COMPONENT ATTACHMENT/LOCATION

```
Attachment: Other/DisConnected
No. of Identical Components.....................:Qty.        1.00
Flange Design Method:
Annex G - Alternative design rules for flanges and gasketed flange connections.
```

GENERAL DESIGN DATA

```
CALCULATION TEMPERATURE.........................:Temp      20.00 °C
Mating Flange: Similar
```

FLANGE GEOMETRY Side 1

```
Flange Type: Loose - Flange(with Collar)
Connecting Shell: Cylindrical or Conical Shell
Axial thickness of flange at dGe................:eFt        18.50 mm
Equivalent axial thickness of flange............:eF         18.50 mm
Axial thickness radially loaded by pressure.....:eP         18.50 mm
Inside diameter of flange(uncorroded)...........:d0        384.52 mm
Average diameter of hub, thin end...............:d1        402.02 mm
Average diameter of hub, thick end..............:d2        395.46 mm
Bolt circle diameter............................:d3        525.00 mm
Outside diameter of flange......................:d4        580.00 mm
Diameter of bolt holes..........................:d5         30.00 mm
Min. wall thickness thin end of hub(uncorroded).....:e1      4.38 mm
Wall thickness at thick end of hub(uncorroded)......:e2     10.94 mm
Length of hub...................................:lH         85.00 mm
Inclination of shell............................:PhiS        0.00
Austenitic THK<=40mm 20'C
Rm=530 Rp=210 Rpt=210 fF=140 fF20=200 ftest=200  (N/mm2)
```

LOOSE FLANGE GEOMETRY Side 1

```
Carbon steel THK<=100mm 20'C
Rm=530 Rp=210 Rpt=210 fL=140 fL20=200 ftest=200  (N/mm2)
Equivalent axial thickness loose flange.........:eL         36.50 mm
Inside diameter of loose flange.................:d6        416.00 mm
Outside diameter stub or collar.................:d8        490.00 mm
Min. diameter of force transfer.................:d7min     432.00 mm
```

SHELL DATA Side 1

```
Austenitic THK<=40mm 20'C
Rm=530 Rp=210 Rpt=210 f=140 f20=200 ftest=200  (N/mm2)
```

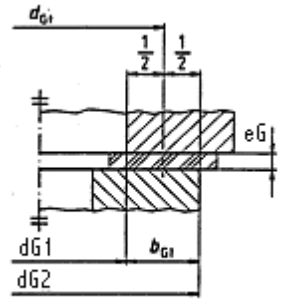
BOLTING DATA

```
Waisted Bolt: NO
Number of bolts.................................:nB         16.00
Nominal diameter................................:dB0        27.00 mm
Effective diameter..............................:dBe        24.19 mm
Number of reassemblies during service...........:NR         20.00
Minimum bolt load in assembly condition.........:FBmin       0.00 kN
Length of clamp.................................:lB        113.00 mm
Carbon Steel Bolt Material: YES
5.6 -2  DIN 267 THK<=30mm 20'C
Rm=500 Rp=300 Rpt=300 fB=200 fB20=200 ftest=285.71  (N/mm2)
```

BOLTING TORQUE

```
BOLTING-UP METHOD: Torque Wrench(Torque measurements) eps= 0.1+0.5* μ
FRICTION COEFFICIENT: Normal/Average Conditions  μ=0.20
```

GASKET FORM AND GEOMETRY




```
Gasket Form: Flat gaskets, soft or composite materials or pure metallic.
Inside diameter.....................................:dG1        407.00 mm
Outside diameter....................................:dG2        490.00 mm
Axial thickness.....................................:eG           3.00 mm
Maximum rotation and deformation of flange..........:ThetaMax     1.00 degr.
```

GASKET TYPE AND MATERIAL

Gasket Type: User Specified

Table GASKET PROPERTIES:

Description	ID	Assembly(T=20C)	Operating(T=20C)
Min. required compressive stress in gasket(MPa)	Qmin	25	0
Max. allowable compressive stress in gasket(MPa)	Qmax	80	80
Compressive E-modulus of gasket at zero compressive stress(MPa)	E0	8000	8000
Rate of change of compressive modulus of elasticity	K1	20	20
Gasket compression factor	mi	1.6	1.6
Gasket creep factor	gC	1	0.9

