DESIGN OF AES TYPE HEAT EXCHANGER
(With the help of PV-Elite Soft ware)

Minimum Required inputs:

1. **Design pressure**
2. **Design temperature**
3. **Specific gravity of working fluid**
4. **Corrosion allowance**
5. **Joint efficiency.**
6. **MOC of all the components.**
7. **Number of passes (Shell Side and channel side)**
8. **Loading data**

Example:

Design the AES type HE for following design parameter

	Shell Side	Channel Side
Design pressure :	**21.7 Kg/Cm^2**	**32.6 Kg/Cm^2**
Design temperature:	**275 ^{o}C**	**240^{o}C**
Specific gravity of working fluid	**0.8290**	**0.7777**
Corrosion allowance	**3.2**	**3.2**
Joint efficiency	**1**	**1**
Number of passes	**1**	**4**
Loading data		
Shell ID	**1250**	
Size of Tube	**25.4 mm OD**	
Number of tube	**958**	
Length of tube	**6000 mm**	
OTL	**1200 mm**	

Step 1. Channel shell design:

Cylindrical shell under internal pressure.

ASME VIII DIV.1-July 2007

t = minimum required thickness	t_n = nominal thickness	E = joint efficiency
P = internal pressure	S = maximum allowable stress	T = temperature
R = inside radius	Ca = Corrosion allowance + Tolerance	σ = circumferential stress
R_o = outside radius	$Tol_{\%}$ = tolerance for pipes	P_a = maximum allowable pressure
$t_{n,min} = (t+Ca)/Tol_{\%}$ shall be $\leq t_n$	$t_u = (t_n \times Tol_{\%})-Ca$ shall be $\geq t$	P_h = hydrostatic pressure

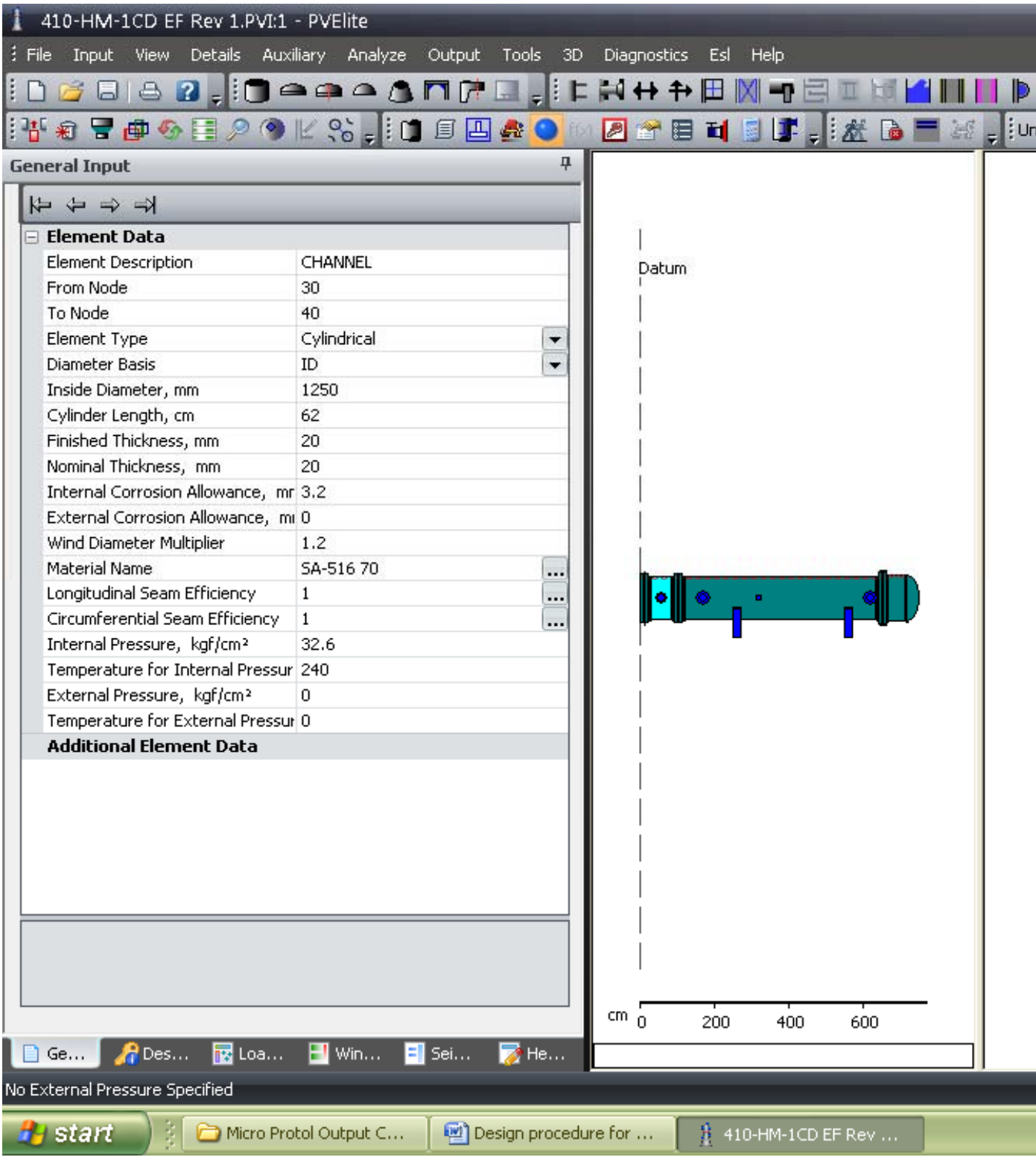
UG-27 (c)	$t = P(R+Ca)/(SE-0.6P)$	$\sigma = (P(R+Ca) / t_u + 0.6P) / E$	$P_a = S\,E\,t_u / ((R+Ca)+ 0.6\,t_u)$
Appendix 1-1.(a)(1)	$t = PR_o/(SE+0.4P)$	$\sigma = (PR_o / t_u - 0.4P) / E$	$P_a = S\,E\,t_u / (R_o - 0.4\,t_u)$

Fill up the highlighted values & Select the shell material to find out minimum required thickness under internal pressure.
Enter the value of shell length; software will check the provided shell thickness under External pressure.

Note: Failure of thickness will be highlighted in red color (it will show minimum required thickness.)

In Our Case: (For Channel Side)
R= 625 mm
P= 32.6 Kg/Cm^2
CA= 3.2 mm
T= 240^{o}C
Software will compute the required thickness.
t= 18.02 mm
Round up the value and select the standard thickness of 20mm.

Sheet shows Input for Channel shell



Step 2. Channel LH flange Design:

Give Input values in the following steps.

2.1 Select the flange type

Weld neck

2.2 Select MOC of flange

SA266 GR 4

Software will automatically take stress values for specified MOC at design conditions.

2.3 Enter Design Pressure, Temperature & Joint efficiency.

P= 32.6 Kg/Cm^2

Ca= 3.2 mm

T= 240^{o}C

Joint Efficiency= 1

2.4 Go to flange dialogue screen and enter the data in the following steps

a. **Flange ID = Generally flange ID is equal to Shell ID**
   Flange ID= 1250 mm
b. **Face ID = Shell ID**
   Face ID = 1250 mm
c. **Gasket ID depends on type of gasket used.**
   Gasket ID = Face ID + 2 x Corrosion allowance
   The Spiral wound Gasket consists of 13mm of inner ring and 4mm of outer ring. In this case,
   Gasket ID = Face ID + 2 x Corrosion allowance + (13 x2)
   Gasket type= Spiral wound
   Gasket ID= 1250 + (2 x 3.2) + (13 x 2)
   Gasket ID= 1282.4 say 1283 mm
d. **Gasket OD = Gasket ID + (2 x Gasket width)**
   Gasket OD = 1283+13x2
   Gasket OD = 1309 mm
e. **Face OD = Gasket OD+3 (in case of Female type face)**
   For male type face, Face OD = Gasket OD
   For Spiral wound gasket add 8mm in Face OD for outer gasket ring.
   Face OD = 1309+4x2+3
   Face OD = 1320

2.5 In case of Weld neck Flange,

Thickness of hub at smaller end (Gi) = Shell (or Channel) thickness
Thickness of shell at large End (Go) = 1.5 x Gi
Hub Length (HL) = 2 x Gi (This value can be equal to 1.5 to 2 x Gi)
Gi= 20 mm
Go= 30 mm
HL= 40 mm

2.6 Select Bolt Material, thread series & size of Bolt. (Initially consider smaller size of bolts to perform the calculation)

Bolt MOC= SA193 B7

Software will automatically take stress values for specified MOC at design conditions.

Thread series= UNC

Bolt Size= 31.75 mm

2.7 Select the number of bolts to satisfy the required bolt area.

Number of bolts= 56

2.8 BCD = Flange ID + Go + 2Rh

Rh is radial distance between Bolt circle and Flange

BCD= 1250 + 2 x 20 + 2x44.45

Minimum BCD= 1378.9

Minimum Circumferential distance between two bolts is 71.45

To satisfy the above conditions selecting the BCD of 1400 mm

2.9 Flange OD = BCD + 2E

For Minimum value for Rh & E refer TEMA Table D-5M

(Note: As size of Flange depends on BCD, try to keep BCD as minimum as possible. Minimum Circumferential spacing between bolts should be kept according to TEMA Table D-5M.)

Flange OD= 1400+2x31.75

Flange OD= 1463.5 Say 1465 mm

2.10 Select the gasket material & thickness.

Gasket MOC= Spiral wound

Gasket thickness= 4.5 mm

Software will automatically take stress values for specified MOC at design conditions.

