



Mechanical Engineering Consulting Services and Software

October 25, 1996

Tom Wallace  
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Dear Tom:

The results of the analysis of the ASME/ANSI flanges with your gaskets is summarized below. All of the flanges met the requirements for the increased working pressures you had proposed.

Some of the flanges also had high stresses when initially seating the gasket. These would have to be preloaded to slightly lower initial bolt loads if the user wishes to avoid stresses in excess of the ASME Section VIII Division 1 allowable stresses. However, it should be noted that these allowable stresses are considerably more conservative than some other codes permit, notably API Specification 6A and ASME Section VIII Division 2.

Size	Class 300	Class 600	Class 900	Class 1500	Class 2500
1/2	1000	2000	3000	5000	10000
3/4	1000	2000	3000	5000	10000
1	1000	2000	3000	5000	10000
1-1/4	1000	2000	3000	5000	10000
1-1/2	1000	2000	3000	5000	10000
2	1000	2000	3000	5000	10000
2-1/2	1000	2000	3000	5000	10000
3	1000	2000	3000	5000	10000
3-1/2	1000	2000			
4	1000	2000	3000	5000	10000
5	1000	2000	3000	5000	10000
6	1000	2000	3000	5000	10000
8	1000	2000	3000	5000	10000
10	1000	2000	3000	5000	10000
12	1000	2000	3000	5000	10000
14	1000	2000	3000	5000	
16	1000	2000	3000	5000	
18	1000	2000	3000	5000	
20	1000	2000	3000	5000	
24	1000	2000	3000	5000	

Sincerely,

John H. Fowler, P. E.

## **On-Line Resources**

P O Box 925393  
Houston, TX 77292

## **Fax Transmittal**

**DATE:** April 7, 1997      **TIME:** 12:30 pm

**TO:** Tom Wallace  
Pikotek      **PHONE:** 303-988-1242  
**FAX:** 303-988-1922

**FROM:** John H. Fowler, P. E.      **PHONE:** 713-688-0767  
**FAX:** 713-688-7610

**RE:** **Code Conformance of Pikotek Flanges**

**Number of pages including cover sheet: 5**

### **Message**

Tom - I have put together the following on B31.3, B31.4, and B31.8 conformance of the Pikotek designs.

#### **A. Conformance to ASME B31.3:**

1. **Standard Equipment:** Paragraph 308.1.2 is the controlling paragraph. Paragraph 308.1.2 states:

*Unlisted Components. Unlisted flanges, blanks, and gaskets may be used only in accordance with paragraph 302.2.3.*

In turn, 302.2.3 says:

*Unlisted Components:*

*(a) Components not listed in Table 326.1, but which conform to a published specification or standard, may be used within the following limitations:*

- (1) The designer shall be satisfied that composition, mechanical properties, method of manufacture, and quality control are comparable to the corresponding characteristics of listed components.*
- (2) Pressure design shall be verified in accordance with para. 304.*

Our flanges meet all of these requirements, since the flanges themselves are actually listed components with different ratings, and they fully conform to the ASME Boiler and Pressure Vessel Code. Section 304.5, **Pressure Design of Flanges and Blanks**, is the applicable section of Paragraph 304.

Paragraph 304.5.1(b) states:

*A flange may be designed in accordance with the BPV Code, Section VIII, Division 1, Appendix 2, using the allowable stresses and temperature limits of this code. Nomenclature shall be as defined in Appendix 2 except as follows:*

*P = design gage pressure*

*Sa = bolt design stress at atmospheric temperature*

*Sb = bolt design stress at design temperature*

$S_f = \text{product } SE$  (of the stress value  $S$  and the appropriate quality factor  $E$  from Table A-1A or A-1B) for flange or pipe material. See para. 302.3.2(e).

This method is the method we used on the high pressure VCS flanges, except that we used the ASME BPV allowable stresses which are lower than the ASME B31.3 allowables. See Table 1 below.

Paragraph 302.3.2(e) states:

(e) *Application Limits. Application of stress values determined in accordance with (d)(3) above is not recommended for flanged joints and other components in which slight deformation can cause leakage or malfunction...*

The referenced paragraph (d)(3) refers to austenitic stainless steels and nickel alloys where the allowable stress is sometimes determined by 90% of the yield strength since these alloys have a very gradual yield starting far below their tensile strength. This is not applicable to our flanges.

Therefore we can determine the limiting temperature by comparing the ASME B31.3 allowable stresses to the 17,500 psi value we used in our analysis for the flange. The bolt allowable stresses in the BPV and B31.3 are identical.

Temperature limits for the following forged carbon steels were determined based on ASME B31.3 Table A-1, and assuming a quality factor of 1.0:

**Table 1 - B31.3 Temperature Limits**

Flange Material	Temperature Limit, F
A350 LF-1 or A181 Cl. 60	340
A420 WPL-6 or A234-WPB	585
A350 LF-2	635
A105 or A181 Cl. 70	635
A234-WPC	715

2. **High Pressure Equipment, B31.3 Chapter IX:** Paragraph K304.5.1(b) is the controlling paragraph. This paragraph states:

*A flange may be designed in accordance with rules, allowable stresses, and temperature limits of the BPV Code, Section VIII, Division 2, Appendix 3 (or Appendices 4, 5 and 6).*

Our analyses were done in accordance with that Appendix, which has design equations and allowable stresses identical to Section VIII Division 1 Appendix 2. Therefore our temperature limits for common forged materials in this case would be as shown below. Temperature limits for the following forged carbon steels were determined based on ASME BPV Section II Part D, Table 1A:

**Table 2 - B31.3 Chapter IX, B31.4, and B31.8 Temperature Limits**

Flange Material	Temperature Limit, F
A350 LF-1 or A181 Cl. 60	Not permitted
A420 WPL-6 or A234-WPB	Not permitted
A350 LF2	650
A105 or A181 Cl. 70	650
A234-WPC	650

## B. Conformance with ASME B31.4

The key paragraph in this specification is Paragraph 408.1

### 408.1 Flanges

#### 408.1.1 General

(a) *Flanged connections shall conform to the requirements of paras. 408.1, 408.3, 408.4, and 408.5.*

(b) *(Permits the use of B16.5 or SP-44 flanges)*

(c) *(Prohibits the use of cast iron flanges except those integral with proprietary products)*

(d) *Flanges Exceeding Scope of Standard Sizes. Flanges exceeding the scope of standard sizes or otherwise departing from the dimensions listed in ANSI B16.5 or MSS SP-44 may be used provided they are designed in accordance with para. 404.5.1.*

Paragraphs 408.3, 408.4, and 408.5 relate to flange facings, gaskets, and bolting respectively. The Pikotek design meets these requirements. The applicable section of 404.5.1 is:

*404.5.1(c) Where conditions require the use of flanges other than those covered in para. 408.1, the flanges shall be designed in accordance with Appendix 2 of Section VIII, Division 1, of the ASME Boiler and Pressure Vessel Code.*

This requirement differs from that of standard B31.3 designs in that the lower ASME BPV Section VIII design stresses are required. The allowable temperatures for B31.4 would be the same as for Chapter IX of B31.3 (Table 2 above).

## C. Conformance with ASME B31.8

The key paragraph in B31.8 is paragraph 831.2.

### 831.2 Flanges

#### 831.2.1 Flange Types and Facings

(a) *The dimensions and drilling for all line or end flanges shall conform to one of the following standards:*

ANSI B16	Series listed in Appendix A (for Iron and Steel)
MSS SP-44	Steel Pipe Line Flanges
Appendix I	Light Weight Steel Flanges
ANSI B16.24	Brass or Bronze Flanges and Flanged Fittings

The Pikotek Flanges meet the above requirements since their drilling and dimensions are in accordance with ASME B16.5.

Paragraph 831.22(b) specifically permits ASTM A193 bolting.

Paragraph 831.23 requires gaskets to withstand the pressure and to maintain their physical and chemical properties at temperatures to which they will be exposed.

Paragraph A842.28 requires flanges in offshore service to “be such that smooth transfer of loads is made without high localized stresses or excessive deformation of the attached pipe. Connectors and flanges shall have a level of safety against failure by yielding and failure by fatigue which is comparable to that of the attached pipeline or riser.” No quantitative guidance is given for these requirements, so one would have to assume that ASME Code design requirements are sufficiently conservative.

ASME B31.8 does not require any particular method for the design or stress limits on flanges. Therefore the limits of the ASME Code should be used, which again limits the temperature to the values of Table 2.

#### D. Applicable Pressure Ratings

##### 1. ASME Flanges

The following pressure ratings were verified for the Pikotek HP VCS flanges, with calculations based on ASTM A105 flange material and ASTM A193 grade B7 or B7M studs (ASTM A194 nuts are acceptable for this situation). These ratings are applicable for ASME B31.3, B31.4, and B31.8 services.

**Table 3. Rated Working Pressures**

ASME B16.5 RF Flange Class	Rated pressure with VCS Gasket, psig
300	1,000
600	2,000
900	3,000
1500	5,000
2500	10,000

##### 2. API Type 6B Flanges

These same working pressures are applicable for API 6A service for the following flanges, providing the flange is constructed of materials meeting API 6A requirements (45,000 psi yield strength for weld neck and 60,000 psi yield strength for integral flanges).

