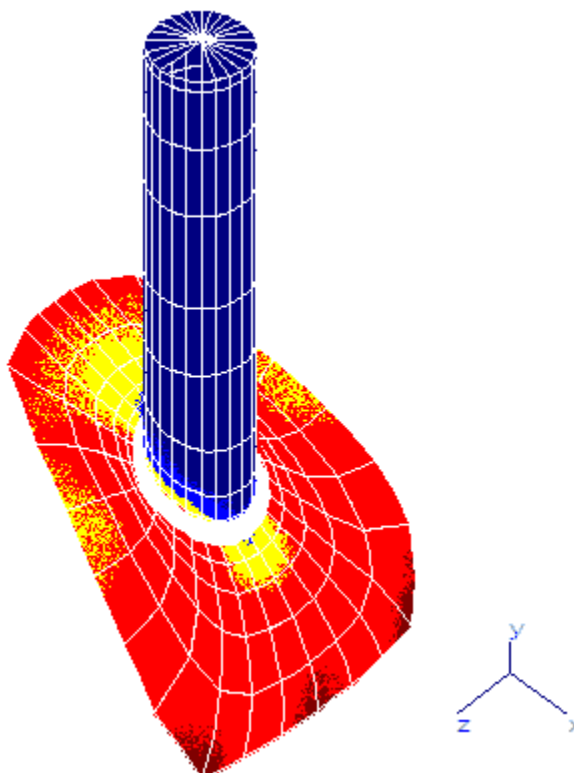
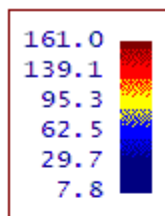
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 360 از 383

8) Membrane < User (OPE Membrane) Case 3



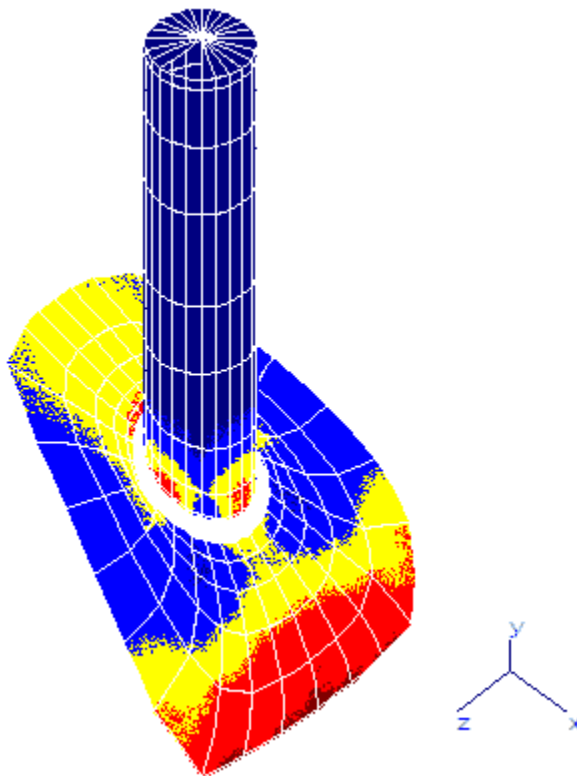
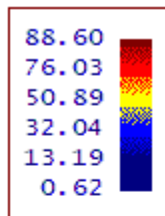
3d(Small)

3d

3d(Deformed)

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 361 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

9) Bending < User (OPE Bending) Case 3



3d(Small) 3d 3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

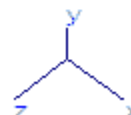
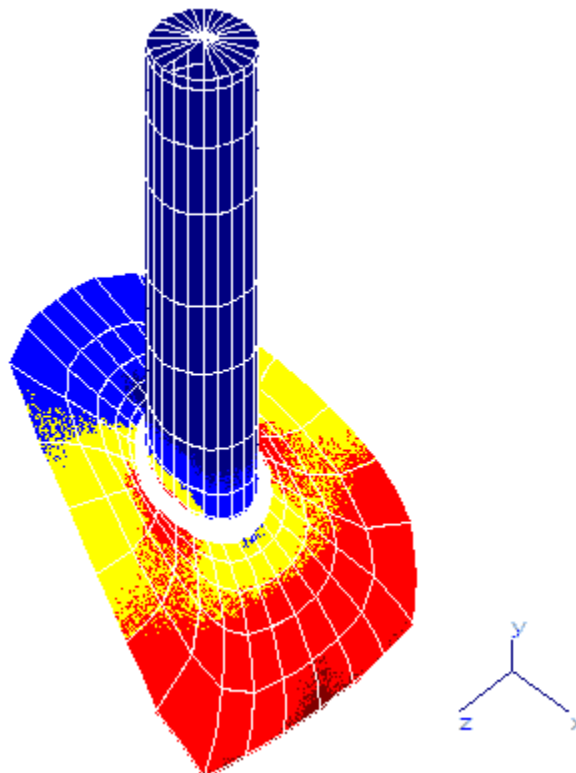
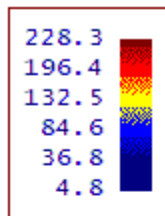
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 362 از 383

15) $P_l + P_b + Q < SPS$ (EXP Inside) Case 4



3d(Small)

3d



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد 08_0010-GCS-HD-BK)



شماره پیمان:

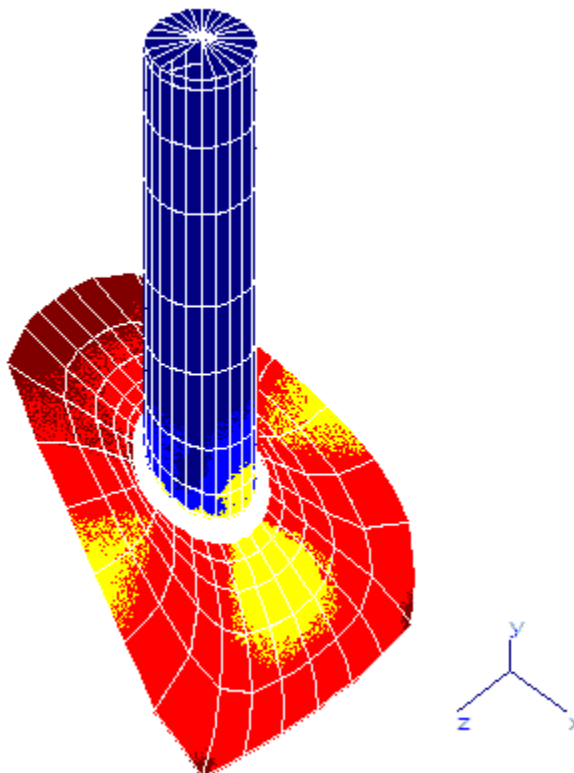
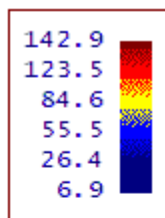
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 363 از 383