LOAD CASES

Table FLANGE LOADS:

Description	*ID*	*Assembly*	*Test(Site)*	*Oper.Cond.1*
Internal pressure(MPa)	*Pi*	*0*	*2.29*	*1.6*
External Axial Force(kN)	*FA*			*154.7*
External Bend.Moment(kNm)	*MA*			
Corrosion Allowance(mm)	*c*	*0*	*0*	*0*
Test Condition (Yes/No)	*Te*	*YES*	*YES*	*No*
Temperature D=Design/A=Ambient	*T*	*A*	*A*	*D*
Overall Axial Thermal Expansion(mm)	*DeltaU*	*NA*		

CALCULATION SUMMARY

ANNEX G - ALTERNATIVE DESIGN RULES FOR FLANGES

LOAD CASE NO: 1 - ASSEMBLY

```
bGe = MIN( bGi, bGt) (G.5-59) =MIN(8.55,41.5)=                  8.55 mm

dGe = dG2 - bGe =490-8.55=                                    481.45 mm

FG0req = Max( FG0min, FGDelta)                                      (G.6-11)
  =Max(3.2337E05,6.5662E05)=                                  656.62 kN

FB0req = FG0req + FR0 (G.6-12) =656.62+0=                     656.62 kN

Nominal Total Pre-Load
Fb0nom = FB0req / (1 - epsn) (G.6-21) =656.62/(1-0.0875)=      719.58 kN
Nominal Required Torque per Bolt
Mtnom = kB * FBnom =6.48*44.97=                               291.43 kN

PhiB = FBI / (AB * fB0) * Sqr( 1 + (CB * 3.2 * µ ) ^ 2)             (G.7-3)
```

```
    =7.8254E05/(7353.29*285.71)*Sqr(1+(1*3.2*0.2)^2)=          0.4422
```

»Bolt Load Ratio PhiB PhiB=0.4422 <= 1 =1« » (U= 44.2%) OK«

```
  PhiG = FGI / (AGt * CG * Qmax)                                (G.7-4)
    =7.8254E05/(58473.68*1.69*80)=                             0.0989
```

»Gasket Load Ratio PhiG PhiG=0.0989 <= 1 =1« » (U= 9.8%) OK«

```
  PhiF0 = Abs( FGI * hG + FQ * (hH - hP) + FR * hH) / WF        (G.7-6)
    =Abs(7.8254E05*4.28+0*(46.31-8.21)+0*46.31)/18445.97=      0.1814
```

»Flange Load Ratio PhiF PhiF=0.1814 <= PhiMax =1« » (U= 18.1%) OK«

```
  PhiL = FBI * hL / WL (G.7-29) =7.8254E05*15.45/27546.52=     0.4389
```

»Loose Flange Load Ratio PhiL PhiL=0.4389 <= 1 =1« » (U= 43.8%) OK«

LOAD CASE NO: 2 - TEST(SITE)

```
  PhiB = FBI / (AB * fB0) * Sqr( 1 + (CB * 3.2 * µ ) ^ 2)       (G.7-3)
    =497.16/(7353.29*285.71)*Sqr(1+(0*3.2*0.2)^2)=             0.2366
```

»Bolt Load Ratio PhiB PhiB=0.2366 <= 1 =1« » (U= 23.6%) OK«

```
  PhiG = FGI / (AGt * CG * Qmax)                                (G.7-4)
    =80.27/(58473.68*1.69*80)=                                 0.0101
```

»Gasket Load Ratio PhiG PhiG=0.0101 <= 1 =1« » (U= 1%) OK«

```
  PhiF0 = Abs( FGI * hG + FQ * (hH - hP) + FR * hH) / WF        (G.7-6)
    =Abs(80.27*-9.45+4.1689E05*(32.59-8.21)+0*32.59)/17880.44=0.5260

  PhiF1 = Abs(FQ+FR)*hH/(PI/4*dE*(fE*MIN(eE^2,eF^2)+MIN(fF0*eF^2,Qmax*(dG2-
d7)^2/4))) (G.7-31)
    =Abs(4.1689E05+0)*32.59/(3.14/4*397.37*(200*MIN(9.03^2,18.5^2)+MIN(200*18.5
^2,80*(490-462.54)^2/4)))=                                 =     1.39

  PhiF = MIN( PhiF0 , PhiF1) =MIN(0.526,1.39)=                 0.5260
```