The following table shows the nominal sizes on which the ASME flanges correspond to API 6A Type 6B flanges. The term “Type 6B” refers to a now obsolete API Standard 6B that previously defined these flanges. API Type 6B flanges are dimensionally interchangeable with ASME B16.5 flanges, but have a different system of nominal sizes which relate to standard wellhead equipment bores.

API 6A equipment can be purchased to eight different temperature ratings and combinations of these ratings. These are shown in API Specification 6A Table 4.2. The three low-temperature ratings K, L, and P are -75 to 180, -50 to 180, and -20 to 180 F. Ratings S, T, and U are 0 to 150, 0 to 180, and 0 to 250 F respectively. There is a special R rating (“Room Temperature”), and a V rating from 35 to 250 F. Temperature ratings of API 6A flanges are stamped on the outside diameter of the flange.

The VCS Gasket can be used up to 350 degrees F.

# Visual Flange - Flange Analysis Report

**Flange Name:** 2"-900# Carbon Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	2.067	in
Flange Outside Diameter	8.500	in
Flange Thickness	1.500	in
Raised Face Diameter	3.630	in
Flange Material:	SA105	

## Bolting Data:

Bolt Circle Diameter	6.500	in
Bolt Size	0.875	in
Number of Bolts	8	
Bolt Material:	SA193-B7	
Thread Root Area	0.4193	in <sup>2</sup>
Total Actual Bolt Area:	3.354	in <sup>2</sup>

## Hub Data:

Hub Length	4.000	in
Hub Major Diameter	4.130	in
Minor Hub Diameter	2.380	in
Hub Material:	SA105	
Hub thickness G0:	0.1565	in
Hub thickness G1:	1.0315	in

## Gasket Data:

Gasket Type:	Pikotek
Seal O.D.	2.506 in
Gasket O.D.	5.500 in
Gasket Material:	Pikotek 300+
Calculated b dimension:	0.265 in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3
Preload Requirement:	ASME

## Maximum Stresses:

	Gasket Seating		Hydro Test		Operating Cond's	
	psi	MPa	psi	MPa	psi	MPa
Flange	23,300	160.6	34,950	241.0	21,600	148.9
Hub	23,300	160.6	34,950	241.0	21,600	148.9
Hub Shear	13,980	96.4	20,970	144.6	12,960	89.4
Bolting	25,000	172.4	37,500	258.6	25,000	172.4

## Forces on Flange:

Separation Force H:	10,950	lbf	48.7	kN
Pressure End Load HD:	7,449	lbf	33.1	kN

$$HT = H - HD; \quad Gasket \ Ret. \ Force \ HP$$

lbf	3,500	kN	15.6
lbf	0	kN	0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	10,950	48.7	3,264	22.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	15,650	69.6	4,666	32.2	<i>OK</i>			
<i>Required Bolt Load:</i>	15,650	69.6	4,666	32.2	<i>OK</i>		25	34
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	49,755	221.3	14,833	102.3	<i>OK</i>		80	108

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>								1.700	43.2
<i>Operating/Test Condition</i>	1.701		43.2	2.107		53.5		1.997	50.7

## Geometry Factors

<i>B sub I:</i>	3.099	<i>Factor F:</i>	0.373	<i>Factor U:</i>	1.553
<i>Factor d:</i>	3.735	<i>Factor ho:</i>	0.569	<i>Factor V:</i>	0.006
<i>Factor e:</i>	0.655	<i>Factor K:</i>	4.112	<i>Factor Y:</i>	1.414
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.903	<i>Factor Z:</i>	1.126
		<i>Factor T:</i>	0.992		

## Flange Moments

<i>Gasket Seating:</i>	84,586	<i>in-lbf</i>	9,558.2	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	20,044	<i>in-lbf</i>	2,265.0	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	8,837	<i>OK</i>	0 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	14,454	<i>OK</i>	0 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	9,440	<i>OK</i>	0 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	11,646	<i>OK</i>	0 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	9,138	<i>OK</i>	0 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0	<i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 2"-900# Stainless Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

<b>Flange Bore Diameter</b>	2.067	in
<b>Flange Outside Diameter</b>	8.500	in
<b>Flange Thickness</b>	1.500	in
<b>Raised Face Diameter</b>	3.630	in
<b>Flange Material:</b>	SA182-F316	

## Bolting Data:

<b>Bolt Circle Diameter</b>	6.500	in
<b>Bolt Size</b>	0.875	in
<b>Number of Bolts</b>	8	
<b>Bolt Material:</b>	SA193-B7	
<b>Thread Root Area</b>	0.4193	in <sup>2</sup>
<b>Total Actual Bolt Area:</b>	3.354	in <sup>2</sup>

## Hub Data:

<b>Hub Length</b>	4.000	in
<b>Hub Major Diameter</b>	4.130	in
<b>Minor Hub Diameter</b>	2.380	in
<b>Hub Material:</b>	SA182-F316	
<b>Hub thickness G0:</b>	0.1565	in
<b>Hub thickness G1:</b>	1.0315	in

## Gasket Data:

<b>Gasket Type:</b>	Pikotek
<b>Seal O.D.</b>	2.506 in
<b>Gasket O.D.</b>	5.500 in
<b>Gasket Material:</b>	Pikotek 300+
<b>Calculated b dimension:</b>	2.506 in
	0.265 in

## Performance Requirements:

<b>Temperature:</b>	250	F	121	C
<b>Working Pressure:</b>	2,220	psi	15	MPa
<b>Test Pressure:</b>	0	psi	0.0	MPa

## Code Requirements:

<b>Code:</b>	ASME B31.3
<b>Preload Requirement:</b>	ASME

## Maximum Stresses:

	<b>Gasket Seating</b>	
	psi	MPa
<b>Flange</b>	20,000	137.9
<b>Hub</b>	20,000	137.9
<b>Hub Shear</b>	12,000	82.7
<b>Bolting</b>	25,000	172.4

## Hydro Test

	<b>Hydro Test</b>	
	psi	MPa
	30,000	206.8
	30,000	206.8
	18,000	124.1
	37,500	258.6

## Operating Cond's

	<b>Operating Cond's</b>	
	psi	MPa
	20,000	137.9
	20,000	137.9
	12,000	82.7
	25,000	172.4

## Forces on Flange:

	<b>lbf</b>	<b>kN</b>
<b>Separation Force H:</b>	10,950	48.7
<b>Pressure End Load HD:</b>	7,449	33.1

$$HT = H - HD; \quad Gasket \ Ret. \ Force \ HP$$

<b>lbf</b>	<b>kN</b>
3,500	15.6
0	0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	10,950	48.7	3,264	22.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	15,650	69.6	4,666	32.2	<i>OK</i>			
<i>Required Bolt Load:</i>	15,650	69.6	4,666	32.2	<i>OK</i>		25	34
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	49,755	221.3	14,833	102.3	<i>OK</i>		80	108

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>								1.700	43.2
<i>Operating/Test Condition</i>	1.701	43.2		2.107	53.5		1.997	50.7	

## Geometry Factors

<i>B sub I:</i>	3.099	<i>Factor F:</i>	0.373	<i>Factor U:</i>	1.553
<i>Factor d:</i>	3.735	<i>Factor ho:</i>	0.569	<i>Factor V:</i>	0.006
<i>Factor e:</i>	0.655	<i>Factor K:</i>	4.112	<i>Factor Y:</i>	1.414
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.903	<i>Factor Z:</i>	1.126
		<i>Factor T:</i>	0.992		

## Flange Moments

<i>Gasket Seating:</i>	84,586	<i>in-lbf</i>	9,558.2	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	20,044	<i>in-lbf</i>	2,265.0	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	8,837 <i>OK</i>	0 <i>OK</i>	2,094 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	14,454 <i>OK</i>	0 <i>OK</i>	3,425 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	9,440 <i>OK</i>	0 <i>OK</i>	2,237 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	11,646 <i>OK</i>	0 <i>OK</i>	2,760 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	9,138 <i>OK</i>	0 <i>OK</i>	2,165 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 4"-900# Carbon Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

**Flange Bore Diameter**

4.026 in

**Flange Outside Diameter**

11.500 in

**Flange Thickness**

1.750 in

**Raised Face Diameter**

6.190 in

**Flange Material:**

SA105

## Bolting Data:

**Bolt Circle Diameter**

9.250 in

**Bolt Size**

1.125 in

**Number of Bolts**

8

**Bolt Material:**

SA193-B7

**Thread Root Area**

0.7277 in<sup>2</sup>

**Total Actual Bolt Area:**

5.822 in<sup>2</sup>

## Hub Data:

**Hub Length**

4.500 in

**Hub Major Diameter**

6.250 in

**Minor Hub Diameter**

4.500 in

**Hub Material:**

SA105

**Hub thickness G0:**

0.237 in

**Hub thickness G1:**

1.112 in

## Gasket Data:

**Gasket Type:**

Pikotek

**Seal O.D.**

4.943 in

**Gasket O.D.**

8.000 in

**Gasket Material:**

Pikotek 300+

4.943 in

**Calculated b dimension:**

0.279 in

## Performance Requirements:

**Temperature:**

250 F 121 C

## Code Requirements:

**Working Pressure:**

2,220 psi 15 MPa

**Code:**

ASME B31.3

**Test Pressure:**

0 psi 0.0 MPa

**Preload Requirement:**

ASME

## Maximum Stresses:

**Flange**

**Gasket Seating**  
psi MPa

## Hydro Test

**psi MPa**

## Operating Cond's

**psi MPa**

**Hub**

23,300 160.6

34,950 241.0

21,600 148.9

**Hub Shear**

23,300 160.6

34,950 241.0

21,600 148.9

**Bolting**

13,980 96.4

20,970 144.6

12,960 89.4

25,000 172.4

37,500 258.6

25,000 172.4

## Forces on Flange:

**Separation Force H:**

lbf

kN

**HT = H - HD:**

**lbf kN**

**Pressure End Load HD:**

42,601  
28,261

189.5  
125.7

**Gasket Ret. Force HP**

14,340  
0

63.8  
0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<i>Makeup Torque,</i>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	42,601	189.5	7,318	50.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	32,514	144.6	5,585	38.5	<i>OK</i>			
<i>Required Bolt Load:</i>	42,601	189.5	7,318	50.5	<i>OK</i>		88	119
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	94,071	418.4	16,159	111.4	<i>OK</i>		194	262