2.11 Put the partition gasket details. (MOC of gasket, width & length of gasket.)

Partition Gasket MOC= material jacketed

Partition Gasket width= 10 mm

Partition Gasket length= 2500 mm

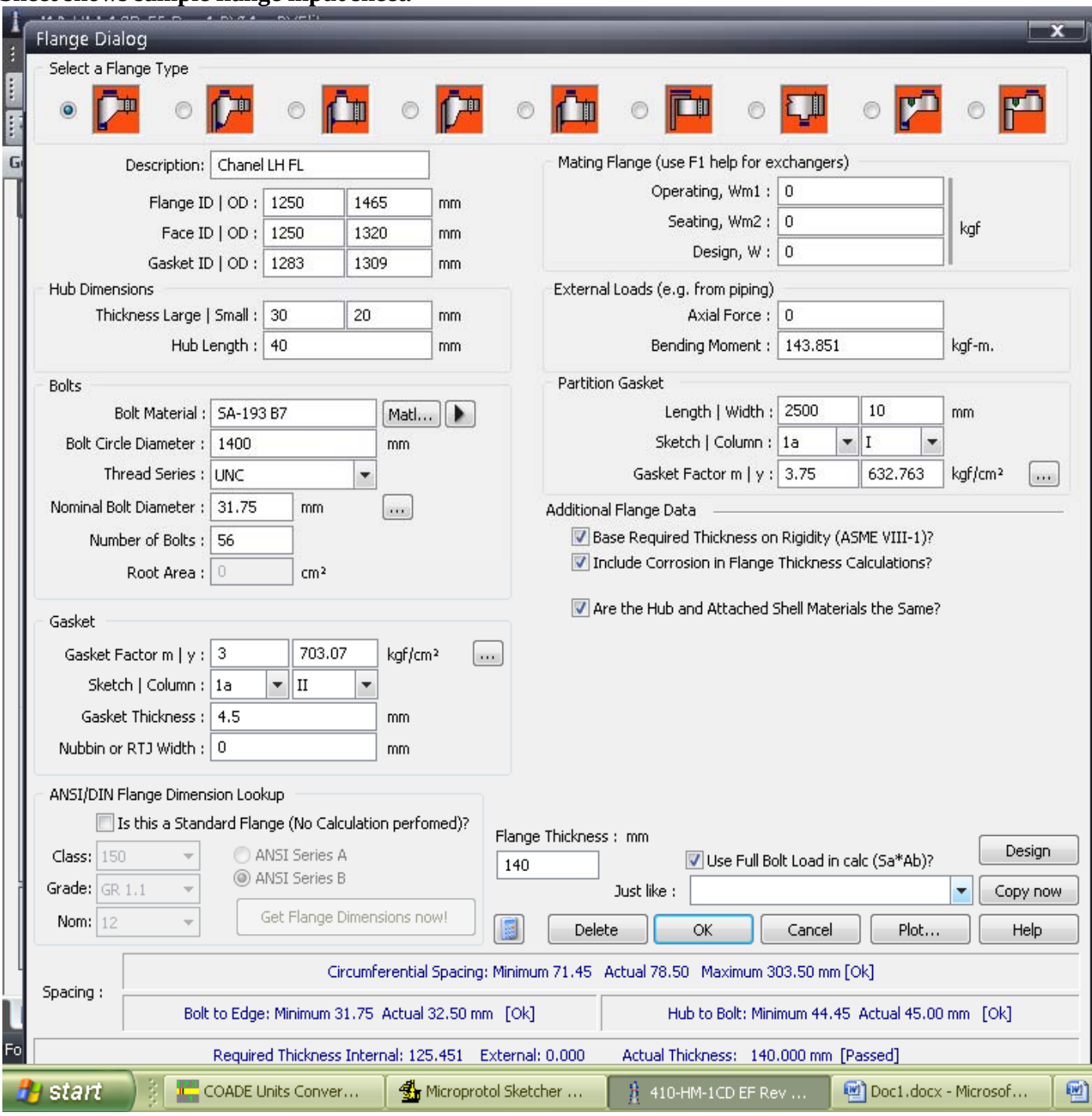
2.12 Put the external loading information. Put banding moment due to various attachments to the flange.

Bending Moment= 143.851 kg-m

2.13 Select the option Use full bolt load calculation. (generally customer asks this)

Flange thickness= 140 mm

Sheet shows sample flange input sheet.



Required & provided thickness is shown at the bottom of the sheet.
Add Step in Flange thickness according to thickness of gasket.
Nominal flange thickness= Flange thickness+ Step+ Hub length
In our case add 6 mm step in flange thickness.
Nominal flange thickness= 140+6+40= 186mm

Step 3. Design of Channel Cover.
Insert the blind flange as channel cover before flange.
Give Input values in the following steps.

3.1 Select the flange type
Bolted Blind flange

3.2 Select MOC of flange
SA266 Gr.4

3.3 Enter Design Pressure, Temperature & Joint efficiency.
P= 32.6 Kg/Cm^2
Ca= 3.2 mm
T= 240^{o}C
Joint Efficiency= 1

3.4 Go to flange dialogue screen and enter the data in the following steps

a. **Face ID= adjacent Flange ID – 3**
   Face ID= 1250-3
   Face ID= 1247mm
b. **Gasket ID & OD = Similar to adjacent Flange**
   Gasket ID= 1283
   Gasket OD= 1309mm
c. **Face OD = adjacent Flange face OD – 3**
   Face OD= 1320-3
   Face OD= 1317 mm

3.5 Bolt Material, size & number of Bolt will be same as adjacent Flange
There are three options for this entry:
1 - TEMA Bolt Table
2 - UNC Bolt Table
3 - User specified root area of a single bolt
Bolt MOC= SA193 B7
Thread series= UNC
Bolt Size= 31.75 mm
Number of bolts= 56

3.6 Gasket material & thickness will be similar to adjacent Flange.
Gasket MOC= Spiral wound
Gasket thickness= 4.5 mm

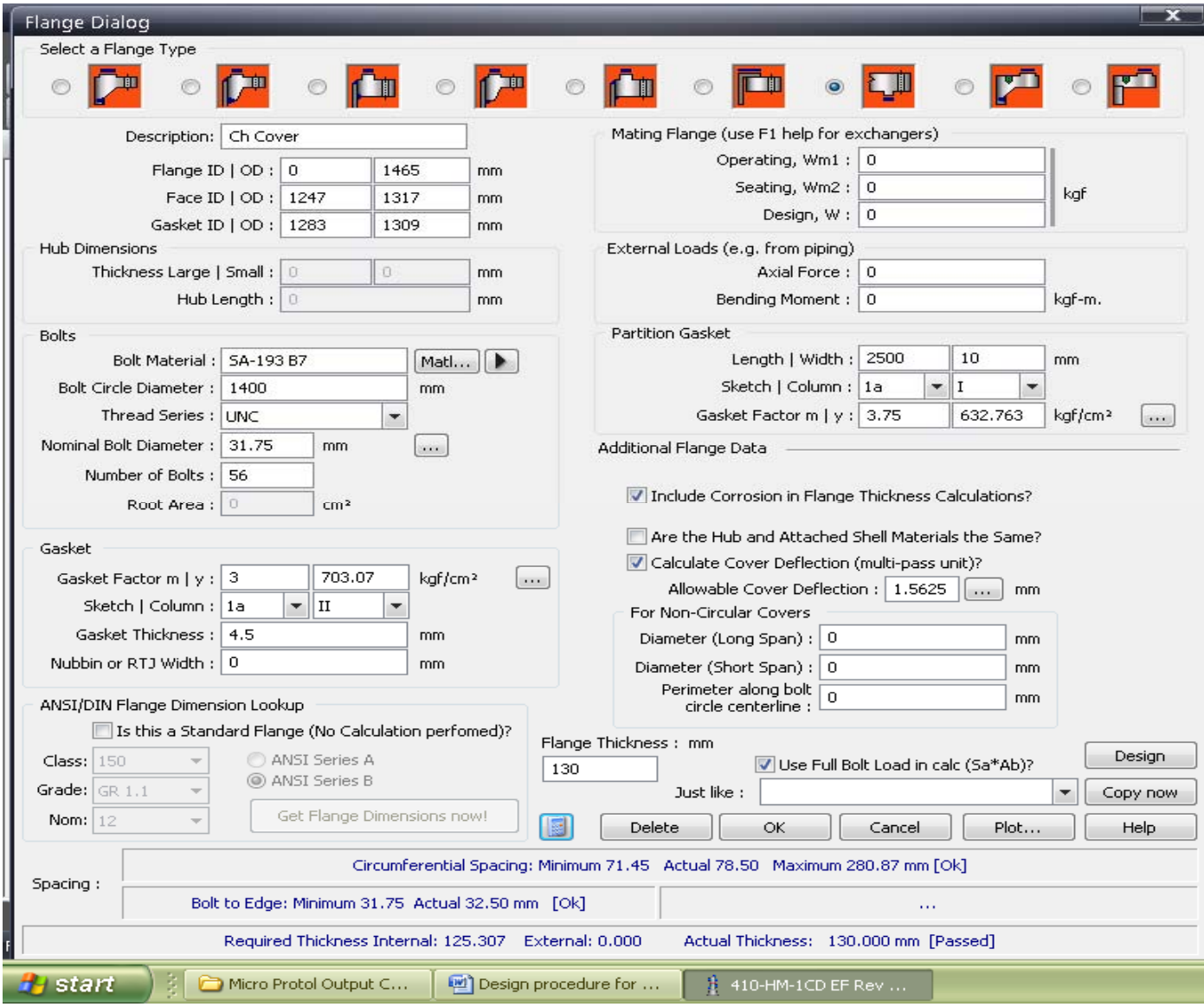
3.7 Put the partition gasket details. (MOC of gasket, width & length of gasket.)
Partition Gasket MOC= material jacketed
Partition Gasket width= 10 mm
Partition Gasket length= 2500 mm

3.8 Select the option of Check Cover for deflection at centre & use full bolt load in calculation.

Required thickness is 125.307 mm

For deflection check provided thickness is 130mm

Sheet shows sample Ch Cover input sheet.



Required & provided thickness is shown at the bottom of the sheet.

Add Step in Cover thickness according to thickness of gasket and raised face of matching flange. Maximum deflection is at center; hence maintain the required minimum thickness at the center.

Step 4. **Channel RH Flange**
Repeat the design procedure for Channel LH Flange.
(Or Copy the flange data from Channel LH Flange as both flanges are identical)

Step 5. Shell LH Flange
Give Input values in the following steps.

