AUTOPIPE NOZZLE

LOCAL STRESS ANALYSIS
V8i Release 8.11

Tutorial with Examples

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List of Examples

This tutorial introduces the main features of AutoPIPE Nozzle using the examples shown below. For more information about the functions and operation of AutoPIPE Nozzle, please refer to the online help.

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Example 1: The basic operating procedures of AutoPIPE Nozzle

This example describes the basic operation procedure of AutoPIPE Nozzle by using ASME Sec.VIII DIV.1(WRC107) option.

Design condition

Design Condition of Vessel

Item	Unit	Data
Vessel of type	**-**	**Cylindrical body**
Material	**-**	**SB410 equivalent**
Vessel inner diameter	**mm**	**2000**
Vessel wall thickness	**mm**	**20.0**
Vessel average radius	**mm**	**1010**
Internal pressure	**N/mm^2**	**1.5**
Temperature	**°C**	**100**
Allowable stress (at rest)	**N/mm^2**	**103**
Allowable stress (during operation)	**N/mm^2**	**103**

Design conditions of nozzle

Item	Unit	Input data
Type of nozzle	-	Hollow cylinder nozzle
Material	-	
Nozzle outer diameter	mm	267.4
Nozzle wall thickness	mm	12.0
Nozzle outer radius	mm	133.7

Piping load

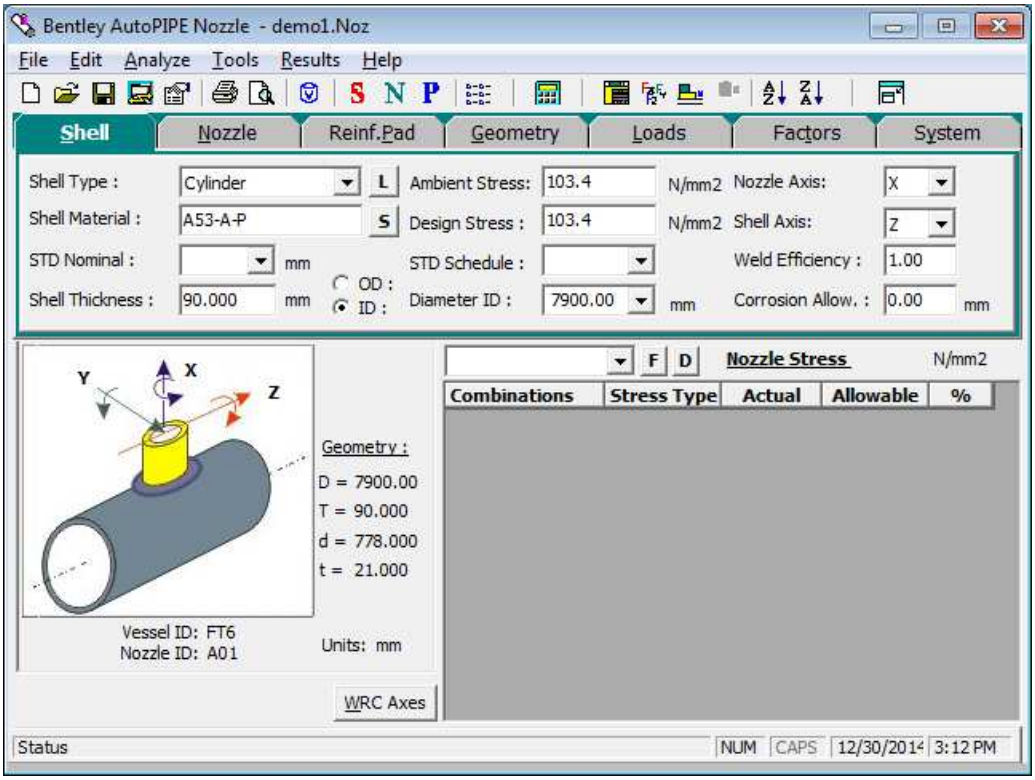
Load	Unit	Own Weight	Heat Load
Radial load P	N	-1000	-2000
Circumferential direction shear force V_C	N	1000	2000
Longitudinal shear force V_L	N	-1000	-2000
Circumferential direction moment M_C	N-m	5000	10000
Longitudinal direction moment M_L	N-m	5000	10000
Torsional moment M_T	N-m	5000	10000

Note: Load values are not the actual data in the example.

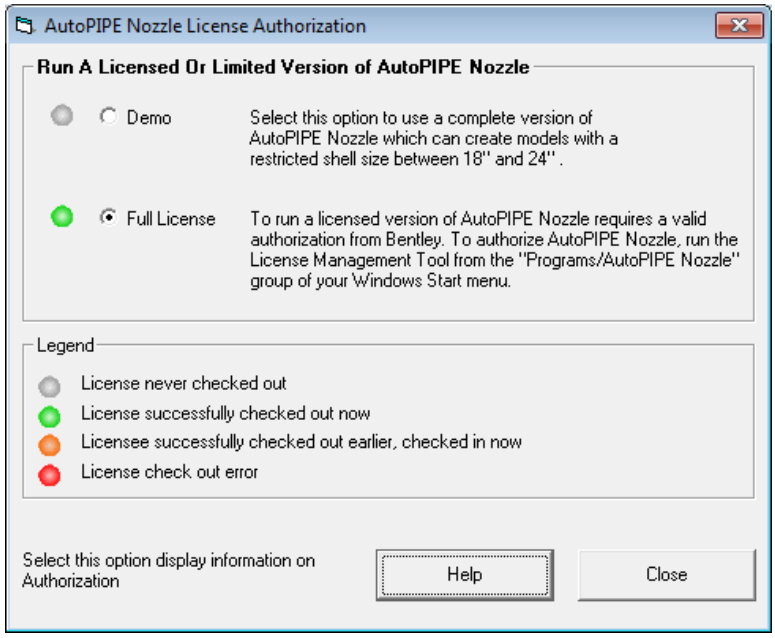
Starting AutoPIPE Nozzle

Open the Start menu, click **All Programs**, [Bentley Engineering], [AutoPIPE Nozzle V8i], and choose the [AutoPIPE Nozzle V8i]. For Win 8 and higher user, using Window 8 specific features, locate the AutoPIPE Nozzle application and open it.

As AutoPIPE Nozzle starts, you can see a screen similar to the following.



If you are running AutoPIPE Nozzle first time, then first select the “Full License” option. To select Full License option, click the File from main menu, a drop down menu will appear select the **Authorize** option. On selecting this option a new dialog box “ AutoPIPE Nozzle License Authorization” will appear.



Select the Full License option.

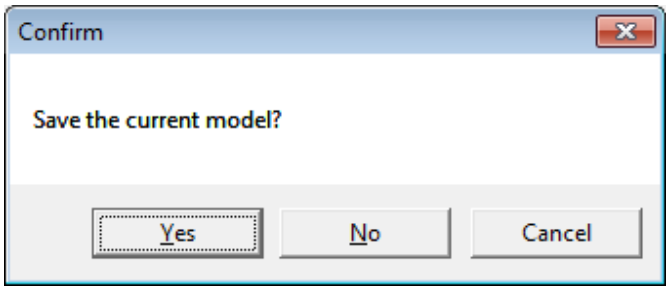
The full license option is only available on systems that have one following:

a. AutoPIPE Advanced License
b. AutoPIPE Nuclear License

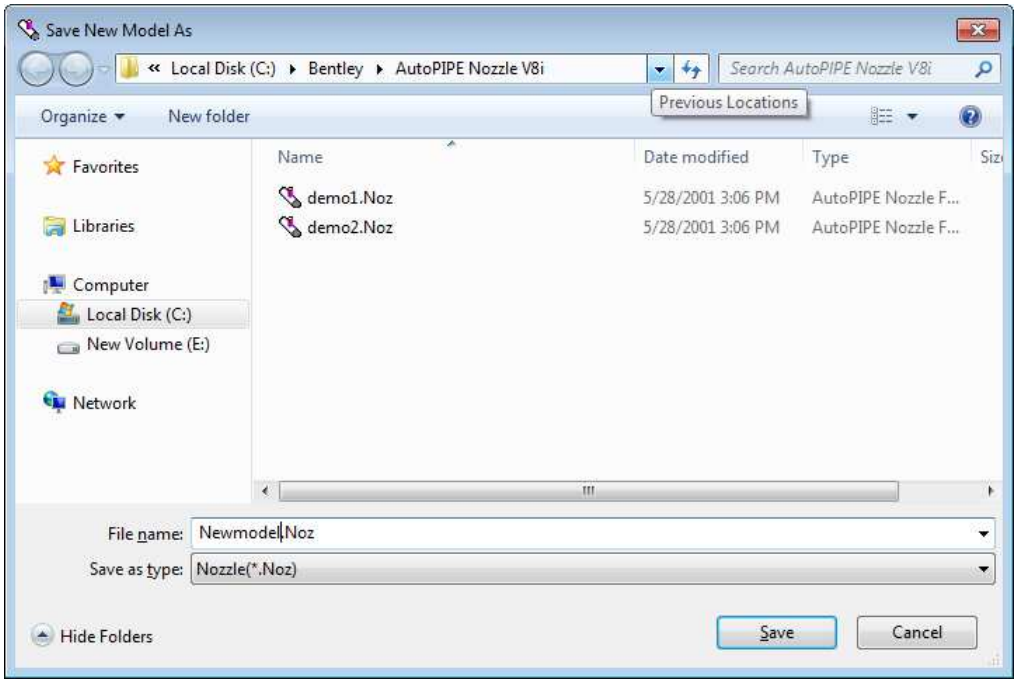
The program will default to demo mode if only AutoPIPE Standard license is available. Check LMT (License Management Tool)> License Checkout tab to verify what licenses are available. Again, the program will only function if AutoPIPE Advanced / Nuclear license(s) are listed. Otherwise it will revert to demo mode.

Creating new Model

To create a new model, Click **File** button from main menu, a drop down menu will appear select **New** from this drop down menu. On selecting this option, a new dialog box invokes.



On clicking <**No>** button, a "Save New Model As" dialog box will appear.

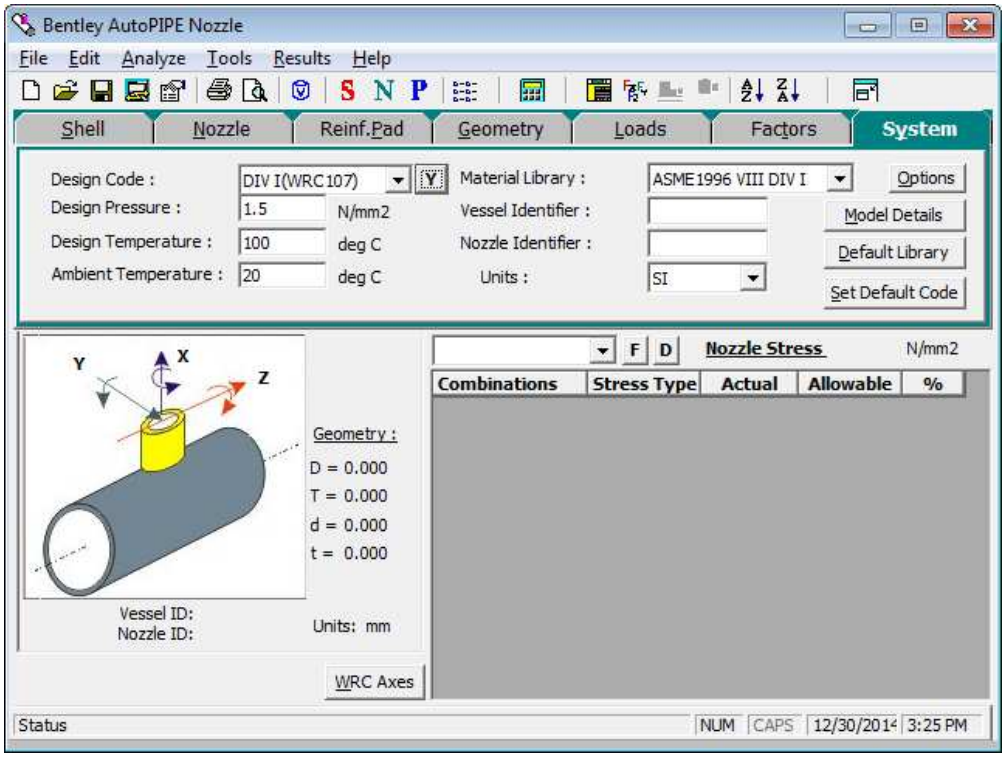


Navigate to the appropriate folder, enter the name of the model to the "File name" field, and press <**Save**> button.

Now enter the data for the following tabs.