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>								1.809	46.0
<i>Operating/Test Condition</i>	2.056		52.2	2.383		60.5		2.154	54.7

## Geometry Factors

<i>B sub I:</i>	5.138	<i>Factor F:</i>	0.448	<i>Factor U:</i>	2.154
<i>Factor d:</i>	8.225	<i>Factor ho:</i>	0.977	<i>Factor V:</i>	0.014
<i>Factor e:</i>	0.459	<i>Factor K:</i>	2.856	<i>Factor Y:</i>	1.960
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.104	<i>Factor Z:</i>	1.279
		<i>Factor T:</i>	1.241		

## Flange Moments

<i>Gasket Seating:</i>	170,190	<i>in-lbf</i>	19,231.5	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	92,274	<i>in-lbf</i>	10,427.0	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	12,730 <i>OK</i>	0 <i>OK</i>	6,902 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	13,562 <i>OK</i>	0 <i>OK</i>	7,353 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	9,702 <i>OK</i>	0 <i>OK</i>	5,260 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	13,146 <i>OK</i>	0 <i>OK</i>	7,128 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	11,216 <i>OK</i>	0 <i>OK</i>	6,081 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 4"-900# Stainless Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	4.026	in
Flange Outside Diameter	11.500	in
Flange Thickness	1.750	in
Raised Face Diameter	6.190	in
Flange Material:	SA182-F316	

## Bolting Data:

Bolt Circle Diameter	9.250	in
Bolt Size	1.125	in
Number of Bolts	8	
Bolt Material:	SA193-B7	
Thread Root Area	0.7277	in <sup>2</sup>
Total Actual Bolt Area:	5.822	in <sup>2</sup>

## Hub Data:

Hub Length	4.500	in
Hub Major Diameter	6.250	in
Minor Hub Diameter	4.500	in
Hub Material:	SA182-F316	
Hub thickness G0:	0.237	in
Hub thickness G1:	1.112	in

## Gasket Data:

Gasket Type:	Pikotek
Seal O.D.	4.943 in
Gasket O.D.	8.000 in
Gasket Material:	Pikotek 300+
Calculated b dimension:	4.943 in
	0.279 in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3
Preload Requirement:	ASME

## Maximum Stresses:

	Gasket Seating	
	psi	MPa
Flange	20,000	137.9
Hub	20,000	137.9
Hub Shear	12,000	82.7
Bolting	25,000	172.4

## Hydro Test

	psi	MPa
	30,000	206.8
	30,000	206.8
	18,000	124.1
	37,500	258.6

## Operating Cond's

	psi	MPa
	20,000	137.9
	20,000	137.9
	12,000	82.7
	25,000	172.4

## Forces on Flange:

	lbf	kN
Separation Force H:	42,601	189.5
Pressure End Load HD:	28,261	125.7

## lbf

HT = H - HD:	14,340	63.8
Gasket Ret. Force HP	0	0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>Makeup Torque,</i>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	42,601	189.5	7,318	50.5	<b>OK</b>		
<i>Gasket Seating Load Wm2</i>	32,514	144.6	5,585	38.5	<b>OK</b>		
<i>Required Bolt Load:</i>	42,601	189.5	7,318	50.5	<b>OK</b>		
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<b>OK</b>		
<i>Design Bolt Preload W:</i>	94,071	418.4	16,159	111.4	<b>OK</b>	194	262

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>		
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	<i>in</i>
<i>Gasket Seating Condition</i>						1.809
<i>Operating/Test Condition</i>	2.056	52.2	2.383	60.5	2.154	54.7

## Geometry Factors

<i>B sub I:</i>	5.138	<i>Factor F:</i>	0.448	<i>Factor U:</i>	2.154
<i>Factor d:</i>	8.225	<i>Factor ho:</i>	0.977	<i>Factor V:</i>	0.014
<i>Factor e:</i>	0.459	<i>Factor K:</i>	2.856	<i>Factor Y:</i>	1.960
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.104	<i>Factor Z:</i>	1.279
		<i>Factor T:</i>	1.241		

## Flange Moments

<i>Gasket Seating:</i>	170,190	<i>in-lbf</i>	19,231.5	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	92,274	<i>in-lbf</i>	10,427.0	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	12,730	<b>OK</b>	6,902
<i>Radial Flange Stress SR, psi:</i>	13,562	<b>OK</b>	7,353
<i>Tangential Flange Stress ST, psi:</i>	9,702	<b>OK</b>	5,260
<i>Combination (SH+SR)/2, psi:</i>	13,146	<b>OK</b>	7,128
<i>Combination (SH+ST)/2, psi:</i>	11,216	<b>OK</b>	6,081
<i>Hub Shear Stress (Swivel Flgs):</i>	0	<b>OK</b>	0

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 8"-900# Carbon Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	7.981	in
Flange Outside Diameter	18.500	in
Flange Thickness	2.500	in
Raised Face Diameter	10.630	in
Flange Material:	SA105	

## Bolting Data:

Bolt Circle Diameter	15.500	in
Bolt Size	1.375	in
Number of Bolts	12	
Bolt Material:	SA193-B7	
Thread Root Area	1.1548	in <sup>2</sup>
Total Actual Bolt Area:	13.858	in <sup>2</sup>

## Hub Data:

Hub Length	6.380	in
Hub Major Diameter	11.750	in
Minor Hub Diameter	8.630	in
Hub Material:	SA105	
Hub thickness G0:	0.3245	in
Hub thickness G1:	1.8845	in

## Gasket Data:

Gasket Type:	Pikotek
Seal O.D.	9.012 in
Gasket O.D.	14.000 in
Gasket Material:	Pikotek 300+
Calculated b dimension:	0.318 in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3
Preload Requirement:	ASME

## Maximum Stresses:

	Gasket Seating	
	psi	MPa
Flange	23,300	160.6
Hub	23,300	160.6
Hub Shear	13,980	96.4
Bolting	25,000	172.4

## Hydro Test

	psi	MPa
	34,950	241.0
	34,950	241.0
	20,970	144.6
	37,500	258.6

## Operating Cond's

	psi	MPa
	21,600	148.9
	21,600	148.9
	12,960	89.4
	25,000	172.4

## Forces on Flange:

	Ibf	kN
Separation Force H:	141,607	629.9
Pressure End Load HD:	111,060	494.0

$$HT = H - HD;$$

$$\text{Gasket Ret. Force HP}$$

	Ibf	kN
	30,547	135.9
	0	0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	141,607	629.9	10,219	70.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	67,525	300.3	4,873	33.6	<i>OK</i>			
<i>Required Bolt Load:</i>	141,607	629.9	10,219	70.5	<i>OK</i>		233	317
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	244,024	1,085.4	17,609	121.4	<i>OK</i>		402	541

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>		
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	
<i>Gasket Seating Condition</i>					2.753	69.9
<i>Operating/Test Condition</i>	2.817	71.6	3.502	88.9	3.244	82.4

## Geometry Factors

<i>B sub I:</i>	9.866	<i>Factor F:</i>	0.414	<i>Factor U:</i>	2.696
<i>Factor d:</i>	49.091	<i>Factor ho:</i>	1.609	<i>Factor V:</i>	0.009
<i>Factor e:</i>	0.257	<i>Factor K:</i>	2.318	<i>Factor Y:</i>	2.453
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.495	<i>Factor Z:</i>	1.457
		<i>Factor T:</i>	1.396		

## Flange Moments

<i>Gasket Seating:</i>	671,797	<i>in-lbf</i>	75,913.1	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	419,852	<i>in-lbf</i>	47,443.3	<i>N-m</i>

## Flange and Hub Stresses in psi

	<i>Gasket Seating</i>	<i>Hydro Test</i>	<i>Operating</i>
<i>Longitudinal Hub Stress SH, psi:</i>	12,822 <i>OK</i>	0 <i>OK</i>	8,013 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	16,710 <i>OK</i>	0 <i>OK</i>	10,443 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	8,685 <i>OK</i>	0 <i>OK</i>	5,428 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	14,766 <i>OK</i>	0 <i>OK</i>	9,228 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	10,754 <i>OK</i>	0 <i>OK</i>	6,721 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 8"-900# Stainless Steel Flange

**Company** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	7.981	in
Flange Outside Diameter	18.500	in
Flange Thickness	2.500	in
Raised Face Diameter	10.630	in
Flange Material:	SA182-F316	