5.1 Select the flange type

Weld neck

5.2 Select MOC of flange similar to adjacent flange.

5.3 Enter Design Pressure, Temperature & Joint efficiency.

P= 21.7 Kg/Cm^2
Ca= 3.2 mm
T= 275^{o}C
Joint Efficiency= 1

5.4 Go to flange dialogue screen and enter the data in the following steps
(Flange dimensions will be same as adjacent flange dimensions.)

a. **Flange ID similar to adjacent flange ID.**
   Flange ID= 1250 mm
b. **Face ID & OD similar to adjacent flange face ID & OD**
   Face ID = 1250 mm
   Face OD = 1309+4x2+3
   Face OD = 1320
c. **Gasket ID & OD similar to adjacent flange Gasket ID & OD**
   Gasket type= Spiral wound
   Gasket ID= 1250 + (2 x 3.2) + (13 x 2)
   Gasket ID= 1282.4 say 1283 mm
   Gasket OD = 1283+13x2
   Gasket OD = 1309 mm

5.5 In case of Weld neck Flange,

Thickness of hub at smaller end (Gi) = Shell (or Channel) thickness
Thickness of shell at large End (Go) = 1.5 x Gi
Hub Length (HL) = 2 x Gi (This value can be equal to 1.5 to 2 x Gi)
Gi= 14 mm
Go= 21 mm
HL= 28 mm
(Change this value of Gi, Go & HL according to designed shell thickness)

5.6 Select Bolt Material, thread series & size of Bolt. Similar to adjacent flange

Bolt MOC= SA193 B7
Thread series= UNC
Bolt Size= 31.75 mm

5.7 Select the number of bolts to satisfy the required bolt area. Number of bolts will be similar to adjacent flange.

Number of bolts= 56

5.8 BCD = Similar to adjacent flange BCD

BCD= 1400

5.9 Flange OD = Similar to adjacent flange

Flange OD= 1465

5.10 The gasket material & thickness will be similar to adjacent flange.

Gasket MOC= Spiral wound

Gasket thickness= 4.5 mm

Software will automatically take stress values for specified MOC at design conditions.

5.11 Put the external loading information. Put banding moment due to various attachments to the flange.

Bending Moment= 3146.66 kg-m

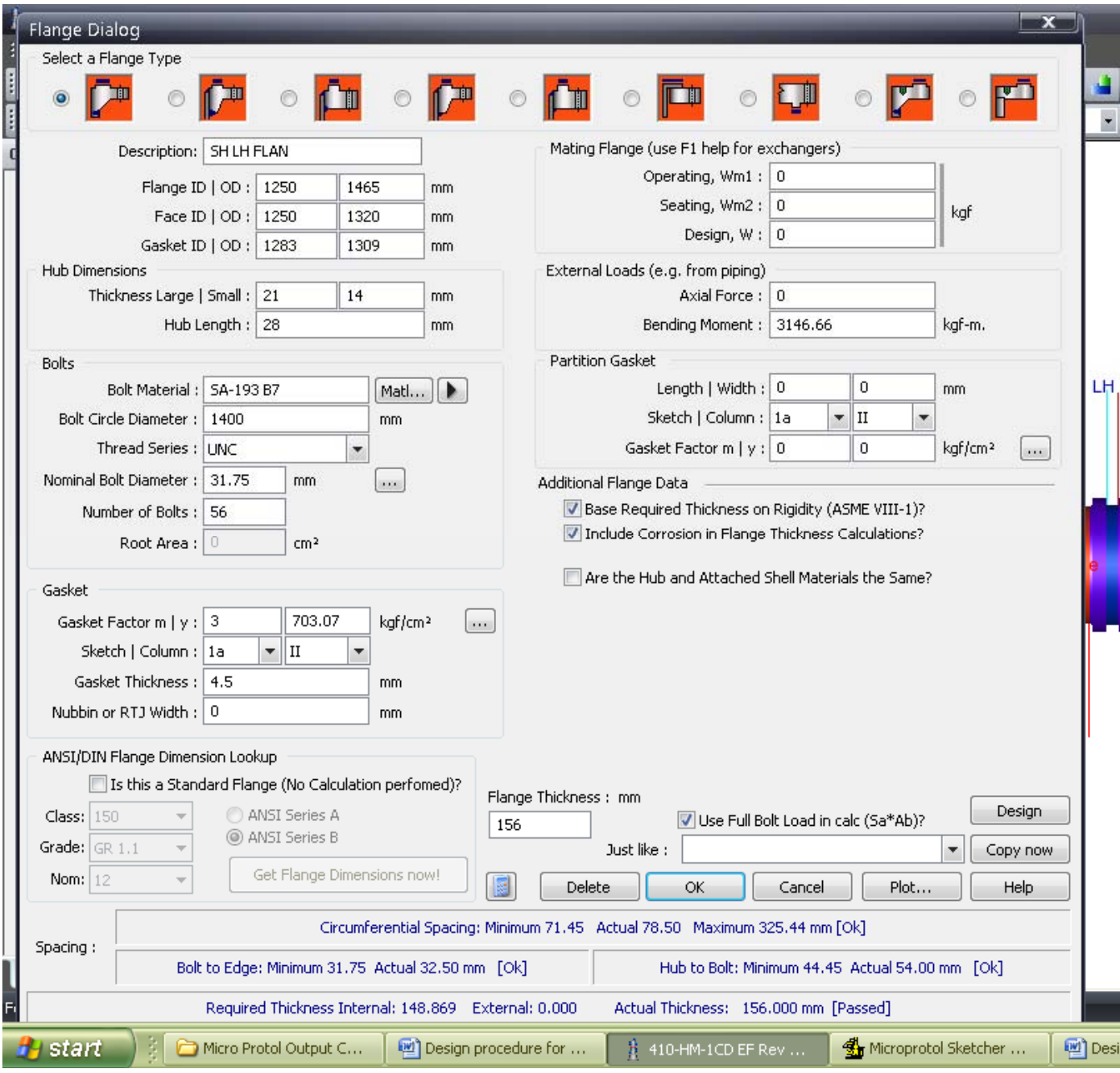
5.12 Select the option Use full bolt load calculation. (generally customer asks this)

5.13 PV-Ellie software will automatically considers Matching flange load.

5.14 Give flange thickness. (initially consider smaller thickness then select flange thickness to satisfy required conditions)

Flange thickness= 156 mm

Sheet shows sample flange input sheet.



Required & provided thickness is shown at the bottom of the sheet.
Add Step in Flange thickness according to thickness of gasket.
Nominal flange thickness= Flange thickness+ Step+ Hub length
In our case add 6 mm step in flange thickness.
Nominal flange thickness= 156+6+28= 190mm

Step 6. **Main Shell**

For main shell design follow the Step 1 & give shell side input values.

In Our Case: (For Shell Side)

Shell ID= 1250 mm

P= 21.7 Kg/Cm^2

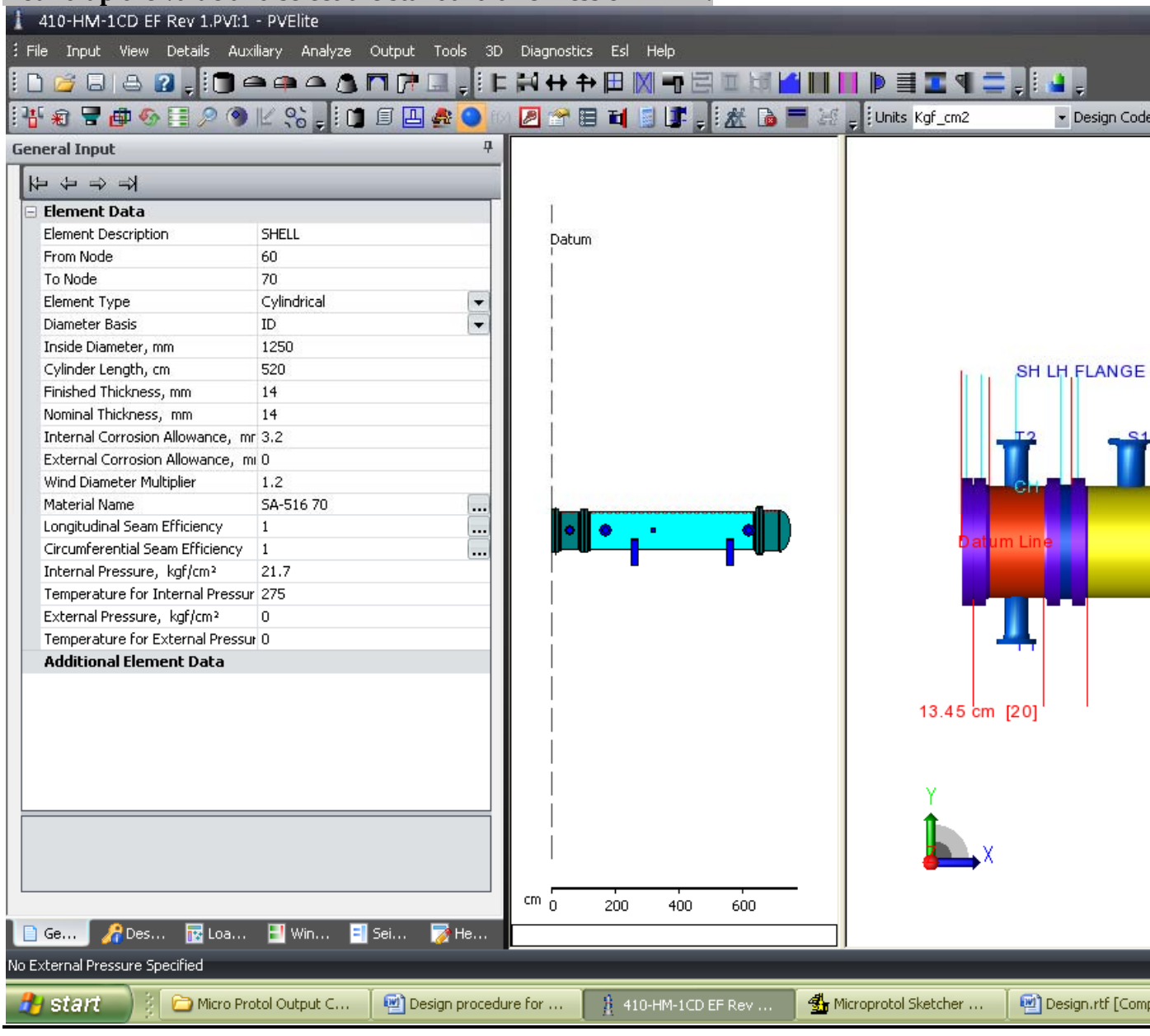
Ca= 3.2 mm

T= 275^{o}C

Software will compute the required thickness.

t= 13.11 mm

Round up the value and select the standard thickness of 14mm.