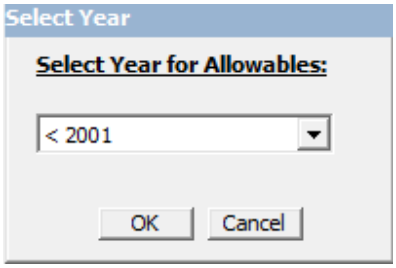
Data for System tab

Click the **System** tab. In this tab first change the **UNIT** option from **Standard** to **SI** and then enter the data as follow



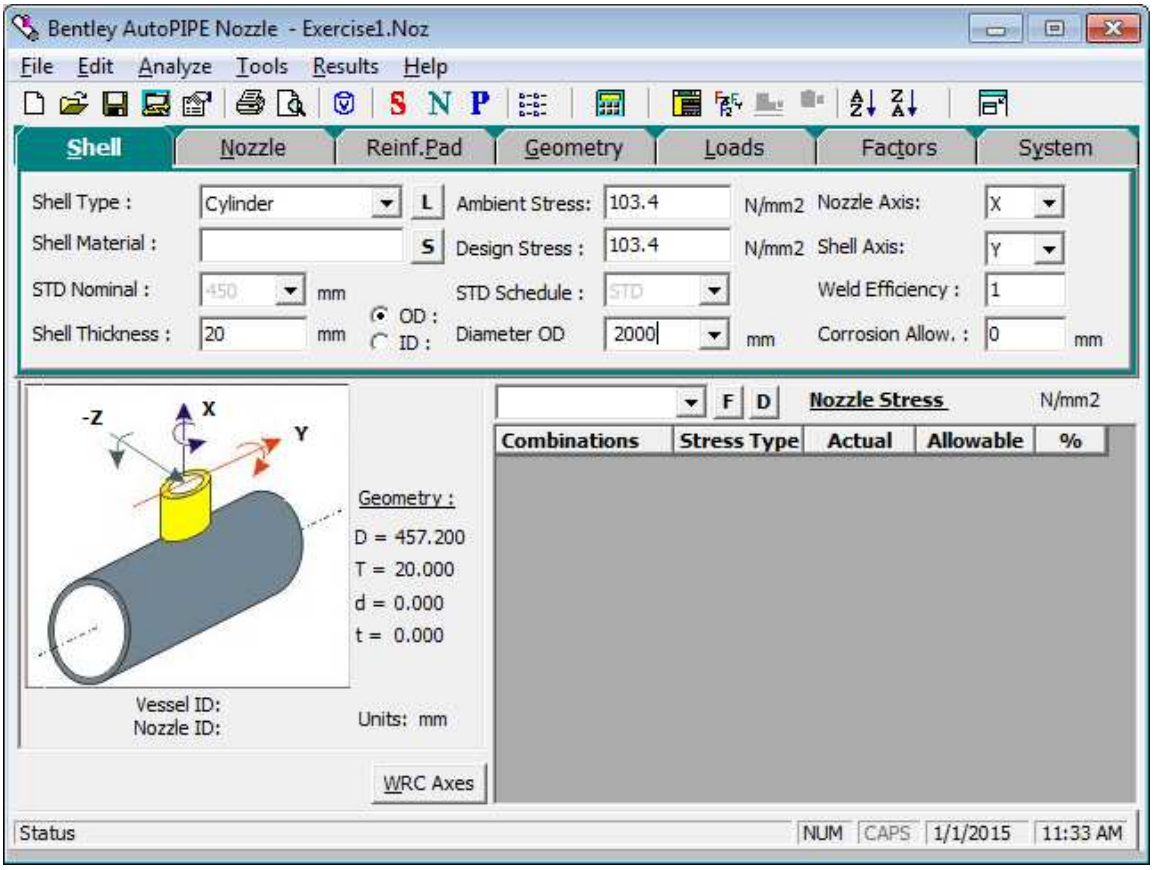
Item	Unit	Input value or selection
Units	-	SI
Design Code	-	DIV I (WRC107)
Material Library	-	ASME1996 VIII DIV I
Design Pressure	N/mm^2	1.5
Design Temperature	℃	100
Ambient Temperature	℃	20

Now click the <**Y**> button to the right of the input field for **Design Code**, to display the following dialog box, and then select the year for calculating the allowable stress values.



Data for Shell tab

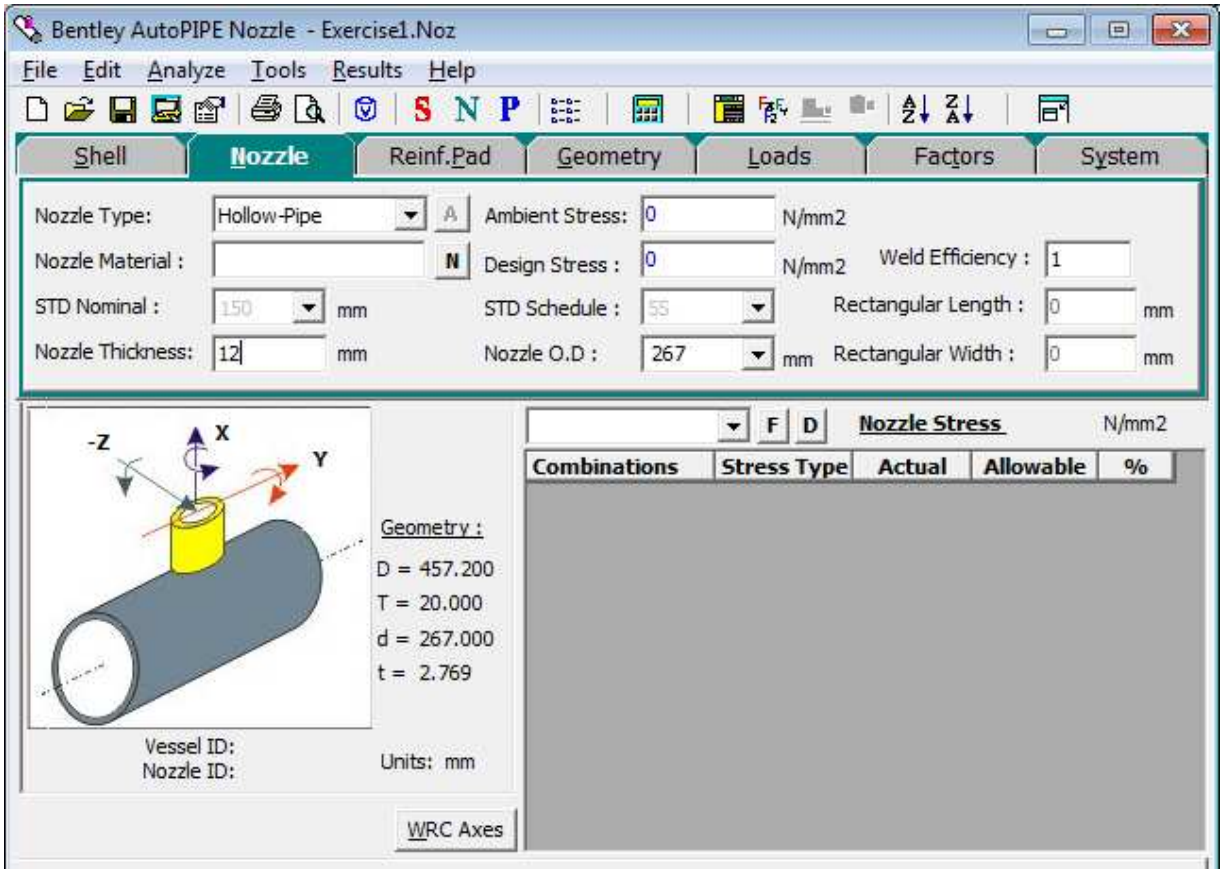
Click the **Shell** tab, and enter the data on the shell as follow:



Item	Unit	Input value or selection
Shell Type	-	Cylinder
Shell Thickness	mm	20
Ambient Stress	N/mm^2	103
Design Stress	N/mm^2	103
ID	-	Click
Diameter ID	mm	2000
Nozzle Axis	-	X
Shell Axis	-	Z

Data for Nozzle tab

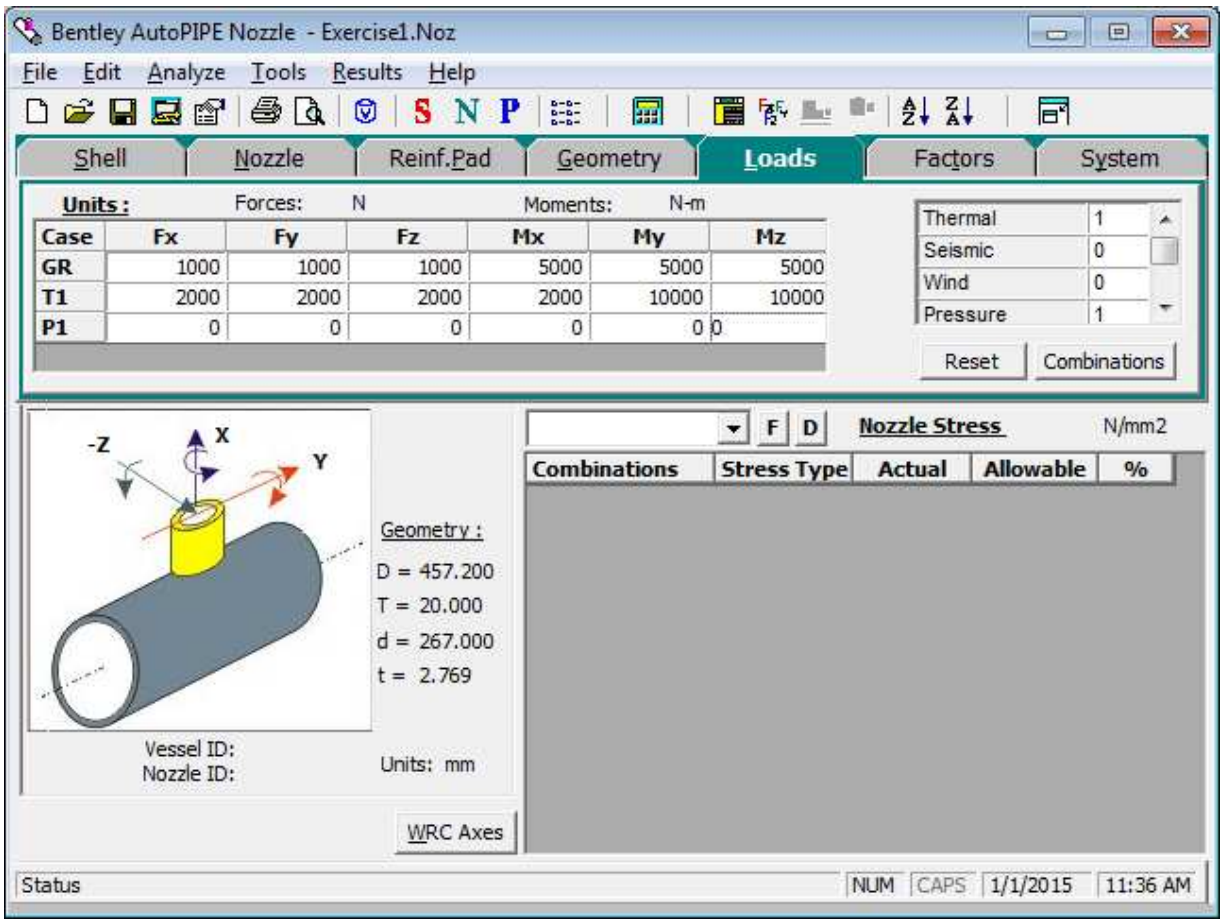
Click the **Nozzle** tab, and enter the data on the nozzle as follow:



Item	Unit	Input value or selected unit
Nozzle Type	-	Hollow-Pipe
Nozzle Thickness	mm	12
Nozzle O.D	mm	267.4

Data for Load Tab

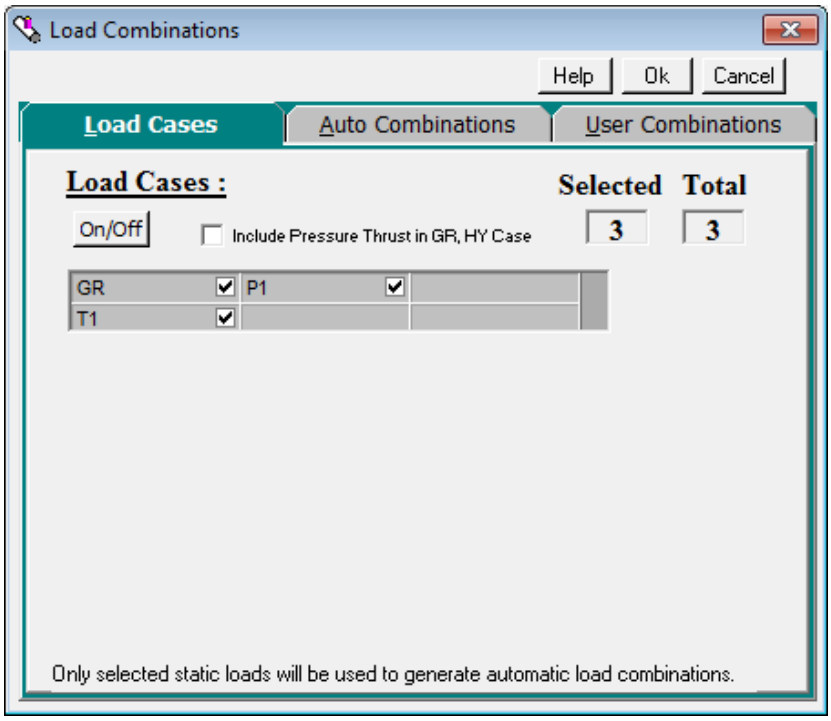
Click the **Loads** tab, and enter the value <**1**> for thermal field, and then enter the following data as shown below:



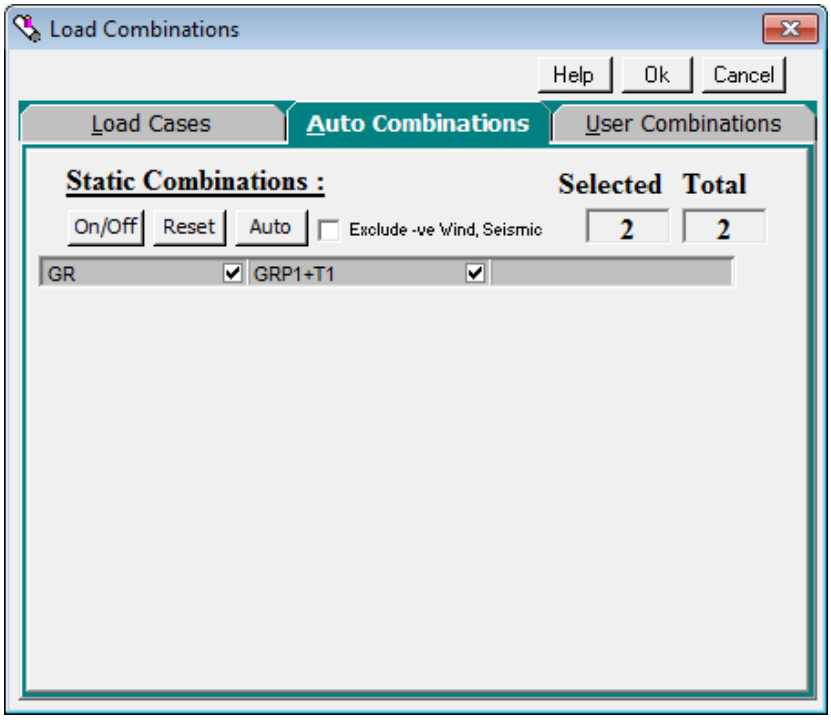
Item	Unit	Input value or selection
Thermal	-	1
GR - Fx	N	1000
Fy	N	1000
Fz	N	1000
Mx	N-m	5000
My	N-m	5000
Mz	N-m	5000
T1 – Fx	N	2000
Fy	N	2000
Fz	N	2000
Mx	N-m	10000
My	N-m	10000
Mz	N-m	10000

Combination Button

Click on the <**Combinations**> button in the Loads tab, click on the <**combination**> button, Load Combinations dialog appears. Click the **Load Cases** tab, check the **GR** and **T1** (P1 will be checked automatically).

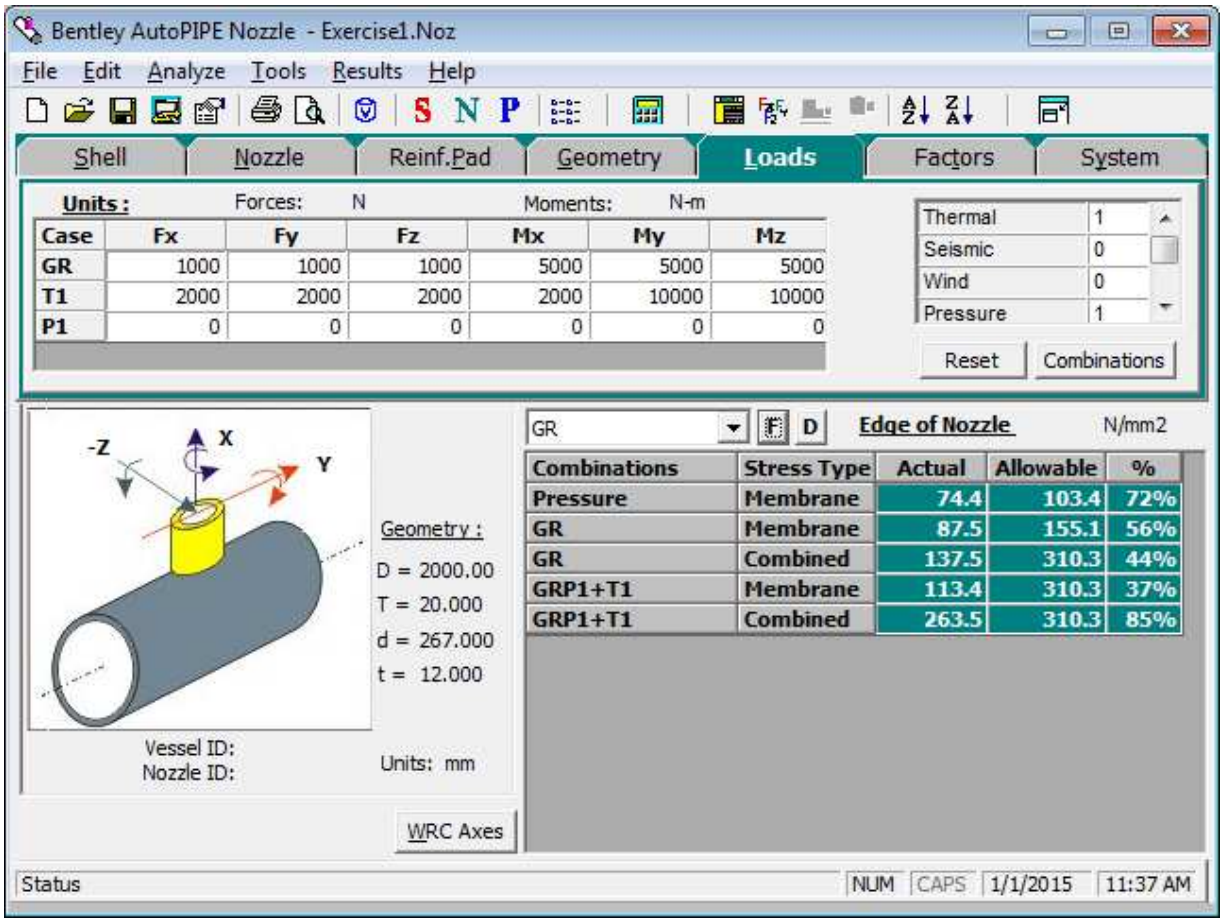


Then, click the **Auto Combinations** tab; you can check the **GR** and **GRP1 + T1** and click <**ok**> to close the dialog.



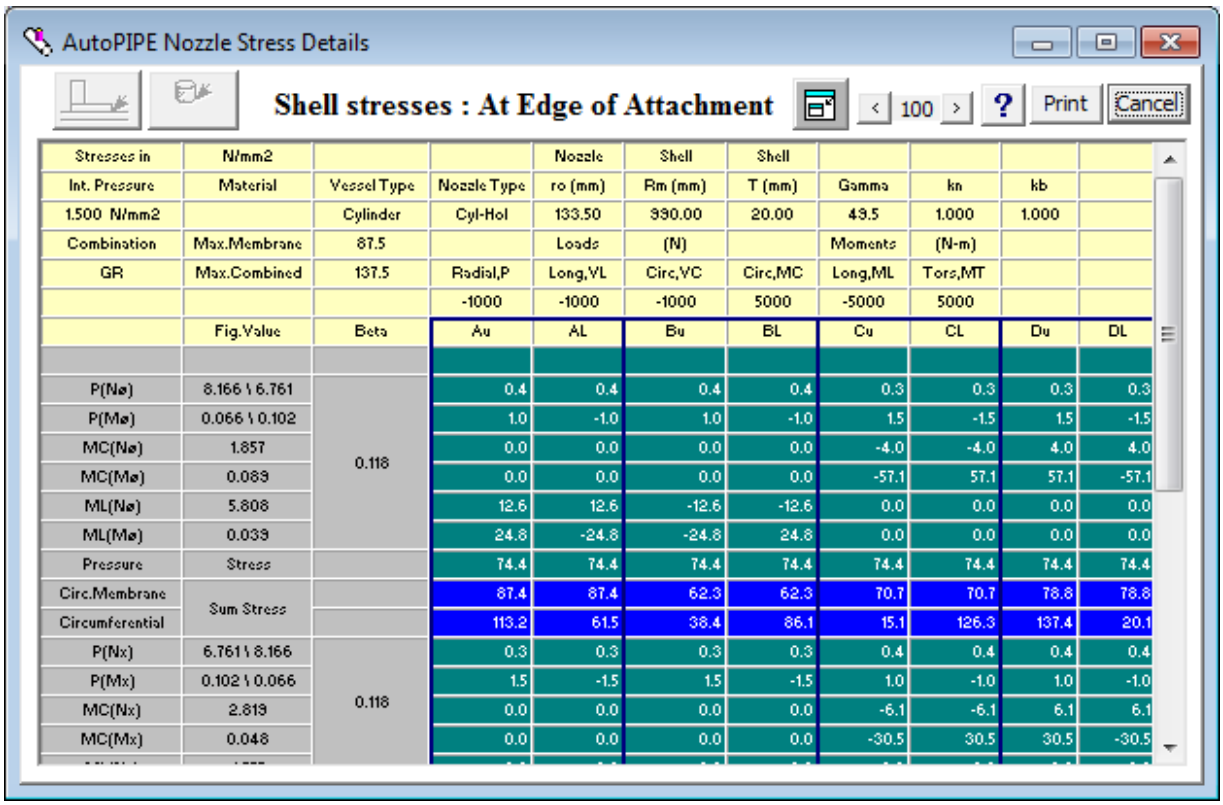
Performing Calculation

Before running the calculation, save the model first and then select **Analyze->Stresses** option from menu bar. After calculation, you will see a list of maximum stress of each combination in AutoPIPE Nozzle window.



View Detail stress value

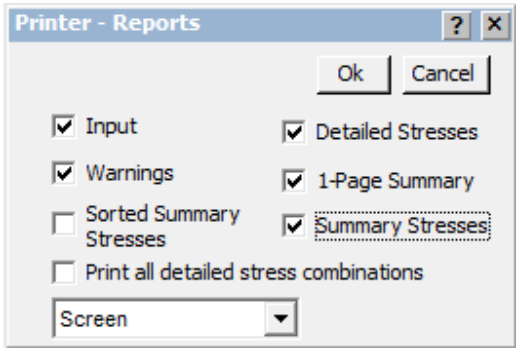
To view the detailed stress of any combination, select any combination from combination list and double click it.



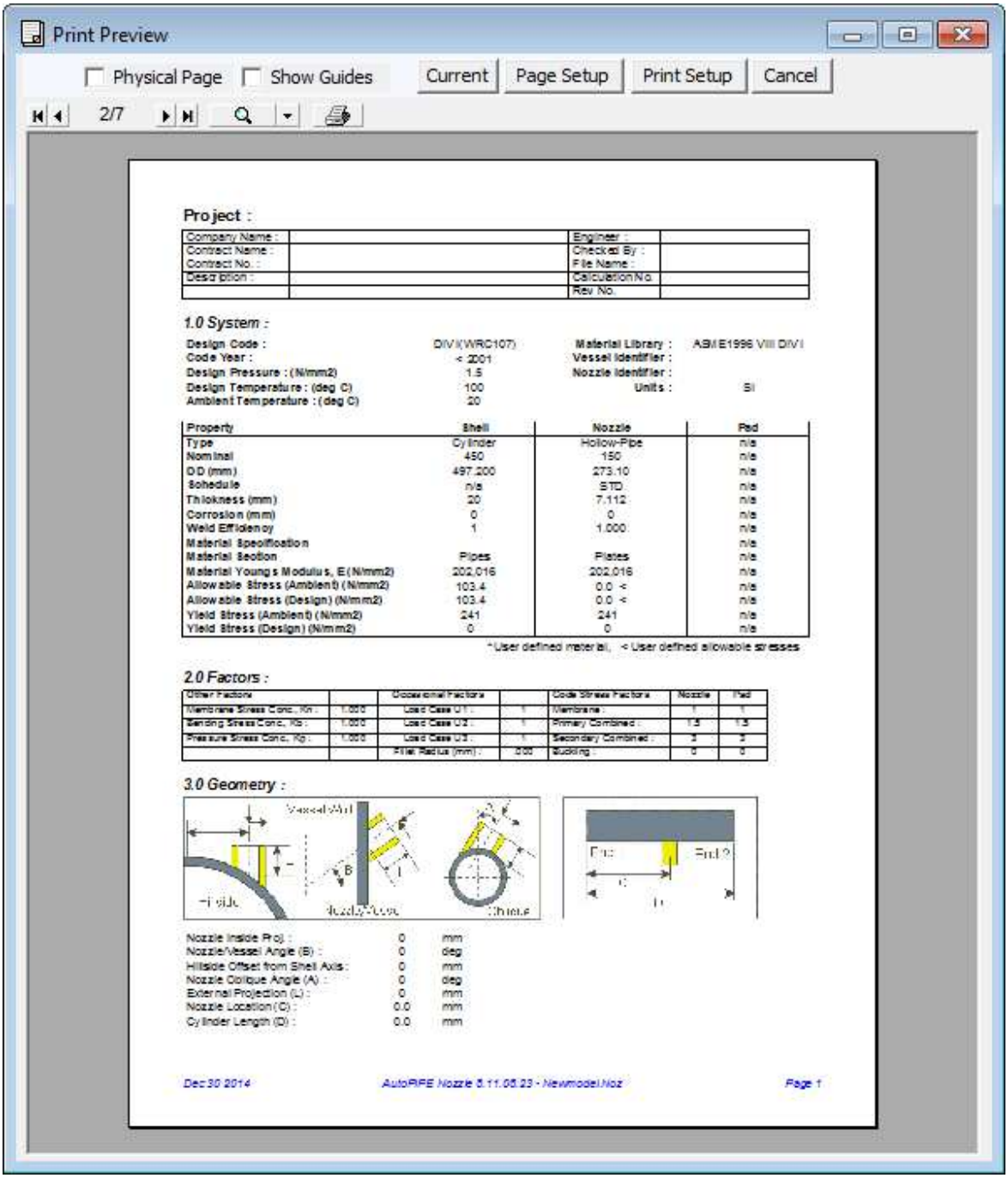
Stresses in	N/mm2			Nozzle	Shell	Shell				
Int. Pressure	Material	Vessel Type	Nozzle Type	ro (mm)	Rm (mm)	T (mm)	Gamma	kn	kb	
1.500 N/mm2		Cylinder	Cyl-Hol	133.50	990.00	20.00	49.5	1.000	1.000	
Combination	Max.Membrane	87.5		Loads	(N)		Moments	(N-m)		
GR	Max.Combined	137.5	Radial,P	Long,VL	Circ,VC	Circ,MC	Long,ML	Tors,MT		
			-1000	-1000	-1000	5000	-5000	5000		
	Fig.Value	Beta	Au	AL	Bu	BL	Cu	CL	Du	DL
P(Nø)	8.166 \ 6.761	0.118	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
P(Mø)	0.066 \ 0.102		1.0	-1.0	1.0	-1.0	1.5	-1.5	1.5	-1.5
MC(Nø)	1.857		0.0	0.0	0.0	0.0	-4.0	-4.0	4.0	4.0
MC(Mø)	0.089		0.0	0.0	0.0	0.0	-57.1	57.1	57.1	-57.1
ML(Nø)	5.808		12.6	12.6	-12.6	-12.6	0.0	0.0	0.0	0.0
ML(Mø)	0.039		24.8	-24.8	-24.8	24.8	0.0	0.0	0.0	0.0
Pressure	Stress		74.4	74.4	74.4	74.4	74.4	74.4	74.4	74.4
Circ.Membrane	Sum Stress		87.4	87.4	62.3	62.3	70.7	70.7	78.8	78.8
Circumferential			113.2	61.5	38.4	86.1	15.1	126.3	137.4	20.1
P(Nx)	6.761 \ 8.166	0.118	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.4
P(Mx)	0.102 \ 0.066		1.5	-1.5	1.5	-1.5	1.0	-1.0	1.0	-1.0
MC(Nx)	2.819		0.0	0.0	0.0	0.0	-6.1	-6.1	6.1	6.1
MC(Mx)	0.048		0.0	0.0	0.0	0.0	-30.5	30.5	30.5	-30.5