## Bolting Data:

Bolt Circle Diameter	15.500	in
Bolt Size	1.375	in
Number of Bolts	12	
Bolt Material:	SA193-B7	
Thread Root Area	1.1548	in <sup>2</sup>
Total Actual Bolt Area:	13.858	in <sup>2</sup>

## Hub Data:

Hub Length	6.380	in
Hub Major Diameter	11.750	in
Minor Hub Diameter	8.630	in
Hub Material:	SA182-F316	
Hub thickness G0:	0.3245	in
Hub thickness G1:	1.8845	in

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	9.012	in
Gasket O.D.	14.000	in
Gasket Material:	Pikotek 300+	
Calculated b dimension:	0.318	in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3
Preload Requirement:	ASME

## Maximum Stresses:

	Gasket Seating		Hydro Test		Operating Cond's	
	psi	MPa	psi	MPa	psi	MPa
Flange	20,000	137.9	30,000	206.8	20,000	137.9
Hub	20,000	137.9	30,000	206.8	20,000	137.9
Hub Shear	12,000	82.7	18,000	124.1	12,000	82.7
Bolting	25,000	172.4	37,500	258.6	25,000	172.4

## Forces on Flange:

Separation Force H:	141,607	lbf	629.9	kN
Pressure End Load HD:	111,060	lbf	494.0	kN

$$HT = H - HD; \quad Gasket Ret. Force HP$$

lbf	30,547
0	135.9

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque, ft-lbf</u>	<u>N-m</u>
<i>Operating Load Wm1:</i>	141,607	629.9	10,219	70.5	<i>OK</i>		
<i>Gasket Seating Load Wm2</i>	67,525	300.3	4,873	33.6	<i>OK</i>		
<i>Required Bolt Load:</i>	141,607	629.9	10,219	70.5	<i>OK</i>	233	317
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>		
<i>Design Bolt Preload W:</i>	244,024	1,085.4	17,609	121.4	<i>OK</i>	402	541

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>								2.753	69.9
<i>Operating/Test Condition</i>	2.817		71.6	3.502		88.9	3.244		82.4

## Geometry Factors

<i>B sub 1:</i>	9.866	<i>Factor F:</i>	0.414	<i>Factor U:</i>	2.696
<i>Factor d:</i>	49.091	<i>Factor ho:</i>	1.609	<i>Factor V:</i>	0.009
<i>Factor e:</i>	0.257	<i>Factor K:</i>	2.318	<i>Factor Y:</i>	2.453
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.495	<i>Factor Z:</i>	1.457
		<i>Factor T:</i>	1.396		

## Flange Moments

<i>Gasket Seating:</i>	671,797	<i>in-lbf</i>	75,913.1	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	419,852	<i>in-lbf</i>	47,443.3	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	12,822	<i>OK</i>	0
<i>Radial Flange Stress SR, psi:</i>	16,710	<i>OK</i>	0
<i>Tangential Flange Stress ST, psi:</i>	8,685	<i>OK</i>	0
<i>Combination (SH+SR)/2, psi:</i>	14,766	<i>OK</i>	0
<i>Combination (SH+ST)/2, psi:</i>	10,754	<i>OK</i>	0
<i>Hub Shear Stress (Swivel Flgs):</i>	0	<i>OK</i>	0

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 12"-900# Carbon Steel Flange      **Company:** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	12.000	in
Flange Outside Diameter	24.000	in
Flange Thickness	3.130	in
Raised Face Diameter	15.000	in
Flange Material:	SA105	

## Bolting Data:

Bolt Circle Diameter	21.000	in
Bolt Size	1.375	in
Number of Bolts	20	
Bolt Material:	SA193-B7	
Thread Root Area	1.1548	in <sup>2</sup>
Total Actual Bolt Area:	23.096	in <sup>2</sup>

## Hub Data:

Hub Length	7.880	in
Hub Major Diameter	16.500	in
Minor Hub Diameter	12.750	in
Hub Material:	SA105	
Hub thickness G0:	0.375	in
Hub thickness G1:	2.25	in

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	13.262	in
Gasket O.D.	19.500	in
Gasket Material:	Pikotek 300+	
Calculated b dimension:	13.262	in
	0.330	in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3	
Preload Requirement:	ASME	

## Maximum Stresses:

	Gasket Seating	
	psi	MPa
Flange	23,300	160.6
Hub	23,300	160.6
Hub Shear	13,980	96.4
Bolting	25,000	172.4

	Hydro Test	
	psi	MPa
	34,950	241.0
	34,950	241.0
	20,970	144.6
	37,500	258.6

	Operating Cond's	
	psi	MPa
	21,600	148.9
	21,600	148.9
	12,960	89.4
	25,000	172.4

## Forces on Flange:

Separation Force H:	306,663	lbf	1,364.0	kN
Pressure End Load HD:	251,076		1,116.8	

$HT = H - HD$ :  
Gasket Ret. Force HP

lbf	55,587	kN	247.2
	0		0.0

# Visual Flange - Flange Analysis Report

Total Bolt Loads:

	Force, lbf	kN	Stress, psi	MPa	OK	Makeup Torque, ft-lbf	N-m
<i>Operating Load Wm1:</i>	306,663	1,364.0	13,278	91.5	OK		
<i>Gasket Seating Load Wm2</i>	102,988	458.1	4,459	30.7	OK		
<i>Required Bolt Load:</i>	306,663	1,364.0	13,278	91.5	OK	303	411
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	OK		
<i>Design Bolt Preload W:</i>	442,031	1,966.2	19,139	132.0	OK	437	588

Moment Arms:

	<u>hD</u>			<u>hT</u>		
	in	mm	in	mm	in	mm
<i>Gasket Seating Condition</i>					3.330	84.6
<i>Operating/Test Condition</i>	3.375	85.7	4.184	106.3	3.869	98.3

Geometry Factors

<i>B sub 1:</i>	14.250	<i>Factor F:</i>	0.413	<i>Factor U:</i>	3.256
<i>Factor d:</i>	109.316	<i>Factor ho:</i>	2.121	<i>Factor V:</i>	0.009
<i>Factor e:</i>	0.195	<i>Factor K:</i>	2.000	<i>Factor Y:</i>	2.963
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.348	<i>Factor Z:</i>	1.667
		<i>Factor T:</i>	1.507		

Flange Moments

<i>Gasket Seating:</i>	1,471,780	in-lbf	166,311.1	N-m
<i>Hydrostatic Test:</i>	0	in-lbf	0.0	N-m
<i>Operating:</i>	1,079,984	in-lbf	122,038.1	N-m

Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	15,130 OK	0 OK	11,102 OK
<i>Radial Flange Stress SR, psi:</i>	16,803 OK	0 OK	12,330 OK
<i>Tangential Flange Stress ST, psi:</i>	9,089 OK	0 OK	6,669 OK
<i>Combination (SH+SR)/2, psi:</i>	15,967 OK	0 OK	11,716 OK
<i>Combination (SH+ST)/2, psi:</i>	12,110 OK	0 OK	8,886 OK
<i>Hub Shear Stress (Swivel Flgs):</i>	0 OK	0 OK	0 OK

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 12"-900# Stainless Steel Flange      **Company:** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

<b>Flange Bore Diameter</b>	12.000	in
<b>Flange Outside Diameter</b>	24.000	in
<b>Flange Thickness</b>	3.130	in
<b>Raised Face Diameter</b>	15.000	in
<b>Flange Material:</b>	SA182-F316	

## Bolting Data:

<b>Bolt Circle Diameter</b>	21.000	in
<b>Bolt Size</b>	1.375	in
<b>Number of Bolts</b>	20	
<b>Bolt Material:</b>	SA193-B7	
<b>Thread Root Area</b>	1.1548	in <sup>2</sup>
<b>Total Actual Bolt Area:</b>	23.096	in <sup>2</sup>

## Hub Data:

<b>Hub Length</b>	7.880	in
<b>Hub Major Diameter</b>	16.500	in
<b>Minor Hub Diameter</b>	12.750	in
<b>Hub Material:</b>	SA182-F316	
<b>Hub thickness G0:</b>	0.375	in
<b>Hub thickness G1:</b>	2.25	in

## Gasket Data:

<b>Gasket Type:</b>	Pikotek	
<b>Seal O.D.</b>	13.262	in
<b>Gasket O.D.</b>	19.500	in
<b>Gasket Material:</b>	Pikotek 300+	
<b>Calculated b dimension:</b>	13.262	in
	0.330	in

## Performance Requirements:

<b>Temperature:</b>	250	F	121	C
<b>Working Pressure:</b>	2,220	psi	15	MPa
<b>Test Pressure:</b>	0	psi	0.0	MPa

## Code Requirements:

<b>Code:</b>	ASME B31.3	
<b>Preload Requirement:</b>	ASME	

## Maximum Stresses:

	<b>Gasket Seating</b>		<b>Hydro Test</b>		<b>Operating Cond's</b>	
	psi	MPa	psi	MPa	psi	MPa
<b>Flange</b>	20,000	137.9	30,000	206.8	20,000	137.9
<b>Hub</b>	20,000	137.9	30,000	206.8	20,000	137.9
<b>Hub Shear</b>	12,000	82.7	18,000	124.1	12,000	82.7
<b>Bolting</b>	25,000	172.4	37,500	258.6	25,000	172.4