Step 7. Tube sheet design

For tube sheet design give the Input values in following steps.

7.1 Tubesheet Type and Design Code:

7.1.a. Select the analysis method.

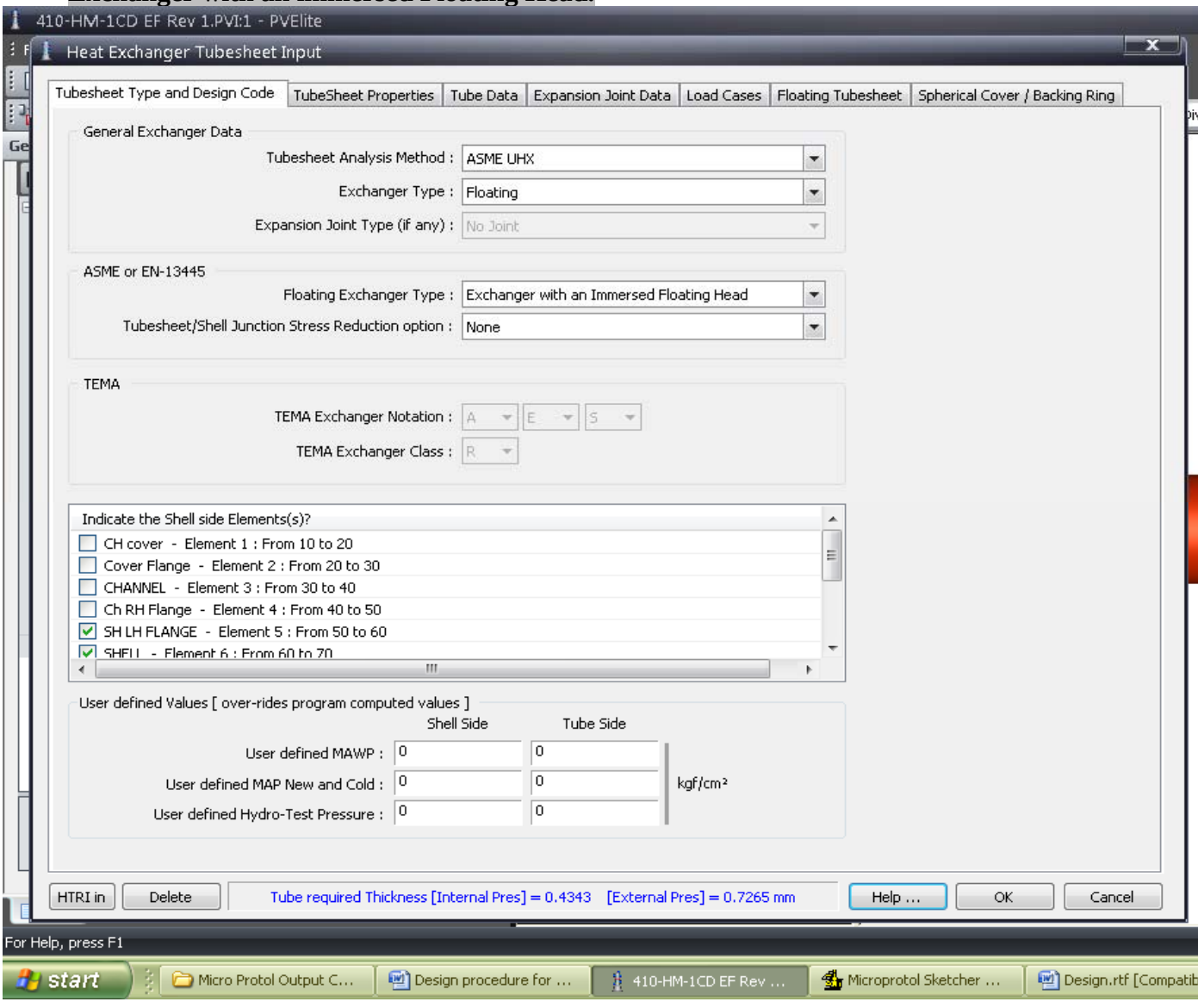
In our cese Tubesheet analysis method: ASME UHX.

7.1.b. Exchanger type.

Floating

7.1.c. Floating Exchanger type:

Exchanger with an immersed Floating Head.



7.2 Tube sheet Properties:

Fill up the tube sheet information. In our case,

7.2.a Distance from Node= 19 cm

7.2.b Tube sheet type: Stationary tube sheet gasketed on both side.

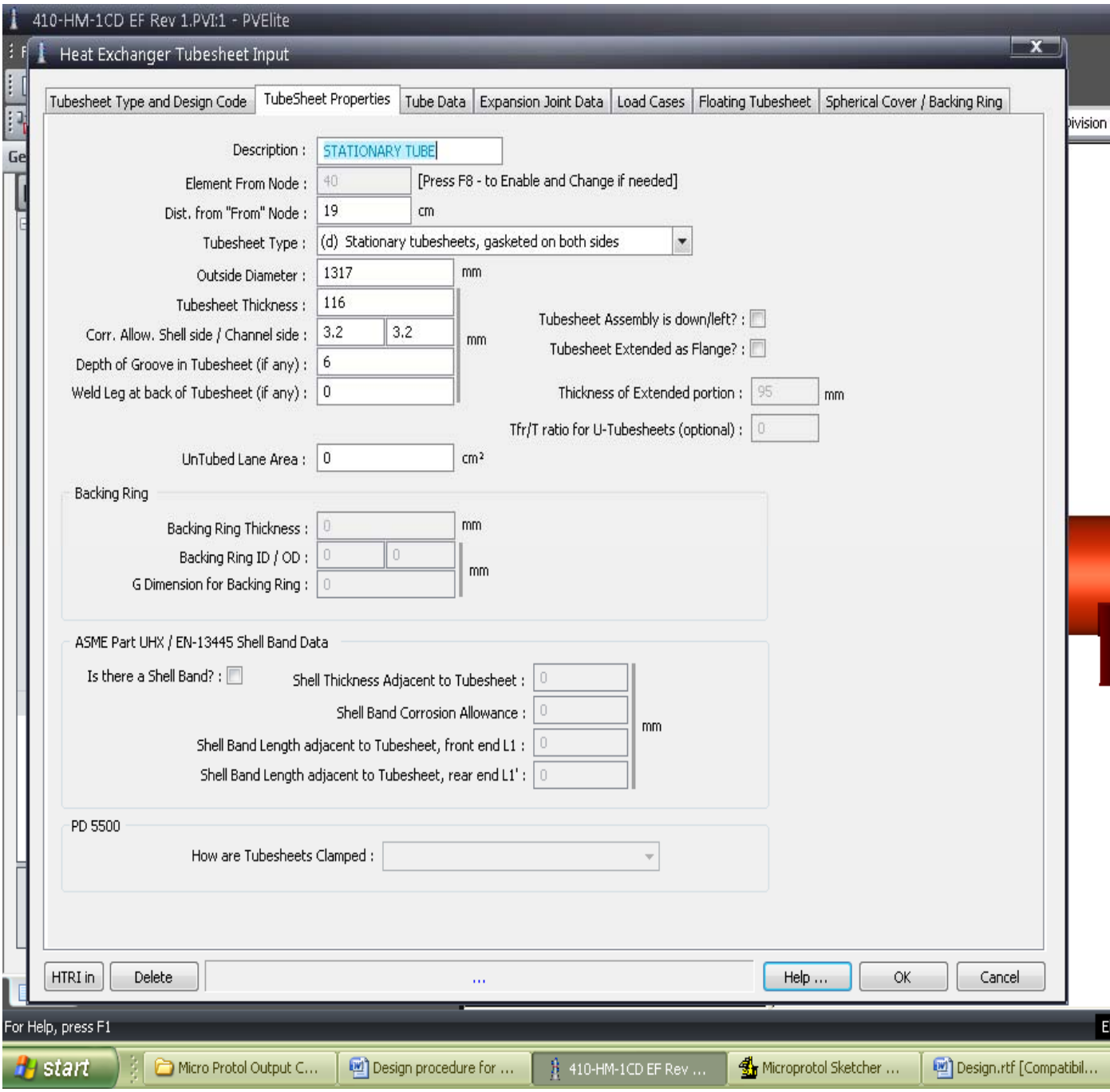
7.2.c Outside Diameter= adjacent flange face ID -3mm
In our case Tube sheet OD= 1320-3= 1317mm

7.2.d Corrosion allowance Shell and channel side.

Corrosion allowance Shell and channel side 3.2 mm both side

7.2.e Give depth of Groove if any.
Depth of groove= 6 mm

7.2.f Give thickness of extended portion if tube sheet is extended as flange.