Print result

To view the print preview, click [File]->[Print Preview] command. A dialog box “Printer-Reports” will appear. Select the options as needed and press <**Ok**> button.



On Clicking OK a print preview dialog box will appear.

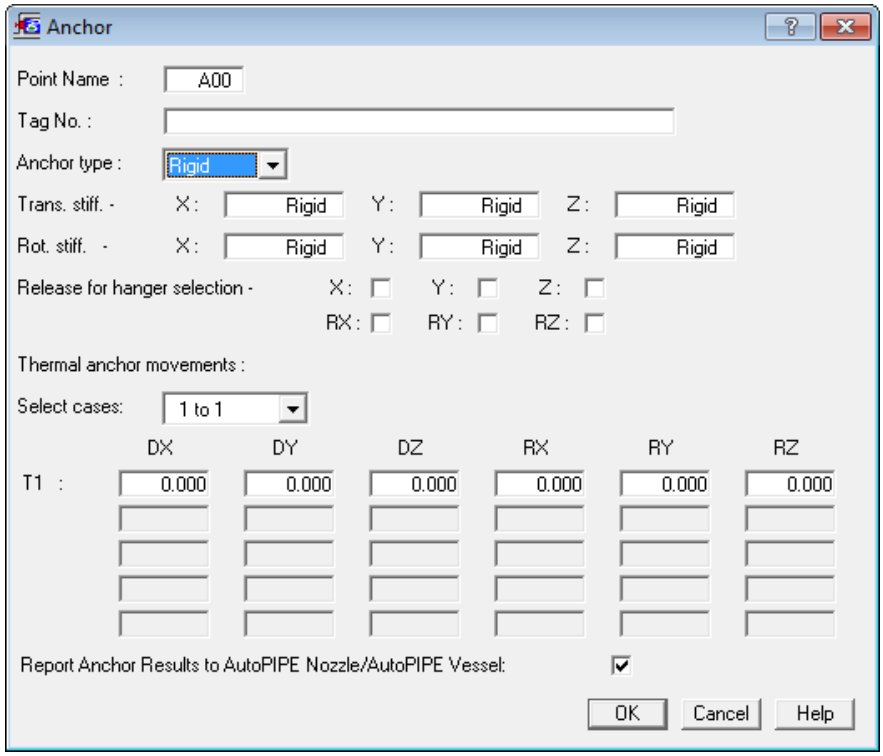


To print the result, click the <**Print**> button.

Example2: Import Anchor Loads from AutoPIPE into AutoPIPE Nozzle

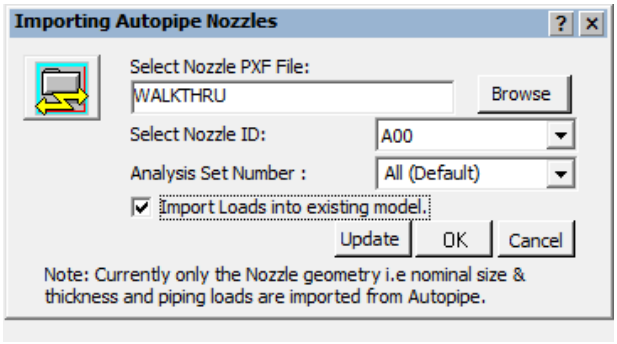
This example describes the interface to transfer the anchor loads calculated in AutoPIPE into AutoPIPE Nozzle.

Open or create a model in AutoPIPE, and select the anchor node of nozzle in model. Now right click on the selected anchor, a pop menu will appear, select the [Modify] > [anchor] command. After selecting this option, an "**Anchor**" dialog will appear, select the anchor type and check the option "**Report Anchor results to AutoPIPE Nozzle/AutoPIPE Vessel**", and close the dialog by pressing the <**Ok**> button.



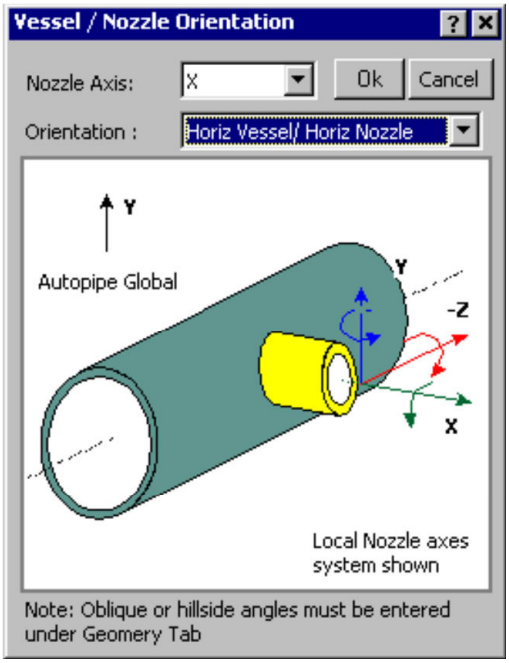
Import Loads

From within AutoPIPE, select [**Analysis]** option from menu bar of AutoPIPE and select **Static** option. After performing the static analysis, select [File] > [export] > [Nozzle Loads to AutoPIPE Nozzle] to export the loads to AutoPIPE Nozzle. The AutoPIPE Nozzle will start automatically, and you can see the following dialog in AutoPIPE Nozzle.

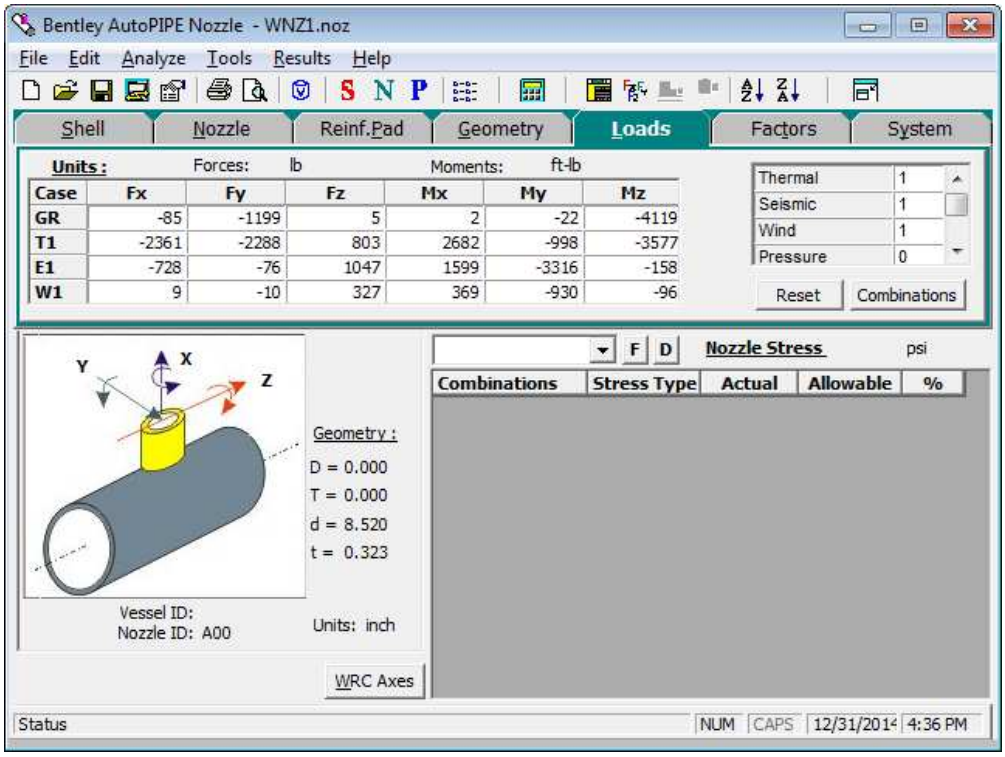


Change the "**Select Nozzle ID**" value to "**A00**", Set "**Analysis set of number**" to (All) , and then press the <**Ok**> button.

Subsequently, a dialog for selecting the direction of the nozzle and the Vessel will be display:



Select the direction of the nozzle and the Vessel, and then press the <**Ok**> button. All of the Anchor loads of AutoPIPE will automatically be imported into AutoPIPE Nozzle. This data can be viewed on the **Load** tab. It should be noted that the coordinate system of both AutoPIPE Nozzle and AutoPIPE may be different; the program will automatically perform coordinate transformation when the data is imported.



After importing the nozzle load from AutoPIPE continue filling out the other tabs with data as needed before running an analysis in AutoPIPE Nozzle.

Example3: Level 1 seismic analysis with a cylindrical shell.

In this example, demonstrate how to perform a "**Level 1 seismic analysis with a cylindrical shell"**. AutoPIPE Nozzle has the ability to import anchor load points that were analyzed by KHK level 1 code in AutoPIPE, this example shows a case in which you enter the piping load directly.

Design condition

Vessel of design conditions

Item	Unit	Data
Vessel of type	_	Cylindrical body
Material	_	SB410
Vessel inner diameter	mm	2000
Vessel wall thickness	mm	20.0
Vessel average radius	mm	1010
Internal pressure	N/mm^2	1.176
Temperature	℃	200
Allowable stress (at rest)	N/mm^2	103
Allowable stress (during operation)	N/mm^2	103
Yield stress (at rest)	N/mm^2	225
Yield stress (during operation)	N/mm^2	189

Design conditions of nozzle

Item	Unit	Input data
Type of nozzle		Hollow cylinder nozzle
Material		(STPG370-S)
Nozzle outer diameter	mm	267.4
Nozzle wall thickness	mm	12.0
Nozzle outer radius	mm	133.7

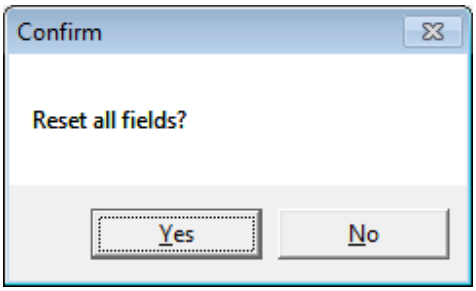
Piping load

Case	F_x	Fy	Fz	Mx	My	Mz
	(N)	(N)	(N)	(N-m)	(N-m)	(N-m)
GR	1000	1000	1000	1000	1000	1000
T1	2000	2000	2000	2000	2000	2000
E1	3000	3000	3000	3000	3000	3000
E2	4000	4000	4000	4000	4000	4000
E3	5000	5000	5000	5000	5000	5000
P1	100	100	100	100	100	100
S1	6000	6000	6000	6000	6000	6000
S2	7000	7000	7000	7000	7000	7000

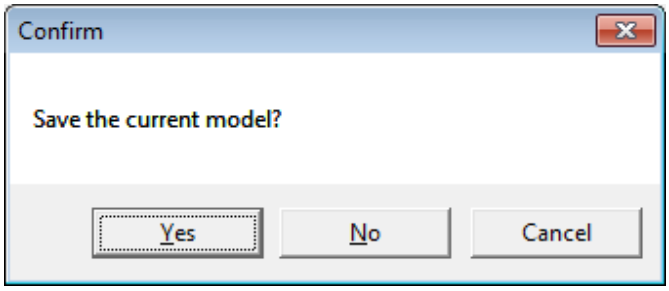
Note: Load values are not the actual data in the example.