## Forces on Flange:

<b>Separation Force H:</b>	306,663	lbf	1,364.0	kN	<b>HT = H - HD:</b>	55,587	lbf	247.2	kN
<b>Pressure End Load HD:</b>	251,076		1,116.8		<b>Gasket Ret. Force HP</b>	0		0.0	

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<i>Makeup Torque,</i>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	306,663	1,364.0	13,278	91.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	102,988	458.1	4,459	30.7	<i>OK</i>			
<i>Required Bolt Load:</i>	306,663	1,364.0	13,278	91.5	<i>OK</i>		303	411
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	442,031	1,966.2	19,139	132.0	<i>OK</i>		437	588

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>								3.330	84.6
<i>Operating/Test Condition</i>	3.375		85.7	4.184		106.3		3.869	98.3

## Geometry Factors

<i>B sub I:</i>	14.250	<i>Factor F:</i>	0.413	<i>Factor U:</i>	3.256
<i>Factor d:</i>	109.316	<i>Factor ho:</i>	2.121	<i>Factor V:</i>	0.009
<i>Factor e:</i>	0.195	<i>Factor K:</i>	2.000	<i>Factor Y:</i>	2.963
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.348	<i>Factor Z:</i>	1.667
		<i>Factor T:</i>	1.507		

## Flange Moments

<i>Gasket Seating:</i>	1,471,780	<i>in-lbf</i>	166,311.1	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	1,079,984	<i>in-lbf</i>	122,038.1	<i>N-m</i>

## Flange and Hub Stresses in psi

	<i>Gasket Seating</i>	<i>Hydro Test</i>	<i>Operating</i>
<i>Longitudinal Hub Stress SH, psi:</i>	15,130 <i>OK</i>	0 <i>OK</i>	11,102 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	16,803 <i>OK</i>	0 <i>OK</i>	12,330 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	9,089 <i>OK</i>	0 <i>OK</i>	6,669 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	15,967 <i>OK</i>	0 <i>OK</i>	11,716 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	12,110 <i>OK</i>	0 <i>OK</i>	8,886 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 20"-900# Carbon Steel      **Company:** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	19.250	in
Flange Outside Diameter	33.750	in
Flange Thickness	4.250	in
Raised Face Diameter	23.000	in
Flange Material:	SA105	

## Bolting Data:

Bolt Circle Diameter	29.500	in
Bolt Size	2.000	in
Number of Bolts	20	
Bolt Material:	SA193-B7	
Thread Root Area	2.6521	in <sup>2</sup>
Total Actual Bolt Area:	53.042	in <sup>2</sup>

## Hub Data:

Hub Length	9.750	in
Hub Major Diameter	24.500	in
Minor Hub Diameter	20.000	in
Hub Material:	SA105	
Hub thickness G0:	0.375	in
Hub thickness G1:	2.625	in

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	21.373	in
Gasket O.D.	27.375	in
Gasket Material:	Pikotek 300+	
Calculated b dimension:	21.373	in
	0.319	in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3	
Preload Requirement:	ASME	

## Maximum Stresses:

	Gasket Seating	
	psi	MPa
Flange	23,300	160.6
Hub	23,300	160.6
Hub Shear	13,980	96.4
Bolting	25,000	172.4

	Hydro Test	
	psi	MPa
	34,950	241.0
	34,950	241.0
	20,970	144.6
	37,500	258.6

	Operating Cond's	
	psi	MPa
	21,600	148.9
	21,600	148.9
	12,960	89.4
	25,000	172.4

## Forces on Flange:

Separation Force H:	796,478	Ibf	3,542.7	kN
Pressure End Load HD:	646,107	Ibf	2,873.9	kN

$HT = H - HD$ :  
Gasket Ret. Force HP

Ibf	150,371	kN	668.9
	0		0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	796,478	3,542.7	15,016	103.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	160,587	714.3	3,028	20.9	<i>OK</i>			
<i>Required Bolt Load:</i>	796,478	3,542.7	15,016	103.5	<i>OK</i>		1,112	1,508
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	1,061,264	4,720.5	20,008	138.0	<i>OK</i>		1,482	1,994

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>			
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	<i>in</i>	
<i>Gasket Seating Condition</i>						3.569	90.6
<i>Operating/Test Condition</i>	3.813	96.8	4.594	116.7	4.063	103.2	

## Geometry Factors

<i>B sub 1:</i>	21.875	<i>Factor F:</i>	0.393	<i>Factor U:</i>	3.990
<i>Factor d:</i>	233.695	<i>Factor ho:</i>	2.687	<i>Factor V:</i>	0.006
<i>Factor e:</i>	0.146	<i>Factor K:</i>	1.753	<i>Factor Y:</i>	3.630
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.340	<i>Factor Z:</i>	1.964
		<i>Factor T:</i>	1.603		

## Flange Moments

<i>Gasket Seating:</i>	3,787,529	<i>in-lbf</i>	427,990.8	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	3,154,125	<i>in-lbf</i>	356,416.1	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	18,756 <i>OK</i>	0 <i>OK</i>	15,620 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	14,849 <i>OK</i>	0 <i>OK</i>	12,366 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	10,377 <i>OK</i>	0 <i>OK</i>	8,642 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	16,803 <i>OK</i>	0 <i>OK</i>	13,993 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	14,567 <i>OK</i>	0 <i>OK</i>	12,131 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 20"-900# Stainless Steel      **Company:** Shell

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	19.250	in
Flange Outside Diameter	33.750	in
Flange Thickness	4.250	in
Raised Face Diameter	23.000	in
Flange Material:	SA182-F316	

## Bolting Data:

Bolt Circle Diameter	29.500	in
Bolt Size	2.000	in
Number of Bolts	20	
Bolt Material:	SA193-B7	
Thread Root Area	2.6521	in <sup>2</sup>
Total Actual Bolt Area:	53.042	in <sup>2</sup>

## Hub Data:

Hub Length	9.750	in
Hub Major Diameter	24.500	in
Minor Hub Diameter	20.000	in
Hub Material:	SA182-F316	
Hub thickness G0:	0.375	in
Hub thickness G1:	2.625	in

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	21.373	in
Gasket O.D.	27.375	in
Gasket Material:	Pikotek 300+	
Calculated b dimension:	21.373	in
	0.319	in

## Performance Requirements:

Temperature:	250	F	121	C
Working Pressure:	2,220	psi	15	MPa
Test Pressure:	0	psi	0.0	MPa

## Code Requirements:

Code:	ASME B31.3	
Preload Requirement:	ASME	

## Maximum Stresses:

	Gasket Seating psi	Gasket Seating MPa
Flange	20,000	137.9
Hub	20,000	137.9
Hub Shear	12,000	82.7
Bolting	25,000	172.4

	Hydro Test psi	Hydro Test MPa
	30,000	206.8
	30,000	206.8
	18,000	124.1
	37,500	258.6

	Operating Cond's psi	Operating Cond's MPa
	20,000	137.9
	20,000	137.9
	12,000	82.7
	25,000	172.4

## Forces on Flange:

Separation Force H:	796,478	lbf	3,542.7	kN
Pressure End Load HD:	646,107		2,873.9	

HT = H - HD:  
Gasket Ret. Force HP

lbf	150,371	kN	668.9
	0		0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	796,478	3,542.7	15,016	103.5	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	160,587	714.3	3,028	20.9	<i>OK</i>			
<i>Required Bolt Load:</i>	796,478	3,542.7	15,016	103.5	<i>OK</i>		1,112	1,508
<i>Bolt Load at Hydro Test:</i>	0	0.0	0	0.0	<i>OK</i>			
<i>Design Bolt Preload W:</i>	1,061,264	4,720.5	20,008	138.0	<i>OK</i>		1,482	1,994

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>		
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	
<i>Gasket Seating Condition</i>					3.569	90.6
<i>Operating/Test Condition</i>	3.813	96.8	4.594	116.7	4.063	103.2

## Geometry Factors

<i>B sub 1:</i>	21.875	<i>Factor F:</i>	0.393	<i>Factor U:</i>	3.990
<i>Factor d:</i>	233.695	<i>Factor ho:</i>	2.687	<i>Factor V:</i>	0.006
<i>Factor e:</i>	0.146	<i>Factor K:</i>	1.753	<i>Factor Y:</i>	3.630
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.340	<i>Factor Z:</i>	1.964
		<i>Factor T:</i>	1.603		

## Flange Moments

<i>Gasket Seating:</i>	3,787,529	<i>in-lbf</i>	427,990.8	<i>N-m</i>
<i>Hydrostatic Test:</i>	0	<i>in-lbf</i>	0.0	<i>N-m</i>
<i>Operating:</i>	3,154,125	<i>in-lbf</i>	356,416.1	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	18,756 <i>OK</i>	0 <i>OK</i>	15,620 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	14,849 <i>OK</i>	0 <i>OK</i>	12,366 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	10,377 <i>OK</i>	0 <i>OK</i>	8,642 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	16,803 <i>OK</i>	0 <i>OK</i>	13,993 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	14,567 <i>OK</i>	0 <i>OK</i>	12,131 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

<b>Flange Name:</b> 5-1/8" 10K	<b>Company</b> Petrofac
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**Methods and Assumptions:**

