Pressure vessel Design
Using PV-Elite

For

Pressure Vessels and Heat Exchangers*

Rev.0
Nov, 2007

0	Issued for use by DEL Engineers	UES	ARC	Nov-07	1st issue
No	Purpose	Revs'd by	Appv'd	Date	Remarks
Revisions					

* Limited use

Profile:

1. These rules will be applicable for making drawings by draftsmen.
2. These are to be followed by all draftsmen and design engineers for DEL /DDFC drawings.
3. Drawings will be prepared by Draftsmen and checked by Designer/ Senior draftsmen for compliance.
4. Sketches and figures shown in this Standard are for understanding the concept.
5. File: Drafting Rules.doc

Writing in Black: Important terms.
Writing in Blue: Guidelines.
Writing in Red: Caution.

Step 1: Read the following carefully;

- **datasheet (Process\Mechanical) thoroughly:**
- **project vessel specifications:**

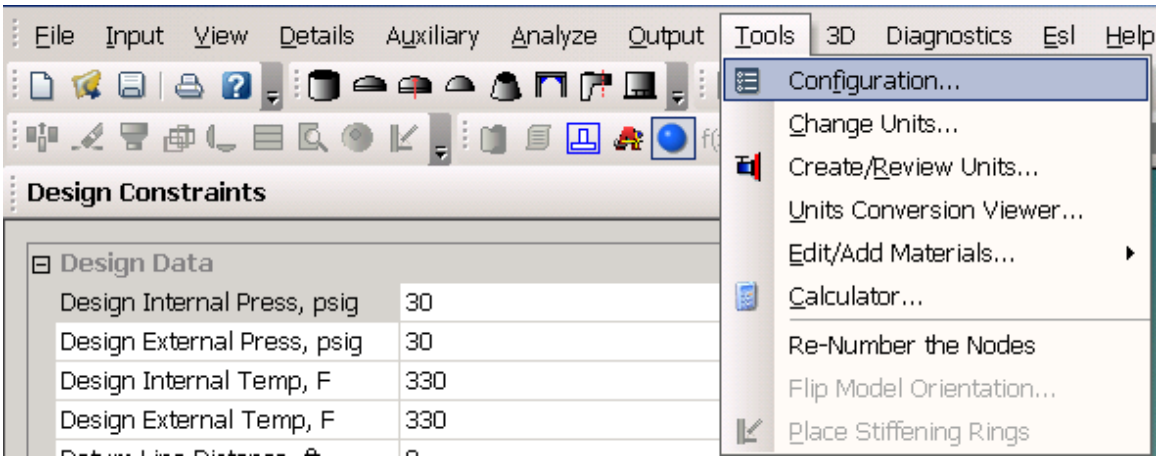
Read the datasheet thoroughly from line to line, to acquire the necessary data for the design. The important design data required is mainly

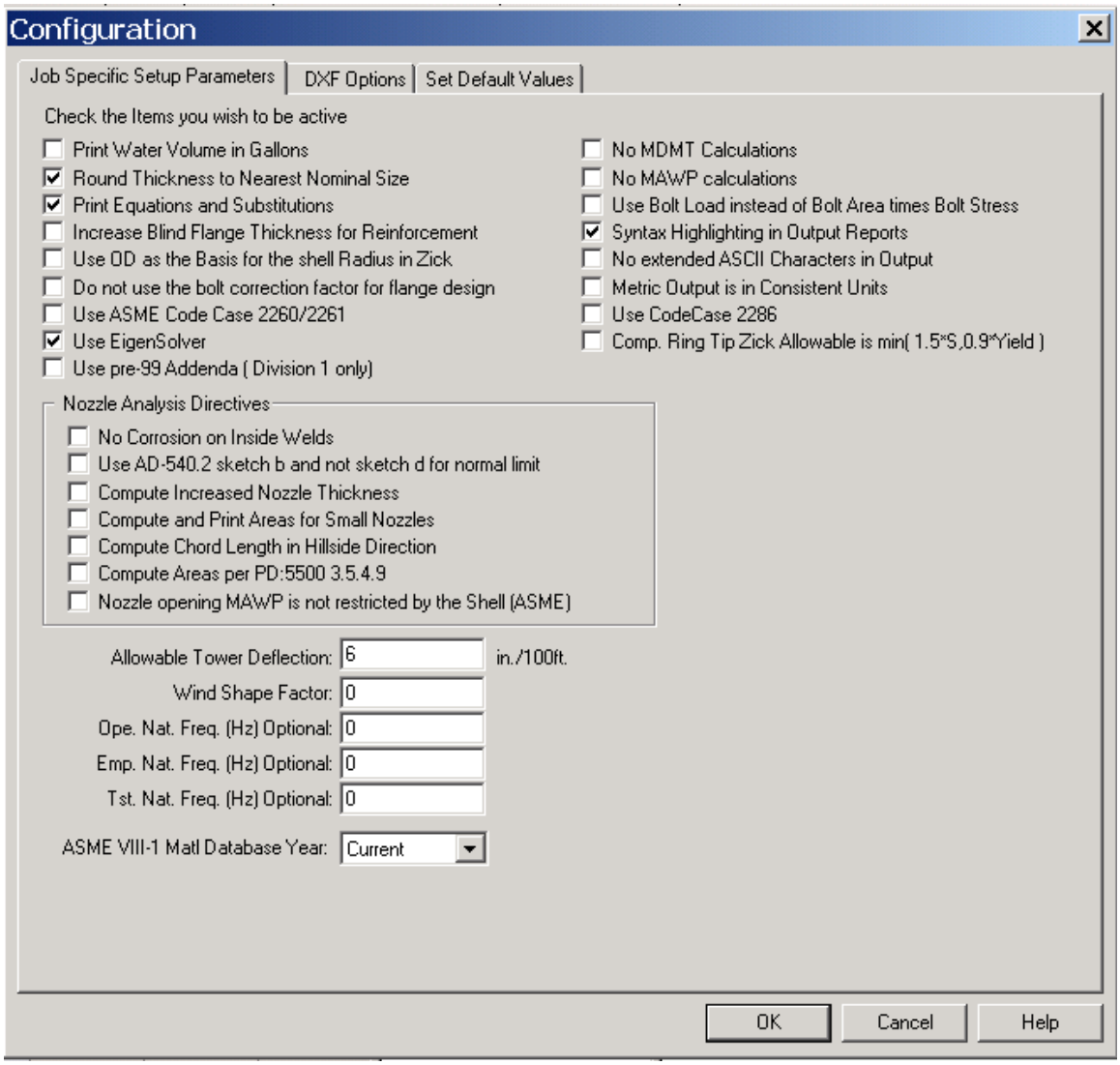
– Pressure
– Temperature
– Material
– Corrosion Allowance
– Minimum thicknesses (shell, head, nozzles)
– Nozzle Projections
– Vessel Dimensions
– Nozzle types (self reinforced or with reinforcement pads)
– Nozzle Sizes
– MDMT, etc.

DESIGN DATA			INTERNALS (Note 4, 5)		
Design Code	ASME VIII Div 1		Mist Eliminator		
Code Stamp	Yes, Level 1 (Note 3)		- Type	Mesh Pad	
Sour / Lethal / Other Service	Hydrocarbons		- Thickness mm		
Design Pressure - Max / Min	1200/FV	kPag	- Material		
Design Temperature - Max / Min	160 / -29	°C	Trays	Bottom	Top
Ambient Temperature - Max / Min	53 / 6	°C	- Type	N/A	
Radiography	Yes		- Spacing mm		
Corrosion Allowance	6	mm	- Number Required		
Steam Out Condition	N/A	kPag @ °C	- Tray Layout		
Test Pressure	As per code	kPag	Schoepentoeter	N/A	
Seismic Design	Refer Specification SP-00-M-0012		Inlet Feed Device		
Wind Design	Refer Specification SP-00-M-0012				
Pressure Drop (Max. Allowable)	34	kPa	Packed Bed	N/A	
VESSEL DATA			- Packing Type		
Orientation (Horizontal / Vertical)	Vertical		- Packed Bed Height		
Inside Diameter	1676	mm	- Material		
Length (Tan to Tan)	5650	mm			
Bottom tan line elevation	§	mm			
Shell Thickness	§	mm			
Head Thickness	§	mm			
Head Type	2:1 Semi - Elipsoidal				
Insulation - Thickness	No	mm			
- Type			NOTES		
Fireproofing - Thickness	Hold (Note 10)		(1). § Vendor to advise. Vendor shall submit completed data sheets with		
- Type	Hold (Note 10)		the bid.		
NACE Requirement	(Note 2)		(2). Pressure vessel is subjected to sour service. Materials and vessel		

Step 2: Set Configuration:

Set Configuration of the program





Print Water Volume in Gallons

Usually this box is unchecked.

Round Thickness to nearest Nominal Size

If you would like to have your thicknesses rounded to the nearest 1/16 of an inch (if you are in English units) or the nearest 1mm if you are in MM units, usually this box is checked.

Print Equations and Substitutions

By default **PVElite** will provide formulas and substitutions for internal and external pressure calculations.

Usually this box is checked.

Increase Blind Flange Thickness for Reinforcement

Usually this box is unchecked.

Use OD as the basis for shell radius in Zick

By default PVElite uses the ID basis on which to perform the Zick analysis calculations. In general, this is more conservative than using the OD.

Usually this box is unchecked.

Do not use the bolt space correction factor.

Usually this box is unchecked.

Use Eigen Solver for Natural Frequency Calc.

Usually this box is checked.

Use Pre-99 Addenda for Division 1

Usually this box is unchecked.

No Corrosion on Inside Welds

By default PVElite will always corrode the inner fillet weld when computing the area available in the inside weld. This directive has no effect when using the PD: 5500 Code.

Usually this box is unchecked.

Use AD-540.2 sketch b and not sketch d for Normal Limit

Usually this box is unchecked.

Use Increased Nozzle Thickness

Calculate minimum nozzle wall to account for external loadings

In many cases pressure vessels are designed and built long before the piping system is attached to them. This means that the nozzle loadings are unknown. If this field is checked, then your minimum nozzle thickness (trn) will be then maximum of:

trn = (.134, trn for internal pressure) <= Nps 18

trn = (OD/150, trn for internal pressure) > Nps 18

Usually this box is unchecked.

Compute and Print Areas for Small Nozzles

The Code paragraph UG-36 discusses the requirement of performing area replacement calculations when small nozzles are involved. The Code States:

Openings in vessels not subject to rapid fluctuations in pressure do not require reinforcement other than that inherent in the construction under the following conditions :

3.5" finished opening in a shell or head .375 inches required thickness or less

2.375" finished opening in a shell or head greater than .375 inches required thickness

Usually this box is unchecked.

Allowable Tower Deflection (inches per 100 feet)

This setup directive applies to vertical tower geometries. By default **PVElite** uses a criterion of 6 inches per 100 feet for the allowable tower deflection. If your design specification requires a different value of allowable deflection then enter it here.

Wind Shape Factor

Based on the wind design specification, **PVElite** will compute the wind shape factor. For cylindrical structures it is typically 0.7.

Usually this value is set to zero.

User defined Natural Frequency (Operating, Empty, And Filled)

For vertical vessels, **PVElite** computes the natural frequency based on the Rayleigh method. In general, this method is suitable for most vessel designs. If however, you have a more precise method and therefore have a better estimate of the natural frequency, then enter that value in the appropriate cell.

Usually this value is set to zero.

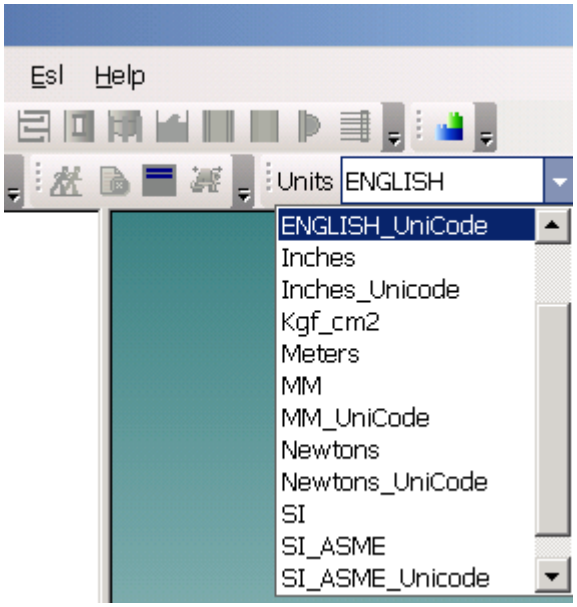
Material Database Year

PVElite allows the selection of either the pre 99 addenda, the current addenda, or addenda database years in between 98 and the current year. Selecting this option will merely change the database the program reads the tables of allowable stress versus temperature from. Please note this option is only valid for Section VIII Division 1.

Usually this value is set to “Current”.

Step 3: Select Units According to data sheet:

Select the units which are consistent with the units in the data sheet

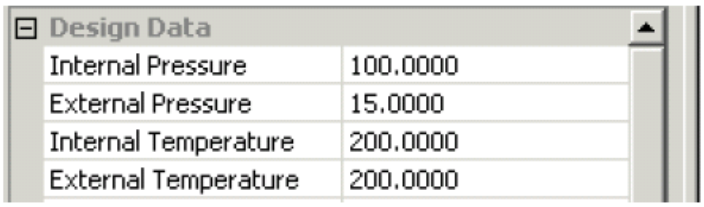


Also open the COADE unit conversion utility to convert the different units given in datasheet.

Step 4: Design Constraints:

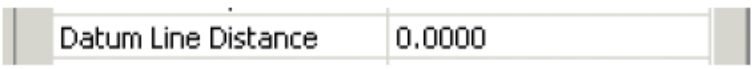
Enter the design Constraints required According to Datasheet

By entering the pressures and temperatures, from the datasheet, in these first four fields, *PVElite* will use these values as the default values for the whole vessel. This saves time later.

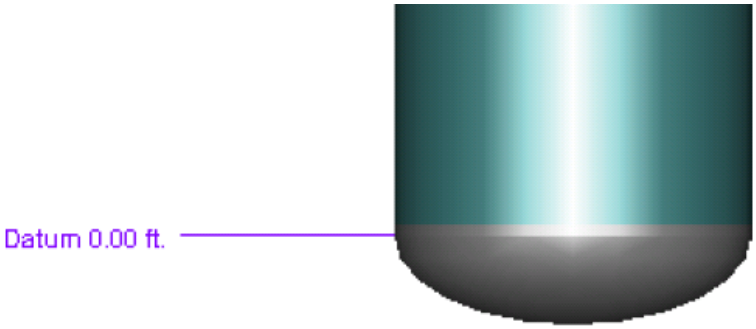


Enter the internal and external pressure according to datasheet. If external pressure is not mentioned on the datasheet then enter 0.000001 psig in the field. The program will assume this value as atmospheric external pressure. If external pressure on the datasheet is mentioned as F.V (i.e. Full Vacuum) then enter in this field 15 psig, the program will calculate it as Full Vacuum Condition.

The datum field.



If you look at your 3D model on the screen it will look something like this:

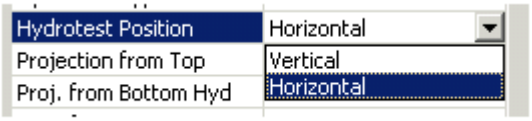


Once you have a skirt attached to the bottom of the vessel you may wish to mover the datum line to the bottom of the skirt as it may be more convenient.
Normally the datum line usually used is the tangent line of the bottom head in the case of vertical vessels. In horizontal vessel it is the tangent line of left head.

Hydrotest Type:

From the drop down box, you can tell *PVElite* how it must calculate the hydrotest pressure.
Select the Hydrotest type given according to datasheet.
If no instructions about hydrotest are given on the datasheet then use UG99b (33). (Based on design pressure and not on MAWP)

Hydrotest Position:
These are the choices you have available to you:



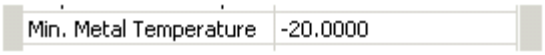
Tall towers for example, are usually hydrotested in the horizontal position. Give careful consideration to the position that is appropriate to your situation.
Usually Horizontal hydrotest position is assumed for vessels if it is not mentioned in datasheet.