Input of the System Data

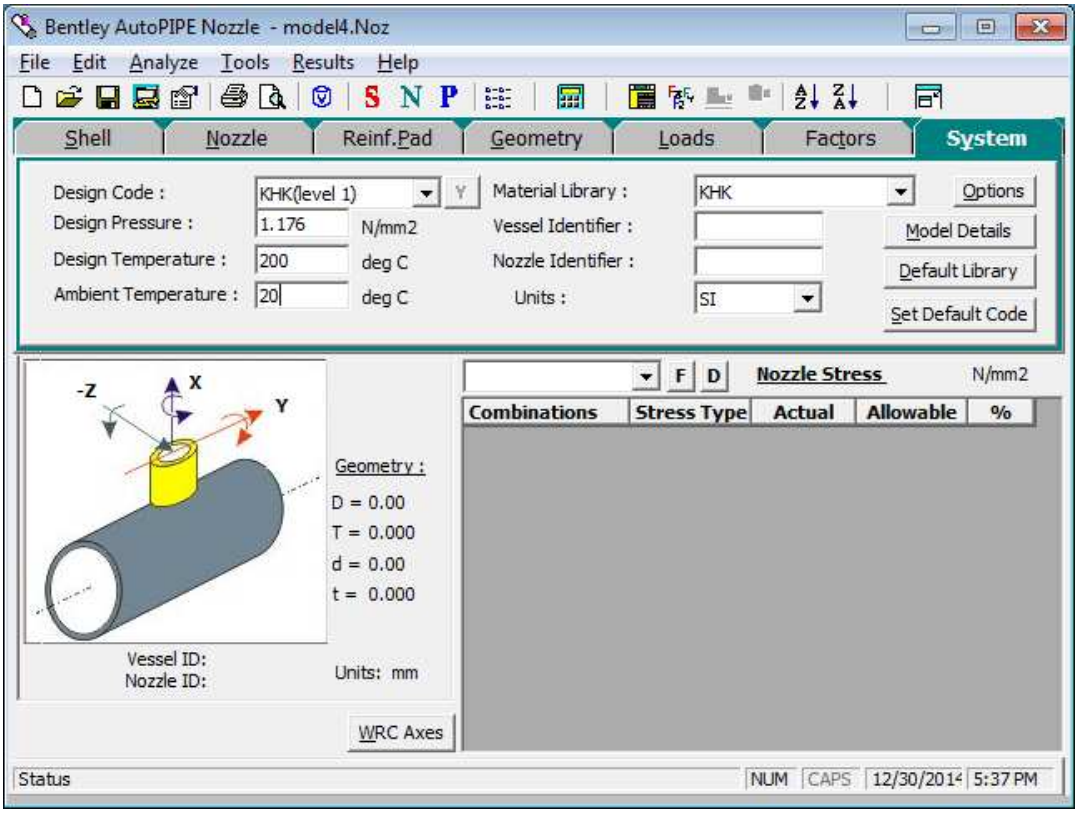
Click the **System** tab, and then select the KHK (Level 1) from Design Code field. After changing the Design Code, the following dialog box will display, click <**Yes**> button.



A "**Save Dialog box**" will appear, to save the data click <**Yes**> button again.



Now select the **System** tab change the Unit value to SI and then enter the other data as follows:

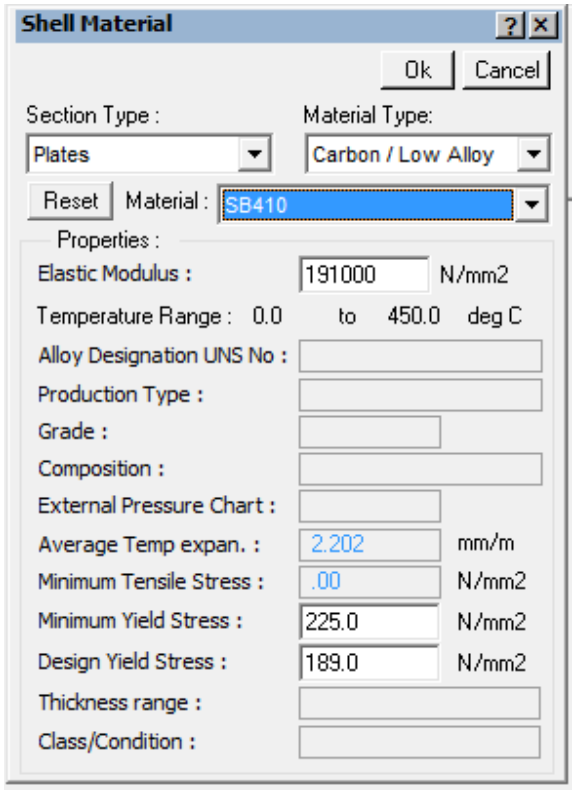


Item	Unit	Input Value or selection
Units	-	SI
Design Code	-	KHK (level 1)
Material Library	-	KHK
Design Pressure	N/mm^2	1.176
Design Temperature	℃	200
Ambient Temperature	℃	20

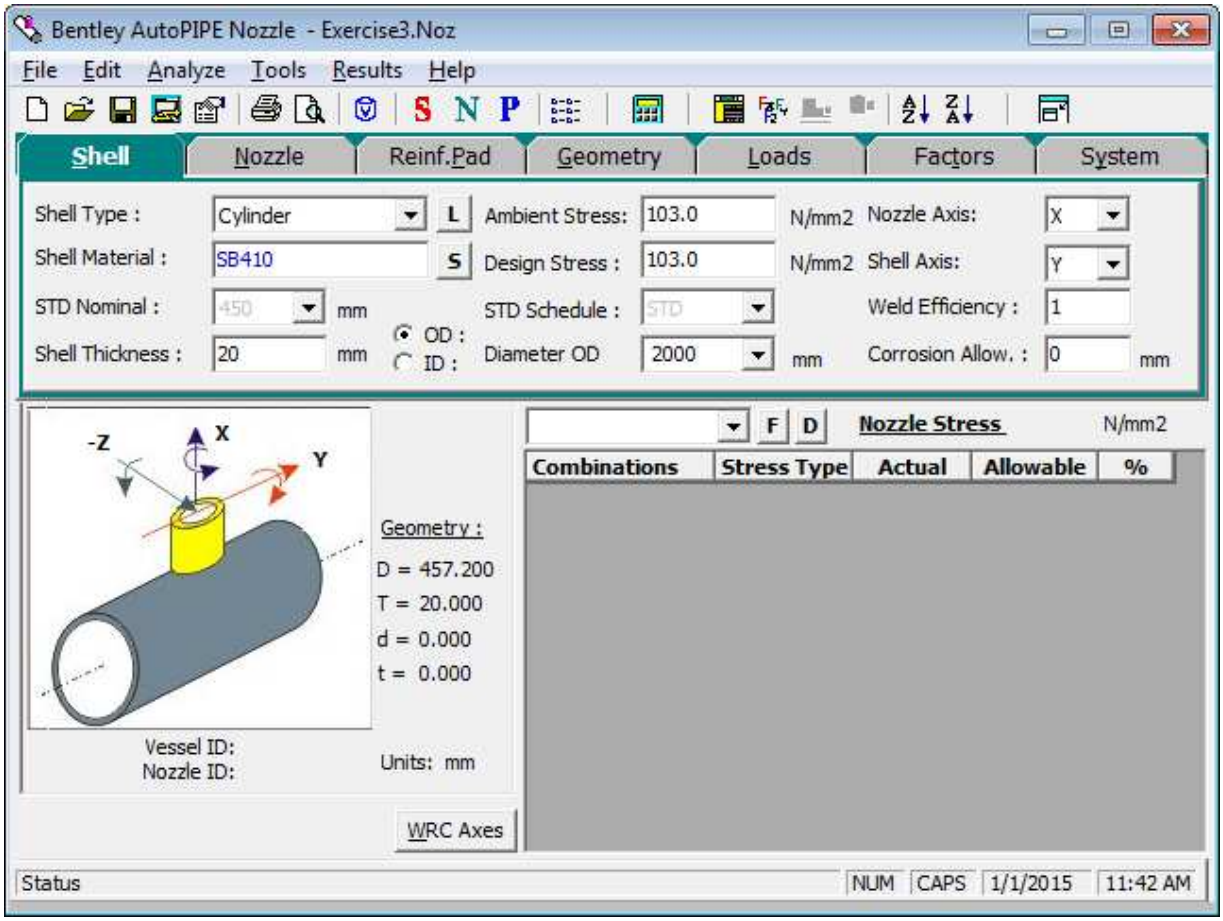
Next, press on [File] > [Save As] command, and then save the data for KHK with a new file name.

Shell input data

Select the **Shell** tab and then click <**S**> button. On clicking this button, a new dialog box "**Shell Material**" will display.



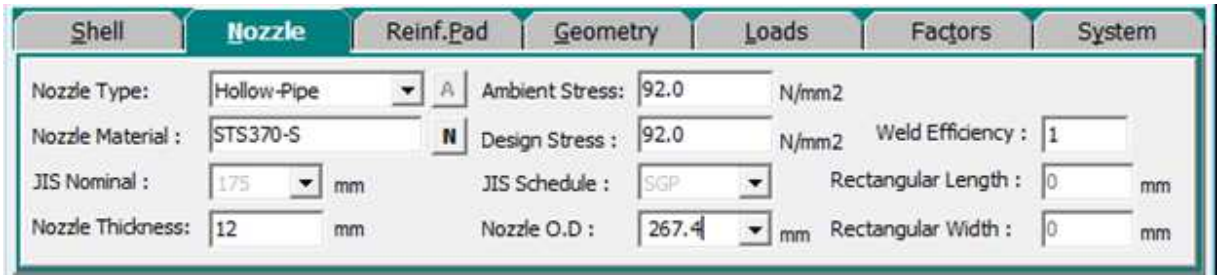
Set "Section Type" = (Plates), and "Material" = (SB410). Some values will be automatically set on the dialog after these selections are made. Now press the <**Ok**> button and then enter the other data on the Shell tab as follows:

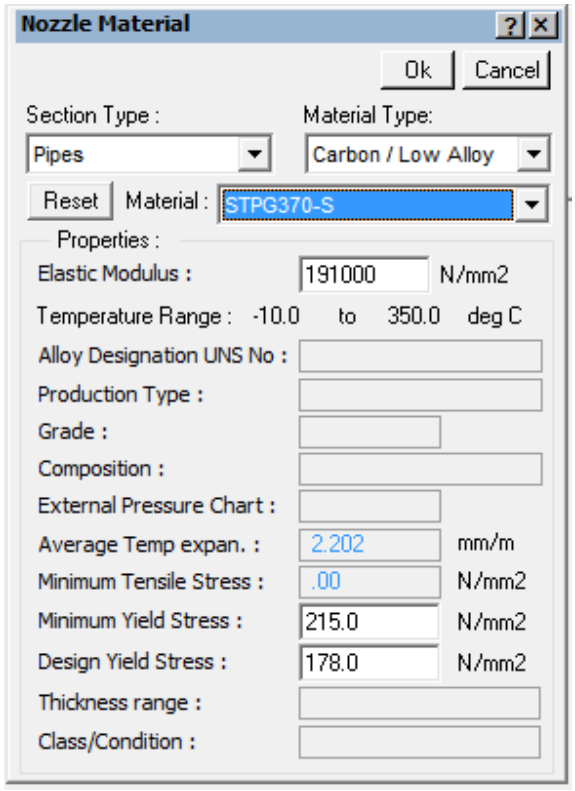


Item	Unit	Input Value and selection
Shell Type	-	Cylinder
Shell Thickness	mm	20
Ambient Stress	N/mm^2	103 (Automatic)
Design Stress	N/mm^2	103 (Automatic)
ID	-	(Click)
Diameter ID	mm	2000
Nozzle Axis	-	X
Shell Axis	-	Y

Data for Nozzle

Click the **Nozzle** tab, and then click <**N**> button to the right of the Nozzle Material field. On clicking this button a "Nozzle Material" dialog box will appear.