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

**Flange Body Data:**

Flange Bore Diameter	125.095	mm
Flange Outside Diameter	357.124	mm
Flange Thickness	69.850	mm
Raised Face Diameter	220.726	mm
Flange Material:	A694 F65	

**Bolting Data:**

Bolt Circle Diameter	299.974	mm
Bolt Size	28.575	mm
Number of Bolts	12	
Bolt Material:	B637	
Thread Root Area	469.48	mm
Total Actual Bolt Area:	633.795	mm

**Hub Data:**

Hub Length	81.026	mm
Hub Major Diameter	223.774	mm
Minor Hub Diameter	182.626	mm
Hub Material:	A694 F65	
Hub thickness G0:	28.7655	mm
Hub thickness G1:	49.3395	mm

**Gasket Data:**

Gasket Type:	Pikotek
Seal O.D.	139.471 mm
Gasket O.D.	269.824 mm
Gasket Material:	Pikotek 300+
	139.471 mm
Calculated b dimension:	11.357 mm

**Performance Requirements:**

Temperature:	200	F	93	C
Working Pressure:	9,572	psi	66	MPa
Test Pressure:	11,371	psi	78.4	MPa

**Code Requirements:**

Code:	API Spec 6A
Preload Requirement:	API

**Maximum Stresses:**

	Gasket Seating		Hydro Test		Operating Cond's	
	psi	MPa	psi	MPa	psi	MPa
Flange	43,300	298.5	53,950	372.0	43,300	298.5
Hub	43,300	298.5	53,950	372.0	43,300	298.5
Hub Shear	25,980	179.1	32,370	223.2	25,980	179.1
Bolting	99,000	682.6	164,340	1,133.1	99,000	682.6

**Forces on Flange:**

Separation Force H:	226,682	lbf	1,008.3	kN	HT = H - HD:	44,323	lbf	197.2	kN
Pressure End Load HD:	182,359		811.1		Gasket Ret. Force HP	0		0.0	

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque, ft-lbf</u>	<u>N-m</u>
<i>Operating Load Wm1:</i>	226,682	1,008.3	25,959	179.0	<i>OK</i>		
<i>Gasket Seating Load Wm2</i>	57,851	257.3	6,625	45.7	<i>OK</i>		
<i>Required Bolt Load:</i>	226,682	1,008.3	25,959	179.0	<i>OK</i>	312	423
<i>Bolt Load at Hydro Test:</i>	269,271	1,197.7	30,836	212.6	<i>OK</i>		
<i>Design Bolt Preload W:</i>	864,508	3,845.3	99,000	682.6	<i>OK</i>	1,191	1,603

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>							2.007		51.0
<i>Operating/Test Condition</i>	2.471		62.8	3.301		83.8	3.160		80.3

## Geometry Factors

<i>B sub I:</i>	6.867	<i>Factor F:</i>	0.744	<i>Factor U:</i>	2.155
<i>Factor d:</i>	35.865	<i>Factor ho:</i>	2.362	<i>Factor V:</i>	0.182
<i>Factor e:</i>	0.315	<i>Factor K:</i>	2.855	<i>Factor Y:</i>	1.961
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.083	<i>Factor Z:</i>	1.280
		<i>Factor T:</i>	1.241		

## Flange Moments

<i>Gasket Seating:</i>	1,735,191	<i>in-lbf</i>	196,076.6	<i>N-m</i>
<i>Hydrostatic Test:</i>	709,123	<i>in-lbf</i>	80,130.9	<i>N-m</i>
<i>Operating:</i>	596,966	<i>in-lbf</i>	67,457.2	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	32,148 <i>OK</i>	13,138 <i>OK</i>	11,060 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	48,122 <i>High</i>	19,666 <i>OK</i>	16,556 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	29,775 <i>OK</i>	12,168 <i>OK</i>	10,244 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	40,135 <i>OK</i>	16,402 <i>OK</i>	13,808 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	30,961 <i>OK</i>	12,653 <i>OK</i>	10,652 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 9" 10K Company Petrofac

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	203.098	mm
Flange Outside Diameter	552.450	mm
Flange Thickness	111.252	mm
Raised Face Diameter	358.648	mm
Flange Material:	A694 F65	

## Bolting Data:

Bolt Circle Diameter	476.250	mm
Bolt Size	38.100	mm
Number of Bolts	16	
Bolt Material:	B637	
Thread Root Area	906.58	mm
Total Actual Bolt Area:	505.261	mm

## Hub Data:

Hub Length	93.726	mm
Hub Major Diameter	374.650	mm
Minor Hub Diameter	327.152	mm
Hub Material:	A694 F65	
Hub thickness G0:	62.027	mm
Hub thickness G1:	85.776	mm

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	240.436	mm
Gasket O.D.	436.702	mm
Gasket Material:	Pikotek 300+	
Calculated b dimension:	240.436	mm
	13.699	mm

## Performance Requirements:

Temperature:	200	F	93	C
Working Pressure:	9,572	psi	66	MPa
Test Pressure:	11,240	psi	77.5	MPa

## Code Requirements:

Code:	API Spec 6A	
Preload Requirement:	API	

## Maximum Stresses:

	Gasket Seating	
	psi	MPa
Flange	43,300	298.5
Hub	43,300	298.5
Hub Shear	25,980	179.1
Bolting	99,000	682.6

	Hydro Test	
	psi	MPa
	53,950	372.0
	53,950	372.0
	32,370	223.2
	164,340	1,133.1

	Operating Cond's	
	psi	MPa
	43,300	298.5
	43,300	298.5
	25,980	179.1
	99,000	682.6

## Forces on Flange:

Separation Force H:	673,669	lbf	2,996.5	kN
Pressure End Load HD:	480,683		2,138.1	

$HT = H - HD$ :  
Gasket Ret. Force HP

lbf	192,986	kN	858.4
	0		0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque, ft-lbf</u>	<u>N-m</u>
<i>Operating Load Wm1:</i>	673,669	2,996.5	29,963	206.6	<i>OK</i>		
<i>Gasket Seating Load Wm2</i>	120,290	535.1	5,350	36.9	<i>OK</i>		
<i>Required Bolt Load:</i>	673,669	2,996.5	29,963	206.6	<i>OK</i>	901	1,222
<i>Bolt Load at Hydro Test:</i>	791,050	3,518.6	35,184	242.6	<i>OK</i>		
<i>Design Bolt Preload W:</i>	2,225,837	9,900.5	99,000	682.6	<i>OK</i>	2,978	4,009

<u>Moment Arms:</u>	<i>hD</i>	<i>in</i>	<i>mm</i>	<i>hT</i>	<i>in</i>	<i>mm</i>	<i>hG</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>							2.854		72.5
<i>Operating/Test Condition</i>	3.689		93.7	5.010		127.2	4.642		117.9

## Geometry Factors

<i>B sub I:</i>	11.373	<i>Factor F:</i>	0.826	<i>Factor U:</i>	2.262
<i>Factor d:</i>	195.002	<i>Factor ho:</i>	4.419	<i>Factor V:</i>	0.306
<i>Factor e:</i>	0.187	<i>Factor K:</i>	2.720	<i>Factor Y:</i>	2.059
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.855	<i>Factor Z:</i>	1.313
		<i>Factor T:</i>	1.277		

## Flange Moments

<i>Gasket Seating:</i>	6,353,271	<i>in-lbf</i>	717,919.6	<i>N-m</i>
<i>Hydrostatic Test:</i>	3,217,147	<i>in-lbf</i>	363,537.7	<i>N-m</i>
<i>Operating:</i>	2,739,764	<i>in-lbf</i>	309,593.4	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	26,405 <i>OK</i>	13,371 <i>OK</i>	11,387 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	46,623 <i>High</i>	23,609 <i>OK</i>	20,105 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	24,071 <i>OK</i>	12,189 <i>OK</i>	10,380 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	36,514 <i>OK</i>	18,490 <i>OK</i>	15,746 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	25,238 <i>OK</i>	12,780 <i>OK</i>	10,883 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 5-1/8" 10K

**Company** Petrofac

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

<b>Flange Bore Diameter</b>	125.095	mm
<b>Flange Outside Diameter</b>	357.124	mm
<b>Flange Thickness</b>	79.375	mm
<b>Raised Face Diameter</b>	220.726	mm
<b>Flange Material:</b>	API 60K/G41350	

## Bolting Data:

<b>Bolt Circle Diameter</b>	299.974	mm
<b>Bolt Size</b>	28.575	mm
<b>Number of Bolts</b>	12	
<b>Bolt Material:</b>	B637	
<b>Thread Root Area</b>	469.48	mm
<b>Total Actual Bolt Area:</b>	633.795	mm

## Hub Data:

<b>Hub Length</b>	81.026	mm
<b>Hub Major Diameter</b>	223.774	mm
<b>Minor Hub Diameter</b>	182.626	mm
<b>Hub Material:</b>	API 60K/G41350	
<b>Hub thickness G0:</b>	28.7655	mm
<b>Hub thickness G1:</b>	49.3395	mm

## Gasket Data:

<b>Gasket Type:</b>	Pikotek	
<b>Seal O.D.</b>	139.471	mm
<b>Gasket O.D.</b>	269.824	mm
<b>Gasket Material:</b>	Pikotek 300+	
<b>Calculated b dimension:</b>	139.471	mm
	11.357	mm