Nozzle Projections:

Enter the nozzle projection from the surface of the vessel pressure envelope. This information is used by *PVElite* to compute any extra liquid level where the nozzle project higher than the vessel envelope.

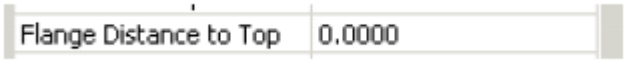
See project/vessel specification for projection

Minimum Metal Temperature:



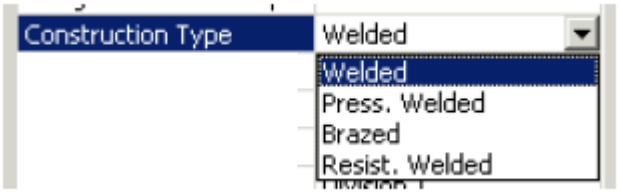
Enter the minimum metal temperature. *PVElite* computes the minimum allowable metal temperature, and compares it with the required minimum metal temperature.
If MDMT is given in the datasheet, use that value. If MDMT is not given then the default value is usually used.

Flange Distance to Top:



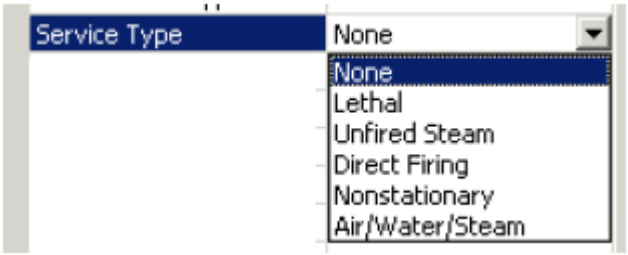
Enter the distance from the centerline/face of flange to the top of the vessel. This value will be used in case the flanges govern the MAP of the vessel

Construction Type:



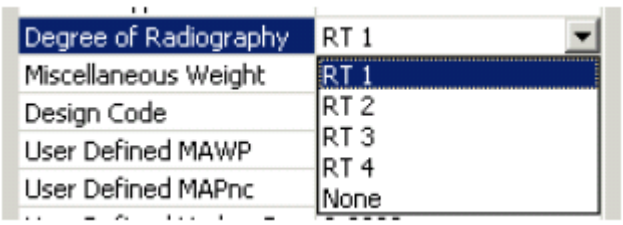
It is most likely that the default 'Welded' is used about 99.9 % of the time.

Service Type:



Enter the service type if any one of the above is given in datasheet. The type of service is specific to ASME Section VIII, Division 1. The code (Section UW) imposes special requirements for vessels in lethal and steam services.
This is usually left at the default value of '*None*' if no service is mentioned on datasheet.

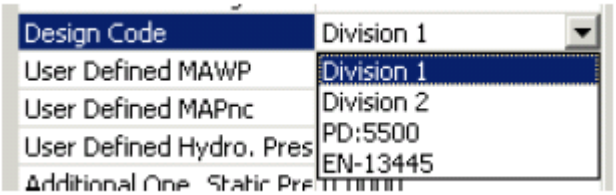
Degree of Radiography:



From the drop down box, click on the appropriate degree of radiography according to datasheet. *PVElite* does NOT automatically set the joint factor (E) from this global

selection.
If radiography is not mentioned on the datasheet, than RT-3 is normally used if no lethal service is available. In case of lethal service use RT-1.

Design Code:



Click on the appropriate code according to datasheet. PVElite allows the user to perform vessel calculations in several pressure vessel codes.
The following design codes are supported by *PVElite*:

- ASME Section VIII, Division 1
- ASME Section VIII, Division 2
- The British PD 5500
- The European EN 13445

Once a code is selected, the user will have to re-select the materials, as each code has its own design stress tables.
Use the code mentioned on datasheet. In most cases ASME Section VIII, Division 1 is usually used.
Use of other codes is restricted due to lack of code knowledge, at DEL

User Defined MAWP:

The ASME Section VIII, Division 1 code determines the Maximum Allowable Working Pressure (MAWP) the vessel is able to sustain.
Usually this field is left to zero and MAWP is calculated by program.

User Defined MAPnc:

In the cold condition, the flange ratings again could be exceeded. The user can set his own value of Maximum Allowable Pressure New and Cold.
Usually this field is left to zero and MAPnc is calculated by program.

User Defined Hydro. Pressure:

In the case of ASME Division 1, the hydrotest pressure is computed per UG-99 with varying degrees of severity. The user can reduce or change the hydrotest pressure.
Usually this field is left to zero and Hydrotest is calculated by program.

Additional Operating Static Pressure:

If for example, the vessel had a piping system attached, the liquid contained in the piping could add to the design pressure. If there are other factors that raise the pressure during the operating condition, this added pressure can be catered for.
Usually this field is left to zero if not given in datasheet or specifications. If given the vessel calculations for these loads are done by program.

Use Higher Longitudinal Stress:

The ASME Code (Section VIII, Division 1, Paragraph UG-23(d)) allows the allowable stress for the combination of earthquake loading, or wind loading with other loadings to be increased by a factor of 1.2.
Usually this box is checked in the case of tall towers.

Hydrotest, Allow Unmodified:

By default *PVElite* uses the hydrotest stress times the allowable stress increase factor for occasional loads (times the joint efficiency. on the tensile side). However, for stainless steel vessels this value is often limited to 0.9 times the yield stress.
Usually this box is checked in the case of tall towers.

Consider Vortex Shedding:

If this box is checked *PVElite* will perform vortex shedding calculations on the vessel.
Usually this box is unchecked. Unless it is a tall vertical vessel.

Is this a Heat Exchanger:

Note: This check box is for Heat Exchanger design case only.
To completely define an exchanger it is necessary to enter in the required information regarding the tubes, tubesheets and the floating head (if any). With the exchanger data, *PVElite* can then compute the weights and required thicknesses of the exchanger components

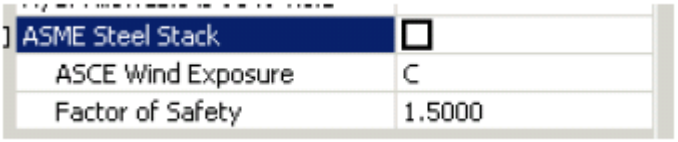
Corroded Hydrotest:

By default *PVElite* uses the uncorroded wall thickness when the stresses on the elements during the hydrotest are computed. In some cases it is necessary to hydrotest the vessel after it has corroded.
Usually this box is unchecked. Unless it is advised by client.

Hydrotest Allowable 90% Yield:

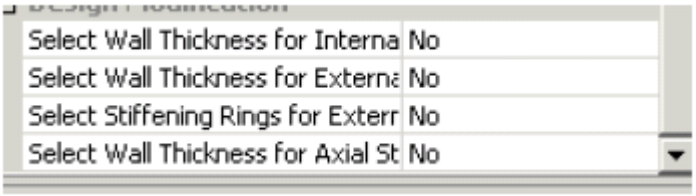
For ASME Division 1, the hydrotest allowable stress is 1.3 times the ambient allowable stress for the material. When the vessel is tested, the largest circumferential stress should not exceed this value. If you wish to use 90 percent of the ambient yield stress instead of 1.3 the ambient allowable, then you can check this box.
Usually this box is unchecked. Unless it is advised by client.

ASME Steel Stack:



PVElite will analyze steel stacks in accordance with ASME STS-2000.
Usually this box is unchecked. Unless steel stack design is under consideration.

Let PVElite automatically select thickness / Stiffening Rings etc.:



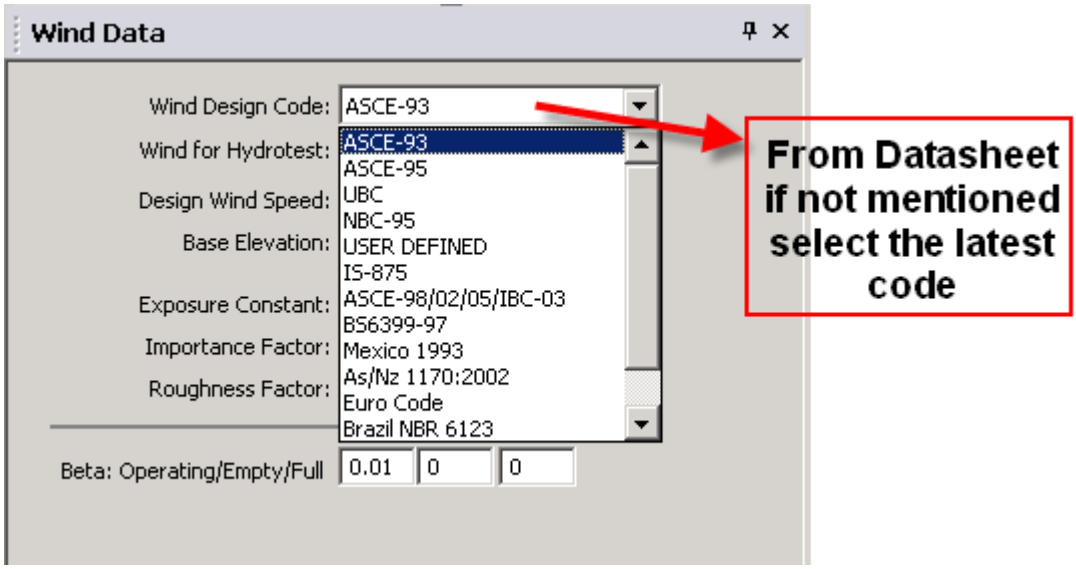
If any of the items is set to yes, *PVElite* will correct the item should it fail in the analysis. For example, if '*Select Wall Thickness for Internal Pressure*' be set to '*Yes*', *PVElite* will automatically increase the thickness of a component should it not be thick enough.
Usually three of the above mentioned values are set to "Yes"
Select Wall Thickness for internal pressure is normally set to **YES**
Select Wall Thickness for Axial stress is normally set to **YES**

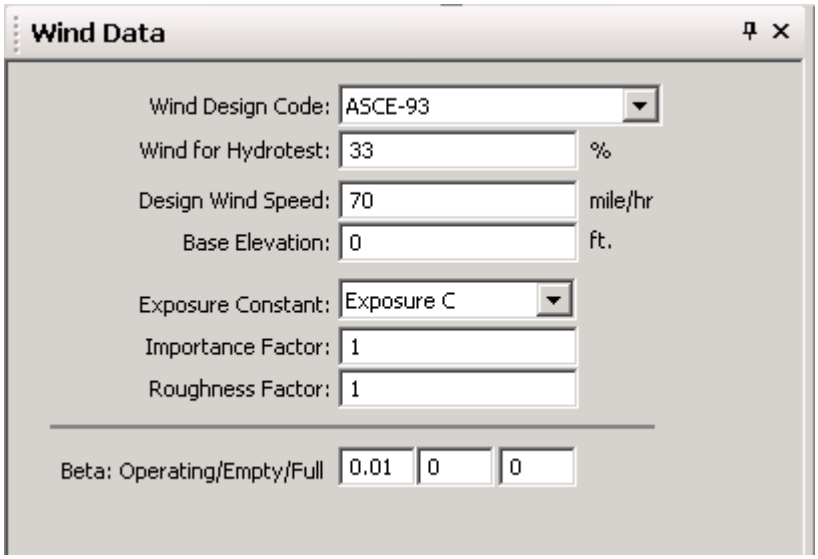
Among the following two one is usually set to YES

In case of small vessels and external pressure;
Select Wall Thickness for external pressure is normally set to **YES**

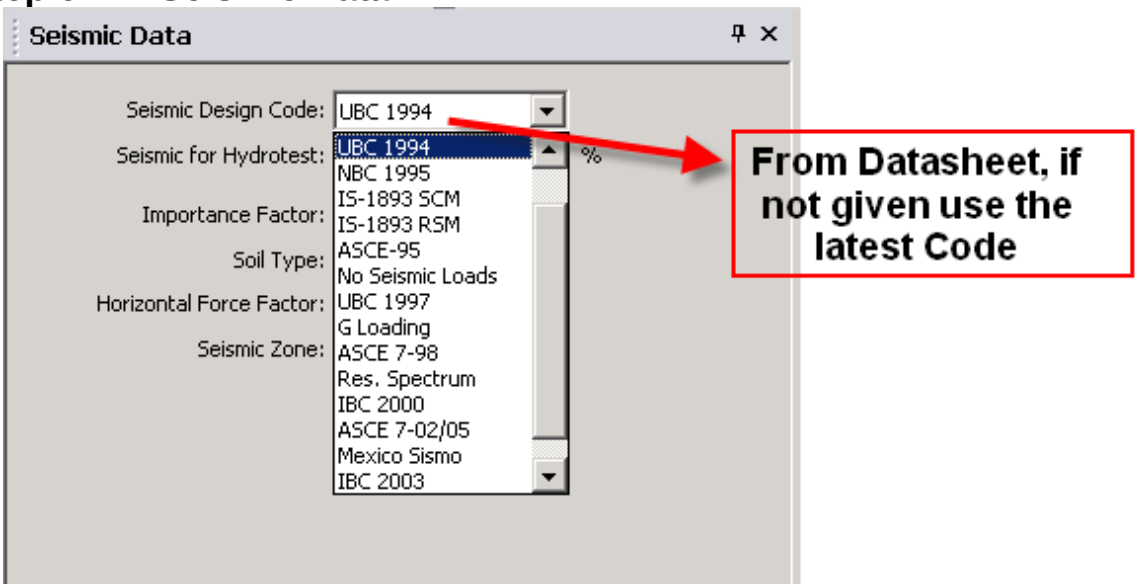
In case of large vessel and external pressure;
Select Stiffening Rings for external pressure is normally set to **YES**

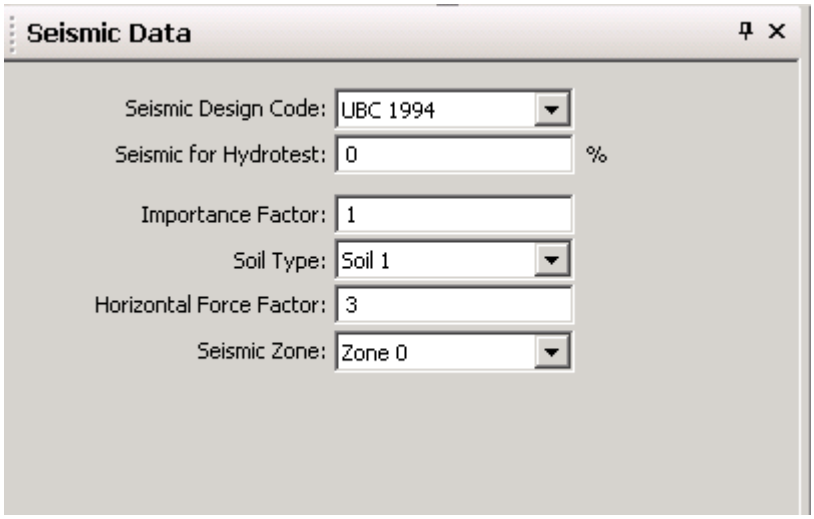
Step 5: Wind Data:


Wind Data
Wind Design Code:
ASCE-93
Wind for Hydrotest:
Design Wind Speed:
Base Elevation:
Exposure Constant:
Importance Factor:
Roughness Factor:
Beta: Operating/Empty/Full
0.01
0
0
ASCE-93
ASCE-95
UBC
NBC-95
USER DEFINED
IS-875
ASCE-98/02/05/IBC-03
BS6399-97
Mexico 1993
As/Nz 1170:2002
Euro Code
Brazil NBR 6123
From Datasheet if not mentioned select the latest code


Wind Data
Wind Design Code:
ASCE-93
Wind for Hydrotest:
33
%
Design Wind Speed:
70
mile/hr
Base Elevation:
0
ft.
Exposure Constant:
Exposure C
Importance Factor:
1
Roughness Factor:
1
Beta: Operating/Empty/Full
0.01
0
0