16) $P_l + P_b + Q < SPS$ (EXP Outside) Case 4



3d(Small)

3d



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

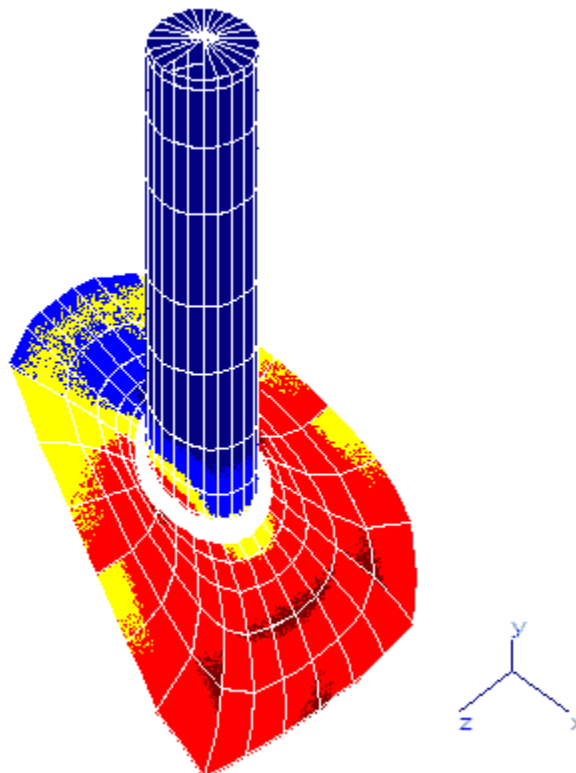
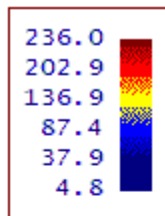
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 364 از 383

17) $P_l + P_b + Q + F < 2S_a$ (EXP Inside) Case 4



3d(Small)

3d



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

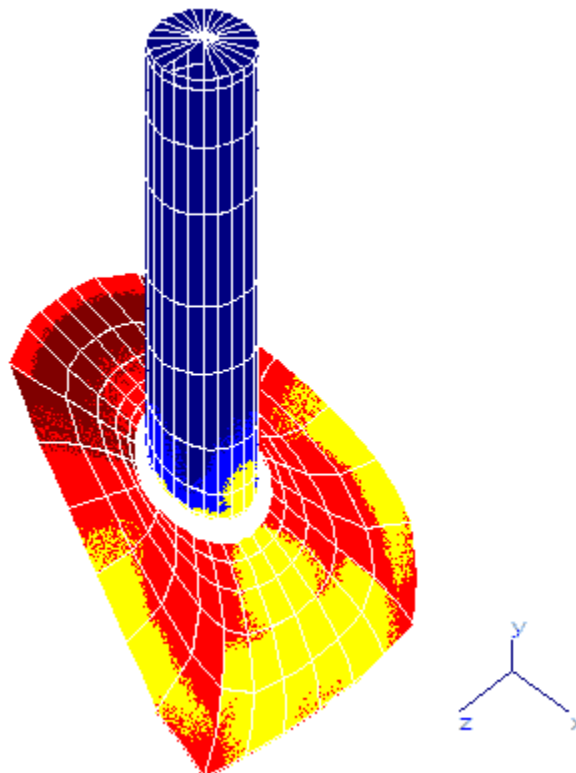
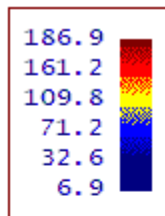
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 365 از 383

18) $P_l + P_b + Q + F < 2S_a$ (EXP Outside) Case 4



3d(Small)

3d



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

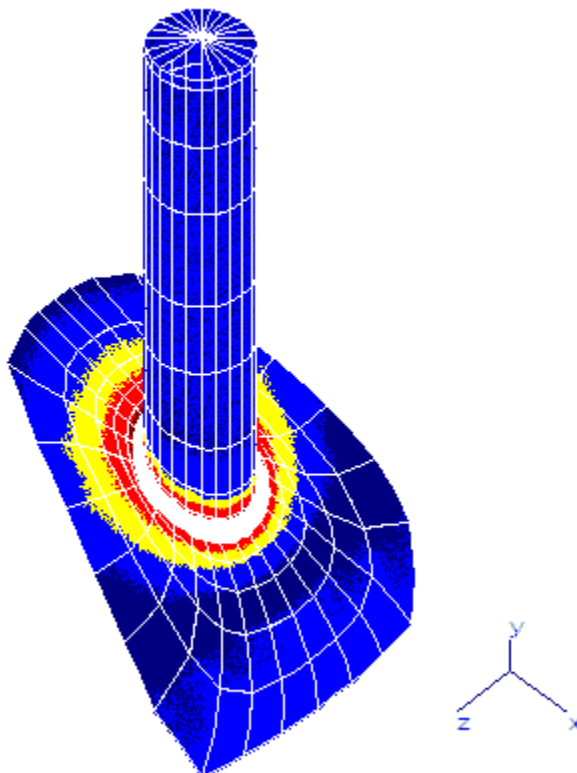
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 366 از 383