410-HM-1CD EF Rev 1.PVI:1 - PVElite
Heat Exchanger Tubesheet Input
Tubesheet Type and Design Code
TubeSheet Properties
Tube Data
Expansion Joint Data
Load Cases
Floating Tubesheet
Spherical Cover / Backing Ring
Description : STATIONARY TUBE
Element From Node : 40 [Press F8 - to Enable and Change if needed]
Dist. from "From" Node : 19 cm
Tubesheet Type : (d) Stationary tubesheets, gasketed on both sides
Outside Diameter : 1317 mm
Tubesheet Thickness : 116
Corr. Allow. Shell side / Channel side : 3.2 3.2 mm
Depth of Groove in Tubesheet (if any) : 6
Weld Leg at back of Tubesheet (if any) : 0
Tubesheet Assembly is down/left? :
Tubesheet Extended as Flange? :
Thickness of Extended portion : 95 mm
Tfr/T ratio for U-Tubesheets (optional) : 0
UnTubed Lane Area : 0 cm²
Backing Ring
Backing Ring Thickness : 0 mm
Backing Ring ID / OD : 0 0 mm
G Dimension for Backing Ring : 0
ASME Part UHX / EN-13445 Shell Band Data
Is there a Shell Band? :
Shell Thickness Adjacent to Tubesheet : 0
Shell Band Corrosion Allowance : 0
Shell Band Length adjacent to Tubesheet, front end L1 : 0
Shell Band Length adjacent to Tubesheet, rear end L1' : 0 mm
PD 5500
How are Tubesheets Clamped :
HTRI in
Delete
...
Help ...
OK
Cancel
For Help, press F1
start
Micro Protol Output C...
Design procedure for ...
410-HM-1CD EF Rev ...
Microprotol Sketcher ...
Design.rtf [Compatibil...

7.3 Tube Data:

7.3.a Number of Tube holes

Number of holes= 958

7.3.b Hole pattern: Specify the total number of tube holes drilled in one of the tubesheets. The code expects the holes to be fairly evenly spaced over the entire area of the tubesheet without large areas that are not drilled. The pattern in which the tubes are arranged can be either a Square, or a Triangular.

Hole pattern = square

Pitch= 32 mm

Tube OD= 25.4

7.3.c Length of expanded portion of tube: Enter the length of tube that is expanded into the tubesheet hole. This value may not exceed the full thickness of the tubesheet to avoid failure of the tube at the inner tubesheet face, and is usually in the region of about 80% to 90% of the tubesheet thickness.

(For tube to tube sheet joint expanded only, generally take length of expansion= Tube sheet tkickness-3)

Length of expansion= 113 mm

7.3.d Radius of Outer most tube hole centre:

Enter the distance from the center of the tubesheet to the centerline of the tube furthest away.

Radius of Outer most tube hole centre= 587.3 mm

7.3.e Distance between Innermost Tube Centers:

Where a Partition Plate is installed, the innermost lanes of tubes may be further apart than general tube pitch in the remainder of the tubesheet. This is maximum distance between the tube innermost centers. If there is no partition plate, this value is zero.

Distance between Innermost Tube Centers= 45

7.3.f Straight Length of Tubes: Specify the straight length of the tubes

There are two options Straight Length of Tubes measured between inner face or in outer face.

Straight Length of Tubes measured between outer face= 5994mm

7.3.g Tube Weld Joint Type

Following table lists the options for the tube/tubesheet welds (ASME UW-20):

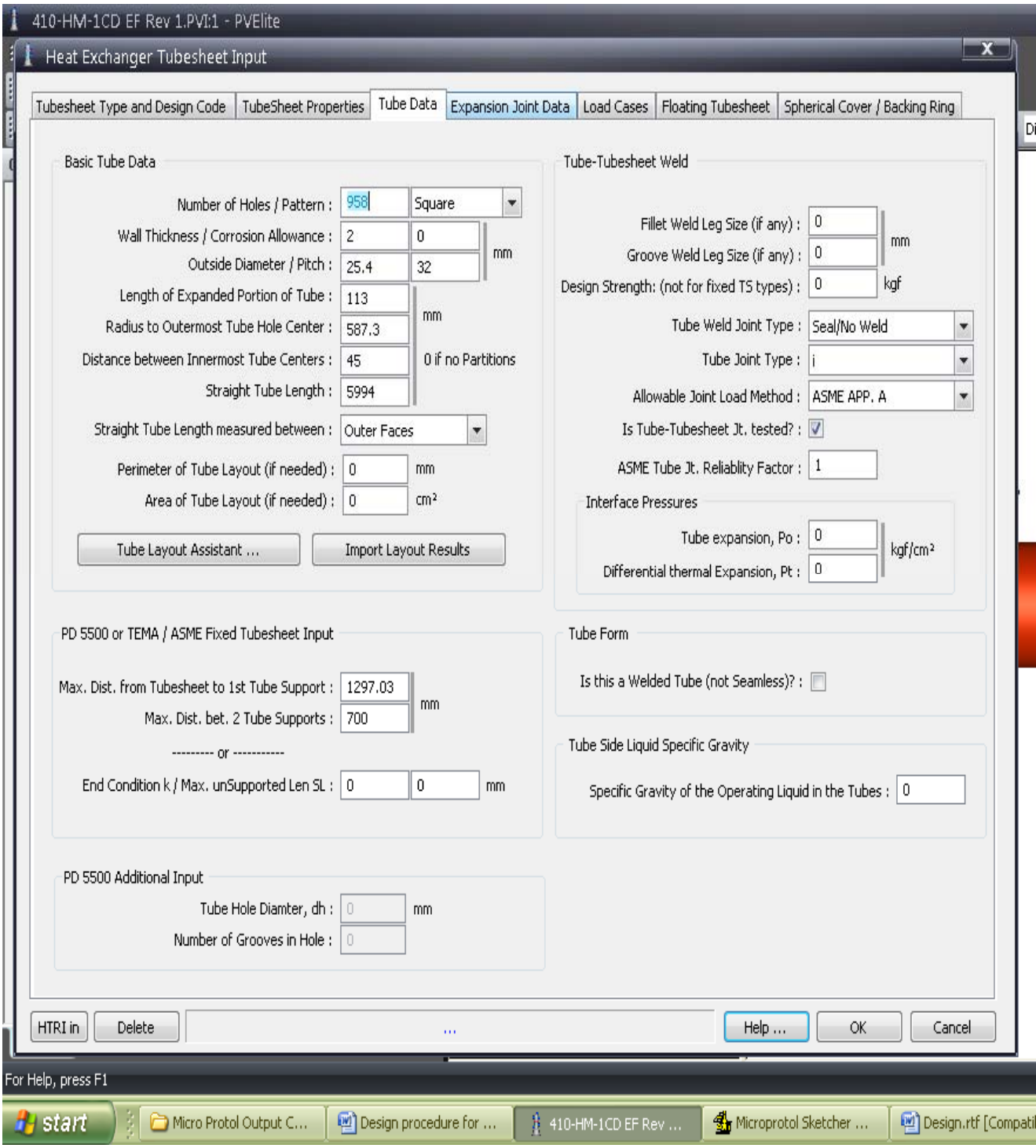
Full Strength:	**In this weld the design strength is equal to or greater than the maximum allowable axial tube strength.**
Partial Strength:	**This weld is designed based on the actual tube-tubesheet axial load.**
Seal Weld:	**No calculations are performed in this case.**

7.3.h Select Tube joint type

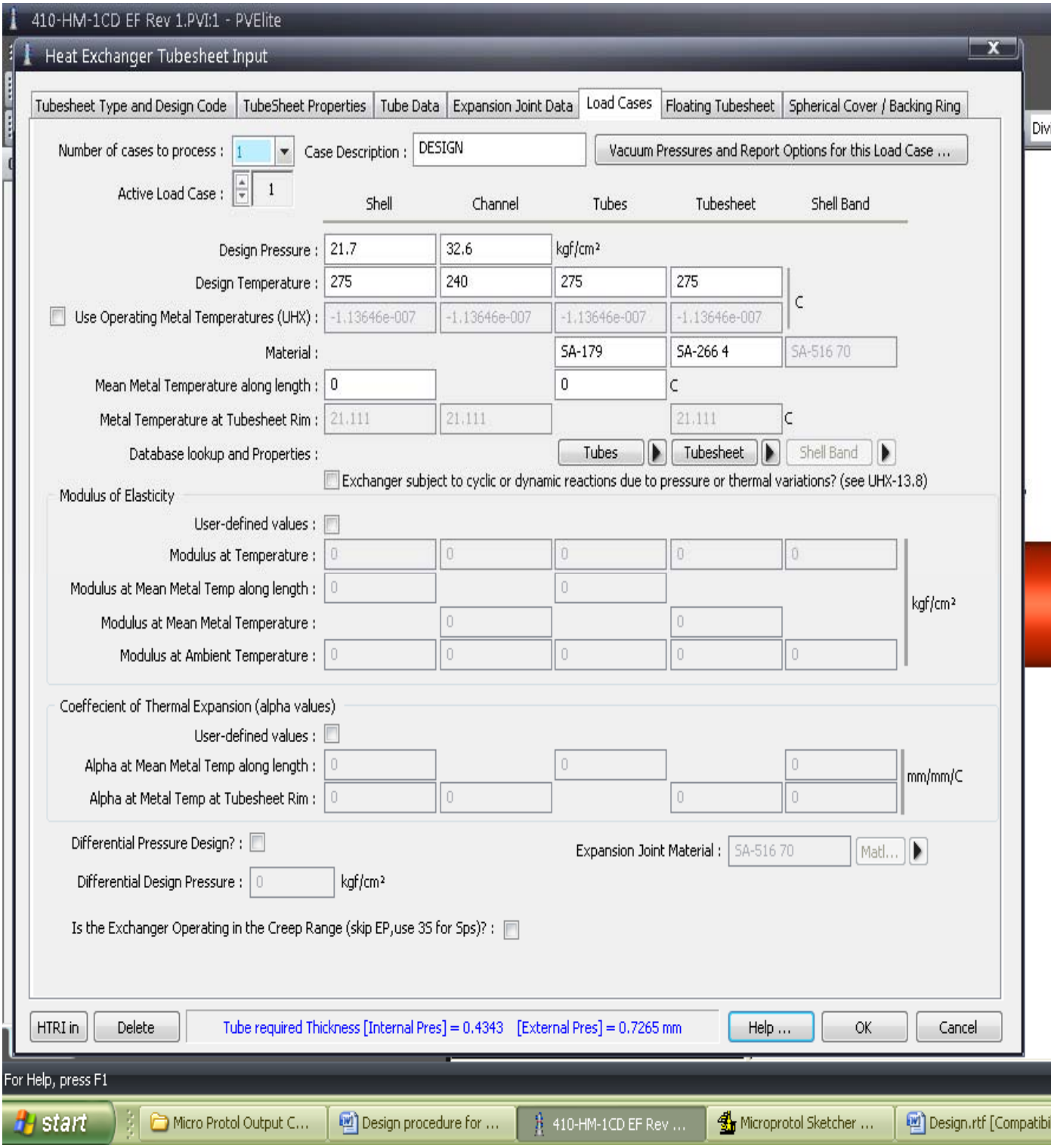
7.3.i Maximum Distance between two Tube Supports