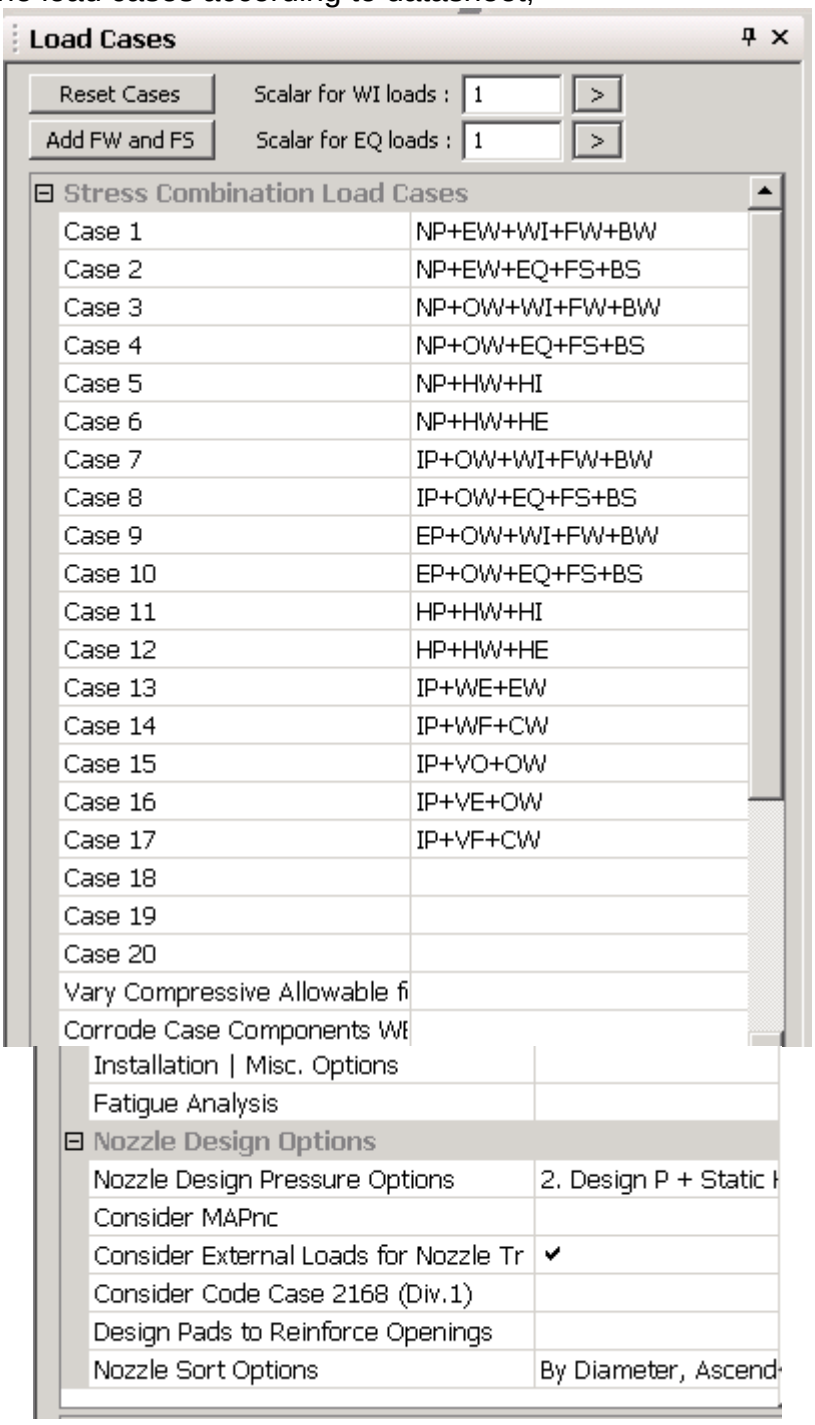
Step 6: Seismic Data:





Step 7: Load Cases:

Adjust the load cases according to datasheet,

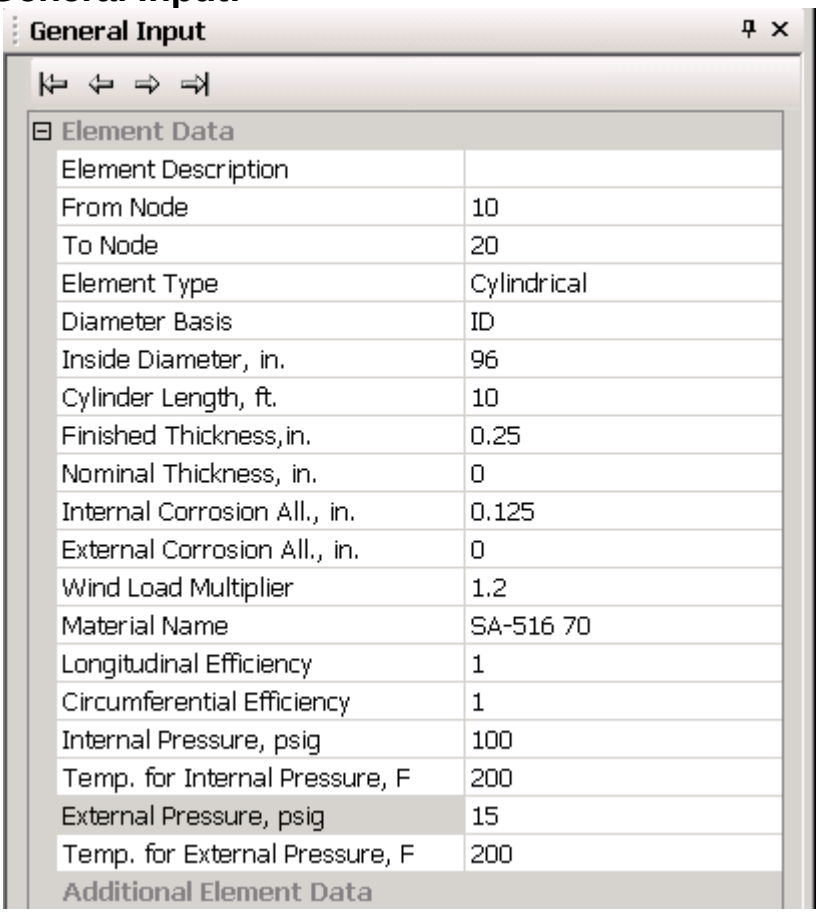


The load Cases are normally not adjusted, but these load cases have provision to enter three more cases if required by project vessel specifications.

1. MAWP + Static Liquid Pressure to the bottom of the Element the Nozzle is attached to
2. Design Pressure + Static Liquid Pressure
3. MAWP + Static Liquid Pressure to the bottom of the Element that is governing the MAWP
4. MAWP + Static Liquid Pressure to the Nozzle

Usually Nozzle Design Pressure Options is set to 2. Design Pressure + Static Liquid Pressure until or unless any other condition is governed.

Step 8: General Input:



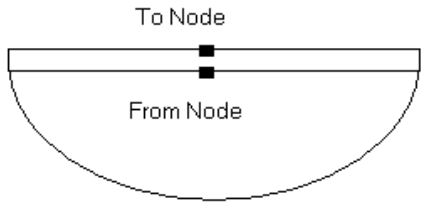
Element Description

Enter an optional alpha numeric description for this element.

Enter an element description according to vessel components. In case of vertical vessel start from bottom head, shell then top head. In the case of horizontal vessel start from left head, shell and then right head.

Element's from Node

Illustration depicting the "From" and "To" Nodes for a typical head type.



The program automatically adjusts the node of different components.

Element's Distance

Enter the distance between the 'From' Node and 'To' Node.

Element Type:

Cylindrical:	Change the current element to a Cylinder
Elliptical:	Change the current element to an elliptical head
Torispherical:	Change the current element to a Torispherical (F&D) head
Spherical:	Change the current element to a spherical head
Conical:	Change the current element to a conical head or shell segment
Welded Flat:	Change the current element to a Welded Flat head
Body Flange:	Change the current element to a Body Flange/Blind Flange etc.
Skirt:	Change the current element to a Skirt with optional

The element type can be changed by this dropdown button.

Element Diameter

Enter the inside or outside diameter of the element as appropriate.

Element's Finished Thickness

Enter the finished thickness of the element. This is typically the nominal thickness minus any mill under tolerance, and taking into account any thinning due to forming. Note that the corrosion allowance is automatically subtracted from this thickness by the program and should not be subtracted by the user. The finished thickness initial guess can be obtained from the bottom of the window.

From the above mentioned bottom strip of the window, T_r is the thickness calculated against internal pressure and T_{rext} is the thickness calculated under external pressure. The larger of these two values is rounded of and is generally considered as finished thickness.

Element Nominal Thickness

For most calculations **PVElite** uses the finished thickness to determine MAWP and some other important results.

Nominal thickness is the finished thickness plus the mill tolerance of the plate. In the case of pipe the mill tolerance of pipe is added.

Element's Corrosion Allowance

Enter the corrosion allowance given in datasheet.

The analysis program will subtract this value from entered thickness and add this value to inside diameter.

External Corrosion Allowance

Most vessels do not normally have an external corrosion allowance specification, but some vessels, such as jacketed types need the consideration of an external corrosion allowance. If given in datasheet enter the external corrosion allowance value, usually this value is entered as zero.

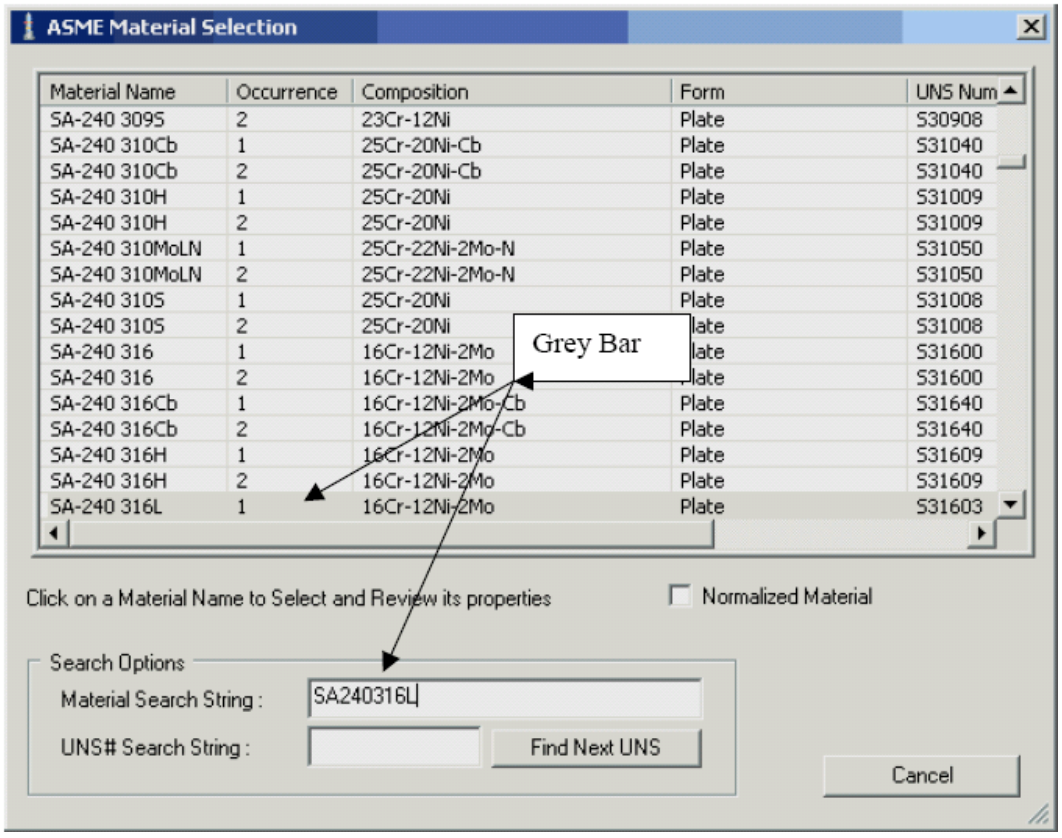
Element's Wind Load Multiplier

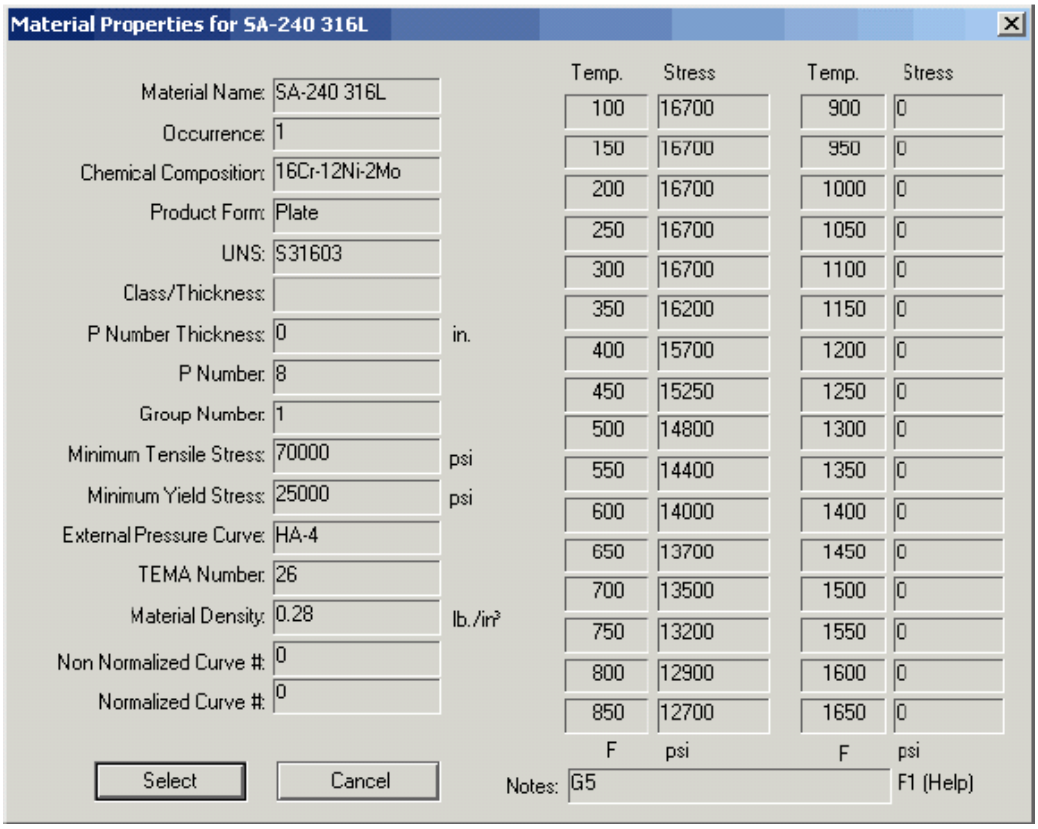
Enter the wind load diameter multiplier. The value entered here will be multiplied by the element outside diameter in order to determine the overall element diameter to be used in wind load calculations.

Usually this value is set to 1.2.

Element's Material Name

Enter the name of the material for this element. This program contains a database which includes most of materials in ASME Code, Section II, Part D, Table 1A, 1B, and 3. In addition, material properties for ASME VIII Div. II and BS5500 are also included in **PVElite**.





Element's Longitudinal & Circumferential Seam Efficiency

Enter the efficiency of the welded joint for shell section with welded longitudinal or circumferential seams. This will be the efficiency of the longitudinal and circumferential seam in a cylindrical shell or any seam in spherical shell. Elliptical and torispherical heads are typically seamless but may require a stress reduction which may be entered as a joint efficiency

For PD5500 and Section VIII Div. II this value is not used by **PVElite**.

Enter the value of longitudinal and circumferential seam according to the radiography mentioned.

Element's Design Temperature for Internal Pressure

Enter the design temperature for internal pressure. This value will be used as the metal design temperature for this element, especially in determining the allowable stress values.

This value is usually automatically updated from the "Design Constraints" data. If the element has different temperature then the new value can be adjusted here.

Element's Internal Pressure

Enter the design internal pressure for the component. For a skirt, you should not enter a value other than zero, since there can not be an internal pressure on a skirt.