10) $P_l + P_b + Q + F < 2S_a$ (SIF Outside) Case 5



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



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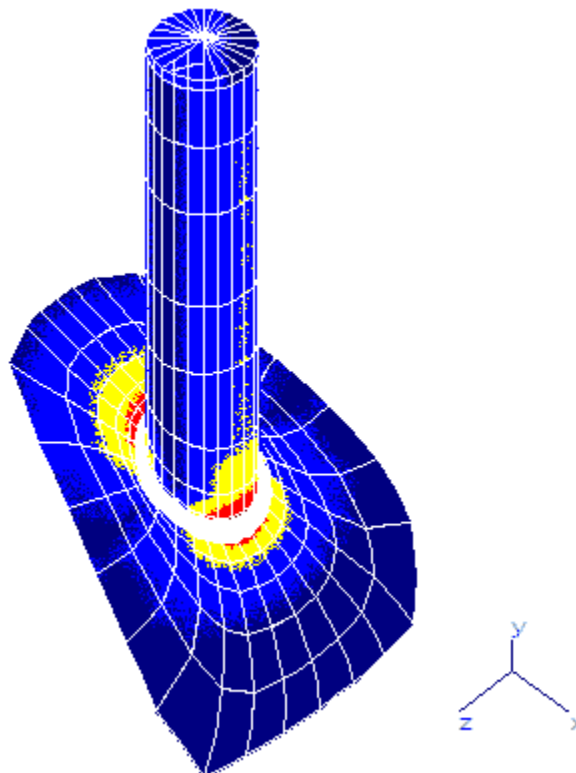
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 367 از 383

11) $P_l + P_b + Q + F < 2S_a$ (SIF Outside) Case 6



3d(Small)

3d

3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



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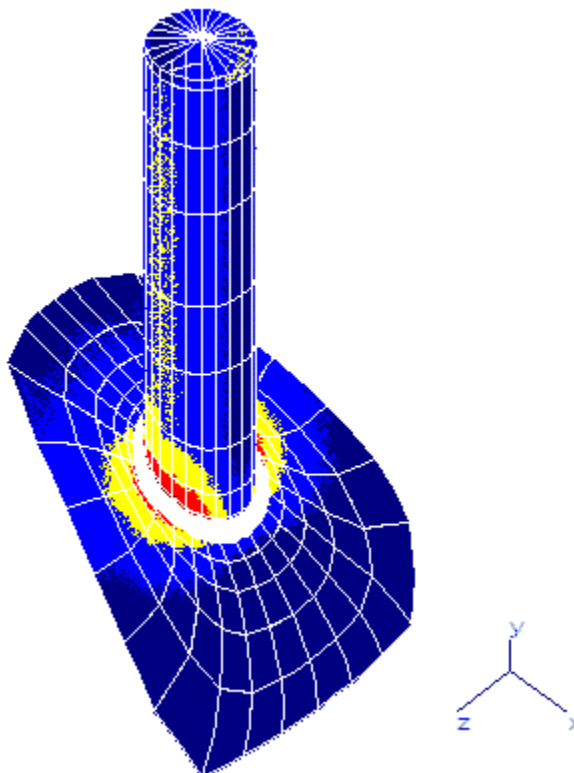
053 - 073 - 9184

MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 368 از 383

12) $P_l + P_b + Q + F < 2S_a$ (SIF Outside) Case 7



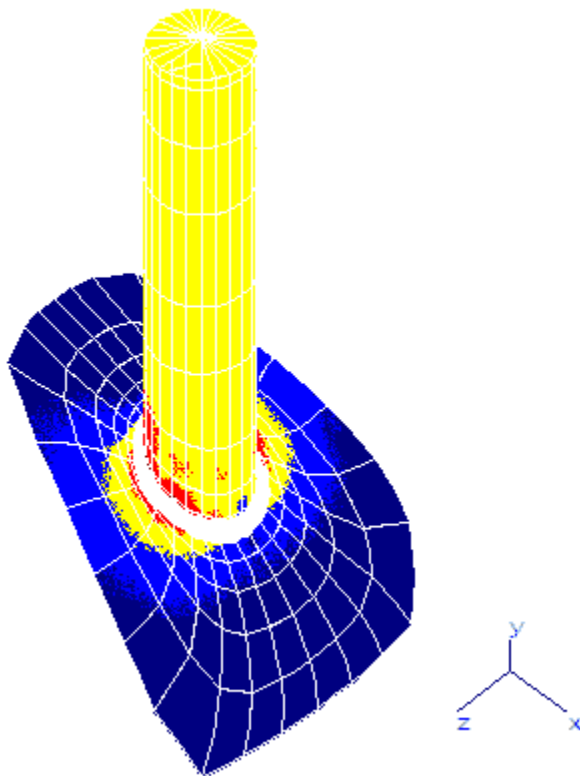
3d(Small)

3d

3d(Deformed)

 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 CONTACTOR (C-100)							شماره صفحه : 369 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

13) $P_l + P_b + Q + F < 2S_a$ (SIF Outside) Case 8



3d(Small) 3d 3d(Deformed)



نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد BK-HD-GCS-CO-0010_08)



شماره پیمان:

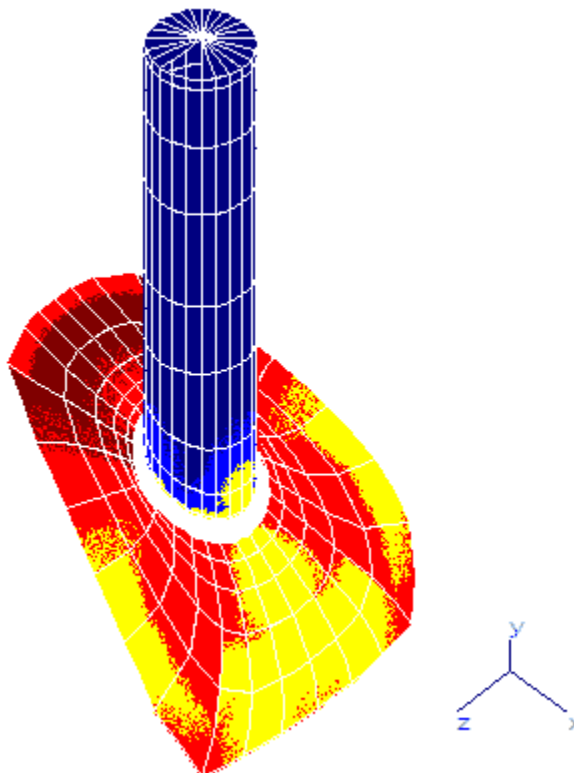
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MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 370 از 383