Tubes are supported by each of the tubesheets, but along the heat exchanger, there are a number of supports often called baffles. Enter the Maximum Unsupported Length between supports because PV Elite uses this dimension to determine the buckling stress in the tubes. Carefully examine the design of the exchanger, and ensure the maximum possible unsupported length is entered.
Max. Distance of 1st tube support from tube sheet = 1297.3mm
Max. Distance between two tube supports = 700 mm

Sheet shows tube data:



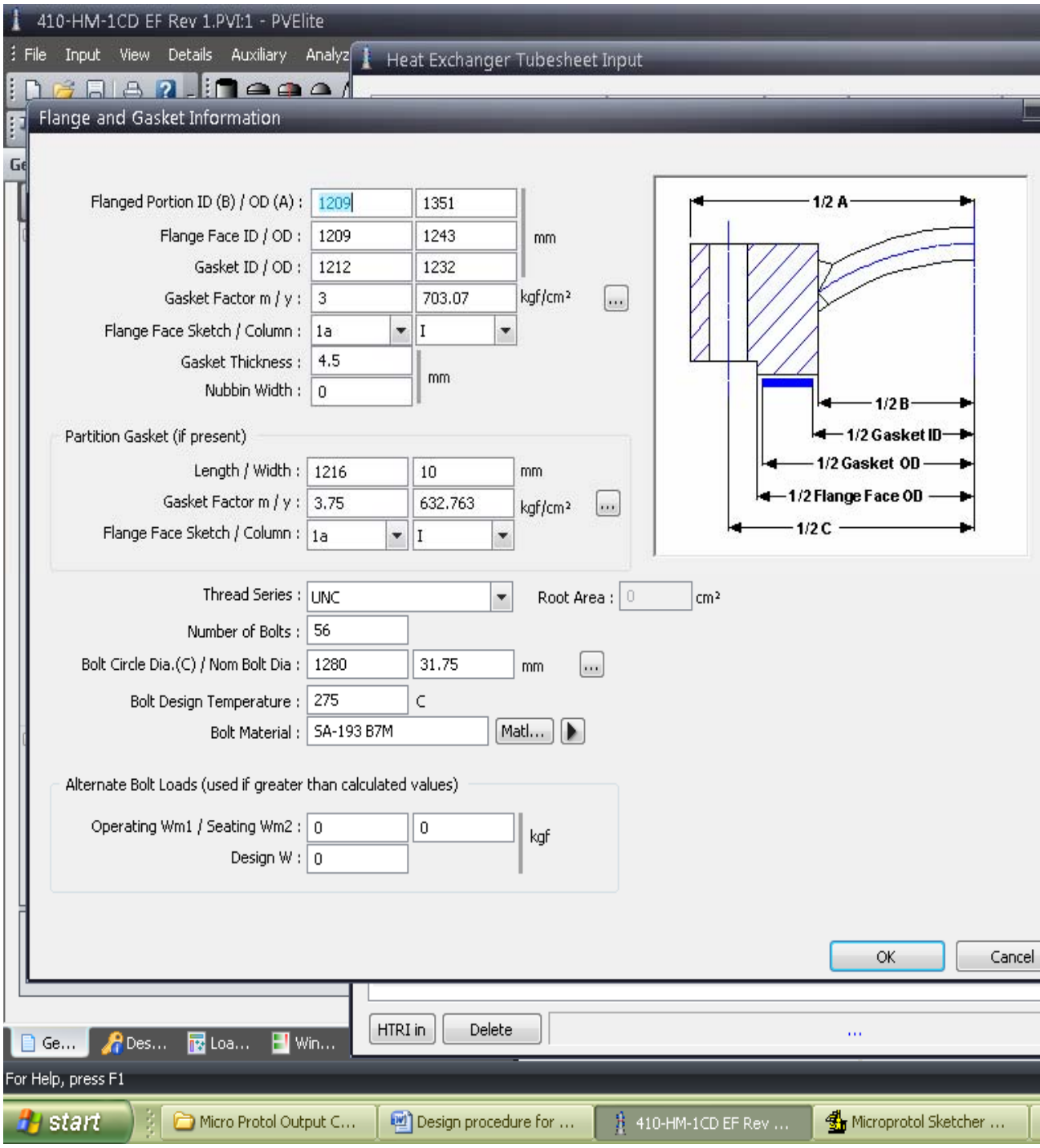
Input the load cases as shown in sheet:
Sheet shows load cases enter for our problem.



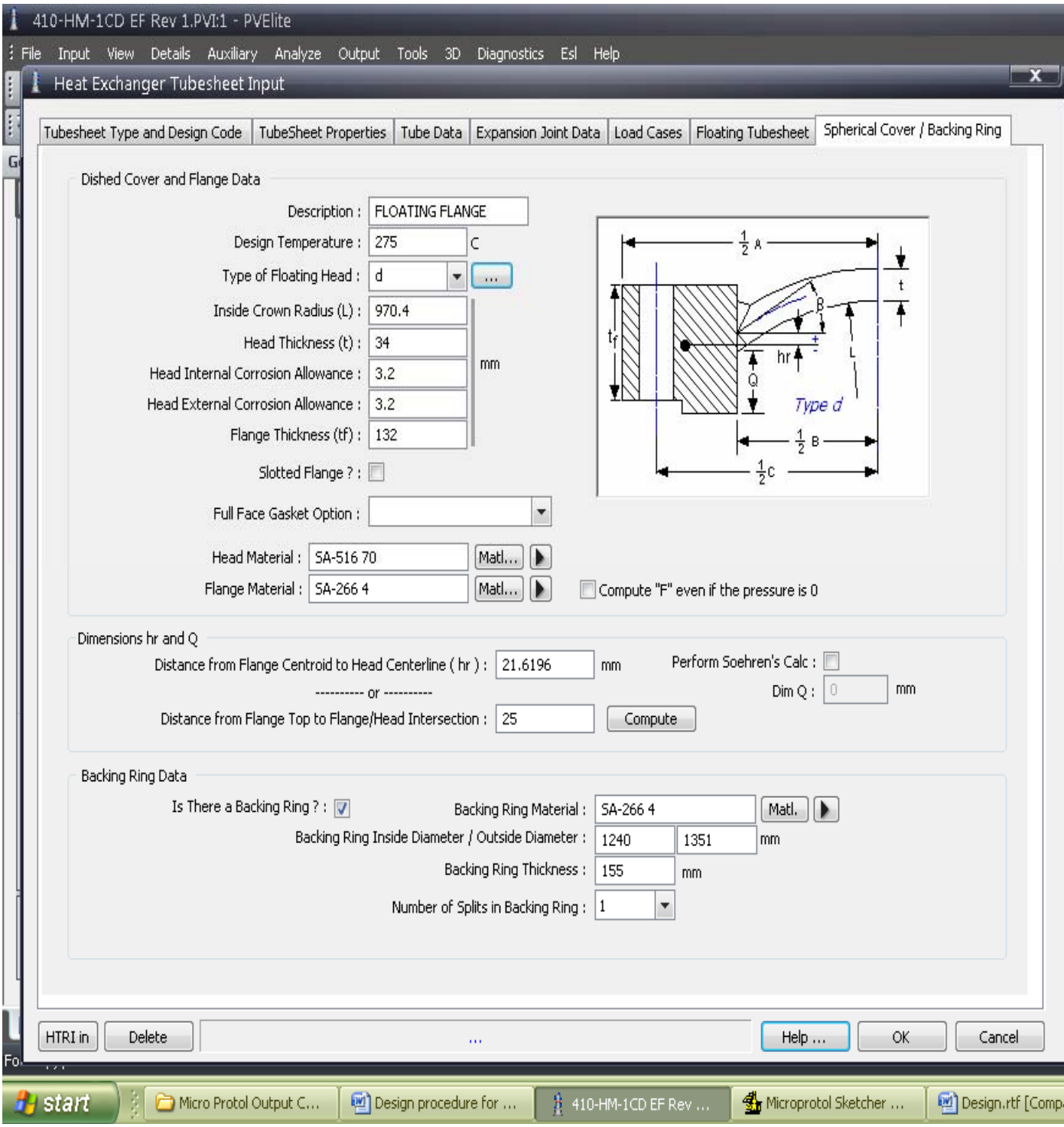
Step 8. Floating tube sheet

Find out the Floating Head data in the following stages:

8.1.Specify OTL
OTL= 1200mm
8.2.Specify Gasket width
Gasket width=10mm
8.3.Floating tube sheet face ID (B-3) = OTL+ 2xY
(Y=3 for tube to tube sheet joint expanded only, & y= 5 for tube to tube sheet joint type welded type.)
Floating tube sheet face ID= 1200 + 2 x 3
Floating tube sheet face ID= 1206 mm
8.4.Floating head Flange ID (B)= Floating tube sheet face ID+3
Floating head Flange ID (B)= 1206 +3
Floating head Flange ID (B)= 1209 mm
8.5.Floating head Flange Face ID= Floating head Flange ID
Floating head Flange Face ID= 1209 mm
8.6.Gasket ID= Flange Face ID+3
Gasket ID= (B+3)= 1209+3
Gasket ID= 1212 mm
8.7.Gasket OD= Gasket ID + 2x Gasket width
Gasket OD= 1212+ 2x10
Gasket OD= 1232 mm
8.8.Floating tube sheet OD= Gasket OD+ 2x4
Floating tube sheet OD= 1232+ 2x4
Floating tube sheet OD= 1240 mm
8.9.Flange face OD= Floating tube sheet OD +3
Flange face OD= 1240 + 3
Flange face OD= 1243 mm
8.10. Select Bolt size
Bolt Size= 36
8.11. BCD= Flange ID+ 3+ 2xRh
(Refet TEMA Table D-5M for Value of Rh & E)
BCD= 1209+ 2x41
BCD= 1291 mm
8.12. Flange OD= BCD+2xE
Flange OD= 1291+ 2x41
Flange OD= 1373
8.13. Backing Ring OD= Flange OD
Backing Ring OD= 1373
8.14. Backing Ring ID= B-1
Backing Ring ID= 1209- 1
Backing Ring ID= 1208
8.15. Backing Ring Groove OD= Tube Sheet OD
Backing Ring Groove OD= 1240 mm
Sheet Shows Floating Head Flange Head flange Head Input details