This value is usually automatically updated from the "Design Constraints" data. If the element has different pressure then the new value can be adjusted here.

Element's External Pressure

Enter the design pressure for external pressure analysis. This should be a positive value, i.e. 14.7 psig. For skirt, you should not enter a value other than zero, since there can not be an external pressure on a skirt.

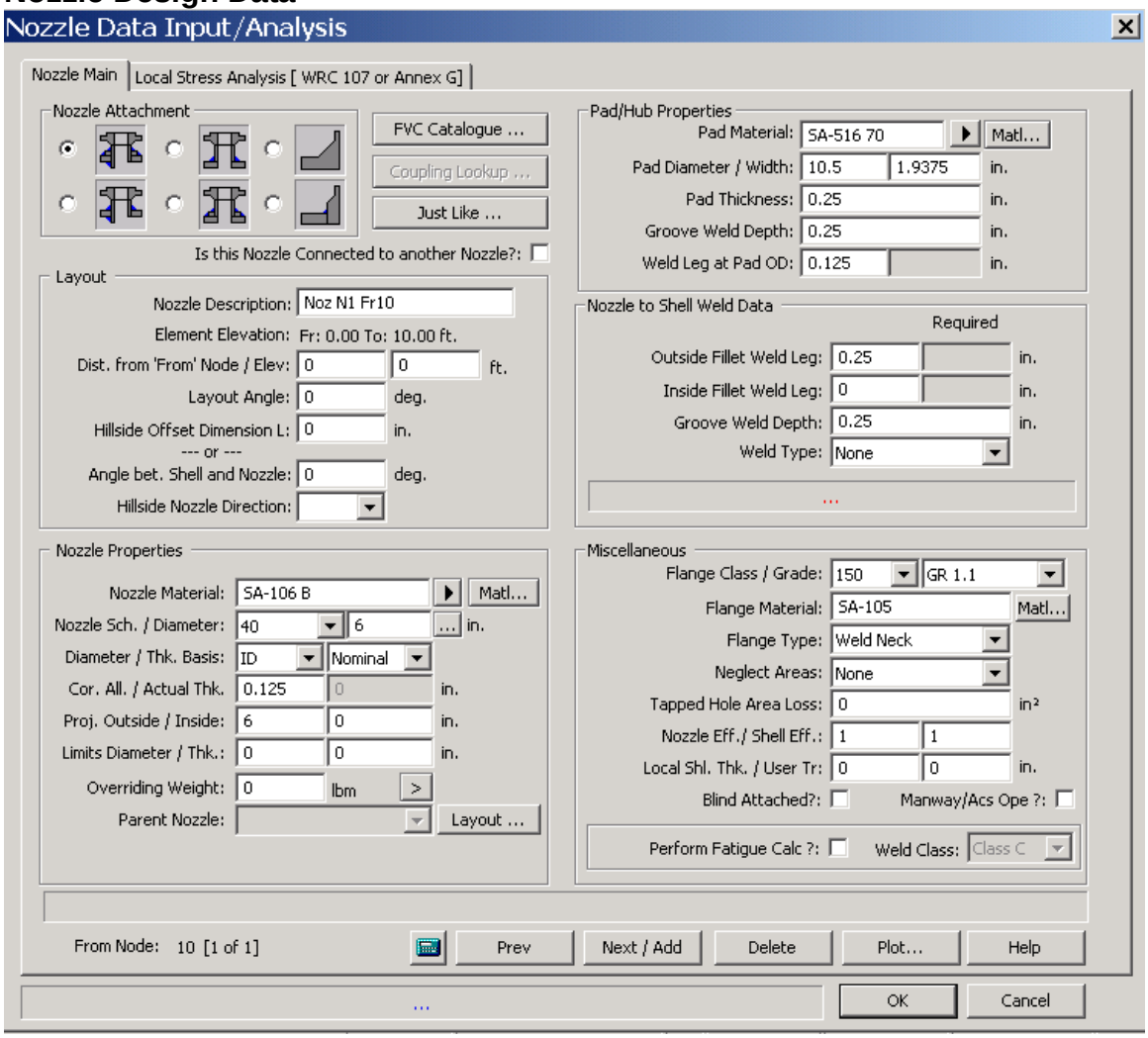
Examples of external pressure:

0 -- No external pressure calculation

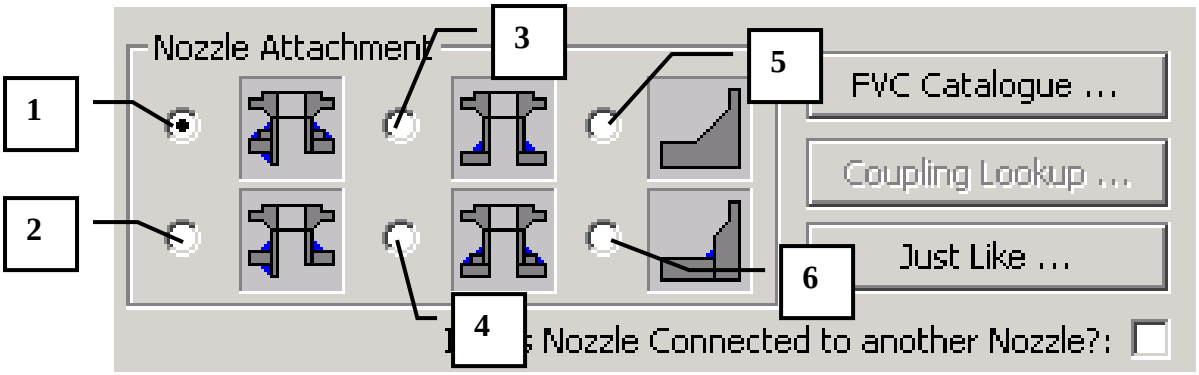
15 -- 1 atmosphere external pressure (= "full vacuum")

Step 9: Nozzle Input:

Nozzle Design Data



Nozzle Attachment



Nozzle Type

PVElite can evaluate 6 styles of nozzle. These 6 types are:

1: Inserted Nozzle with reinforcing Pad.

2: Inserted Nozzle with out reinforcing Pad.

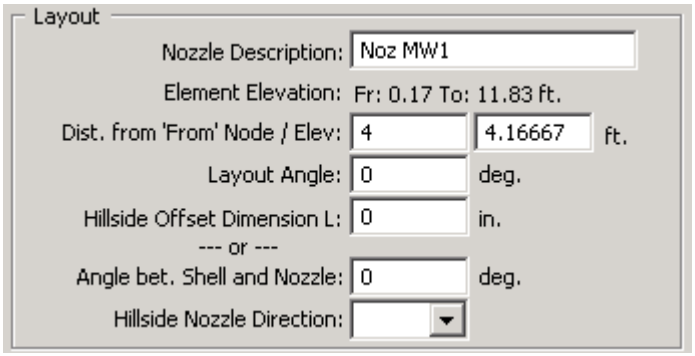
3: Abutting Nozzle with reinforcing Pad.

4: Abutting Nozzle without reinforcing Pad.

5: Heavy Barrel Type, HB

6: Type “F” connection

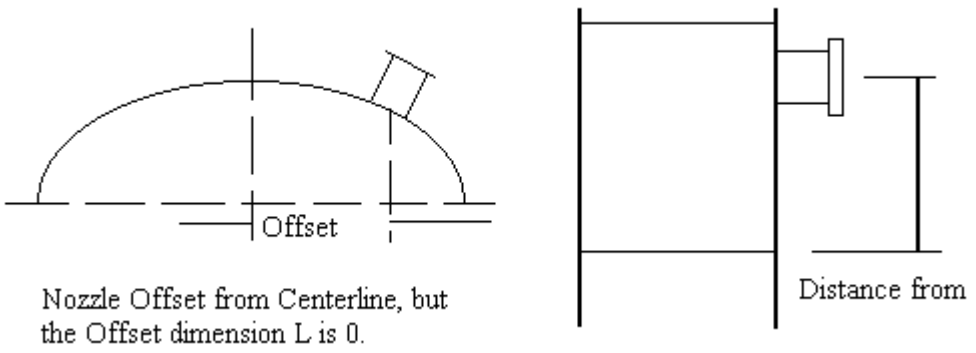
Simply click the radio button for the type of nozzle you wish to evaluate and fill in all of the information. Usually Type 1 & 2 is normally used.



Detail ID

Enter any alpha-numeric string to identify the detail, e.g. Noz A1

Distance from "FROM" Node / Offset from Element Centerline

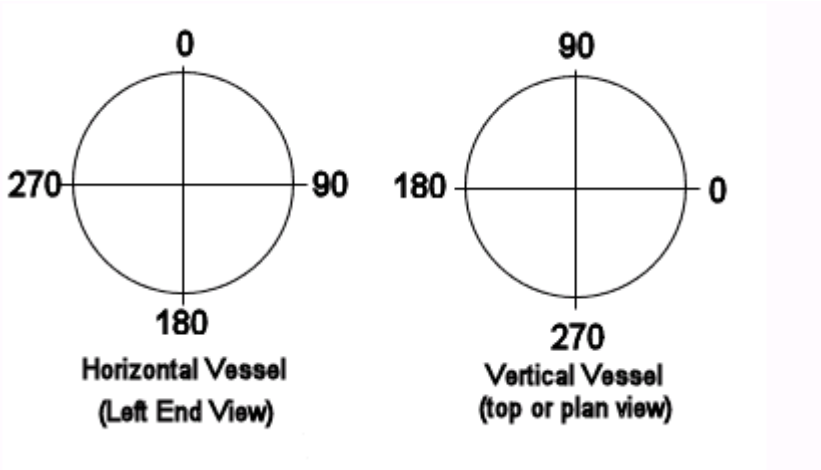


In the case of vertical vessels it is the distance from the tangent line of bottom head to the centerline of the nozzle. In the case of horizontal vessel it is the distance from the tangent line of the left head to the centerline of the nozzle.

Layout Angle (degrees)

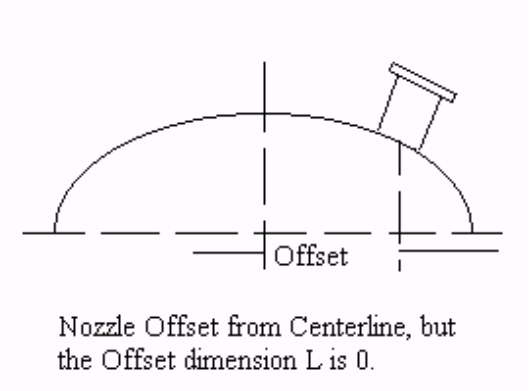
For a horizontal vessel, the 0 degree line is taken to be 12:00 (looking at a clock); 90 degrees is taken to be at 3:00 etc. Entering these layout angles is important if the horizontal vessel has a liquid level and the nozzles are being designed using the Design Pressure plus static head option.

For a vertical vessel the angle is a little bit more arbitrary. For purposes of rendering the graphics, the assumption is that the 0 degree line is at 3:00; 90 degrees is taken to be at 12:00 etc.



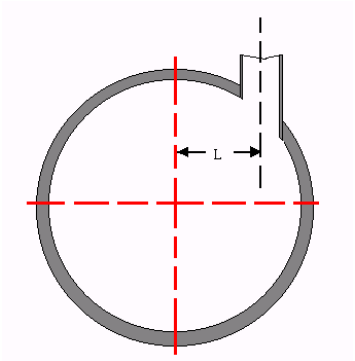
Offset Dimension

The offset dimension is the horizontal dimension typically referred to as "L". For a perpendicular nozzle, this dimension is 0. For a hillside nozzle you must enter this dimension.

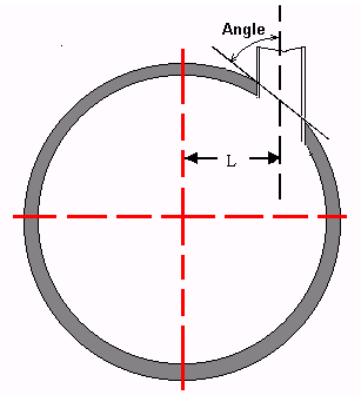


Nozzle Offset from Centerline, but the Offset dimension L is 0.

When this dimension is entered the nozzle will plot in green indicating a hillside nozzle.

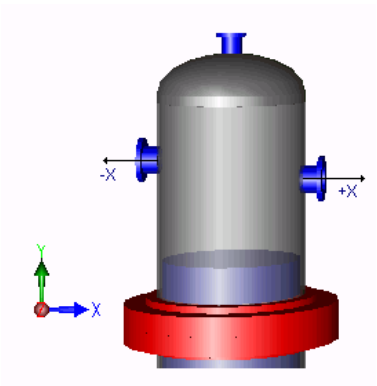


Angle between Shell and Nozzle

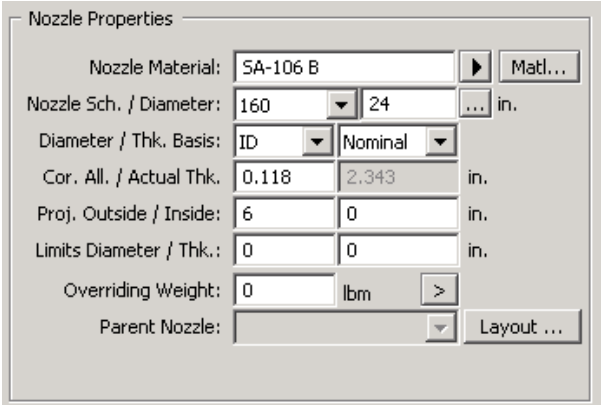


If it is a hill side nozzle then if the Hillside dimension is given the program will calculate the angle automatically. In case of radial nozzle this value is usually set to zero.

Nozzle Direction



Usually there is no need to adjust or select this option. It is therefore usually neglected.



Nozzle Material

Enter the name of the material for this nozzle. This program contains a database which includes most of materials in ASME Code, Section II, Part D, Table 1A, 1B, and 3.

Press the "Material…" button to select material directly from database.

Select the material of the nozzle according to datasheet. Usually SA-106 B is normally used.

Nozzle Schedule

Enter the thickness of the nozzle by specifying the schedule of the nozzle neck pipe. Acceptable schedules are:

SCH 10	SCH 10S	SCH 20	SCH 30
SCH 40	SCH 40S	SCH 60	SCH 80
SCH 80S	SCH 100	SCH 120	SCH 140
SCH 160	SCH STD	SCH X-STG	SCH XX-STG

If the nozzle is made up of plate or Long Welded Neck nozzle is to be used than the nozzle schedule is set to “None”

Nominal Nozzle Diameter

Enter the nominal diameter of the nozzle. The values shown below are in English units.

0.125	0.25	0.375	0.50
0.75	1.00	1.25	1.50
2.00	2.50	3.00	3.50
4.00	5.00	6.00	8.00
10.0	12.0	14.0	16.0
18.0	20.0	24.0	30.0

Diameter Basis

The ASME code gives different equations for required thickness based on whether the geometry is specified on inside or outside dimensions.

Usually ID is selected.

Nozzle Thickness Basis

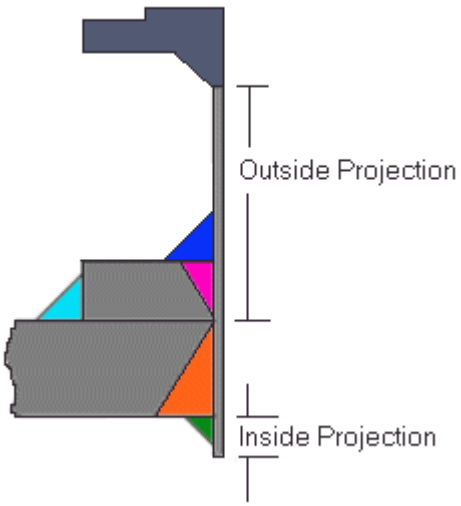
If the nozzle is made up of pipe than the nozzle thickness basis is taken as “Nominal”. If the nozzle is made up of plate or Long Welded Neck nozzle is to be used than the nozzle thickness basis is taken as “Actual”

Nozzle Corrosion Allowance

Normally the corrosion allowance of the nozzle is equal to the corrosion allowance of the component on which it is being adjusted.