14) $P_l + P_b + Q + F < 2S_a$ (SIF Outside) Case 9



3d(Small)

3d

3d(Deformed)

 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 CONTACTOR (C-100)							شماره صفحه : 371 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Lifting WRC

Input Echo, 107/537 Item 1, Description: SLOP

Diameter Basis for Vessel	Vbasis	ID	
Cylindrical or Spherical Vessel	Cylsph	Cylindrical	
Internal Corrosion Allowance	Cas	0.0000	mm.
Vessel Diameter	Dv	700.000	mm.
Vessel Thickness	Tv	20.000	mm.
Design Temperature		90.00	C
Vessel Material		SA-516 70	
Vessel UNS Number		K02700	
Vessel Cold S.I. Allowable	Smc	137.90	N./mm ²
Vessel Hot S.I. Allowable	Smh	137.90	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-516 70*

Attachment Type	Type	Rectangular	
Parameter C11	C11	360.00	mm.
Parameter C22	C22	160.00	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	8.0	kNf
Longitudinal Shear (SUS)	Vl	2.2	kNf
Circumferential Shear (SUS)	Vc	42.9	kNf
Circumferential Moment (SUS)	Mc	0.0	N-m
Longitudinal Moment (SUS)	Ml	2480.0	N-m
Torsional Moment (SUS)	Mt	13299.0	N-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

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 SUS tained loads:

Radial Load	P	8.0	kNf
Circumferential Shear	VC	42.9	kNf

 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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</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>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 372 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادرکننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Longitudinal Shear	VL	2.2	kNf
Circumferential Moment	MC	0.0	N-m
Longitudinal Moment	ML	2480.0	N-m
Torsional Moment	MT	13299.0	N-m

Dimensionless Parameters used : Gamma = 18.00

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979 B1/B2	Beta	Figure	Value	Location
N(PHI) / (P/Rm)	0.321	4C	2.410	(A,B)
N(PHI) / (P/Rm)	0.321	3C	1.540	(C,D)
M(PHI) / (P)	0.439	2C1	0.017	(A,B)
M(PHI) / (P)	0.439	1C !	0.057	(C,D)
N(PHI) / (MC/ (Rm**2 * Beta))	0.382	3A	0.736	(A,B,C,D)
M(PHI) / (MC/ (Rm * Beta))	0.469	1A	0.067	(A,B,C,D)
N(PHI) / (ML/ (Rm**2 * Beta))	0.291	3B	1.855	(A,B,C,D)
M(PHI) / (ML/ (Rm * Beta))	0.360	1B1	0.020	(A,B,C,D)
N(x) / (P/Rm)	0.428	3C	1.115	(A,B)
N(x) / (P/Rm)	0.428	4C	2.006	(C,D)
M(x) / (P)	0.361	1C1	0.046	(A,B)
M(x) / (P)	0.361	2C !	0.030	(C,D)
N(x) / (MC/ (Rm**2 * Beta))	0.382	4A	1.744	(A,B,C,D)
M(x) / (MC/ (Rm * Beta))	0.375	2A	0.034	(A,B,C,D)
N(x) / (ML/ (Rm**2 * Beta))	0.291	4B	0.744	(A,B,C,D)
M(x) / (ML/ (Rm * Beta))	0.315	2B1	0.041	(A,B,C,D)

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

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction (N./mm^2)

Type of Stress Load		Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-2.7	-2.7	-2.7	-2.7	-1.7	-1.7	-1.7	-1.7
Circ. Bend. P		-2.0	2.0	-2.0	2.0	-6.8	6.8	-6.8	6.8
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Bend. MC		-5.3	-5.3	5.3	5.3	0.0	0.0	0.0	0.0
Circ. Bend. ML		-5.9	5.9	5.9	-5.9	0.0	0.0	0.0	0.0
Tot. Circ. Str.		-15.9	-0.1	6.4	-1.2	-8.5	5.1	-8.5	5.1
Long. Memb. P		-1.2	-1.2	-1.2	-1.2	-2.2	-2.2	-2.2	-2.2
Long. Bend. P		-5.5	5.5	-5.5	5.5	-3.6	3.6	-3.6	3.6
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		-1.7	-1.7	1.7	1.7	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 CONTACTOR (C-100)							شماره صفحه : 373 از 383
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال	
	BK	GCS	MF	120	ME	CN	0001	V01

Long. Bend. ML	-13.5	13.5	13.5	-13.5	0.0	0.0	0.0	0.0
Tot. Long. Str.	-22.0	16.2	8.4	-7.6	-5.8	1.4	-5.8	1.4
Shear VC	3.0	3.0	-3.0	-3.0	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
Shear MT	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Tot. Shear	49.1	49.1	43.2	43.2	45.8	45.8	46.5	46.5
Str. Int.	98.5	99.6	86.4	86.6	91.7	91.7	93.1	93.1

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)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Pl (SUS)		-8.0	-8.0	2.6	2.6	-1.7	-1.7	-1.7	-1.7
Circ. Q (SUS)		-7.9	7.9	3.8	-3.8	-6.8	6.8	-6.8	6.8
Long. Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Pl (SUS)		-2.9	-2.9	0.4	0.4	-2.2	-2.2	-2.2	-2.2
Long. Q (SUS)		-19.1	19.1	8.0	-8.0	-3.6	3.6	-3.6	3.6
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	-3.0	-3.0	-0.4	-0.4	0.4	0.4
Shear Q (SUS)		46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pm+Pl (SUS)		9.4	9.4	6.3	6.3	2.4	2.4	2.4	2.4
Pm+Pl+Q (Total)		98.5	99.6	86.4	86.6	91.7	91.7	93.1	93.1

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	0.00	137.90	Passed
Pm+Pl (SUS)	9.35	206.85	Passed
Pm+Pl+Q (TOTAL)	99.61	413.70	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

 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 CONTACTOR (C-100)							شماره صفحه : 374 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Input Echo, 107/537 Item 2, Description: 90 Deg