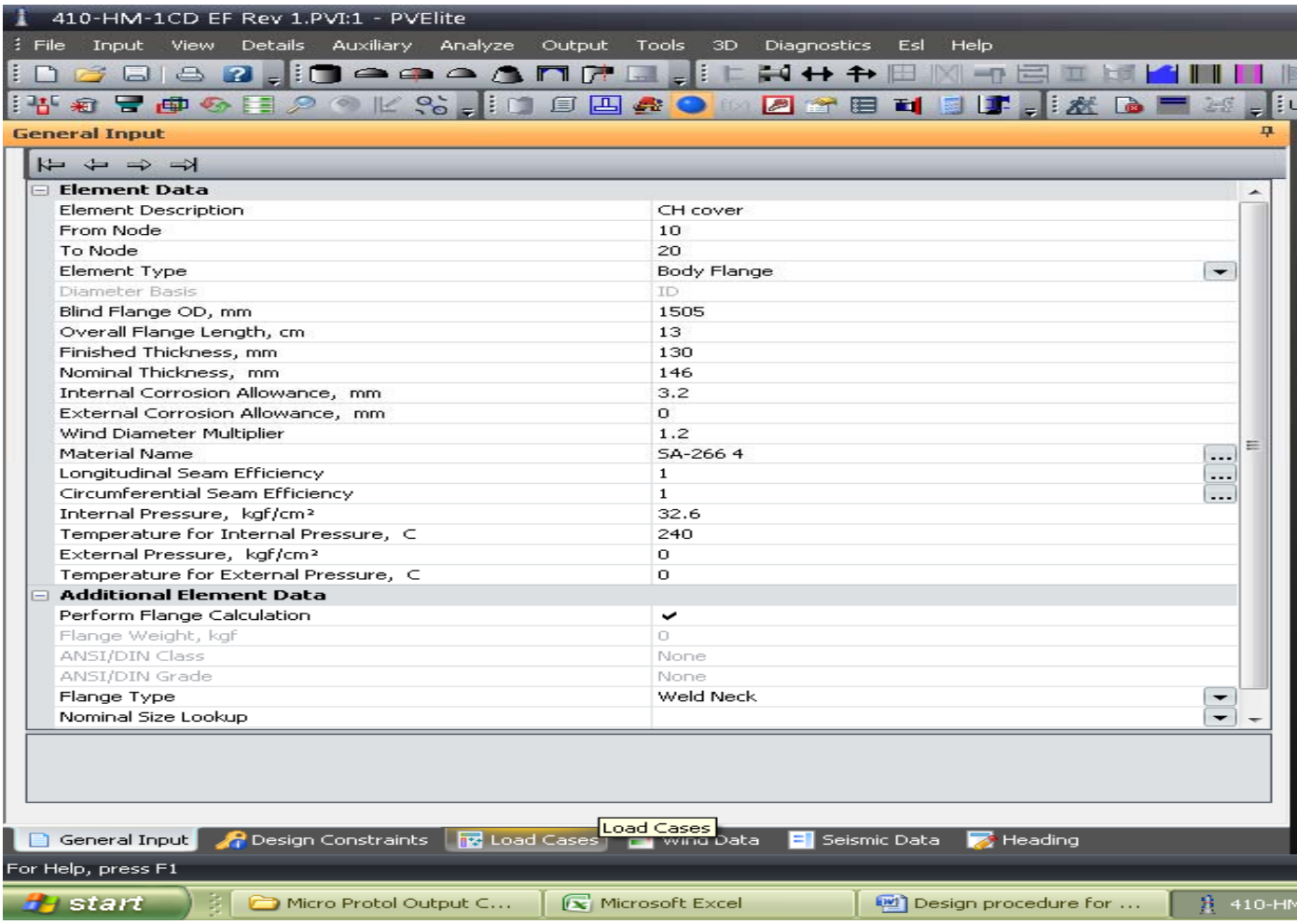

410-HM-1CD EF Rev 1.PVI:1 - PVElite
File Input View Details Auxiliary Analyz
Heat Exchanger Tubesheet Input
Flange and Gasket Information
Flanged Portion ID (B) / OD (A) : 1209 1351
Flange Face ID / OD : 1209 1243 mm
Gasket ID / OD : 1212 1232
Gasket Factor m / y : 3 703.07 kgf/cm²
Flange Face Sketch / Column : 1a I
Gasket Thickness : 4.5
Nubbin Width : 0 mm
Partition Gasket (if present)
Length / Width : 1216 10 mm
Gasket Factor m / y : 3.75 632.763 kgf/cm²
Flange Face Sketch / Column : 1a I
1/2 A
1/2 B
1/2 Gasket ID
1/2 Gasket OD
1/2 Flange Face OD
1/2 C
Thread Series : UNC
Root Area : 0 cm²
Number of Bolts : 56
Bolt Circle Dia.(C) / Nom Bolt Dia : 1280 31.75 mm
Bolt Design Temperature : 275 C
Bolt Material : SA-193 B7M Matl...
Alternate Bolt Loads (used if greater than calculated values)
Operating Wm1 / Seating Wm2 : 0 0 kgf
Design W : 0
OK
Cancel
HTRI in
Delete
Ge... Des... Loa... Win...
For Help, press F1
start
Micro Protol Output C...
Design procedure for ...
410-HM-1CD EF Rev ...
Microprotol Sketcher ...

Sheet Shows Floating Head Flange Head flange Head Input details



<u>Step 9.</u> Barrel design

Cylindrical shell under internal pressure.
For Barrel shell design follow the Step 1 & give shell side input values.
Barrel ID= Floating flange OD+ 2x M
M= Gap between barrel shell ID and Floating flange OD. Value of M depends on shell ID
Barrel ID= 1351+ 2X12
Barrel ID= 1375mm
We have considered, Barrel ID= 1385mm
P= 21.7 Kg/Cm^2
Ca= 3.2 mm
T= 275^{o}C
Software will compute the required thickness.
t= 14.19 mm
Round up the value and select the standard thickness of 16mm.



Step 10. SH Cover Flange
Give Input values in the following steps.

10.1. Select the flange type

Weld neck

10.2. Select MOC of flange

SA266 GR 4

Software will automatically take stress values for specified MOC at design conditions.

10.3. Enter Design Pressure, Temperature & Joint efficiency.

P= 32.6 Kg/Cm^2

Ca= 3.2 mm

T= 240^{o}C

Joint Efficiency= 1

10.4. Go to flange dialogue screen and enter the data in the following steps

10.4.a. Flange ID = Barrel shell ID

Flange ID= 1385 mm

10.4.b. Face ID = Flange ID

Face ID = 1385 mm

10.4.c. Gasket ID depends on type of gasket used.

Gasket ID = Face ID + 2 x Corrosion allowance

The Spiral wound Gasket consists of 13mm of inner ring and 4mm of outer ring. In this case,

Gasket ID = Face ID + 2 x Corrosion allowance + (13 x2)

Gasket type= Spiral wound

Gasket ID= 1385 + (2 x 3.2) + (13 x 2)

Gasket ID= 1418 mm

10.4.d. Gasket OD = Gasket ID + (2 x Gasket width)

Gasket OD = 1418+13x2

Gasket OD = 1444 mm

10.4.e. Face OD = Gasket OD+3 (in case of Female type face)

For male type face, Face OD = Gasket OD

For Spiral wound gasket add 8mm in Face OD for outer gasket ring.

Face OD = 1444+4x2+3

Face OD = 1455

10.5. In case of Weld neck Flange,

Thickness of hub at smaller end (Gi) = Shell (or Channel) thickness

Thickness of shell at large End (Go) = 1.5 x Gi

Hub Length (HL) = 2 x Gi (This value can be equal to 1.5 to 2 x Gi)

Gi= 16 mm

Go= 24 mm

HL= 32 mm

10.6. Select Bolt Material, thread series & size of Bolt. (Initially consider smaller size of bolts to perform the calculation)

Bolt MOC= SA193 B7
Software will automatically take stress values for specified MOC at design conditions.
Thread series= UNC
Bolt Size= 25.4 mm

10.7. Select the number of bolts to satisfy the required bolt area.

Number of bolts= 68

10.8. BCD = Flange ID + Go + 2Rh

Rh is radial distance between Bolt circle and Flange
BCD= 1385 + 2 x 24 + 2x34.92
Minimum BCD= 1502.8
Minimum Circumferential distance between two bolts is 57.15
To satisfy the above conditions selecting the BCD of 1505 mm

10.9. Flange OD = BCD + 2E

For Minimum value for Rh & E refer TEMA Table D-5M
(Note: As size of Flange depends on BCD, try to keep BCD as minimum as possible. Minimum Circumferential spacing between bolts should be kept according to TEMA Table D-5M.)
Flange OD= 1505+2x26.99
Flange OD= 1558.98 Say 1560 mm