Select the "**Section Type**" = (**Pipes**), select the (**STPG370-S**) from Material drop down listing and then press the <**Ok**> button. Some values will be automatically set on the dialog after these selections are made. Now press the <**Ok**> button and then enter the other data on the Nozzle tab as follows:

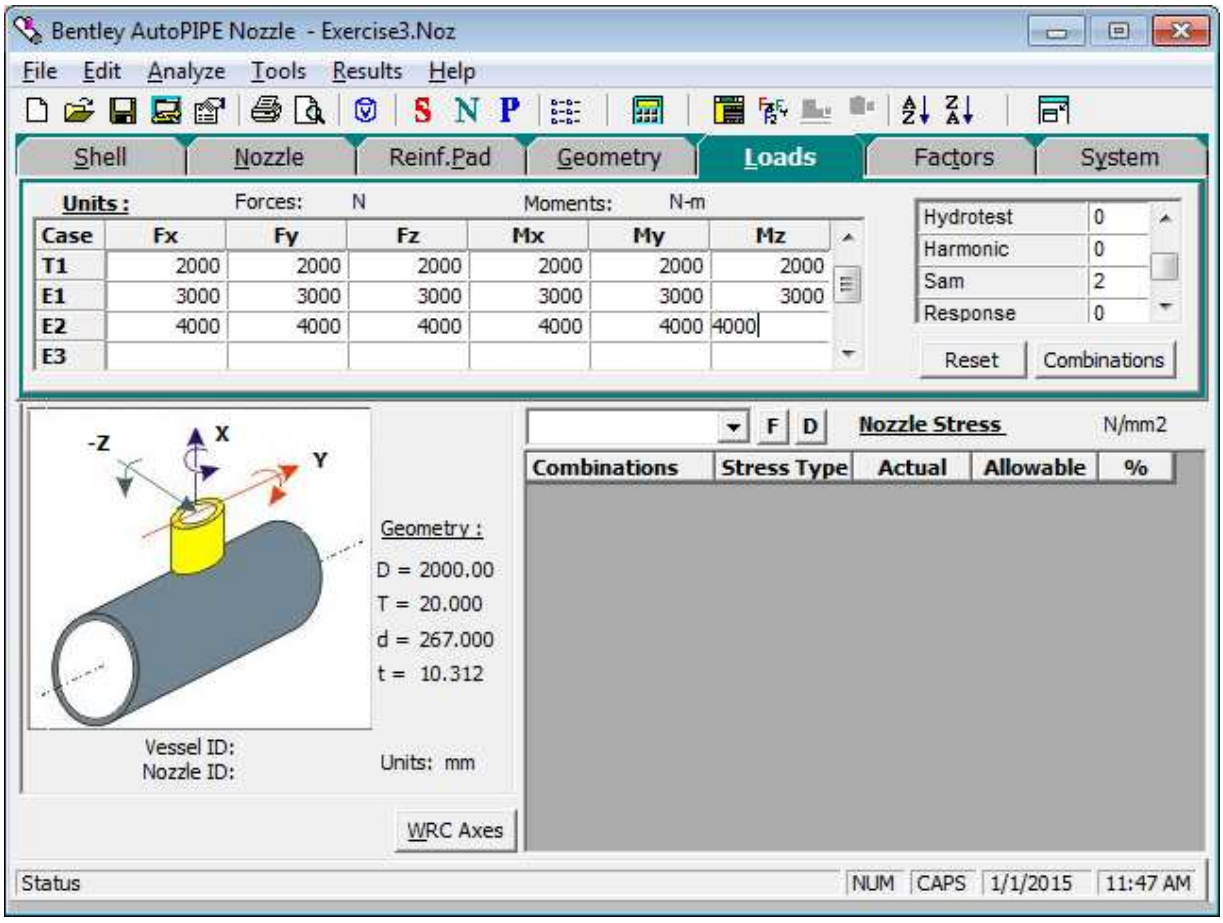
Item	Unit	Input value or selection
Nozzle Type	-	Hollow-Pipe
Nozzle Thickness	mm	12
Ambient Stress	N/mm^2	92 (Automatic)
Design Stress	N/mm^2	92 (Automatic)
Nozzle O.D	mm	267.4

Data for Load tab

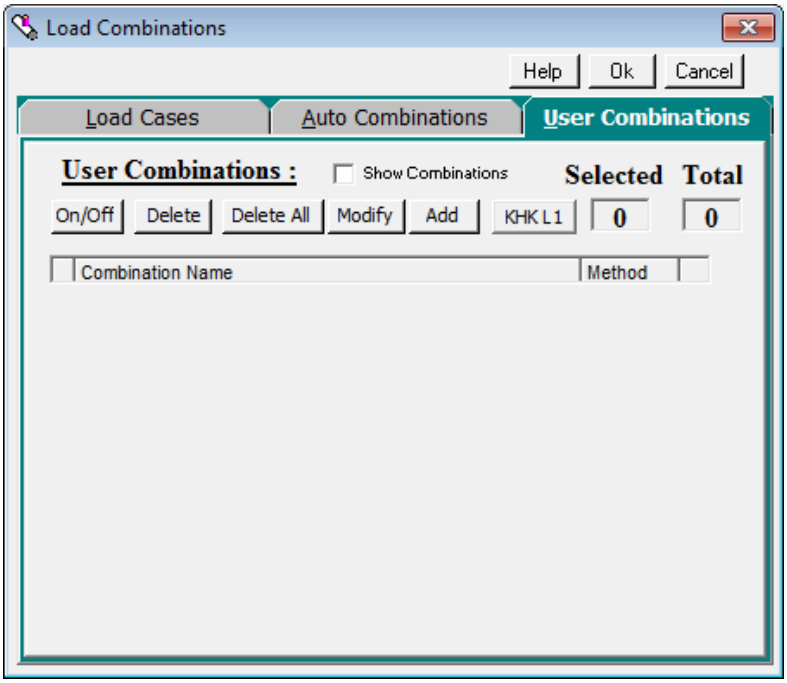
Click the **Loads** tab, and enter the following values in the right-hand column of the load number of cases.

Item	Unit	Input value or section
Thermal	-	1
Seismic	-	3
Sam	-	2
Pressure	-	1

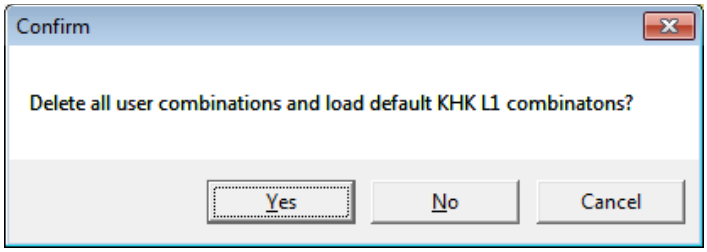
After entering the above settings, the input field for load case GR, T1, E1, E2, E3, P1, S1, S2 will be displayed. Please enter the following data of piping load as shown below:



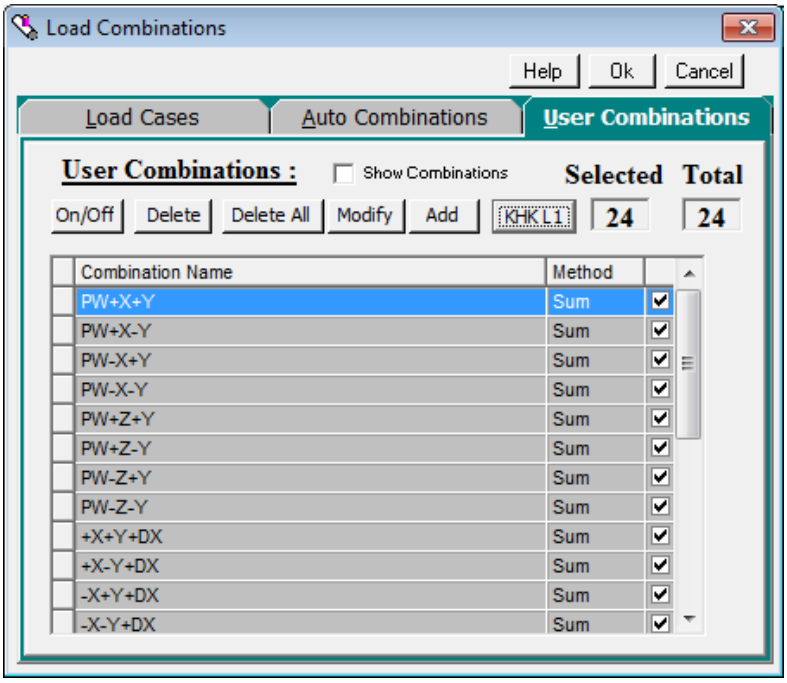
Then, press the <**Combinations**> button, a new dialog box "**Load Combination**" will appear, now click the **User Combinations** tab and press the <**KHK L1**> button.



A dialog will appear, click on the <**Yes**> button.

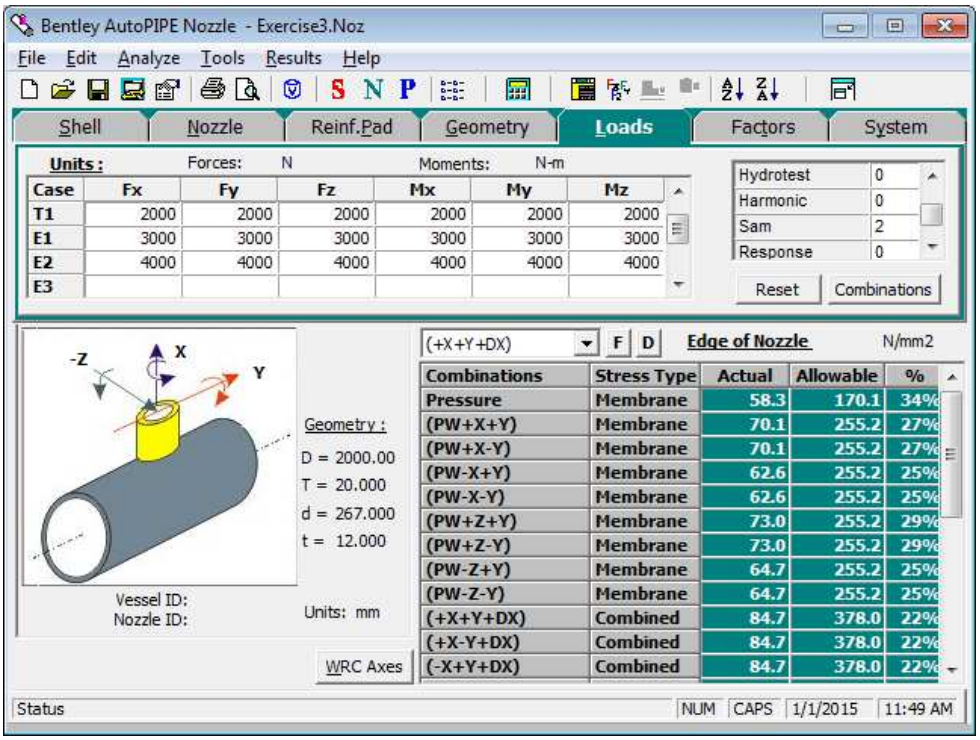


The combination for KHK will be automatically set, click on <**Ok**> button to close the dialog box.

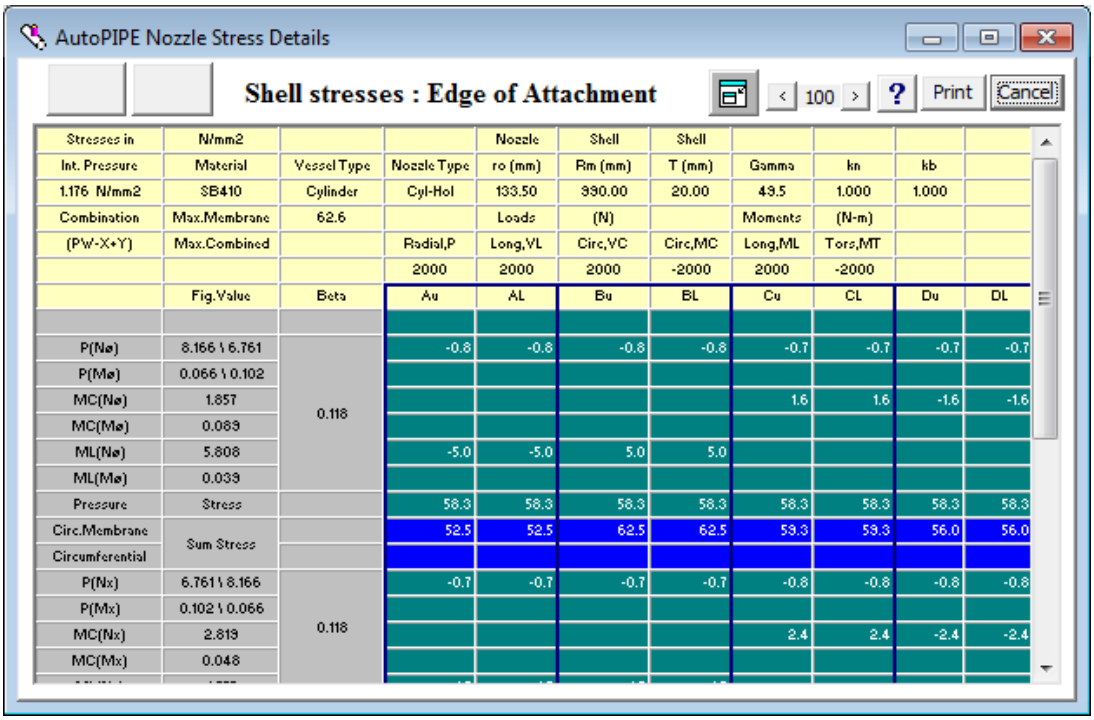


Execution and output result of calculation

Press [File] / [Save] command, and then save the data to a file. First Save the file and then run “Stress” from drop down menu of Analyze for stress Calculation. After the calculation, you will see a list of maximum stress of each combination in the lower right area of AutoPIPE Nozzle window.



To view the detailed stress of any combination, select any combination from combination list and double click it.



Exercise 4: Level 2 seismic standards evaluation of high-pressure gas

In this example, demonstrate how to perform a "**Level 2 seismic standards evaluation of high-pressure gas"**. AutoPIPE Nozzle has the ability to import anchor load points that were analyzed by KHK level 2 code in AutoPIPE, this example will then calculate the stress generated at the junction of the shell and the nozzle.