»Flange Load Ratio PhiF PhiF=0.526 <= PhiMax =1« » (U= 52.6%) OK«

```
  PhiL = FBI * hL / WL (G.7-29) =497.16*29.18/27546.52=        0.5266
```

»Loose Flange Load Ratio PhiL PhiL=0.5266 <= 1 =1« » (U= 52.6%) OK«

LOAD CASE NO: 3 - OPER.COND.1

```
  PhiB = FBI / (AB * fB0) * Sqr( 1 + (CB * 3.2 * µ ) ^ 2)       (G.7-3)
    =480.24/(7353.29*200)*Sqr(1+(0*3.2*0.2)^2)=                0.3265
```

»Bolt Load Ratio PhiB PhiB=0.3265 <= 1 =1« » (U= 32.6%) OK«

```
  PhiG = FGI / (AGt * CG * Qmax)                                (G.7-4)
    =34.26/(58473.68*1.69*80)=                                 0.0043
```

»Gasket Load Ratio PhiG PhiG=0.0043 <= 1 =1« » (U= .4%) OK«

```
  PhiF0 = Abs( FGI * hG + FQ * (hH - hP) + FR * hH) / WF        (G.7-6)
    =Abs(34.26*-12.92+2.9128E05*(29.12-8.21)+154700*29.12)/12496.42=0.8124

  PhiF1 = Abs(FQ+FR)*hH/(PI/4*dE*(fE*MIN(eE^2,eF^2)+MIN(fF0*eF^2,Qmax*(dG2-
d7)^2/4))) (G.7-31)
    =Abs(2.9128E05+154700)*29.12/(3.14/4*397.37*(140*MIN(9.03^2,18.5^2)+MIN(140
*18.5^2,80*(490-455.6)^2/4)))=                             =     1.19

  PhiF = MIN( PhiF0 , PhiF1) =MIN(0.8124,1.19)=                0.8124
```

»Flange Load Ratio PhiF PhiF=0.8124 <= PhiMax =1« » (U= 81.2%) OK«

```
  PhiL = FBI * hL / WL (G.7-29) =480.24*32.65/19282.56=        0.8131
```

»Loose Flange Load Ratio PhiL PhiL=0.8131 <= 1 =1« » (U= 81.3%) OK«

Table LOAD CONDITIONS AND LOAD RATIOS FOR F.3 (m=mating flange):

DESCRIPTION	ID	ASSEMBLY	TEST(SITE)	OPER.COND.1
Design Pressure(MPa)	P	0.000	2.290	1.600
Resulting Force(kN)	FR	0.000	0.000	154.7
Axial Fluid-Pressure Force(kN)	FQ	0.000	416.893	291.279
Gasket Force(kN)	FG	782.543	80.270	34.256
Total Bolt Force(all bolts)(kN)	FB	782.543	497.163	480.235
Minimum Gasket Seating Force(kN)	FGmin	323.368	47.392	33.112
Bolt Load Ratio	PhiB	0.442	0.237	0.327

DESCRIPTION	ID	ASSEMBLY	TEST(SITE)	OPER.COND.1
Gasket Load Ratio	PhiG	0.099	0.010	0.004
Flange Load Ratio	PhiF	0.181	0.526	0.812
Loose Flange Load Ratio	PhiL	0.439	0.527	0.813
Flange Rotation(degr.)	ThetaF	0.120	0.660	0.715
Loose Flange Rotation(degr.)	ThetaL	0.486	0.387	0.376
Diameter of Force Transfer(mm)	d7	490	462.544	455.603
Nominal Bolt Force(per bolt)(kN)	FBnom	44.974	0.000	0.000
Nominal Bolt Torque(per bolt)(Nm)	Mtnom	291.43	0.000	0.000
Bolt Elongation at Assembly(mm)	DeltaB	0.052	0.000	0.000

Volume:0.01 m3 Weight:48 kg (SG= 7.93)