10.10. Select the gasket material & thickness.

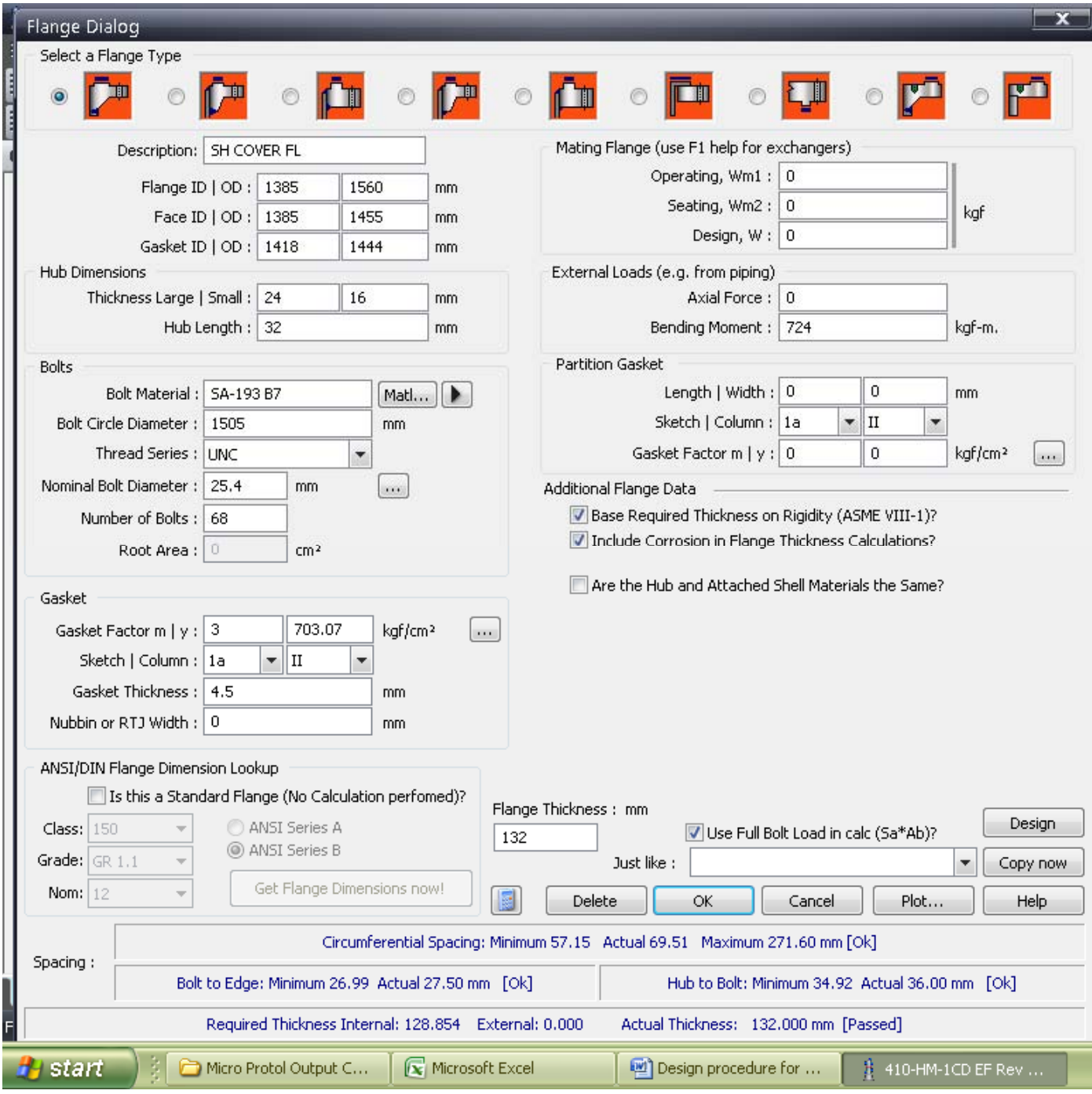
Gasket MOC= Spiral wound
Gasket thickness= 4.5 mm
Software will automatically take stress values for specified MOC at design conditions.

10.11. Put the external loading information. Put banding moment due to various attachments to the flange.

Bending Moment= 724 kg-m

10.12. Select the option Use full bolt load calculation. (generally customer asks this)

Flange thickness= 132 mm



Required & provided thickness is shown at the bottom of the sheet.
Add Step in Flange thickness according to thickness of gasket.
Nominal flange thickness= Flange thickness+ Step+ Hub length
In our case add 6 mm step in flange thickness.
Nominal flange thickness= 132+6+32= 170

Step 11. SH RHS Flange
Repeat the design procedure for Sh RH Flange.

11.1. Select the flange type
Weld neck

11.2. Select MOC of flange similar to adjacent flange.

11.3. Enter Design Pressure, Temperature & Joint efficiency.
P= 21.7 Kg/Cm^2
Ca= 3.2 mm
T= 275^{o}C
Joint Efficiency= 1

11.4. Go to flange dialogue screen and enter the data in the following steps (Flange dimensions will be same as adjacent flange dimensions.)
a. Flange ID similar to adjacent flange ID.
Flange ID= 1250 mm
b. Face ID
Face ID = 1250 mm
c. Face OD= Face OD of Barrel Flange - 3
Face OD = 1455-3
Face OD = 1452
d. Gasket ID & OD similar to adjacent flange Gasket ID & OD
Gasket ID= 1418 mm
Gasket OD = 1444 mm

11.5. In case of Weld neck Flange,
Thickness of hub at smaller end (Gi) = Shell (or Channel) thickness
Thickness of shell at large End (Go) = 1.5 x Gi
Hub Length (HL) = 2 x Gi (This value can be equal to 1.5 to 2 x Gi)
Gi= 14 mm
Go= 21 mm
HL= 28 mm
(Change this value of Gi, Go & HL according to designed shell thickness)

11.6. Select Bolt Material, thread series & size of Bolt. Similar to adjacent flange
Bolt MOC= SA193 B7
Thread series= UNC
Bolt Size= 25.4 mm

11.7. Select the number of bolts to satisfy the required bolt area. Number of bolts will be similar to adjacent flange.
Number of bolts= 68

11.8. BCD = Similar to adjacent flange BCD
BCD= 1505

11.9. Flange OD = Similar to adjacent flange
Flange OD= 1560

11.10. The gasket material & thickness will be similar to adjacent flange.
Gasket MOC= Spiral wound
Gasket thickness= 4.5 mm
Software will automatically take stress values for specified MOC at design conditions.

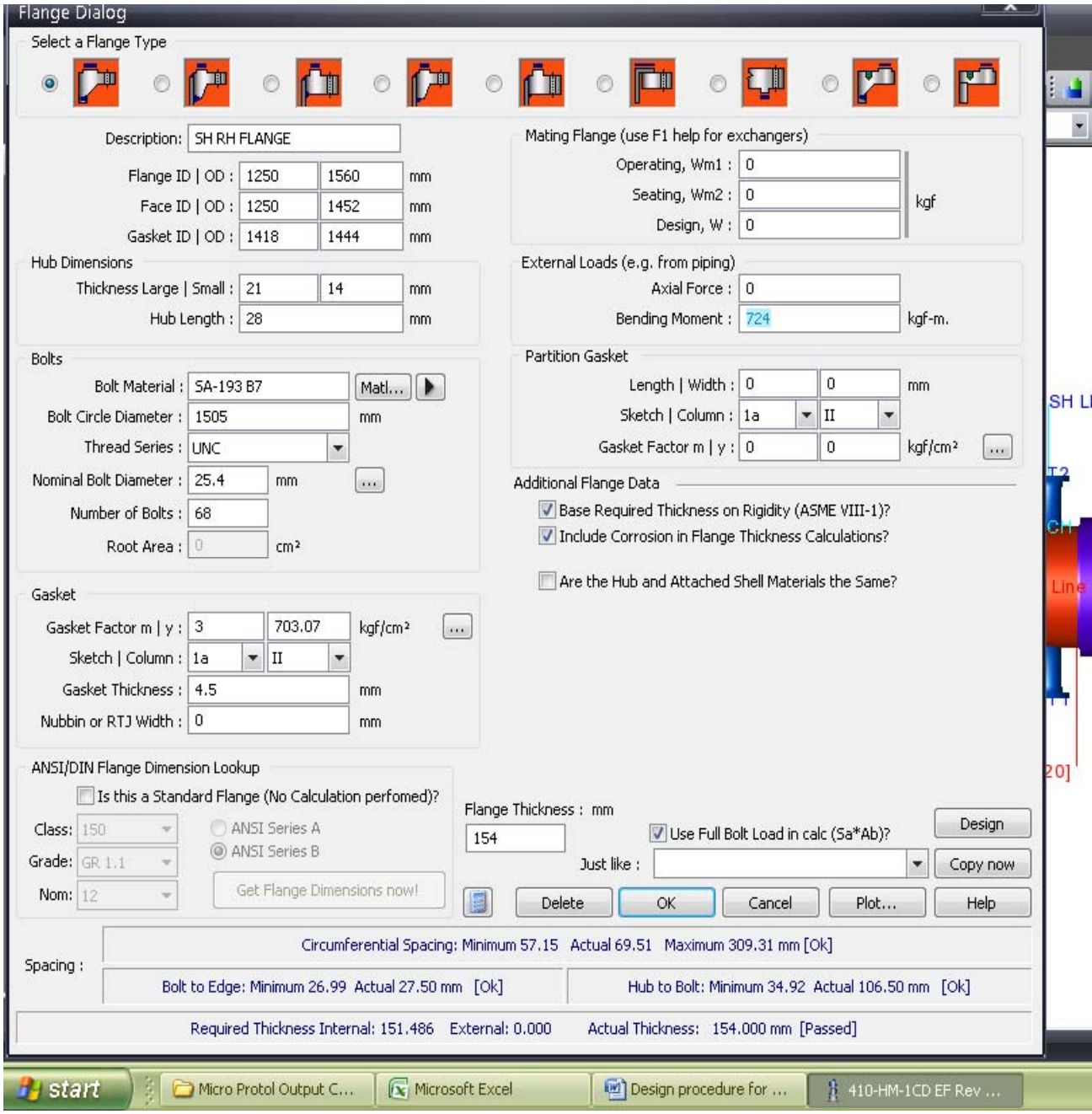
11.11. Put the external loading information. Put banding moment due to various attachments to the flange.
Bending Moment= 724 kg-m

11.12. Select the option Use full bolt load calculation. (generally customer asks this)

11.13. PV-Ellie software will automatically considers Matching flange load.

11.14. Give flange thickness. (initially consider smaller thickness then select flange thickness to satisfy required conditions)

Flange thickness= 154 mm



Required & provided thickness is shown at the bottom of the sheet.
Add Step in Flange thickness according to thickness of gasket.
(Note: As flange face is male type, no need to add step in flange thickness)
Nominal flange thickness= Flange thickness+ Hub length
Nominal flange thickness= 154+28= 182