Nozzle Outside Projection

This length will be used for weight calculations and for external pressure calculations.



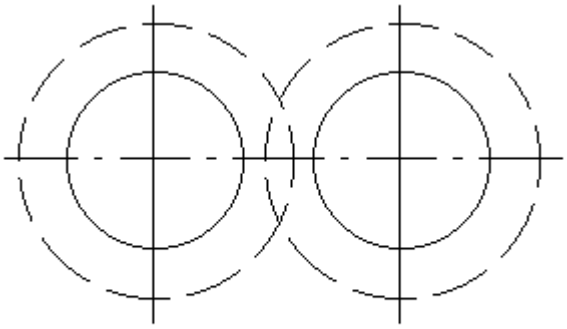
If the nozzle outside projection is given in the datasheet then enter that value. If it is not given in datasheet then usually 150mm is normally used.

Nozzle Inside Projection

If the nozzle inside projection is given in the datasheet then enter that value. If inside projection is mentioned in the figure and its value is not given in datasheet then usually 50mm is normally used. Normally inside projection is not used and its value is set to zero.

Maximum Diameter Limit

Enter the maximum diameter for material contributing to nozzle reinforcement.



Overlapping Nozzles with interfering diameter limits of reinforcement

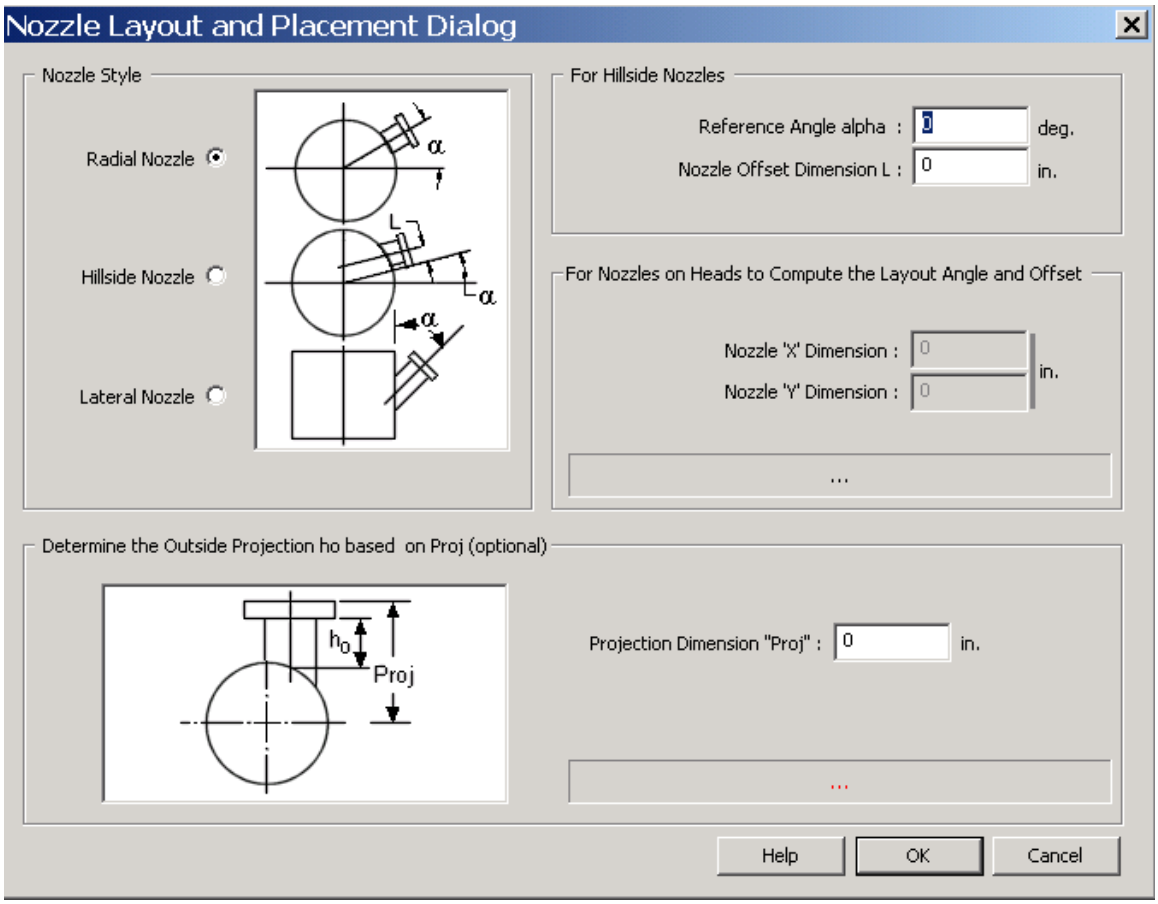
Maximum Thickness Limit

Enter the maximum thickness for material contributing to nozzle reinforcement.

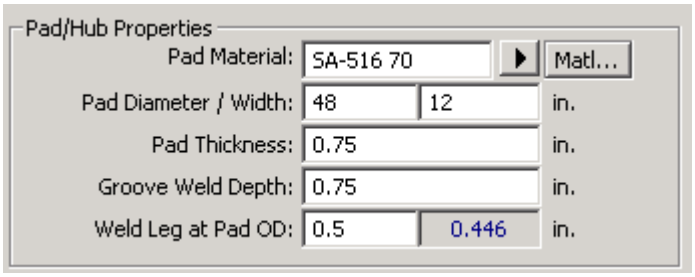
Weight of Nozzle

Normally the program calculates the weight of the nozzle from the information the user has already entered, and internal tables of typical weights. If your nozzle is significantly different from a standard weight nozzle, you can enter the weight here, and it will override the program calculated weight.

Nozzle Placement and Layout



It is normally used for hillside and lateral nozzle.



Pad Material

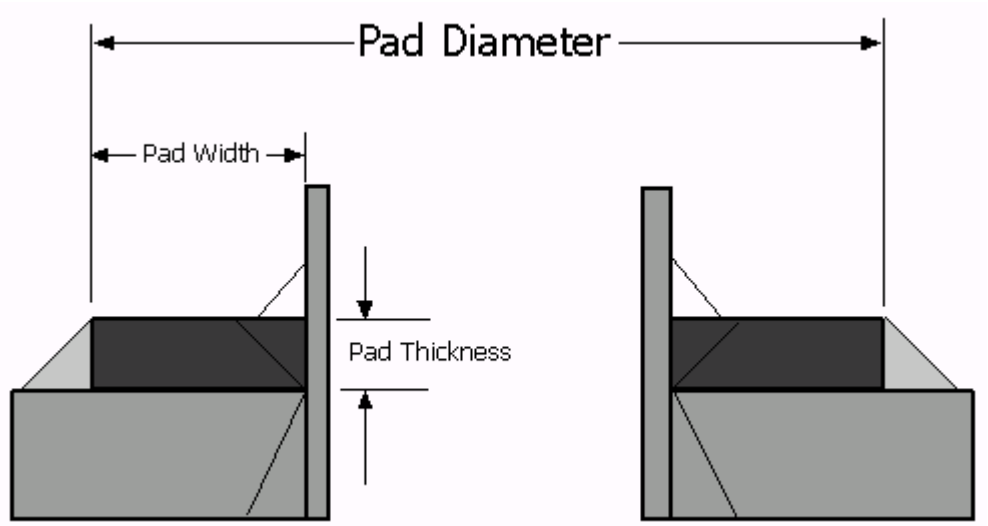
Enter the name of the material for this pad. This program contains a database which includes most of materials in ASME Code, Section II, Part D, Table 1A, 1B, and 3.

You may press the "Pad Material…" button to select material directly from database.

Select the material of the pad according to datasheet. Usually pad material is same as the shell material.

Pad Diameter/Pad Width

Enter the diameter of the pad. The diameter of the pad is entered as the length along the vessel shell - not the projected diameter around the nozzle. Alternatively, you can enter in the width of the pad in the Pad Width cell. This will cause the program to compute the Pad Diameter. At that instant the new pad diameter will appear.



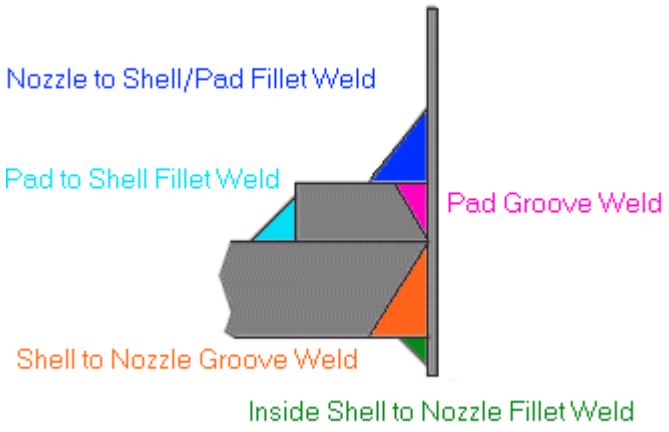
By entering the pad dia the pad width is automatically calculated by program. If pad width is mentioned pad diameter is automatically calculated. Usually pad width is taken as 50mm if it is not mentioned in datasheet.

Pad Thickness

Usually thickness of pad is same as the thickness of shell if not mentioned on datasheet.

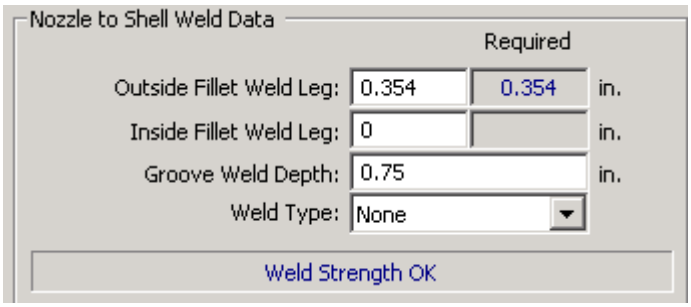
Depth of Groove Weld between Pad and Nozzle Neck

Enter the total depth of the groove weld. Most groove welds between the pad and the nozzle are full penetration welds. Thus the depth of the weld would be the same as the depth of the component that is the thickness of the pad. If the pad is attached with a partial penetration weld, or just a fillet weld, enter the depth of the partial penetration or a zero, respectively, in this field.



Pad Weld Leg Size as Outside Diameter

Enter the size of one leg of the fillet weld between the pad OD and the shell.



Weld Leg Size for Fillet between Nozzle and Shell or Pad

Enter the size of one leg of the fillet weld between the nozzle and the pad or shell.

Weld Leg Size between Inward Nozzle and Inside Shell

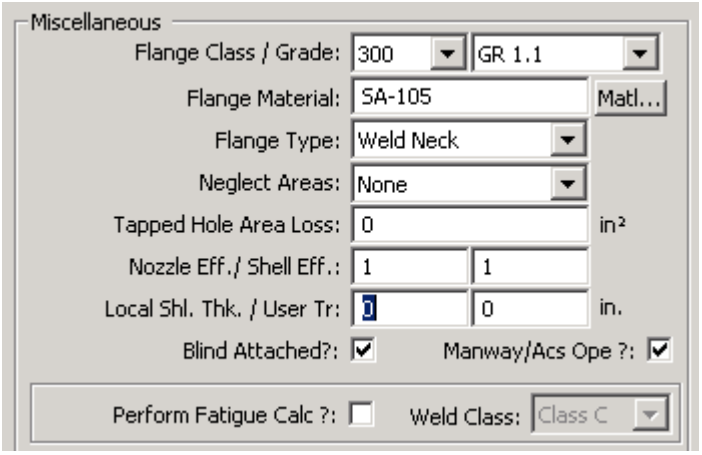
Enter the size of one leg of the fillet weld between the inward nozzle and the inside shell.

Depth of Groove Weld between Nozzle and Vessel

Enter the total depth of the groove weld. Most groove welds between the nozzle and the vessel are full penetration welds. Thus the depth of the weld would be the same as the depth of the component, that is the thickness of the nozzle. If the nozzle is attached with a partial penetration weld, or just a fillet welds, enter the depth of the partial penetration or a zero, respectively, in this field.

ASME Code Weld Type

Usually “None” is selected and PV Elite calculate it automatically.



Nozzle Class

Select the pressure rating class for the nozzle. Typically this is based on the pressure rating class for the attached flange. Allowable classes are:

150, 300, 400, 600, 900, 1500, 2500.

Select nozzle class given in datasheet. If not given in datasheet then firstly calculate it from “Pressure Temperature Rating Tables” then select it.

Nozzle Flange Grade

Select the nozzle flange material grade (group). Please note that there are certain advisories on the use of certain material grades.

Select Nozzle Flange Grade from “Pressure Temperature Rating Tables in ANSI B16.5 code”.

Neglect Area

In some vessel design specifications it is mandated that no credit be taken for the area contributed by the shell or nozzle. You can enter the text "A1" or "A2" in this field. If you do so, that area will be set equal to 0. You can also enter "A1 A2". This would give you no credit for Area1 - available area in the vessel wall or Area2 - available are in the nozzle wall.

Usually it is selected as “None”.

Joint Efficiency / BS-5500 C Factor

Enter the seam efficiency of the nozzle. Note that for shell and nozzle wall thickness calculations, the seam efficiency is always 1.0. However it is important to enter the correct value because the nozzle seam efficiency will be printed out in the input echo and may be used in other calculations where it is required.

Usually Seamless Nozzle is assumed and this value is set to 1.

Joint Efficiency of Shell Seam

Enter the seam efficiency. The seam efficiency is used in the 'area available' calculations to reduce the area available in the shell.

For shell and nozzle wall thickness calculations, the seam efficiency is always 1.0.

Local Shell Thickness

Some vessels have insert plates which are thicker than the surrounding shell. If your vessel uses insert plates, enter the thickness of the plate here. This value will be thicker than the shell course thickness this nozzle is located on. The maximum of this value and the element thickness will be used in the nozzle reinforcement calculations.

User tr

Under special conditions, project requirements may specify that full area replacement for nozzle reinforcement is required. To implement this you can enter the actual thickness of the shell or head minus the corrosion allowance. This value will replace what the program would normally compute for the required thickness based on internal or external pressure.

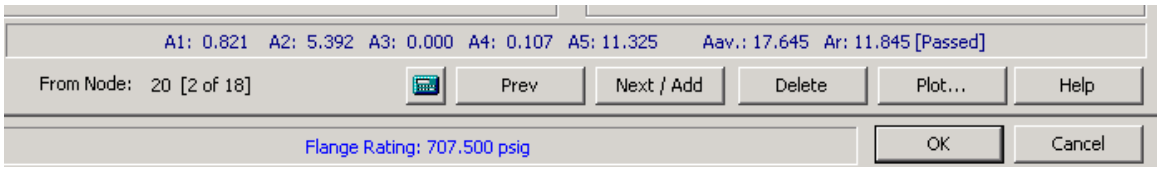
Nozzle Blind

Check this box if there is a blind on the flange. Note that this is used only to determine the weight of the nozzle - there is no structural effect.

Is this a Manway or Access Opening?

For PD 5500 this check box is not used for any computational purpose.

Paragraph UG-45 states that if the opening is a manway, access or inspection opening the minimum thickness requirement per UG-45 is not required. Checking this box will cause the program to bypass the UG-45 minimum nozzle neck thickness requirement.



Nozzle Edit Window Help

The Nozzle Edit Window allows the user input and edit the data for nozzles which are attached to the current element. The following buttons are available:

The "OK" button allows the data to be saved and then closes the window.

The "Cancel" button closes the window WITHOUT saving any changes that were made while in that window.

The "Delete" button deletes all of this nozzle data and restores the default values.

The "Nozzle To..." button is an alternative way to define the nozzles position on the vessel.

The "OK" button saves the information for all of the nozzles defined on this element.

The "Cancel" button exits the nozzle input screen WITHOUT SAVING the data.