In AutoPIPE, it is necessary to use separate option for KHK level 2 code.

Design condition

Design Condition of Vessel

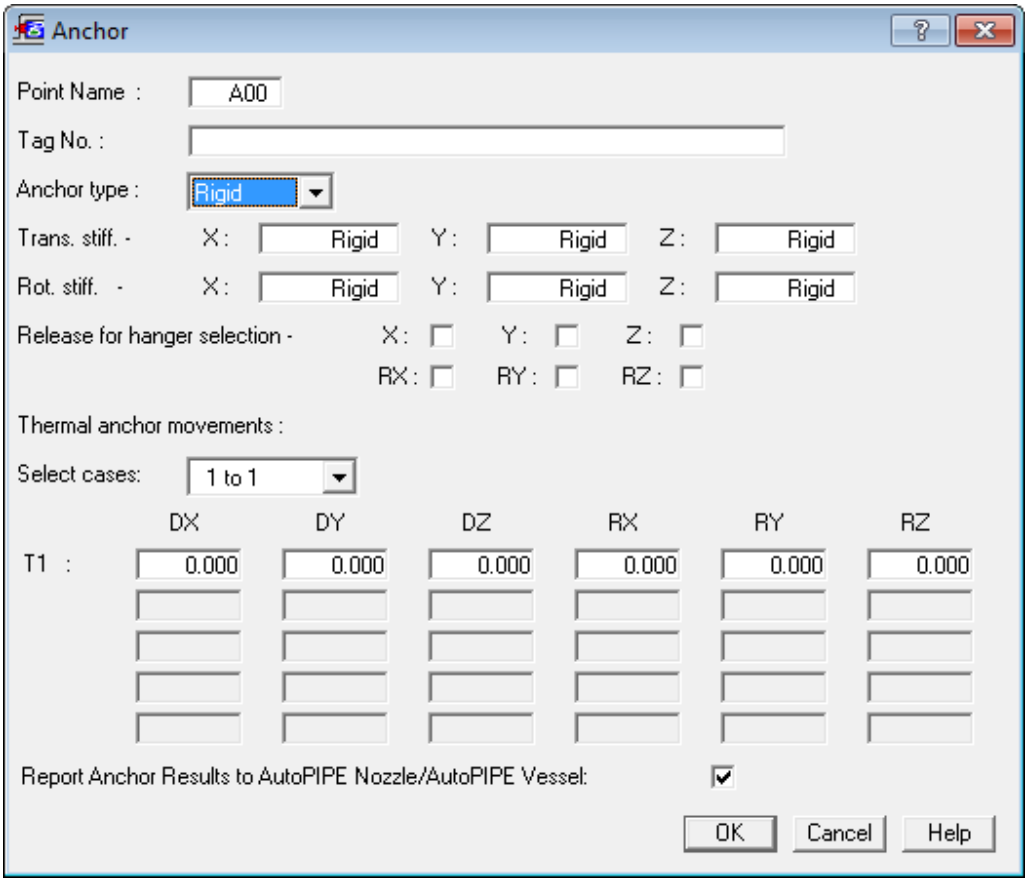
Item	Unit	Data
Vessel of type	-	Spherical shell
Material	-	SPV490
Vessel inner diameter	mm	2000
Vessel wall thickness	mm	15.0
Vessel average radius	mm	1007.5
Internal pressure	N/mm^2	1.0
Temperature pressure	℃	40
Allowable stress (at rest)	N/mm^2	152
Allowable stress (during operation)	N/mm^2	152
Yield stress (at rest)	N/mm^2	490
Yield stress (during operation)	N/mm^2	490

Design conditions of nozzle

Item	Unit	Input Data
Type of nozzle	-	Hollow cylinder nozzle
Material	-	(STPG370-E)
Nozzle outer diameter	mm	457.2
Nozzle wall thickness	mm	9.0
Nozzle outer radius	mm	228.6

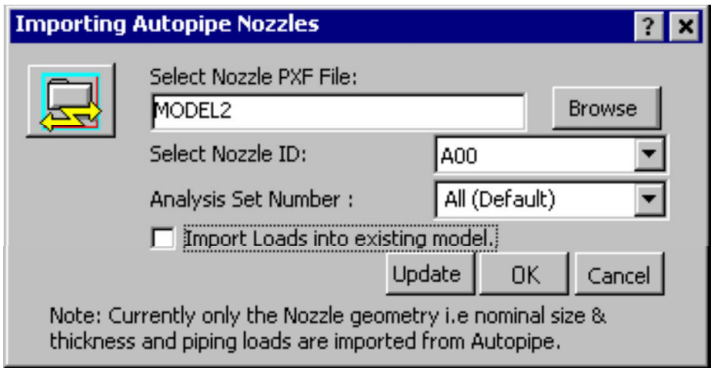
AutoPIPE settings

Open the model in AutoPIPE, click the anchor node of the nozzle, and then click [Modify] > [anchor] command. Select the check box "Report Anchor Results to AutoPIPE Nozzle/AutoPIPE Vessel", and then close the dialog by pressing the <**Ok**> button.



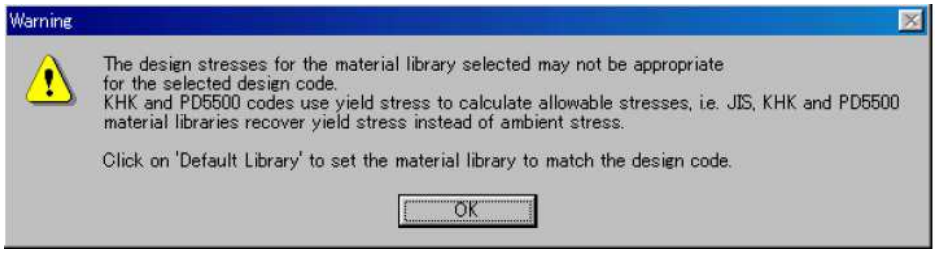
AutoPIPE's Anchor dialog

Click **Analysis** option from menu bar of AutoPIPE and select **static** option. After performing the static analysis, select [File] > [export] > [Nozzle Loads to AutoPIPE Nozzle] to export this in AutoPIPE Nozzle. The AutoPIPE Nozzle will start automatically, and you can see the following dialog in AutoPIPE Nozzle.

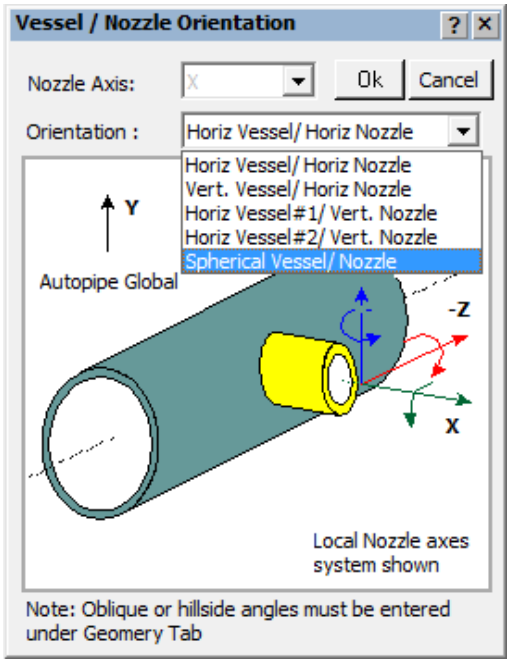


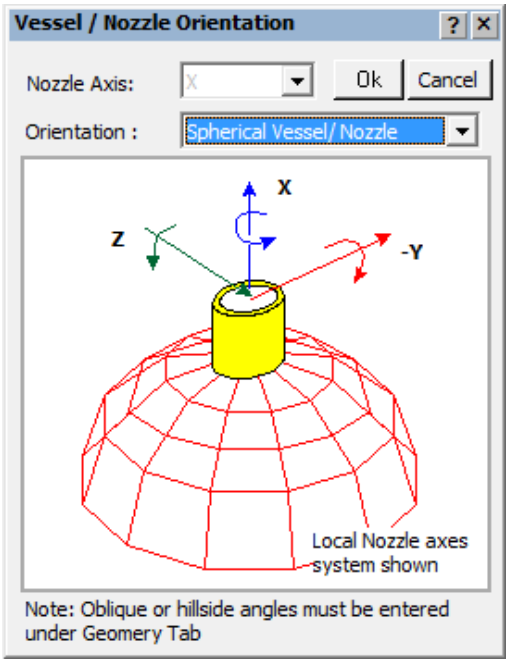
Change the "**Select Nozzle ID**" value to "**A00**", Set "**Analysis set of number**" to (All) , and then press the <**Ok**> button.

If a non-KHK code was selected in the previous work of AutoPIPE Nozzle, you may receive the following dialog box will be displayed. Please go ahead and press the <OK> button.



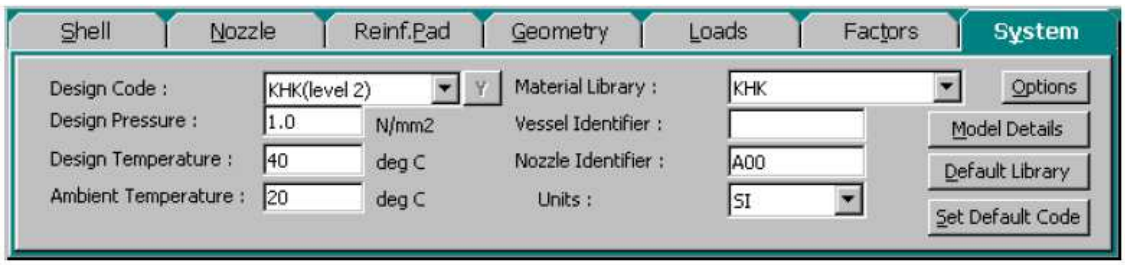
Subsequently, the following dialog will appear, select the **Orientation** and **Nozzle** A**xis** and press <**Ok**> button each time to move to the next step:





Data for System tab

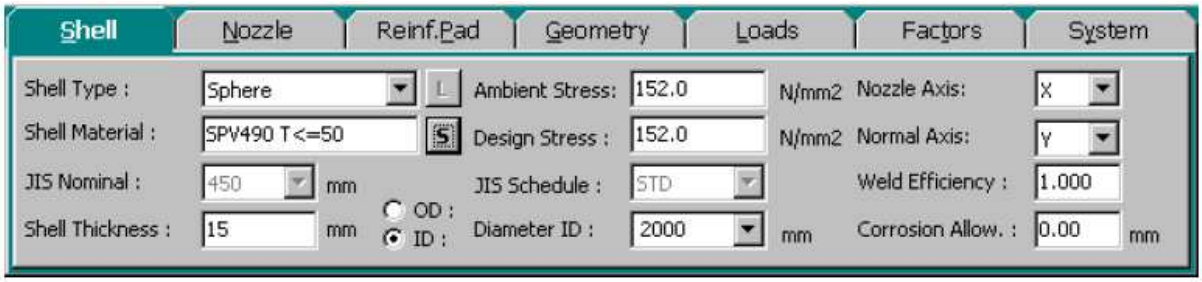
Click the System tab. The Design Code and Material Library have been set automatically. Now enter the other data as follows.



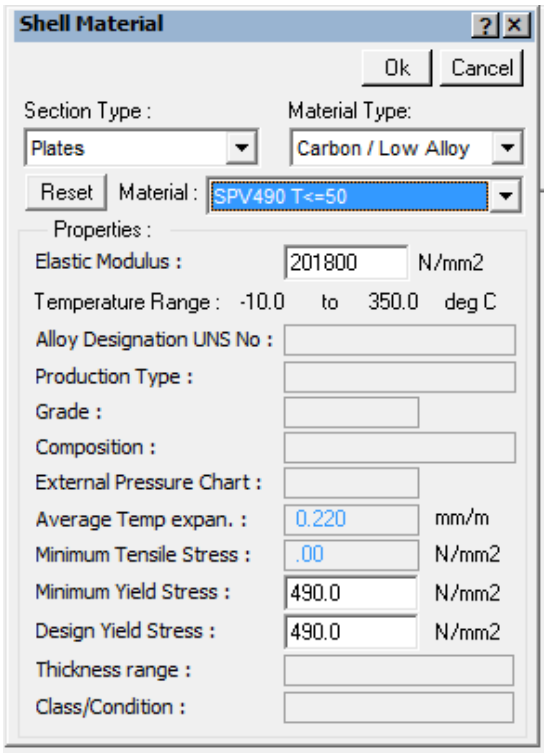
Item	Unit	Input Value or selection
Units	-	SI
Design Code	-	KHK (level 2)
Material Library	-	KHK
Design Pressure	N/mm^2	1.0
Design Temperature	℃	40
Ambient Temperature	℃	20

Data for Shell tab

Click the **Shell** tab, and then click <**S**> button to the right of the Shell Material field. On clicking this button a "Shell Material" dialog box will appear.



