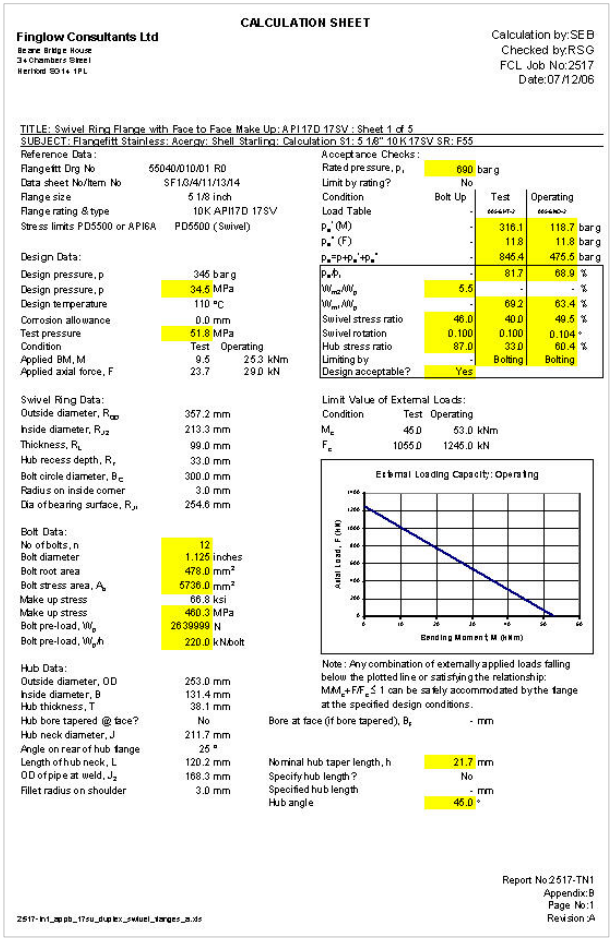
FLANGE DESIGN BY TRADITIONAL & FE METHODS

FCL have, for many years now, provided engineering support services to a major supplier of subsea flanges in the oil & gas industry. This has included a full flange design capability which is made available to their clients on all projects.

As a result of this relationship our client can provide fully detailed calculations for weld neck and swivel ring flanges to satisfy requirements of all major design codes including DNV-OS-F101 using rules in PD5500 and ASME Section VIII Division 3. Calculations are regulary provided for weld neck flanges to API 6A (6BX) and swivel ring flanges to API 17D (17SV) and both flange types to ASME B16.5.



CALCULATION SHEET

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34 Chambers Street
Hertford SG14 1PL

Calculation by:SEB
Checked by:RSG
FCL Job No:2517
Date:07/12/06

TITLE: Swivel Ring Flange with Face to Face Make Up: API 17D 17SV : Sheet 1 of 5
SUBJECT: Flangefitt Stainless: Acergy: Shell Starling: Calculation S1: 5 1/8" 10K 17SV SR: F55

Reference Data:
Flangefitt Drg No 55040/010/01 R0
Data sheet No/Item No SF1/3/4/11/13/14
Flange size 5 1/8 inch
Flange rating & type 10K API17D 17SV
Stress limits PD5500 or API6A PD5500 (Swivel)

Design Data:
Design pressure, p 345 barg
Design pressure, p 34.5 MPa
Design temperature 110 °C
Corrosion allowance 0.0 mm
Test pressure 51.8 MPa
Condition Test Operating
Applied BM, M 9.5 25.3 kNm
Applied axial force, F 23.7 29.0 kN

Swivel Ring Data:
Outside diameter, R_{op} 357.2 mm
Inside diameter, R_{i2} 213.3 mm
Thickness, R_t 99.0 mm
Hub recess depth, R_r 33.0 mm
Bolt circle diameter, B_c 300.0 mm
Radius on inside corner 3.0 mm
Dia of bearing surface, R_{si} 264.6 mm

Bolt Data:
No of bolts, n 12
Bolt diameter 1.125 inches
Bolt root area 478.0 mm²
Bolt stress area, A_s 5736.0 mm²
Make up stress 66.8 ksi
Make up stress 460.3 MPa
Bolt pre-load, W_{p_1} 2639999 N
Bolt pre-load, W_{p_1}/h 220.0 kN/bolt