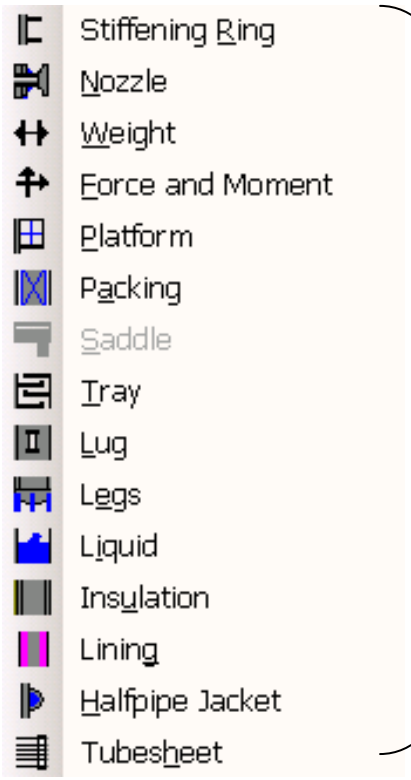
The "Help" button displays this help screen.

The "Material" buttons provide access to the material database.

Information about a specific cell can be obtained by pressing the F1 key when the cursor is on that cell.

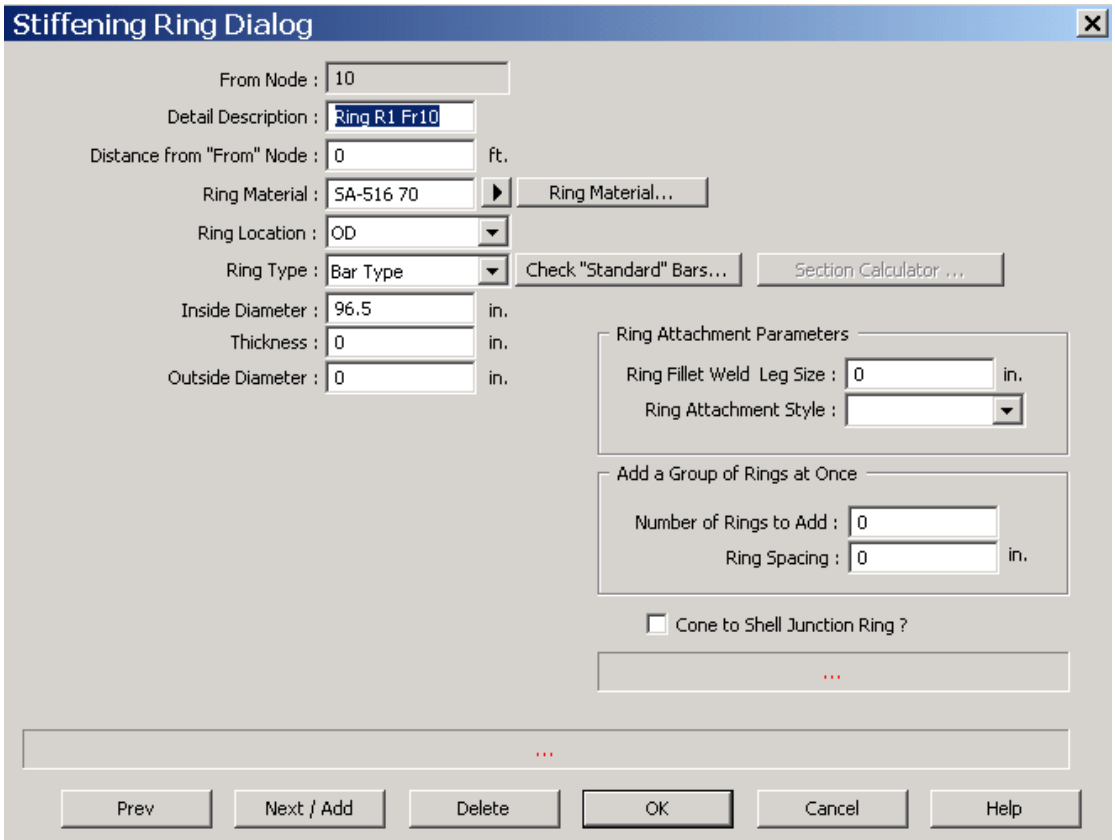
Step 10: Vessel Accessories:

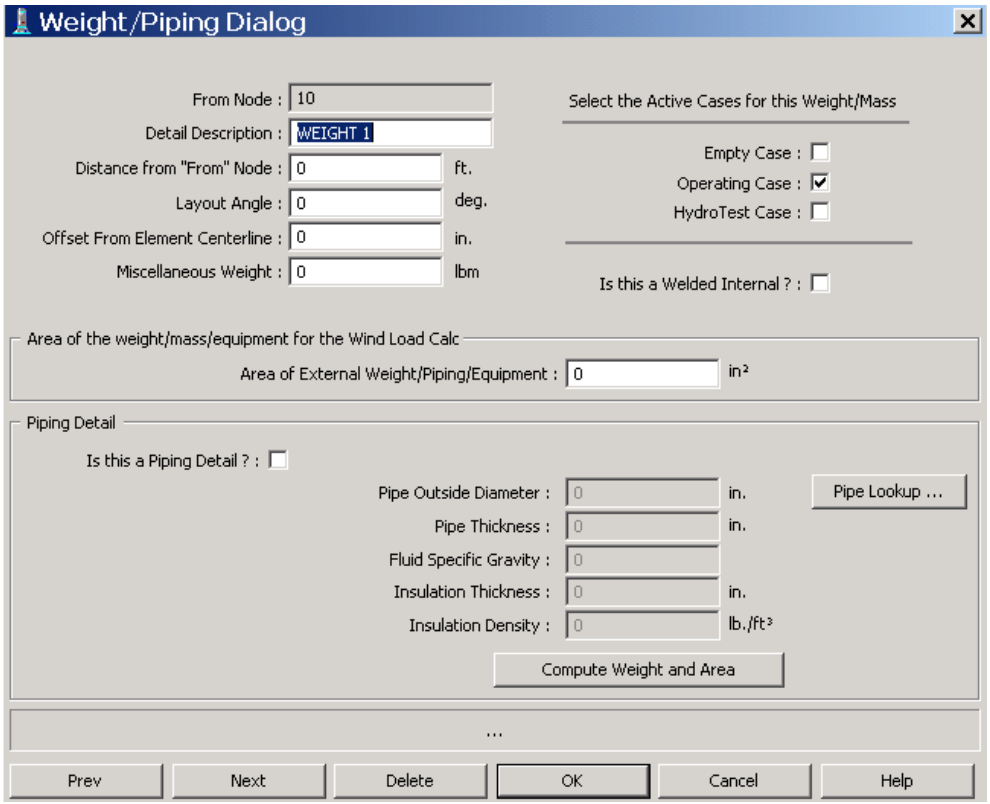
The accessories of the vessel can be inserted from the following bar;

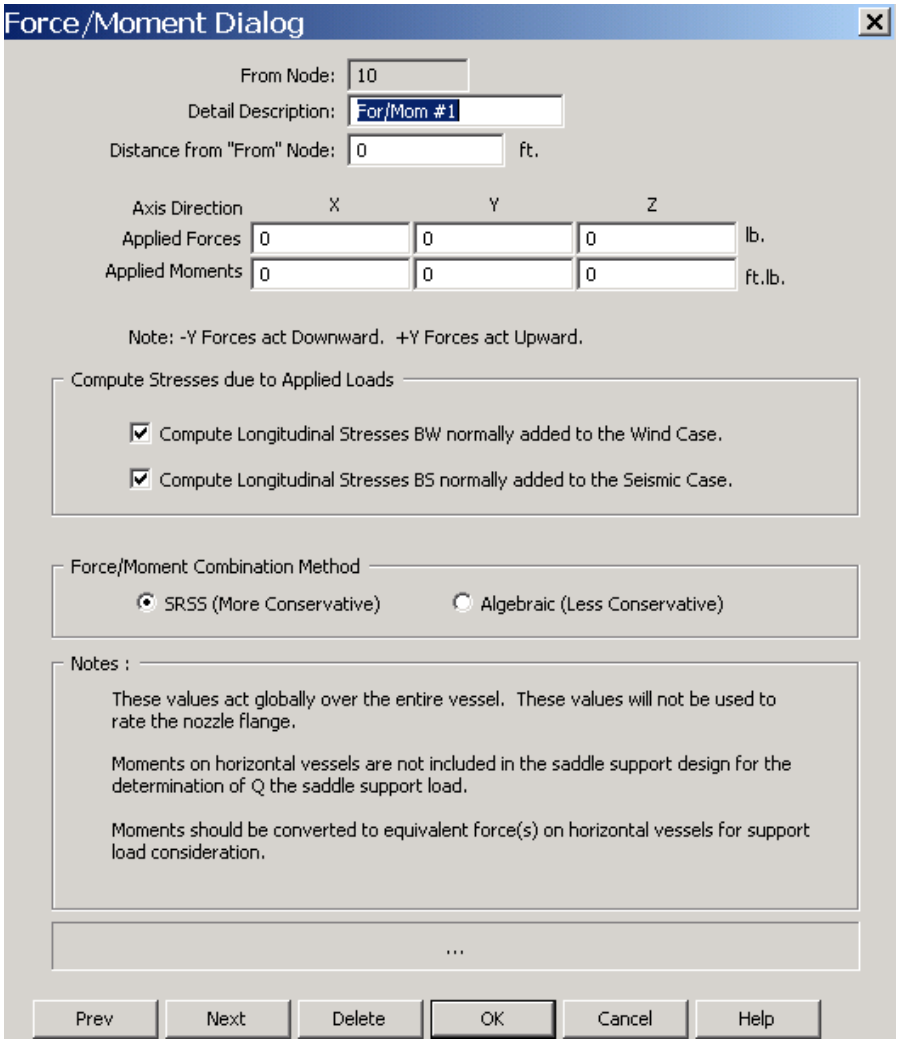


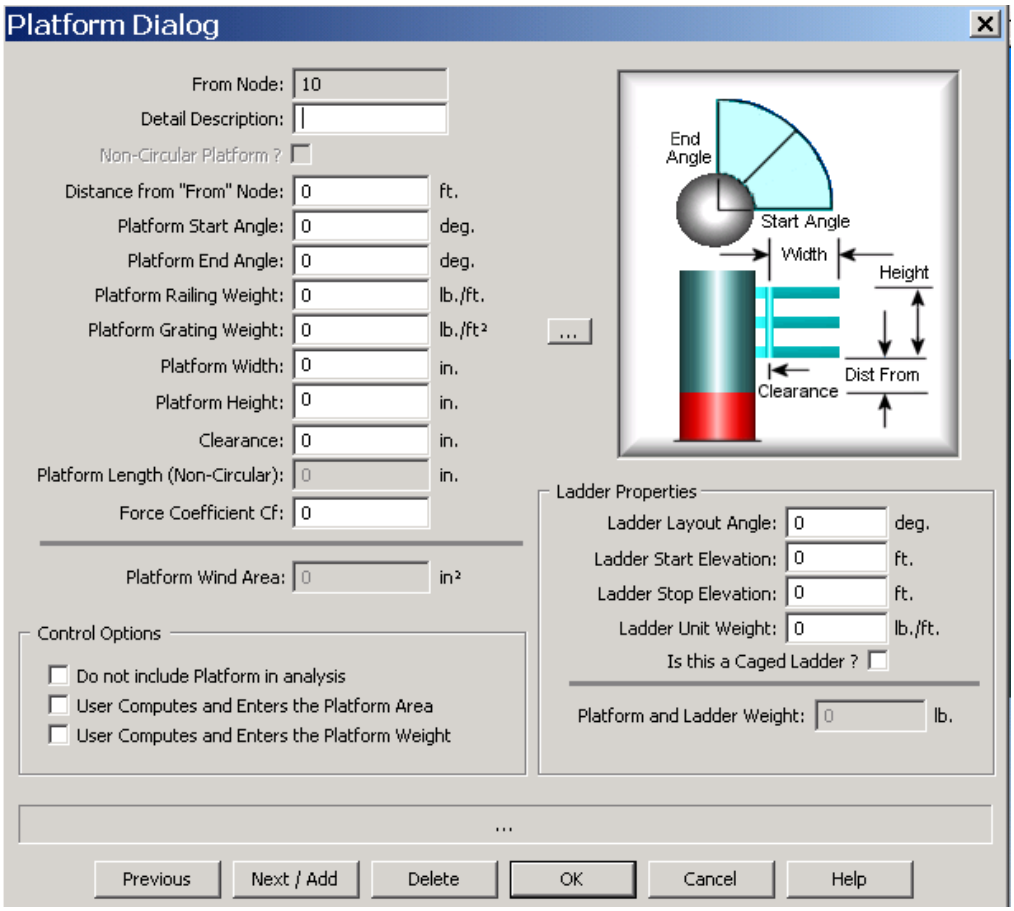
To insert any of these just select the part on which any one of these is to be added. Enter the dimensions according to datasheet.

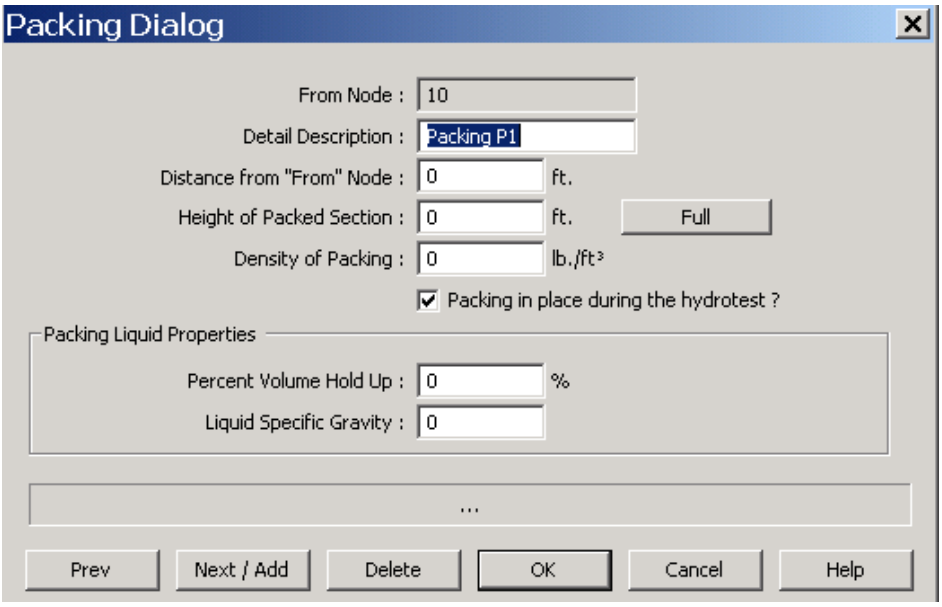
For further clarification regarding inserting items refer to the help by pressing F1 button.