Diameter Basis for Vessel	Vbasis	ID	
Cylindrical or Spherical Vessel	Cylsph	Cylindrical	
Internal Corrosion Allowance	Cas	3.0000	mm.
Vessel Diameter	Dv	700.000	mm.
Vessel Thickness	Tv	20.000	mm.
Design Temperature		90.00	C
Vessel Material		SA-516 70	
Vessel UNS Number		K02700	
Vessel Cold S.I. Allowable	Smc	137.90	N./mm ²
Vessel Hot S.I. Allowable	Smh	137.90	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-516 70*

Attachment Type	Type	Rectangular	
Parameter C11	C11	360.00	mm.
Parameter C22	C22	160.00	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	8.0	kNf
Longitudinal Shear (SUS)	Vl	91.3	kNf
Circumferential Shear (SUS)	Vc	0.0	kNf
Circumferential Moment (SUS)	Mc	0.0	N-m
Longitudinal Moment (SUS)	Ml	2480.0	N-m
Torsional Moment (SUS)	Mt	0.0	N-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

*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 SUS tained loads:

Radial Load	P	8.0	kNf
Circumferential Shear	VC	0.0	kNf
Longitudinal Shear	VL	91.3	kNf
Circumferential Moment	MC	0.0	N-m
Longitudinal Moment	ML	2480.0	N-m

 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 08_0010-BK-HD-GCS-CO)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 375 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

Torsional Moment MT 0.0 N-m

Dimensionless Parameters used : Gamma = 21.26

Dimensionless Loads for Cylindrical Shells at Attachment Junction:

Curves read for 1979 B1/B2	Beta	Figure	Value	Location
N(PHI) / (P/Rm)	0.320	4C	2.698	(A,B)
N(PHI) / (P/Rm)	0.320	3C	1.611	(C,D)
M(PHI) / (P)	0.437	2C1	0.015	(A,B)
M(PHI) / (P)	0.437	1C !	0.058	(C,D)
N(PHI) / (MC/ (Rm**2 * Beta))	0.380	3A	0.839	(A,B,C,D)
M(PHI) / (MC/ (Rm * Beta))	0.466	1A	0.067	(A,B,C,D)
N(PHI) / (ML/ (Rm**2 * Beta))	0.290	3B	2.076	(A,B,C,D)
M(PHI) / (ML/ (Rm * Beta))	0.358	1B1	0.019	(A,B,C,D)
N(x) / (P/Rm)	0.426	3C	1.145	(A,B)
N(x) / (P/Rm)	0.426	4C	2.225	(C,D)
M(x) / (P)	0.360	1C1	0.042	(A,B)
M(x) / (P)	0.360	2C !	0.030	(C,D)
N(x) / (MC/ (Rm**2 * Beta))	0.380	4A	2.045	(A,B,C,D)
M(x) / (MC/ (Rm * Beta))	0.373	2A	0.032	(A,B,C,D)
N(x) / (ML/ (Rm**2 * Beta))	0.290	4B	0.882	(A,B,C,D)
M(x) / (ML/ (Rm * Beta))	0.313	2B1	0.039	(A,B,C,D)

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

Stress Concentration Factors: Kn = 1.00, Kb = 1.00

Stresses in the Vessel at the Attachment Junction (N./mm^2)

Type of Stress	Load	Stress Intensity Values at							
		Au	Al	Bu	Bl	Cu	Cl	Du	Dl
Circ. Memb. P		-3.5	-3.5	-3.5	-3.5	-2.1	-2.1	-2.1	-2.1
Circ. Bend. P		-2.4	2.4	-2.4	2.4	-9.6	9.6	-9.6	9.6
Circ. Memb. MC		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Circ. Memb. ML		-7.0	-7.0	7.0	7.0	0.0	0.0	0.0	0.0
Circ. Bend. ML		-7.4	7.4	7.4	-7.4	0.0	0.0	0.0	0.0
Tot. Circ. Str.		-20.4	-0.6	8.5	-1.5	-11.7	7.5	-11.7	7.5
Long. Memb. P		-1.5	-1.5	-1.5	-1.5	-2.9	-2.9	-2.9	-2.9
Long. Bend. P		-7.0	7.0	-7.0	7.0	-5.0	5.0	-5.0	5.0
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		-2.3	-2.3	2.3	2.3	0.0	0.0	0.0	0.0
Long. Bend. ML		-17.5	17.5	17.5	-17.5	0.0	0.0	0.0	0.0
Tot. Long. Str.		-28.4	20.8	11.3	-9.7	-7.9	2.1	-7.9	2.1

 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)								
شماره پیمان: 053 – 073 – 9184	MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)							شماره صفحه : 376 از 383	
	پروژه	بسته کاری	صادر کننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

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	0.0	-16.8	-16.8	16.8	16.8
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	-16.8	-16.8	16.8	16.8
Str. Int.	28.4	21.4	11.3	9.7	33.8	34.0	33.8	34.0	34.0

WRC 107/537 Stress Summations:

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

Type of Stress		Stress Intensity Values at							
		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)		-10.5	-10.5	3.5	3.5	-2.1	-2.1	-2.1	-2.1
Circ. Q (SUS)		-9.9	9.9	5.0	-5.0	-9.6	9.6	-9.6	9.6
Long. Pm (SUS)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long. Pl (SUS)		-3.8	-3.8	0.8	0.8	-2.9	-2.9	-2.9	-2.9
Long. Q (SUS)		-24.6	24.6	10.5	-10.5	-5.0	5.0	-5.0	5.0
Shear Pm (SUS)		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	-16.8	-16.8	16.8	16.8
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)		10.5	10.5	3.5	3.5	33.6	33.6	33.6	33.6
Pm+Pl+Q (Total)		28.4	21.4	11.3	9.7	33.8	34.0	33.8	34.0

Vessel Stress Summation Comparison (N./mm²):

Type of Stress Int.	Max. S.I.	S.I. Allowable	Result
Pm (SUS)	0.00	137.90	Passed
Pm+Pl (SUS)	33.58	206.85	Passed
Pm+Pl+Q (TOTAL)	34.01	413.70	Passed

Because only sustained loads were specified, the Pm+Pl+Q allowable was 3 * Smh.