## Performance Requirements:

<b>Temperature:</b>	200	F	93	C
<b>Working Pressure:</b>	10,000	psi	69	MPa
<b>Test Pressure:</b>	15,000	psi	103.4	MPa

## Code Requirements:

<b>Code:</b>	API Spec 6A
<b>Preload Requirement:</b>	API

## Maximum Stresses:

	<b>Gasket Seating</b>		<b>Hydro Test</b>		<b>Operating Cond's</b>	
	psi	MPa	psi	MPa	psi	MPa
<b>Flange</b>	40,000	275.8	49,800	343.4	40,000	275.8
<b>Hub</b>	40,000	275.8	49,800	343.4	40,000	275.8
<b>Hub Shear</b>	24,000	165.5	29,880	206.0	24,000	165.5
<b>Bolting</b>	75,000	517.1	124,500	858.4	75,000	517.1

## Forces on Flange:

<b>Separation Force H:</b>	236,806	lbf	1,053.3	kN	<b>HT = H - HD:</b>	46,303	lbf	206.0	kN
<b>Pressure End Load HD:</b>	190,503		847.4		<b>Gasket Ret. Force HP</b>	0		0.0	

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	236,806	1,053.3	27,118	187.0	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	57,851	257.3	6,625	45.7	<i>OK</i>			
<i>Required Bolt Load:</i>	236,806	1,053.3	27,118	187.0	<i>OK</i>		326	442
<i>Bolt Load at Hydro Test:</i>	355,209	1,580.0	40,677	280.5	<i>OK</i>			
<i>Design Bolt Preload W:</i>	654,930	2,913.1	75,000	517.1	<i>OK</i>		902	1,214

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>		
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	
<i>Gasket Seating Condition</i>					2.007	51.0
<i>Operating/Test Condition</i>	2.471	62.8	3.301	83.8	3.160	80.3

## Geometry Factors

<i>B sub I:</i>	6.867	<i>Factor F:</i>	0.744	<i>Factor U:</i>	2.155
<i>Factor d:</i>	35.865	<i>Factor ho:</i>	2.362	<i>Factor V:</i>	0.182
<i>Factor e:</i>	0.315	<i>Factor K:</i>	2.855	<i>Factor Y:</i>	1.961
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.449	<i>Factor Z:</i>	1.280
		<i>Factor T:</i>	1.241		

## Flange Moments

<i>Gasket Seating:</i>	1,314,539	<i>in-lbf</i>	148,542.9	<i>N-m</i>
<i>Hydrostatic Test:</i>	935,440	<i>in-lbf</i>	105,704.7	<i>N-m</i>
<i>Operating:</i>	623,627	<i>in-lbf</i>	70,469.8	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	20,713 <i>OK</i>	14,740 <i>OK</i>	9,827 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	25,763 <i>OK</i>	18,333 <i>OK</i>	12,222 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	20,627 <i>OK</i>	14,678 <i>OK</i>	9,785 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	23,238 <i>OK</i>	16,537 <i>OK</i>	11,024 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	20,670 <i>OK</i>	14,709 <i>OK</i>	9,806 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 9" 10K Company Petrofac

**Methods and Assumptions:**

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

**Flange Body Data:**

**Flange Bore Diameter** 203.098 mm

**Flange Outside Diameter** 552.450 mm

**Flange Thickness** 123.952 mm

**Raised Face Diameter** 358.648 mm

**Flange Material:** API 60K/G41350

**Bolting Data:** Bolt Circle Diameter 476.250 mm

Bolt Size 38.100 mm

Number of Bolts 16

Bolt Material: B637

Thread Root Area 906.58 mm

Total Actual Bolt Area: 505.261 mm

**Hub Data:**

Hub Length 93.726 mm

Hub Major Diameter 374.650 mm

Minor Hub Diameter 327.152 mm

Hub Material: API 60K/G41350

Hub thickness G0: 62.027 mm

Hub thickness G1: 85.776 mm

**Gasket Data:**

Gasket Type: Pikotek

Seal O.D. 240.436 mm

Gasket O.D. 436.702 mm

Gasket Material: Pikotek 300+

Calculated b dimension: 240.436 mm

**Performance Requirements:**

Temperature: 200 F 93 C

Working Pressure: 10,000 psi 69 MPa

Test Pressure: 15,000 psi 103.4 MPa

**Code Requirements:**

Code: API Spec 6A

Preload Requirement: API

**Maximum Stresses:**

	psi	MPa
--	-----	-----

Flange	40,000	275.8
--------	--------	-------

Hub	40,000	275.8
-----	--------	-------

Hub Shear	24,000	165.5
-----------	--------	-------

Bolting	75,000	517.1
---------	--------	-------

	psi	MPa
--	-----	-----

Flange	49,800	343.4
--------	--------	-------

Hub	49,800	343.4
-----	--------	-------

Hub Shear	29,880	206.0
-----------	--------	-------

Bolting	124,500	858.4
---------	---------	-------

	psi	MPa
--	-----	-----

Flange	40,000	275.8
--------	--------	-------

Hub	40,000	275.8
-----	--------	-------

Hub Shear	24,000	165.5
-----------	--------	-------

Bolting	75,000	517.1
---------	--------	-------

**Forces on Flange:**

Separation Force H: 703,755 lbf 3,130.3 kN

Pressure End Load HD: 502,150 lbf 2,233.6 kN

HT = H - HD: HT = H - HD: 201,605 lbf 896.7 kN

Gasket Ret. Force HP: 0 lbf 0.0 kN

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>Makeup Torque,</i>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	703,755	3,130.3	31,301	215.8	<b>OK</b>		
<i>Gasket Seating Load Wm2</i>	120,290	535.1	5,350	36.9	<b>OK</b>		
<i>Required Bolt Load:</i>	703,755	3,130.3	31,301	215.8	<b>OK</b>	942	1,277
<i>Bolt Load at Hydro Test:</i>	1,055,632	4,695.5	46,952	323.7	<b>OK</b>		
<i>Design Bolt Preload W:</i>	1,686,240	7,500.4	75,000	517.1	<b>OK</b>	2,256	3,037

<u>Moment Arms:</u>	<i>hD</i>	<i>hT</i>	<i>hG</i>			
	<i>in</i>	<i>mm</i>	<i>in</i>	<i>mm</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>					2.854	72.5
<i>Operating/Test Condition</i>	3.689	93.7	5.010	127.2	4.642	117.9

## Geometry Factors

<i>B sub I:</i>	11.373	<i>Factor F:</i>	0.826	<i>Factor U:</i>	2.262
<i>Factor d:</i>	195.002	<i>Factor ho:</i>	4.419	<i>Factor V:</i>	0.306
<i>Factor e:</i>	0.187	<i>Factor K:</i>	2.720	<i>Factor Y:</i>	2.059
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.093	<i>Factor Z:</i>	1.313
		<i>Factor T:</i>	1.277		

## Flange Moments

<i>Gasket Seating:</i>	4,813,084	<i>in-lbf</i>	543,878.5	<i>N-m</i>
<i>Hydrostatic Test:</i>	4,293,184	<i>in-lbf</i>	485,129.8	<i>N-m</i>
<i>Operating:</i>	2,862,123	<i>in-lbf</i>	323,419.9	<i>N-m</i>

## Flange and Hub Stresses in psi

	<i>Gasket Seating</i>	<i>Hydro Test</i>	<i>Operating</i>	
<i>Longitudinal Hub Stress SH, psi:</i>	17,727	<b>OK</b>	10,541	<b>OK</b>
<i>Radial Flange Stress SR, psi:</i>	26,715	<b>OK</b>	15,886	<b>OK</b>
<i>Tangential Flange Stress ST, psi:</i>	16,971	<b>OK</b>	10,092	<b>OK</b>
<i>Combination (SH+SR)/2, psi:</i>	22,221	<b>OK</b>	13,214	<b>OK</b>
<i>Combination (SH+ST)/2, psi:</i>	17,349	<b>OK</b>	10,317	<b>OK</b>
<i>Hub Shear Stress (Swivel Flgs):</i>	0	<b>OK</b>	0	<b>OK</b>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:**