Weight/Piping Dialog
From Node : 10
Detail Description : WEIGHT 1
Distance from "From" Node : 0 ft.
Layout Angle : 0 deg.
Offset From Element Centerline : 0 in.
Miscellaneous Weight : 0 lbm
Select the Active Cases for this Weight/Mass
Empty Case :
Operating Case :
HydroTest Case :
Is this a Welded Internal ? :
Area of the weight/mass/equipment for the Wind Load Calc
Area of External Weight/Piping/Equipment : 0 in²
Piping Detail
Is this a Piping Detail ? :
Pipe Outside Diameter : 0 in.
Pipe Thickness : 0 in.
Fluid Specific Gravity : 0
Insulation Thickness : 0 in.
Insulation Density : 0 lb./ft³
Pipe Lookup ...
Compute Weight and Area
...
Prev
Next
Delete
OK
Cancel
Help

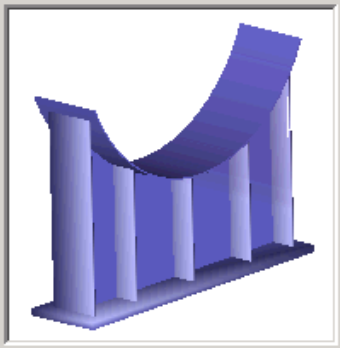

Force/Moment Dialog
From Node: 10
Detail Description: For/Mom #1
Distance from "From" Node: 0 ft.
Axis Direction X Y Z
Applied Forces 0 0 0 lb.
Applied Moments 0 0 0 ft.lb.
Note: -Y Forces act Downward. +Y Forces act Upward.
Compute Stresses due to Applied Loads
Compute Longitudinal Stresses BW normally added to the Wind Case.
Compute Longitudinal Stresses BS normally added to the Seismic Case.
Force/Moment Combination Method
SRSS (More Conservative)
Algebraic (Less Conservative)
Notes :
These values act globally over the entire vessel. These values will not be used to rate the nozzle flange.
Moments on horizontal vessels are not included in the saddle support design for the determination of Q the saddle support load.
Moments should be converted to equivalent force(s) on horizontal vessels for support load consideration.
...
Prev
Next
Delete
OK
Cancel
Help


Platform Dialog
From Node: 10
Detail Description:
Non-Circular Platform ?
Distance from "From" Node: 0 ft.
Platform Start Angle: 0 deg.
Platform End Angle: 0 deg.
Platform Railing Weight: 0 lb./ft.
Platform Grating Weight: 0 lb./ft²
Platform Width: 0 in.
Platform Height: 0 in.
Clearance: 0 in.
Platform Length (Non-Circular): 0 in.
Force Coefficient Cf: 0
Platform Wind Area: 0 in²
End Angle
Start Angle
Width
Height
Clearance
Dist From
Ladder Properties
Ladder Layout Angle: 0 deg.
Ladder Start Elevation: 0 ft.
Ladder Stop Elevation: 0 ft.
Ladder Unit Weight: 0 lb./ft.
Is this a Caged Ladder ?
Platform and Ladder Weight: 0 lb.
Control Options
Do not include Platform in analysis
User Computes and Enters the Platform Area
User Computes and Enters the Platform Weight
Previous
Next / Add
Delete
OK
Cancel
Help


Packing Dialog
From Node : 10
Detail Description : Packing P1
Distance from "From" Node : 0 ft.
Height of Packed Section : 0 ft.
Full
Density of Packing : 0 lb./ft³
Packing in place during the hydrotest ?
Packing Liquid Properties
Percent Volume Hold Up : 0 %
Liquid Specific Gravity : 0
Prev
Next / Add
Delete
OK
Cancel
Help

Saddle Dialog

From Node : 10
Detail Description : Lft Sdl
Dist. from "From" Node : 2 ft.
Saddle Width : 8 in.
Centerline Dim. B : 72 in.
Saddle Contact Angle : 120 deg.
Wear Plate Width : 12 in.
Wear Plate Thickness : 0.375 in.
Wear Pl. Contact Angle : 132 deg.
Height of Section Ring : 0 in.
Saddle Dimension A : 26 in.
Friction Coefficient Mu : 0
Moment Factor : 3



Perform Saddle Check ?

Rib, Web and Baseplate Data

BasePlate Allowable Stress : 13800 psi Matl...
Material Yield Stress : 34800 psi
E for Plates : 2.9e+007 psi
Baseplate Length : 91.2 in.
Baseplate Thickness : 1 in.
Baseplate Width : 10 in.
Number of Ribs : 5
Rib Thickness : 0.375 in.
Web Thickness : 0.375 in.
Height of Web : 12 in.
Web Location : Center

Perform Anchor Bolt Calculations ?

Anchor Bolt Data

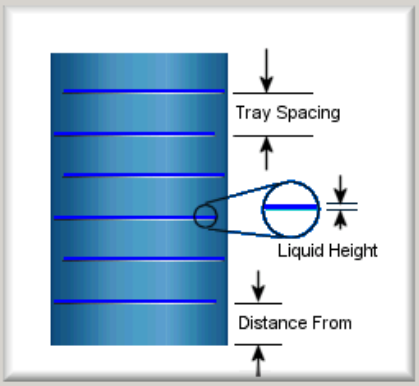
Number of Bolts:
Num of Bolts in Tension:
Edge Distance: in.
Bolt Corrosion Allowance: in.
Bolt Material: Matl:
Bolt Allowable Stress: psi
Thread Series:
Bolt Nominal Diameter: in. ...
Bolt Root Area: in²

Add Saddle Ring ... | Select Saddle ... | ...

Same as First | Prev | Next | Delete | OK | Cancel | Help

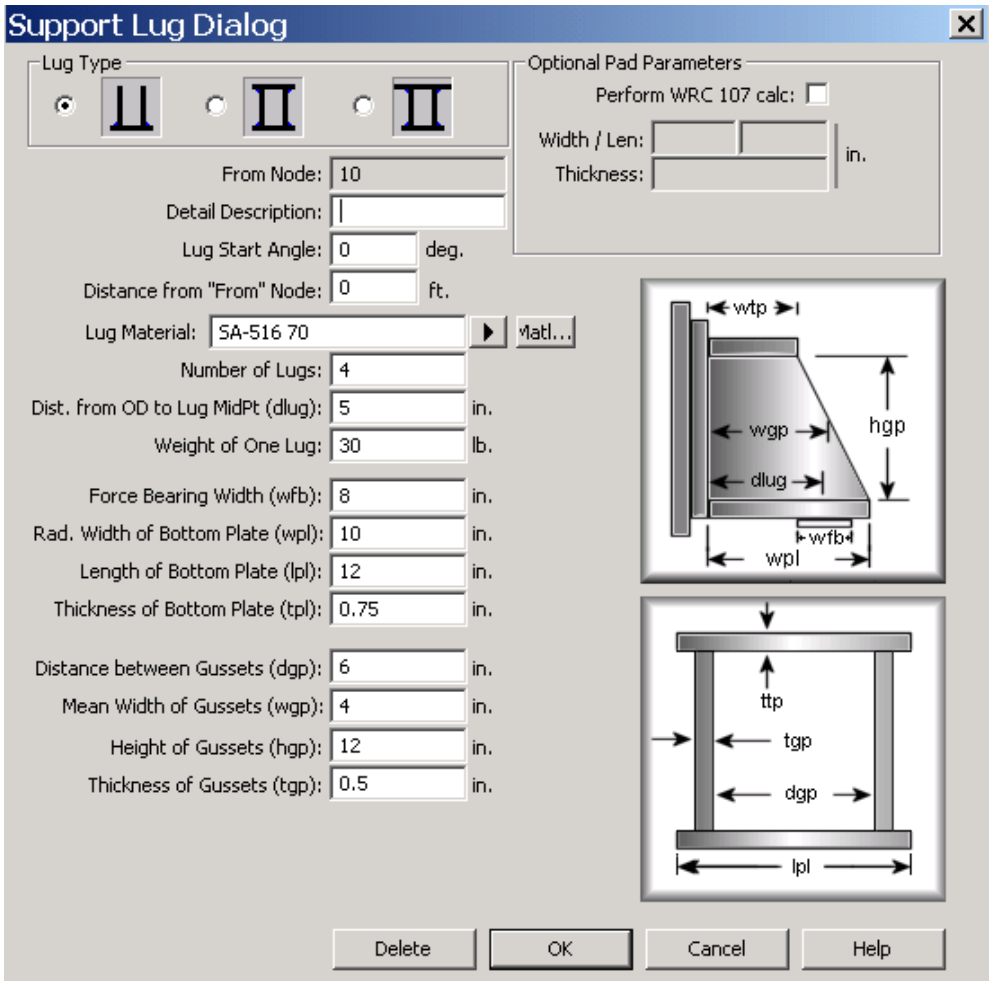
Tray Dialog

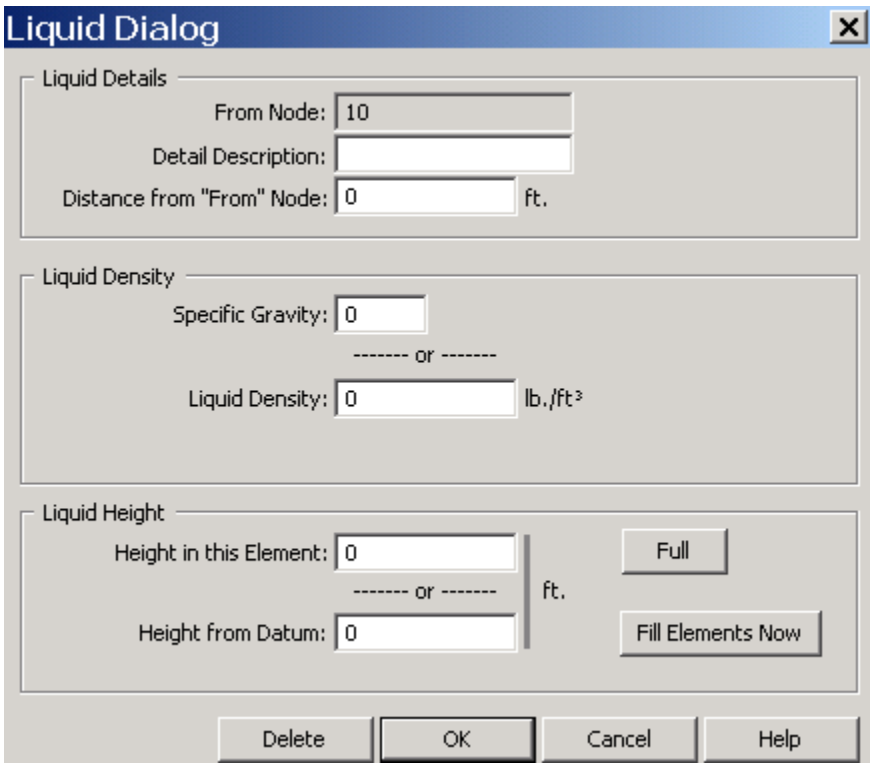
From Node : 10
Detail Description : TRAY 1
Distance from "From" Node : 0 ft.
Number of Trays : 0
Tray Spacing : 0 in.
Tray Weight Per Unit Area : 0 lb./ft²
Support Ring and Bolting Bar Weight : 0 lb.
Height of Liquid on Tray : 0 in.
Density of Liquid on Tray : 0 lb./ft³

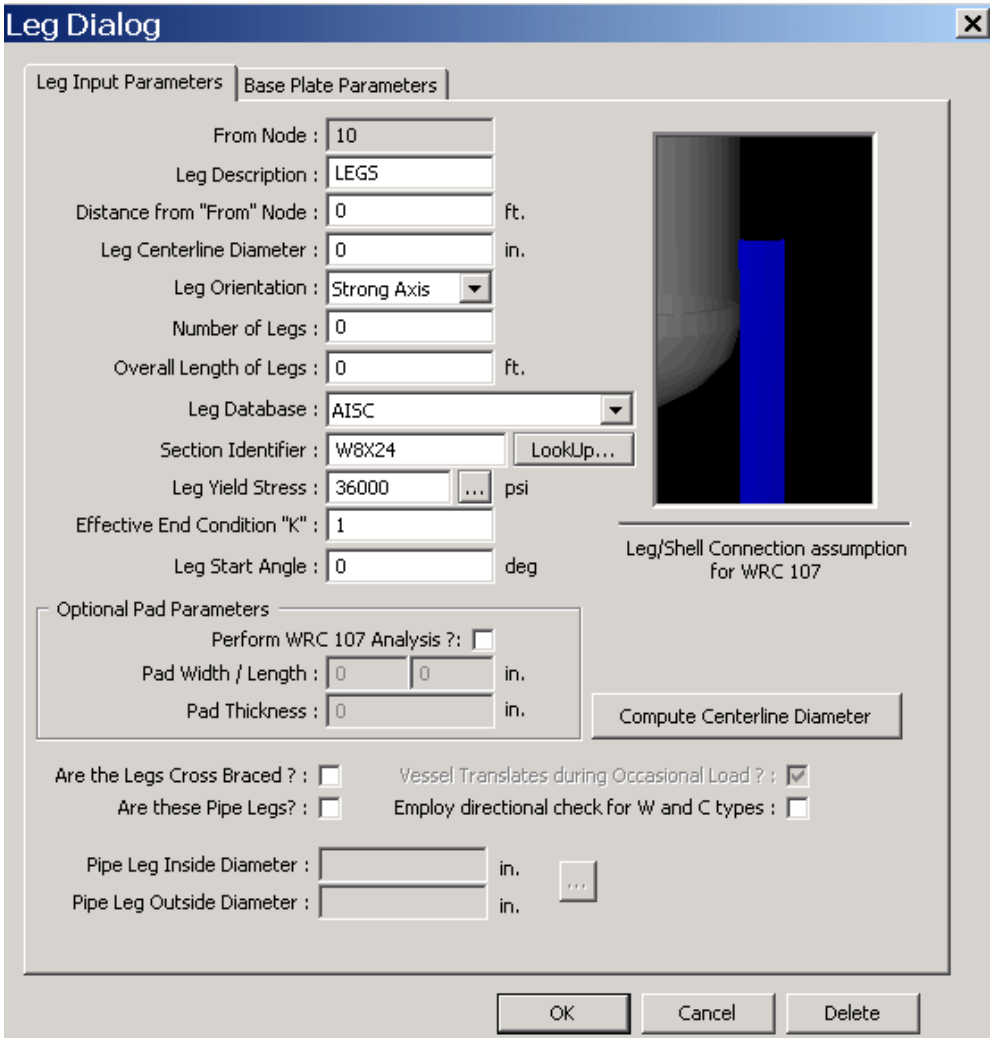


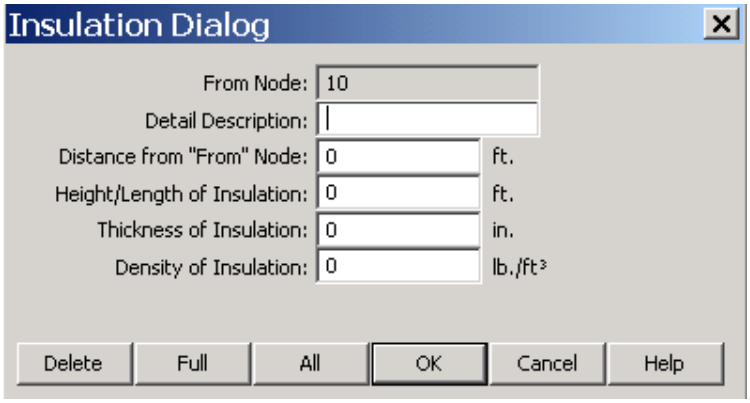
...