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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	<table><tr><th colspan="8">MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>V01</td><td>0001</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 CONTACTOR (C-100)								نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه	V01	0001	CN	ME	120	MF	GCS	BK	شماره صفحه : 377 از 383
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)																										
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه																			
V01	0001	CN	ME	120	MF	GCS	BK																			

Lifting and Tailing lug Calculation for C-100

LIFTING-TAILING LUG AND BASE BLOCK UNDER ERECTION CONDITION C-100

1) Calculation Of Lifting And Tailing Forces

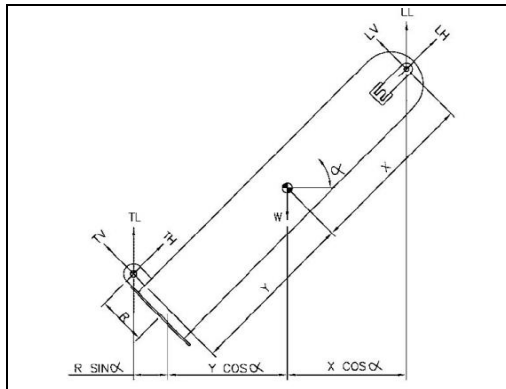
Bottom T.L. to Lifting Lug Hole	10796	(mm)	$LL= W*(Y*cos\alpha+R*sinV) / ((X+Y)*cos\alpha+R*sin\alpha)$
Length of Skirt	1500	(mm)	$TL= W*(X*cos\alpha) / ((X+Y)*cos\alpha+R*sin\alpha)$
Shell I.D. (mm)	700	(mm)	$LV=LL*cos\alpha$
C.G. from Top of Base Ring	5830	(mm)	$TV=TL*cos\alpha$
Heigh of Tailing Lug	213	(mm)	$LH=LL*sin\alpha$
X (LIFTING LUG HOLE TO C.G.)	6466	(mm)	$TH=TL*sin\alpha$
Y (C.G. TO TAILING LUG HOLE)	5723.5	(mm)	
R (TOWER C.L. TO TAILING LUG HOLE)	608	(mm)	Note:
Ercetion Weight (We)	9.3	(ton)	Spreader beam has been considered in calculation.
Dynamic Load Factor	2		
Lifting Weight (Ton)	18.6	(ton)	

1-1) Forces In Varius Angle

R	α(deg)	LL(Kg)	TL(Kg)	LV(Kg)	LH(Kg)	TV(Kg)	TH(Kg)
608	0	8734	9866	8734	0	9866	0
608	5	8776	9824	8743	765	9786	856
608	15	8864	9736	8562	2294	9405	2520
608	30	9010	9590	7803	4505	8305	4795
608	45	9202	9398	6507	6507	6645	6645
608	60	9518	9082	4759	8243	4541	7865
608	75	10282	8318	2661	9932	2153	8035
608	85	12316	6284	1073	12269	548	6260
608	90	18600	0	0	18600	0	0

1-2) Summary Of Lifting And Tailing Maximum Forces

α °	90	LL	18600	(Kg)
		LH	18600	(Kg)
α °	0	TL	9866	(Kg)
		TV	9866	(Kg)
α °	3	LV	8747	(Kg)
Max. Lifting		LH	458	(Kg)
α °	70	TH	8154	(Kg)
Max. Tailing		TV	2968	(Kg)





نگهداشت و افزایش تولید میدان نفتی بینک
سطح الارض و ابنیه تحت الارض

خرید بسته نیم زدای گاز ایستگاه تقویت فشار گاز بینک
(قرارداد 08_0010_CO-GCS-BK-HD)



شماره پیمان:

053 - 073 - 9184

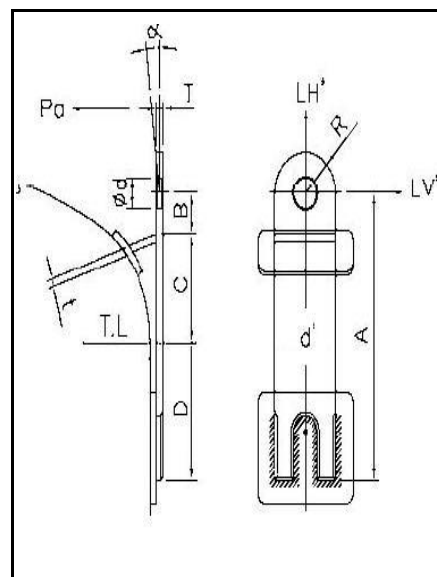
MECHANICAL CALCULATION BOOK FOR GLYCOL CONTACTOR (C-100)

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V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 378 از 383

2) Calculation Of Lifting Lug

Material	Ma	SA-283 C	SA-283 C
Allowable stress	Sa	108.25	mpa
Yeld strength	Sy	206.84	mpa
Lifting lug No.	N	2	
Vertivcal force per lug	LV'	4374	(kg)
Horizontal force per lug	LH'	9300	(kg)
Lifting half angle	α^{**}	5	(deg)
Normal force per lug	Pa	814	(kg)
Lifting lug dimension			
T	20	(mm)	
t	12	(mm)	
R	130	(mm)	
d	65	(mm)	
d'	260	(mm)	
PAD THK.	20	(mm)	
B	160	(mm)	
C	77	(mm)	
D	160	(mm)	
A	397	(mm)	



S1	S2	S3	S4	S5	S6	S7
7.15	4.77	2.38	7.51	1.79	9.30	0.26
OK	OK	OK	OK	OK	OK	OK

2-1) CHECK OF LUG

A) BEARING STRESS CHECK	$S1=LH'/(T*d)$	must be smaller than $0.9*Sy =$	18.98	>	7.15
B) SHEAR STRESS DUE TO LH'	$S2=LH'/(T*(R-d/2))$	must be smaller than $0.4*Sy =$	8.43	>	4.77
C) TENSION STRESS DUE TO LH'	$S3=LH'/(d'-d)*T$	must be smaller than $0.6*Sy =$	12.65	>	2.38