Hub Data:
Outside diameter, OD 253.0 mm
Inside diameter, B 131.4 mm
Hub thickness, T 38.1 mm
Hub bore tapered @ face? No
Hub neck diameter, J 211.7 mm
Angle on rear of hub flange 25 °
Length of hub neck, L 120.2 mm
OD of pipe at weld, J_2 168.3 mm
Fillet radius on shoulder 3.0 mm

Acceptance Checks:
Rated pressure, p_r 690 barg
Limit by rating? No

Condition	Bolt Up	Test	Operating
Load Table	-	[illegible]	[illegible]
$p_e^*(M)$	-	316.1	118.7 barg
$p_e^*(F)$	-	11.8	11.8 barg
$p_e=P+p_e^*+p_e^*$	-	845.4	475.5 barg
p_e/p_r	-	81.7	68.9 %
W_{m2}/W_{p_1}	5.5	-	- %
W_m/W_{p_1}	-	69.2	63.4 %
Swivel stress ratio	46.0	40.0	49.5 %
Swivel rotation	0.100	0.100	0.104 °
Hub stress ratio	87.0	33.0	60.4 %
Limiting by	-	Bolting	Bolting
Design acceptable?	Yes		

Limit Value of External Loads:

Condition	Test	Operating
M_e	45.0	53.0 kNm
F_e	1055.0	1245.0 kN

External Loading Capacity: Operating
Axial Load, F (kN)
Bending Moment M (kNm)

Note : Any combination of externally applied loads falling below the plotted line or satisfying the relationship: $M/M_e+F/F_e \leq 1$ can be safely accommodated by the flange at the specified design conditions.

Bore at face (if bore tapered), B_f - mm

Nominal hub taper length, h 21.7 mm
Specify hub length? No
Specified hub length - mm
Hub angle 45.0 °

Report No:2517-TN1
Appendix:B
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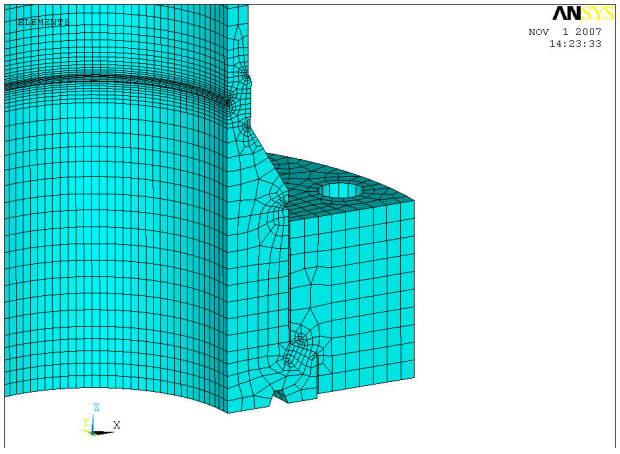
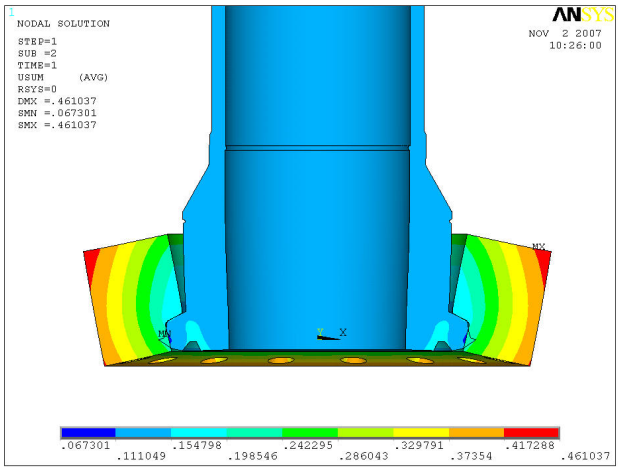
Revision :A

2517-tn1_appb_17su_duplex_swivel_flanges_a.xls





The calculations provide assurance that the flanges can accommodate the applied design loads and that the prescribed bolt make-up stress (bolt pre-load) is sufficient to avoid flange leakage in service.

The use of traditional design methods are supplemented by both linear and non-linear finite element stress analysis, particularly when it is necessary to demonstrate that the design of flanges in duplex materials comply with the requirements of DNV-RP-F112 to avoid hydrogen embrittlement resulting from the cathodic protection system employed.

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