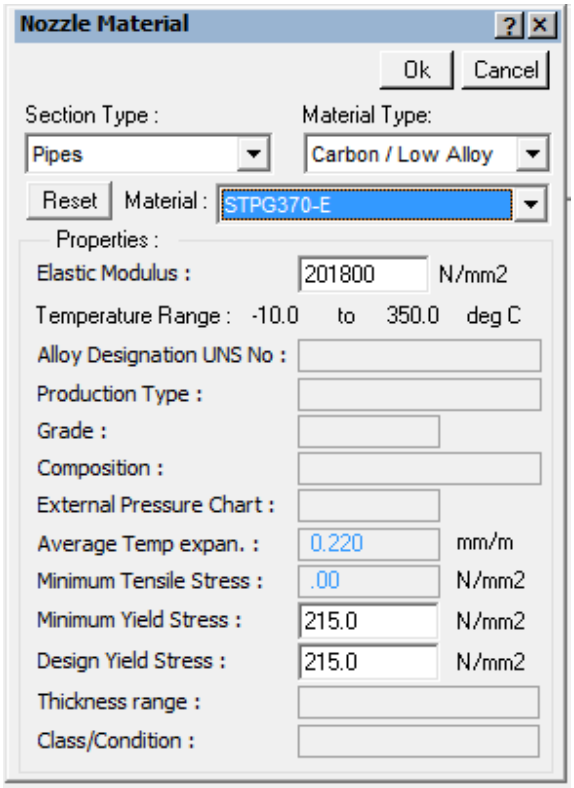
Select the "**Section Type**" = (**Plates**), select the (**SPV490 T <= T50**) from Material drop down listing and then press the <**Ok**> button. Some values will be automatically set on the dialog after these selections are made. Now press the <**Ok**> button and then enter the other data on the Nozzle tab as follows:



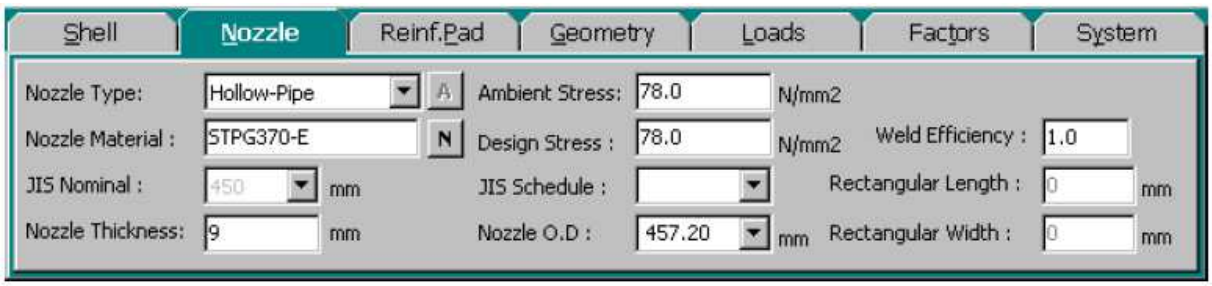
Item	Unit	Input value or selection
Shell Type	-	Sphere
Shell Thickness	mm	15
Ambient Stress	N/mm^2	152 (Automatic)
Design Stress	N/mm^2	152 (Automatic)
ID	-	click
Diameter ID	mm	2000
Nozzle Axis	-	X
Shell Axis	-	Y

Data for Nozzle

Click the **Nozzle** tab, and then click <**N**> button to the right of the Nozzle Material field. On clicking this button a "Nozzle Material" dialog box will appear.



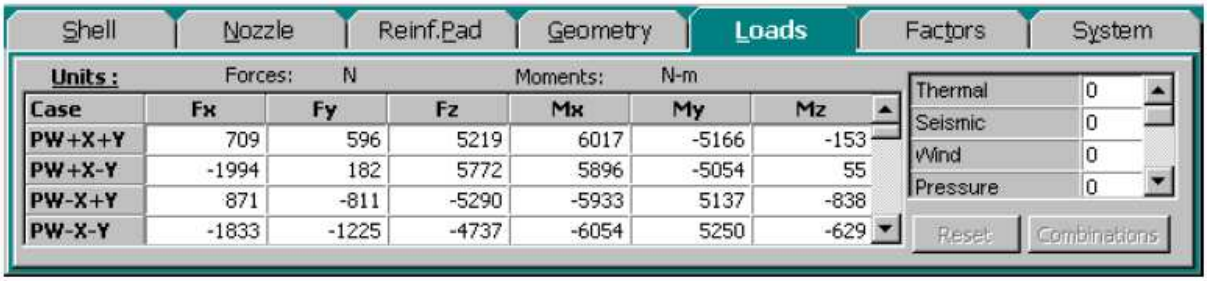
Select the "**Section Type**" = (**Pipes**), select the (**STPG370-E**) from Material drop down listing and then press the <**Ok**> button. Some values will be automatically set on the dialog after these selections are made. Now press the <**Ok**> button and then enter the other data on the Nozzle tab as follows:



Item	Unit	Input value or selection
Nozzle Type	-	Hollow-Pipe
Nozzle Thickness	mm	9
Ambient Stress	N/mm^2	78 (Automatic)
Design Stress	N/mm^2	78 (Automatic)
Nozzle O.D	mm	457.2

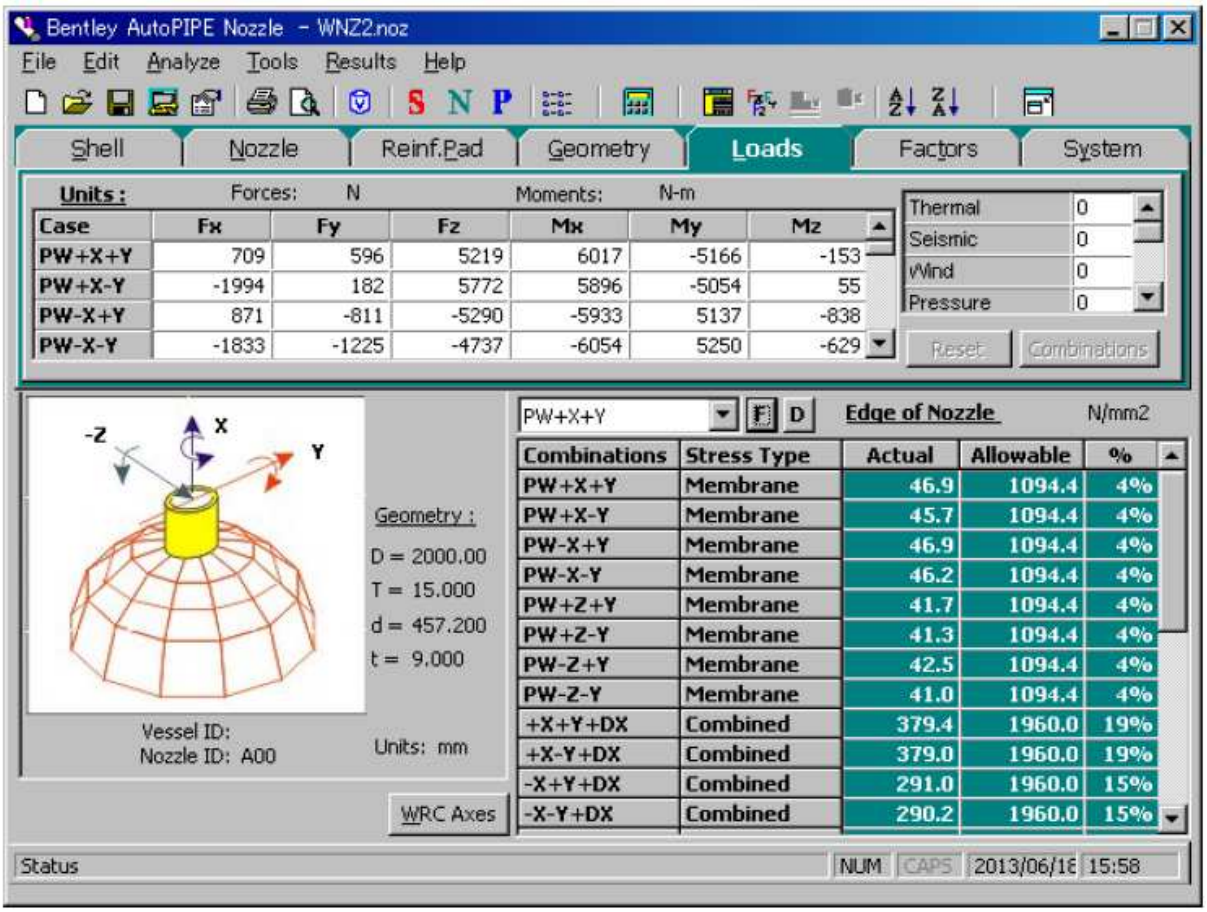
Confirmation of Load Data

Click the Loads tab to check the load data imported from AutoPIPE.



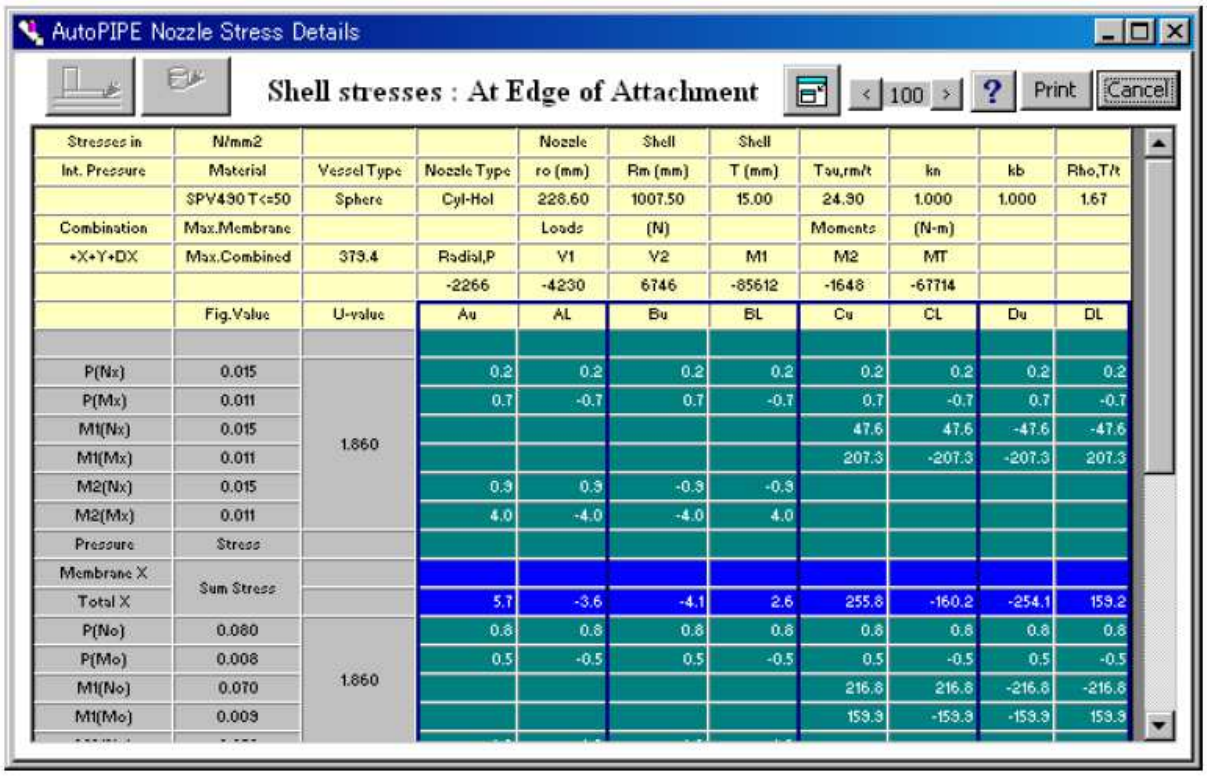
Execution and result output of calculation

Press [File] / [Save] command, and then save the data to a file. First Save the file and then run “Stress” from drop down menu of Analyze for stress Calculation. After the calculation, you will see a list of maximum stress of each combination in the lower right area of AutoPIPE Nozzle window



To view the detailed stress of any combination, select any combination from combination list and double click it.

The results of the X + Y + DX detailed stress is shown below.



Stresses in	N/mm2			Nozzle	Shell	Shell				
Int. Pressure	Material	Vessel Type	Nozzle Type	ro (mm)	Rm (mm)	T (mm)	Tau,rm/t	kn	kb	Rho,T/t
	SPV490 T<=50	Sphere	Cyl-Hol	228.60	1007.50	15.00	24.90	1.000	1.000	1.67
Combination	Max.Membrane			Loads	(N)		Moments	(N-m)		
+X+Y+DX	Max.Combined	373.4	Radial,P	V1	V2	M1	M2	MT		
			-2266	-4230	6746	-85612	-1648	-67714		
	Fig.Value	U-value	Au	AL	Bu	BL	Cu	CL	Du	DL
P(Nx)	0.015	1.860	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
P(Mx)	0.011		0.7	-0.7	0.7	-0.7	0.7	-0.7	0.7	-0.7
M1(Nx)	0.015						47.6	47.6	-47.6	-47.6
M1(Mx)	0.011						207.3	-207.3	-207.3	207.3
M2(Nx)	0.015		0.9	0.9	-0.9	-0.9				
M2(Mx)	0.011		4.0	-4.0	-4.0	4.0				
Pressure	Stress									
Membrane X	Sum Stress									
Total X			5.7	-3.6	-4.1	2.6	255.8	-160.2	-254.1	159.2
P(No)	0.080	1.860	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
P(Mo)	0.008		0.5	-0.5	0.5	-0.5	0.5	-0.5	0.5	-0.5
M1(No)	0.070						216.8	216.8	-216.8	-216.8
M1(Mo)	0.009						159.9	-159.9	-159.9	159.9

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