2-2) STRESS DUE TO GUIDE POINT

A) BENDING STRESS DUE RO Pa	$S4=6*Pa*B/(d'*T^2)$	must be smaller than $0.66Sy =$	13.92	>	7.51
B) TENSION DUE TO LH'	$S5=LH'/(d'*T)$	must be smaller than $0.6Sy =$	12.65	>	1.788
C) COMBIND STRESS	$S6=S5+S4$	must be smaller than $0.9*Sy =$	18.98	>	9.30
D) AXIAL STRESS DUE TO Pa	$S7=Pa/(d'*t)$	must be smaller than $0.6*Sy =$	12.65	>	0.26

$Pa=LH'*\tan\alpha$



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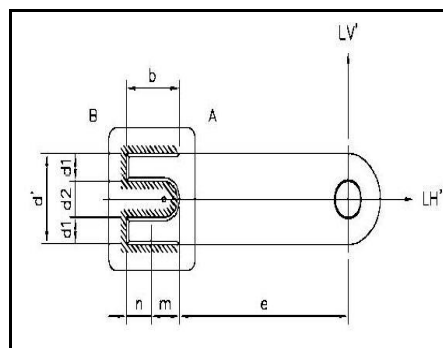
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3) LIFTING LUG WELD CALCULATION - LUG TO PAD WELD

b	180	(mm)
d'	260	(mm)
e	217	(mm)
LV'	4374	(kg)
LH'	9300	(kg)
Min. Weld Size	14	(mm)
d1	85	(mm)
d2	90	(mm)



(n)	(m)	(T)	(Jw)	(C)	(L)	(fs)	(f)	(fv)	(fh)	(F)	(S)	(W)	(A)	fs'
91.0	89.0	1E+06	1E+07	157.5	890.0	4.9	18.2	10.3	15.0	21.4	8.4	3.6	2257.1	4.1
												OK		OK

(A) horizontal position with load lv'

lug weld check per unit width of throat

Centroid : $n = (2b^2 + bd^2) / (4 * b + 2d1)$, $m = b - n$

T: Twisting Moment(kg-mm) , $T = (b + e - n) * LV'$

Jw: The Polar moment of inertia of weld (mm^3)

C : Distance from c.g to point being analyzed(mm) , $C = \sqrt{m^2 + (0.5d')^2}$

Analyzed point is A

L : Weld length (mm) , $L = 4 * b + 2 * d1$

a) fs : Direct shear force(kg/mm) , $fs = LV' / L$

b) f : Max.Load from twisting (kg/mm) , $f = T * c / Jw$

fv : Vertical component (kg/mm) , $fv = m * f / c$

fh : Horizontal component(kg/mm) , $fh = 0.5 * d' * f / c$

c) F : Combined load per(kg/mm) , $F = \sqrt{fh^2 + (fs + fv)^2}$

d) weld size check

S : Allowable stress(kg/mm^2) , $S = 0.4 * Sy$

W : leg size(mm) , $W = F / 0.707S$ must be smaller than Min. size =

14 > 3.59 OK

(B) Vertical position with load LH'

A : Weld area(mm^2) , $A = L * (0.707 * W)$

fs' = LH' / A must be smaller than $0.4 * Sy$ =

8.43 > 4.12 OK



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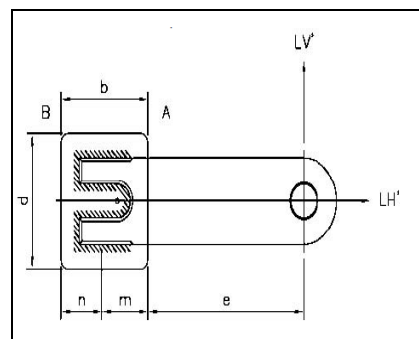
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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
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4) LIFTING LUG WELD CALCULATION - PAD TO SHELL WELD

b	130	(mm)
d	230	(mm)
e	357	(mm)
LV'	4374	(kg)
LH'	9300	(kg)
Min. Weld Size	14	(mm)



(n)	(m)	(T)	(Jw)	(C)	(L)	(fs)	(f)	(fv)	(fh)	(F)	(S)	(W)	(A)	fs'
65.0	65.0	2E+06	8E+06	132.1	720.0	6.1	31.4	15.4	27.3	34.7	8.4	5.8	2966.4	3.1
												OK		OK

(A) horizontal position with load lv'

lug weld check per unit width of throat

Centroid : $n = m = b/2$

T: Twisting Moment(kg-mm) , $T = (b+e-n) \cdot LV'$

Jw : The Polar moment of inertia of weld (mm³) , $Jw = (b+d)^3/6$

C : Distance from c.g to point being analyzed(mm) , $C = \sqrt{m^2 + (0.5d)^2}$

Analyzed point is A or B

L : Weld length (mm) , $L = 2 \cdot b + 2 \cdot d$

a) fs : Direct shear force(kg/mm) , $fs = LV'/L$

b) f : Max.Load from twisting (kg/mm) , $f = T \cdot c/Jw$

fv : Vertical component (kg/mm) , $fv = m \cdot f/c$

fh : Horizontal component(kg/mm) , $fh = 0.5 \cdot d \cdot f/c$

c) F : Combined load per(kg/mm) , $F = \sqrt{fh^2 + (fs+fv)^2}$

d) weld size check

S : Allowable stress(kg/mm²) , $S = 0.4 \cdot Sy$

W : leg size(mm) , $W = F/0.707S$ must be smaller than Min. size

14 > 5.83 OK

(B) Vertical position with load LH'

A:Weld area(mm²) , $A = L \cdot (0.707 \cdot W)$

fs'=LH'/A must be smaller than 0.4*Sy

8.43 > 3.14 OK



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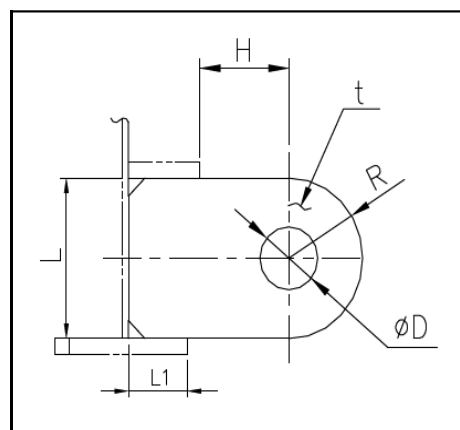
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نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