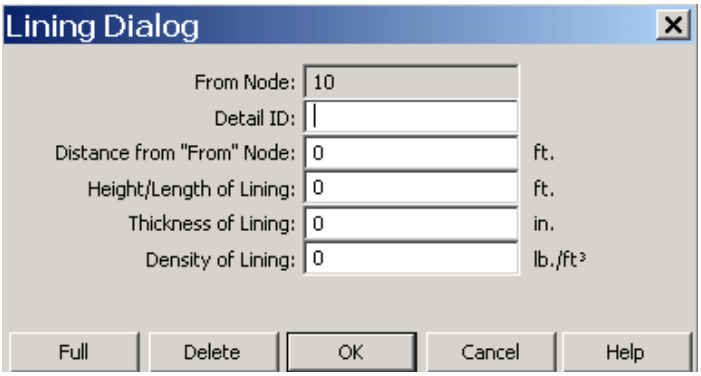
Prev | Next / Add | Delete | OK | Cancel | Help

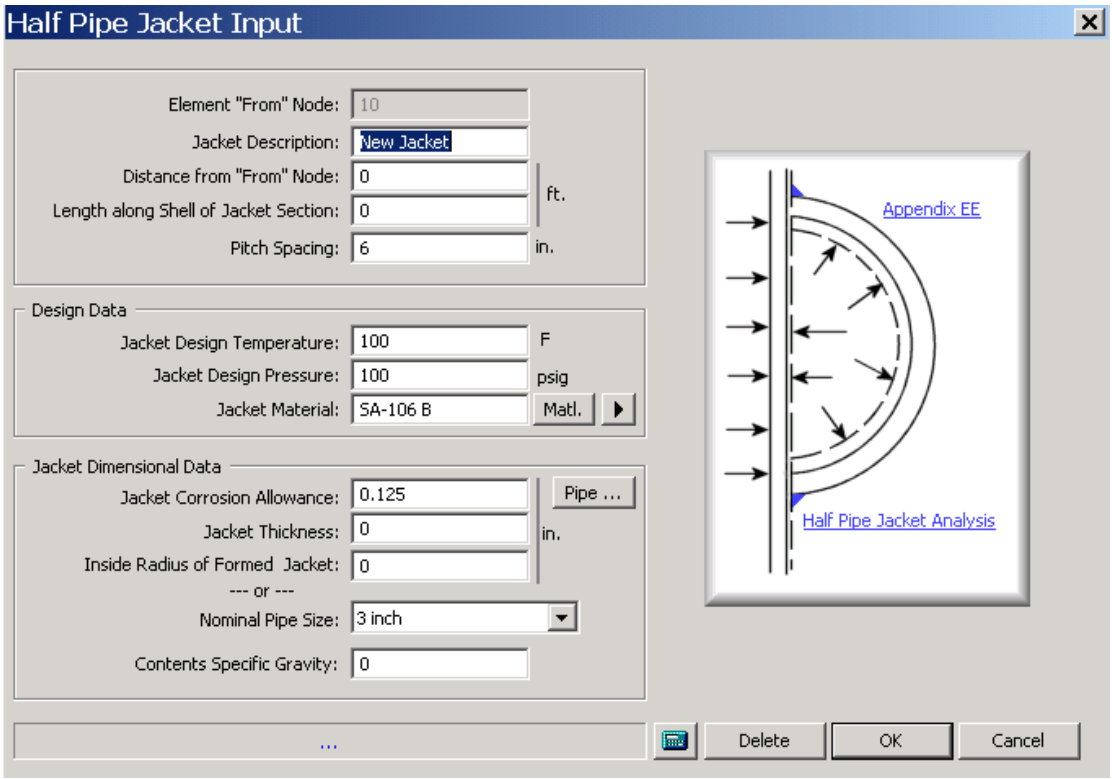

Support Lug Dialog
Lug Type
Optional Pad Parameters
Perform WRC 107 calc:
Width / Len:
Thickness:
in.
From Node: 10
Detail Description:
Lug Start Angle: 0 deg.
Distance from "From" Node: 0 ft.
Lug Material: SA-516 70
Matl...
Number of Lugs: 4
Dist. from OD to Lug MidPt (dlug): 5 in.
Weight of One Lug: 30 lb.
Force Bearing Width (wfb): 8 in.
Rad. Width of Bottom Plate (wpl): 10 in.
Length of Bottom Plate (lpl): 12 in.
Thickness of Bottom Plate (tpl): 0.75 in.
Distance between Gussets (dgp): 6 in.
Mean Width of Gussets (wgp): 4 in.
Height of Gussets (hgp): 12 in.
Thickness of Gussets (tgp): 0.5 in.
wtp
wgp
hgp
dlug
wfb
wpl
ttp
tgp
dgp
lpl
Delete
OK
Cancel
Help


Liquid Dialog
Liquid Details
From Node: 10
Detail Description:
Distance from "From" Node: 0 ft.
Liquid Density
Specific Gravity: 0
------- or -------
Liquid Density: 0 lb./ft³
Liquid Height
Height in this Element: 0
------- or -------
Height from Datum: 0
ft.
Full
Fill Elements Now
Delete
OK
Cancel
Help


Leg Dialog
Leg Input Parameters
Base Plate Parameters
From Node : 10
Leg Description : LEGS
Distance from "From" Node : 0 ft.
Leg Centerline Diameter : 0 in.
Leg Orientation : Strong Axis
Number of Legs : 0
Overall Length of Legs : 0 ft.
Leg Database : AISC
Section Identifier : W8X24 LookUp...
Leg Yield Stress : 36000 psi
Effective End Condition "K" : 1
Leg Start Angle : 0 deg
Leg/Shell Connection assumption for WRC 107
Optional Pad Parameters
Perform WRC 107 Analysis ?:
Pad Width / Length : 0 0 in.
Pad Thickness : 0 in.
Compute Centerline Diameter
Are the Legs Cross Braced ? :
Vessel Translates during Occasional Load ? :
Are these Pipe Legs? :
Employ directional check for W and C types :
Pipe Leg Inside Diameter : in.
Pipe Leg Outside Diameter : in.
OK
Cancel
Delete


Insulation Dialog
From Node: 10
Detail Description:
Distance from "From" Node: 0 ft.
Height/Length of Insulation: 0 ft.
Thickness of Insulation: 0 in.
Density of Insulation: 0 lb./ft³
Delete
Full
All
OK
Cancel
Help

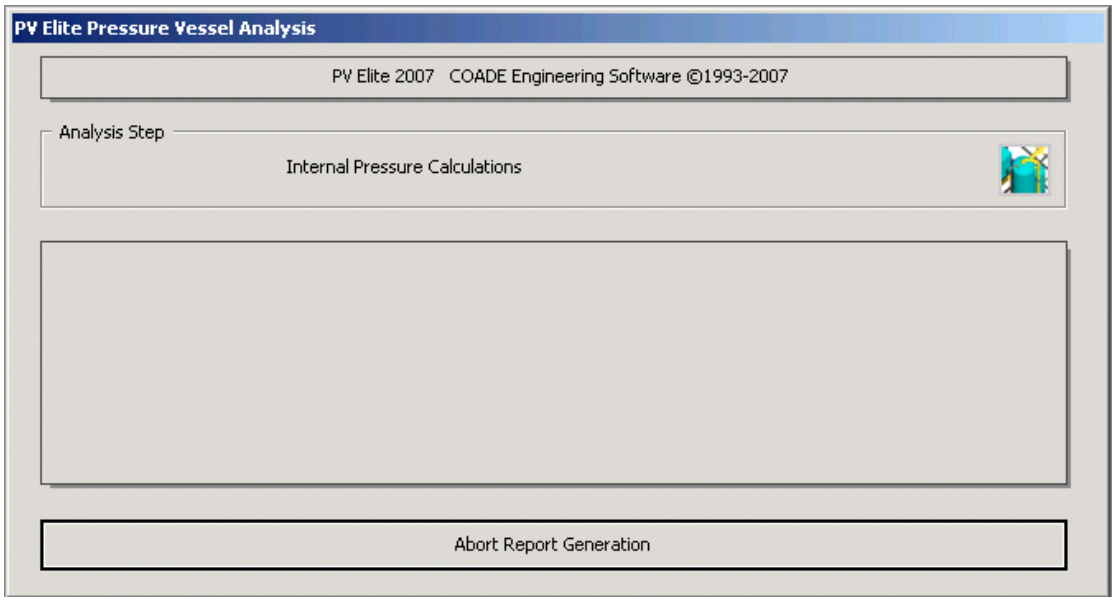

Lining Dialog
From Node: 10
Detail ID:
Distance from "From" Node: 0 ft.
Height/Length of Lining: 0 ft.
Thickness of Lining: 0 in.
Density of Lining: 0 lb./ft³
Full
Delete
OK
Cancel
Help


Half Pipe Jacket Input
Element "From" Node:
10
Jacket Description:
New Jacket
Distance from "From" Node:
0
Length along Shell of Jacket Section:
0
ft.
Pitch Spacing:
6
in.
Design Data
Jacket Design Temperature:
100
F
Jacket Design Pressure:
100
psig
Jacket Material:
SA-106 B
Matl.
Jacket Dimensional Data
Jacket Corrosion Allowance:
0.125
Pipe ...
Jacket Thickness:
0
in.
Inside Radius of Formed Jacket:
0
--- or ---
Nominal Pipe Size:
3 inch
Contents Specific Gravity:
0
Appendix EE
Half Pipe Jacket Analysis
...
Delete
OK
Cancel

Step 11: Running the Program\ Output File:

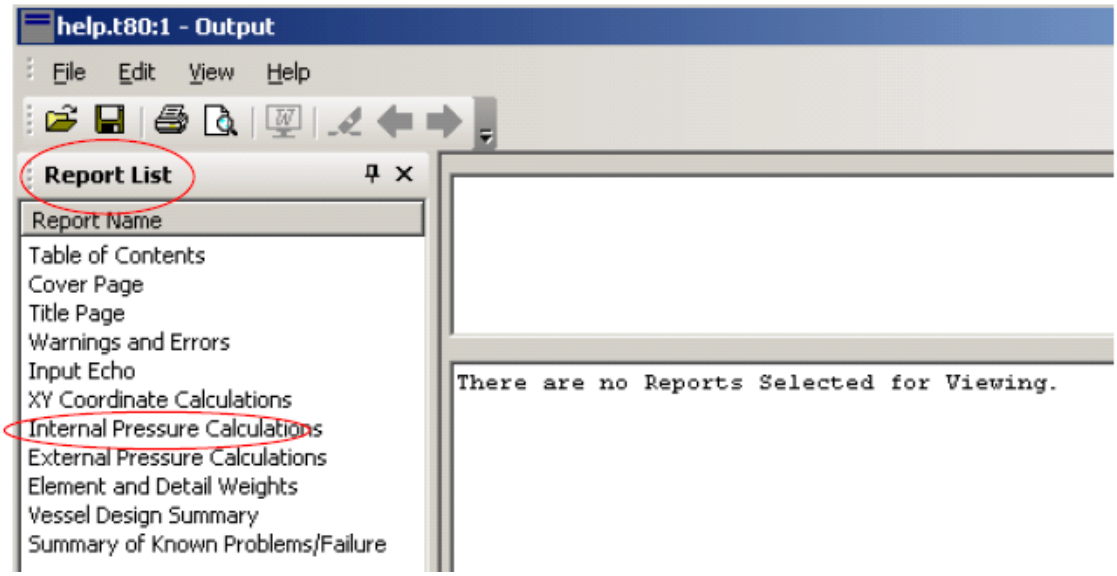
Click this button  . We now get the 'Output Processor' as follows:

By clicking the analyze button the program will start analyzing the vessel;

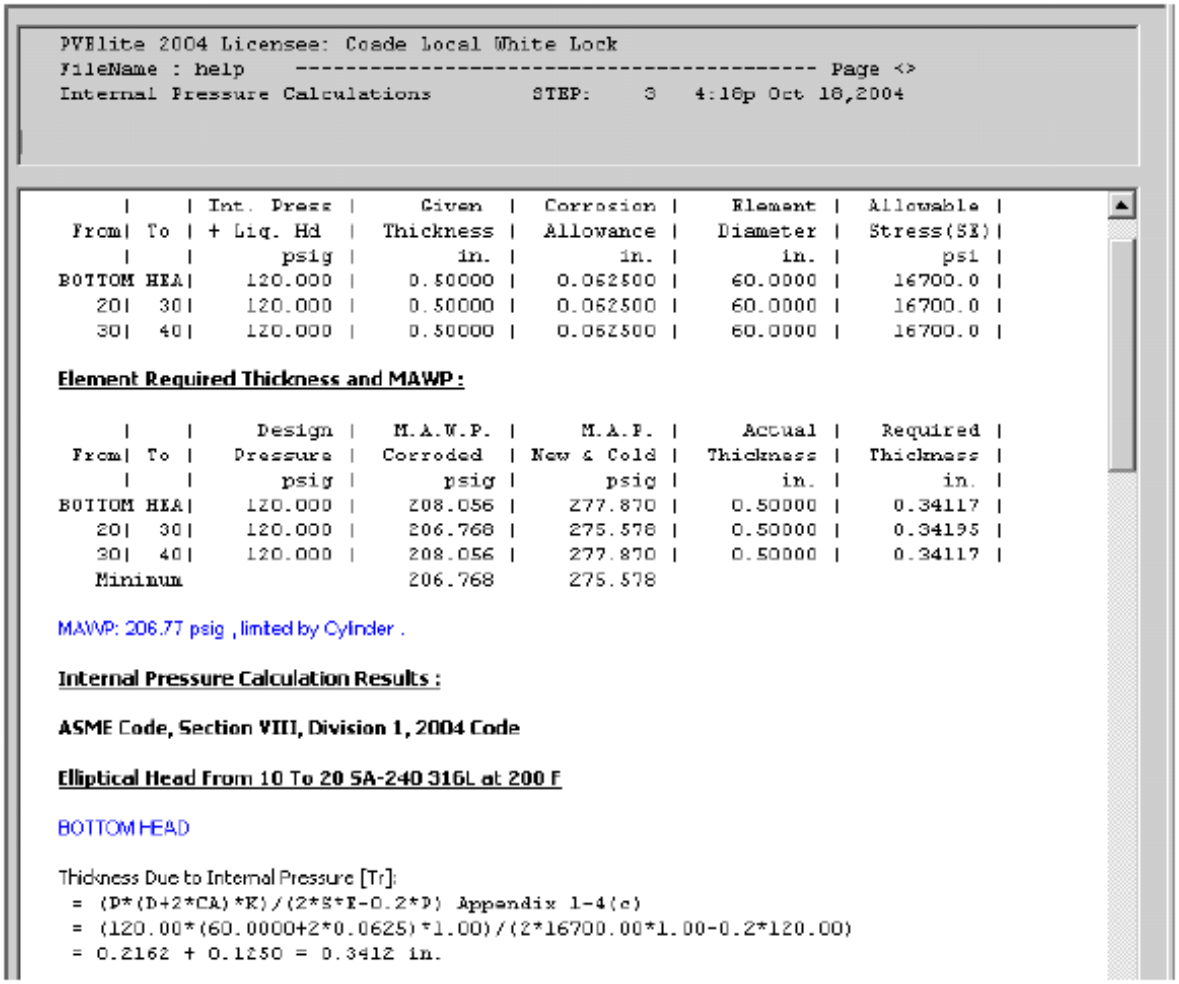


If the model is built errors free than no warning or error will be shown during analyzing. But if there are errors in the model than go to the model again and remove the errors

The Output Processor Now we have built our simple model, we need to get the complete details of the calculations performed by PVElite. At the top of the screen there is a button that looks like this:



The left window has the heading 'Report List'. In the right window, we are told 'There are no Reports Selected for Viewing'. In the left hand window, click on 'Internal Pressure Calculations' The right hand window now shows the results of the item you selected in the left hand window. The output window now looks as shown below:



PVElite 2004 Licensee: Coade Local White Lock
FileName : help ---------- Page <>
Internal Pressure Calculations STEP: 3 4:16p Oct 18,2004

From	To	Int. Press + Liq. Hd psig	Given Thickness in.	Corrosion Allowance in.	Element Diameter in.	Allowable Stress(SE) psi
BOTTOM HEA		120.000	0.50000	0.062500	60.0000	16700.0
20	30	120.000	0.50000	0.062500	60.0000	16700.0
30	40	120.000	0.50000	0.062500	60.0000	16700.0

Element Required Thickness and MAWP :

From	To	Design Pressure psig	M.A.W.P. Corroded psig	M.A.P. New & Cold psig	Actual Thickness in.	Required Thickness in.
BOTTOM HEA		120.000	208.056	277.870	0.50000	0.34117
20	30	120.000	206.768	275.578	0.50000	0.34195
30	40	120.000	208.056	277.870	0.50000	0.34117
Minimum			206.768	275.578		

MAWP: 206.77 psig , limited by Cylinder .

Internal Pressure Calculation Results :

ASME Code, Section VIII, Division 1, 2004 Code

Elliptical Head From 10 To 20 SA-240 316L at 200 F

BOTTOM HEAD

Thickness Due to Internal Pressure [Tr]:
= (P*(D+2*CA)*K)/(2*S*E-0.2*P) Appendix 1-4(c)
= (120.00*(60.0000+2*0.0625)*1.00)/(2*16700.00*1.00-0.2*120.00)
= 0.2162 + 0.1250 = 0.3412 in.

IMPORTANT NOTES:

The important output files which are usually reviewed are,

Internal pressure calculations

In internal pressure calculations the most important part to be observed is the percentage elongations of shell and head. If the percentage elongation exceeds 5% than it means that PWHT is required for the vessel. PWHT is not generally required for stainless steel vessels and the vessels made from pipe.

Nozzle Summary

Thoroughly observe the nozzle schedules and nozzle diameter clashes

Vessel Design Summary

MAWP, Vessel summary and weights

Support Calculations

Thoroughly observe the vessel support calculations and check the stresses.