9" 10K

**Company**

Petrofac

**Methods and Assumptions:**

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:**

Integral Hub

**Flange Body Data:**

**Flange Bore Diameter**

203.098

mm

**Bolt Circle Diameter**

476.250

mm

**Flange Outside Diameter**

552.450

mm

**Bolt Size**

38.100

mm

**Flange Thickness**

111.252

mm

**Number of Bolts**

16

**Raised Face Diameter**

358.648

mm

**Bolt Material:**

B637

**Flange Material:**

A694 F65

**Thread Root Area**

906.58

mm

**Total Actual Bolt Area:**

,505.261

mm

**Hub Data:**

**Hub Length**

93.726

mm

**Gasket Data:**

Pikotek

**Hub Major Diameter**

374.650

mm

240.436 mm

**Minor Hub Diameter**

327.152

mm

436.702 mm

**Hub Material:**

A694 F65

**Gasket Material:**

Pikotek 300+

**Hub thickness G0:**

62.027

mm

240.436 mm

**Hub thickness G1:**

85.776

mm

**Calculated b dimension:**

13.699 mm

**Performance Requirements:**

**Temperature:**

200

F

93

C

**Gasket Type:**

API Spec 6A

**Working Pressure:**

9,572

psi

66

MPa

**Code:**

API

**Test Pressure:**

11,240

psi

77.5

MPa

**Preload Requirement:**

API

**Maximum Stresses:**

**Gasket Seating**

psi

MPa

**Hydro Test**

psi

MPa

**Operating Cond's**

psi

MPa

**Flange**

43,300

298.5

53,950

372.0

43,300

298.5

**Hub**

43,300

298.5

53,950

372.0

43,300

298.5

**Hub Shear**

25,980

179.1

32,370

223.2

25,980

179.1

**Bolting**

86,300

595.0

143,258

987.7

86,300

595.0

**Forces on Flange:**

**Ibf**

**kN**

**Separation Force H:**

673,669

2,996.5

**Ibf**

**kN**

**Pressure End Load HD:**

480,683

2,138.1

**HT = H - HD:**

**Gasket Ret. Force HP**

192,986

858.4

0

0.0

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque,</u>	<i>ft-lbf</i>	<i>N-m</i>
<i>Operating Load Wm1:</i>	673,669	2,996.5	29,963	206.6	<i>OK</i>			
<i>Gasket Seating Load Wm2</i>	120,290	535.1	5,350	36.9	<i>OK</i>			
<i>Required Bolt Load:</i>	673,669	2,996.5	29,963	206.6	<i>OK</i>		901	1,222
<i>Bolt Load at Hydro Test:</i>	791,050	3,518.6	35,184	242.6	<i>OK</i>			
<i>Design Bolt Preload W:</i>	1,940,300	8,630.5	86,300	595.0	<i>OK</i>		2,596	3,495

<u>Moment Arms:</u>	<i>hD</i>		<i>hT</i>		<i>hG</i>	
	<i>in</i>	<i>mm</i>	<i>in</i>	<i>mm</i>	<i>in</i>	<i>mm</i>
<i>Gasket Seating Condition</i>					2.854	72.5
<i>Operating/Test Condition</i>	3.689	93.7	5.010	127.2	4.642	117.9

## Geometry Factors

<i>B sub I:</i>	11.373	<i>Factor F:</i>	0.826	<i>Factor U:</i>	2.262
<i>Factor d:</i>	195.002	<i>Factor ho:</i>	4.419	<i>Factor V:</i>	0.306
<i>Factor e:</i>	0.187	<i>Factor K:</i>	2.720	<i>Factor Y:</i>	2.059
<i>Factor f:</i>	1.000	<i>Factor L:</i>	1.855	<i>Factor Z:</i>	1.313
		<i>Factor T:</i>	1.277		

## Flange Moments

<i>Gasket Seating:</i>	5,538,255	<i>in-lbf</i>	625,822.9	<i>N-m</i>
<i>Hydrostatic Test:</i>	3,217,147	<i>in-lbf</i>	363,537.7	<i>N-m</i>
<i>Operating:</i>	2,739,764	<i>in-lbf</i>	309,593.4	<i>N-m</i>

## Flange and Hub Stresses in psi

	<u>Gasket Seating</u>	<u>Hydro Test</u>	<u>Operating</u>
<i>Longitudinal Hub Stress SH, psi:</i>	23,017 <i>OK</i>	13,371 <i>OK</i>	11,387 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	40,642 <i>OK</i>	23,609 <i>OK</i>	20,105 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	20,983 <i>OK</i>	12,189 <i>OK</i>	10,380 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	31,829 <i>OK</i>	18,490 <i>OK</i>	15,746 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	22,000 <i>OK</i>	12,780 <i>OK</i>	10,883 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_

# Visual Flange - Flange Analysis Report

**Flange Name:** 36" 1500#

**Company** Aramco

## Methods and Assumptions:

This analysis system is based on the methods of the ASME Code, Section VIII. The equations used are from Appendix 2 of Section VIII Division 1 (also Appendix 3 of Section VIII Division 2). Gasket loads are calculated based on the actual gasket diameter for swivel flanges, instead of the lap joint pitch diameter. However, flange ring moments and stresses are based on the actual ring dimensions.

**Flange Type:** Integral Hub

## Flange Body Data:

Flange Bore Diameter	33.500	in
Flange Outside Diameter	57.874	in
Flange Thickness	8.071	in
Raised Face Diameter	43.500	in
Flange Material:	API 60K/G41350	

## Bolting Data:

Bolt Circle Diameter	50.630	in
Bolt Size	3.750	in
Number of Bolts	20	
Bolt Material:	SA193-B7	
Thread Root Area	10.109	in <sup>2</sup>
Total Actual Bolt Area:	202.176	in <sup>2</sup>

## Hub Data:

Hub Length	6.496	in
Hub Major Diameter	41.811	in
Minor Hub Diameter	36.000	in
Hub Material:	API 60K/G41350	
Hub thickness G0:	1.25	in
Hub thickness G1:	4.155512	in

## Gasket Data:

Gasket Type:	Pikotek	
Seal O.D.	38.084	in
Gasket O.D.	46.817	in
Gasket Material:	Pikotek 300+	
Calculated b dimension:	38.084	in
	0.582	in

## Performance Requirements:

Temperature:	100	F	38	C
Working Pressure:	3,705	psi	26	MPa
Test Pressure:	5,575	psi	38.4	MPa

## Code Requirements:

Code:	ASME VIII
Preload Requirement:	ASME

## Maximum Stresses:

	psi	MPa
Flange	24,285	167.4
Hub	24,285	167.4
Hub Shear	14,571	100.5
Bolting	25,000	172.4

## Gasket Seating

	psi	MPa
	54,000	372.3
	54,000	372.3
	32,400	223.4
	37,500	258.6

## Hydro Test

	psi	MPa
	24,285	167.4
	24,285	167.4
	14,571	100.5
	25,000	172.4

## Operating Cond's

	psi	MPa
	954,913	4,247.5
	0	0.0

## Forces on Flange:

	lbf	kN
Separation Force H:	4,220,548	18,773.0
Pressure End Load HD:	3,265,635	14,525.5

$$HT = H - HD:$$

$$\text{Gasket Ret. Force HP}$$

# Visual Flange - Flange Analysis Report

<u>Total Bolt Loads:</u>	<i>Force, lbf</i>	<i>kN</i>	<i>Stress, psi</i>	<i>MPa</i>	<i>OK</i>	<u>Makeup Torque, ft-lbf</u>	<u>N-m</u>
<i>Operating Load Wm1:</i>	4,220,548	18,773.0	20,876	143.9	<i>OK</i>		
<i>Gasket Seating Load Wm2</i>	522,066	2,322.2	2,582	17.8	<i>OK</i>		
<i>Required Bolt Load:</i>	4,220,548	18,773.0	20,876	143.9	<i>OK</i>	10,702	14,511
<i>Bolt Load at Hydro Test:</i>	6,350,757	28,248.2	31,412	216.6	<i>OK</i>		
<i>Design Bolt Preload W:</i>	4,637,474	20,627.5	22,938	158.2	<i>OK</i>	11,759	15,827

<u>Moment Arms:</u>	<i>hD</i>			<i>hT</i>		
	<i>in</i>	<i>mm</i>		<i>in</i>	<i>mm</i>	<i>in</i>
<i>Gasket Seating Condition</i>						4.147
<i>Operating/Test Condition</i>	6.487	164.8	7.419	188.4	6.273	159.3

## Geometry Factors

<i>B sub 1:</i>	37.656	<i>Factor F:</i>	0.677	<i>Factor U:</i>	4.093
<i>Factor d:</i>	592.659	<i>Factor ho:</i>	6.471	<i>Factor V:</i>	0.070
<i>Factor e:</i>	0.105	<i>Factor K:</i>	1.728	<i>Factor Y:</i>	3.724
<i>Factor f:</i>	1.000	<i>Factor L:</i>	2.030	<i>Factor Z:</i>	2.008
		<i>Factor T:</i>	1.614		

## Flange Moments

<i>Gasket Seating:</i>	19,230,467	<i>in-lbf</i>	2,173,042.8	<i>N-m</i>
<i>Hydrostatic Test:</i>	42,537,395	<i>in-lbf</i>	4,806,725.6	<i>N-m</i>
<i>Operating:</i>	28,269,246	<i>in-lbf</i>	3,194,424.8	<i>N-m</i>

## Flange and Hub Stresses in psi

	<i>Gasket Seating</i>	<i>Hydro Test</i>	<i>Operating</i>
<i>Longitudinal Hub Stress SH, psi:</i>	14,569 <i>OK</i>	32,226 <i>OK</i>	21,416 <i>OK</i>
<i>Radial Flange Stress SR, psi:</i>	9,217 <i>OK</i>	20,388 <i>OK</i>	13,549 <i>OK</i>
<i>Tangential Flange Stress ST, psi:</i>	14,316 <i>OK</i>	31,667 <i>OK</i>	21,045 <i>OK</i>
<i>Combination (SH+SR)/2, psi:</i>	11,893 <i>OK</i>	26,307 <i>OK</i>	17,483 <i>OK</i>
<i>Combination (SH+ST)/2, psi:</i>	14,442 <i>OK</i>	31,946 <i>OK</i>	21,231 <i>OK</i>
<i>Hub Shear Stress (Swivel Flgs):</i>	0 <i>OK</i>	0 <i>OK</i>	0 <i>OK</i>

Analyzed by \_\_\_\_\_ Date \_\_\_\_\_ Checked \_\_\_\_\_ Date \_\_\_\_\_