شماره صفحه : 381 از 383

5) CALCULATION OF TAILING LUG

Material	Ma	SA-283 C	SA-283 C
Allowable stress	Sa	108.25	mpa
Yeld strength	Sy	206.84	mpa
Tailing lug No.	N	1	
Vertivcal force per lug	TV'(kg)	9866	
Horizontal force per lug	TH'(kg)	8154	
	t(mm)	16	
	R(mm)	200	
	t1 (reinforce thk.)(mm)	20	
	R1(reinforce od)(mm)	110	
	H(mm)	240	
	L1(mm)	162	
	D(mm)	54	
	L(mm)	265	
	Min Weld Leg Size	10	



S1	S2	S3	S4	Ws	W
5.1	3.3	10.5	1.7	11.6	1.9
OK	OK	OK	OK	-	OK

5-1) Bearing Stress Check	$S1 = TV' / ((t+t1) * D)$	must be smaller than $0.9 * Sy$	18.976	>	5.1
5-2) Shear Stress In Lug	$S2 = TV' / ((t+t1) * (R1-D/2))$	must be smaller than $0.4 * Sy$	8.434	>	3.3
5-3) Bending Stress In Lug	$S3 = (6 * TH' * H) / (t * L^2)$	must be smaller than $0.66 * Sy$	13.916	>	10.5
5-4) Tensile Stress In Lug	$S4 = TV' / ((t+t1) * (2 * R1 - D))$	must be smaller than Sa	11.034	>	1.7
5-5) Shear Force In Weldment	$Ws = TV' / (2 * (L+L1))$				11.6
6-5) fillet Weld Size	$W = Ws / (0.707 * 0.4 * Sy)$	must be smaller than Min Leg Size	10.00	>	1.9



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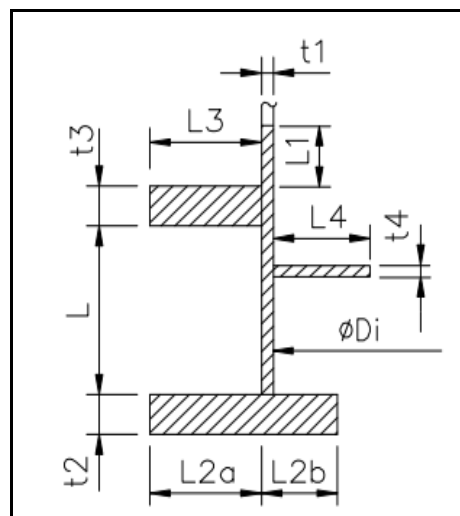
نسخه	سریال	نوع مدرک	رشته	تسهیلات	صادر کننده	بسته کاری	پروژه
V01	0001	CN	ME	120	MF	GCS	BK

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6) Base Block Under Erection Condition

6-1) sectional properties of Base Block

t1	10	(mm)
t2	30	(mm)
t3	30	(mm)
t4	0	(mm)
L2a	89	(mm)
L2b	31	(mm)
L3	140	(mm)
L4	0	(mm)
L	200	(mm)
Di	3322	(mm)



6-2) Effective Length Of Skirt

$Rm = (Di + t1) / 2$	1666	(mm)
$L1 = \text{Min.}(0.78 \cdot \sqrt{Rm \cdot t1}, 16 \cdot t1)$	101	(mm)

6-3) Section Area , A

$A1 = t1 \cdot (L + L1 + t3)$	3306.8	(mm) ²
$A2 = t2 \cdot (L2a + L2b)$	3600.0	(mm) ²
$A3 = t3 \cdot L3$	4200.0	(mm) ²
$A4 = t4 \cdot L4$	0.0	(mm) ²
Total Area , A = A1 + A2 + A3 + A4	11106.8	(mm) ²

6-4) Centroid , C

$h1 = L2a + t1 / 2$	94.0	(mm)
$h2 = (L2a + L2b) / 2$	60.0	(mm)
$h3 = L3 / 2 - (L3 - L2a)$	19.0	(mm)
$h4 = L2a + t1 + L4 / 2$	99.0	(mm)
$C = [(A1 \cdot h1) + (A2 \cdot h2) + (A3 \cdot h3) + (A4 \cdot h4)] / A$	54.6	(mm)
$Y = (L2a + L2b) - C$	65.4	(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 CONTACTOR (C-100)							شماره صفحه : 383 از 383	
	پروژه	بسته کاری	صادرکننده	تسهیلات	رشته	نوع مدرک	سریال		نسخه
	BK	GCS	MF	120	ME	CN	0001		V01

6-5) Moment Of Inertia Of Area , I (About Neutral Axis)

$I1=(L+L1+t3)*t1^3/12+A1*(h1-C)^2$	5156008	(mm) ⁴
$I2=t2*(L2a+L2b)^3/12+A2*(h2-C)^2$	4424253	(mm) ⁴
$I3=t3*L3^3/12+A3*(h3-C)^2$	12188484	(mm) ⁴
$I4=t4*L4^3/12+A4*(h4-C)^2$	0.0	(mm) ⁴
Total I=I1+I2+I3+I4	21768745	(mm) ⁴

6-6) Min. Section Modulus ,Z

$Z1=I/C$	398559	(mm) ³
$Z2=I/Y$	332950.3	(mm) ³
$Z=Min(Z1,Z2)$	332950	(mm) ³

6-7) Stress In Base Block Due To TV

Max Force At Tailing Lug	TV =	9866	kg
Radius To Neutral Axis	R =	1705	(mm)
Yield Strength Of Base	Sy =	21	kg/mm ²
Section Modulus Of Base	Z =	332950	kg/mm ³
Section Area Of Base	A =	11107	mm ²

Bending Moment (Ma) & Tangential Force (Ta) At Base Block

Case ; No Bracing : roark 6th ED . Table 17, Case 15

$Ma=0.2387*TV*R$	4016397	
$Ta=0.2387*TV$	2355	
$\sigma =Ma/Z+Ta/A$	12	must be smaller than $0.66Sy = 13.9$ OK bracing is not required