

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.

Example 1: The basic operating procedures of AutoPIPE Nozzle

Example 2: Anchor load of AutoPIPE

Example 3: Evaluation example by the level 1 seismic standards of high-pressure gas

Example 4: Evaluation example by level 2 seismic standards of high-pressure gas

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

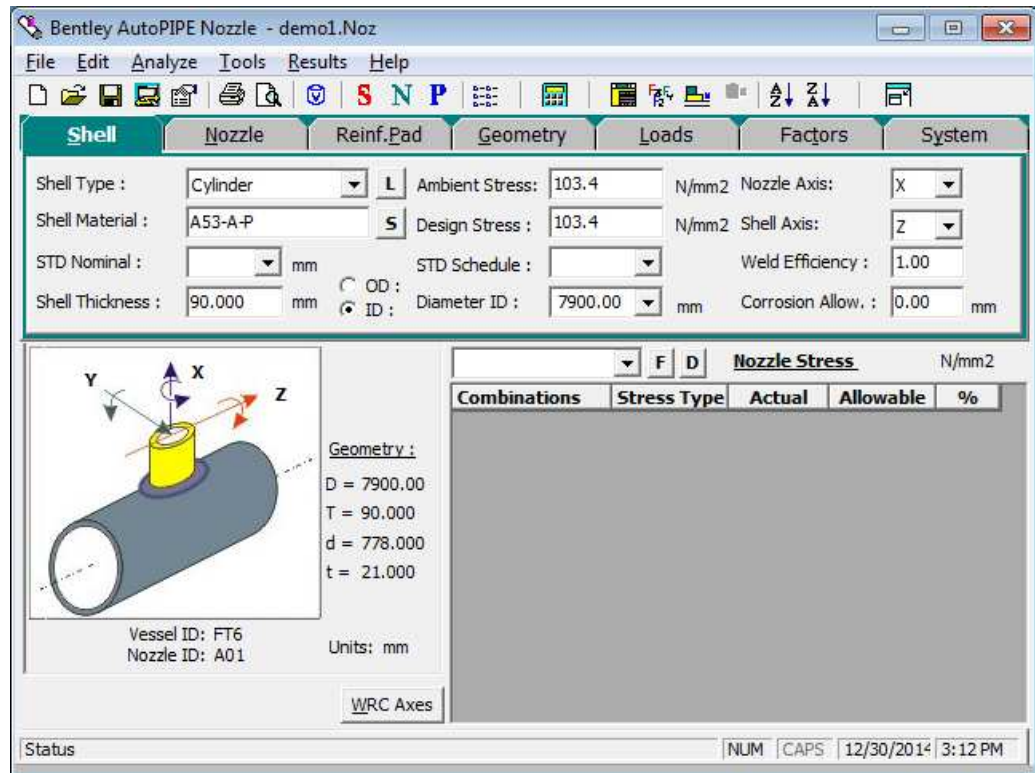
Load	Unit	Own Weight	Heat Load
Radial load P	N	-1000	-2000
Circumferential direction shear force V _C	N	1000	2000
Longitudinal shear force V _L	N	-1000	-2000
Circumferential direction moment M _C	N·m	5000	10000
Longitudinal direction moment M _L	N·m	5000	10000
Torsional moment M _T	N·m	5000	10000

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

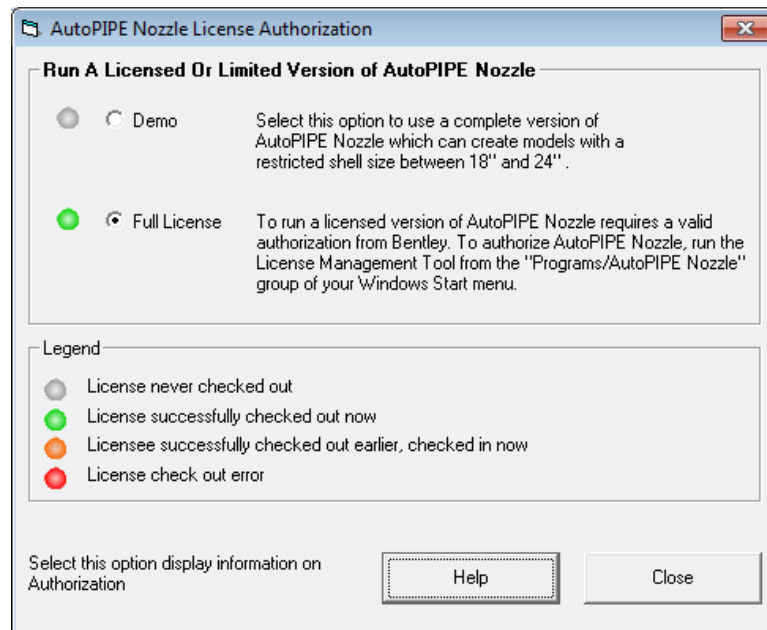
Starting AutoPIPE Nozzle

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.

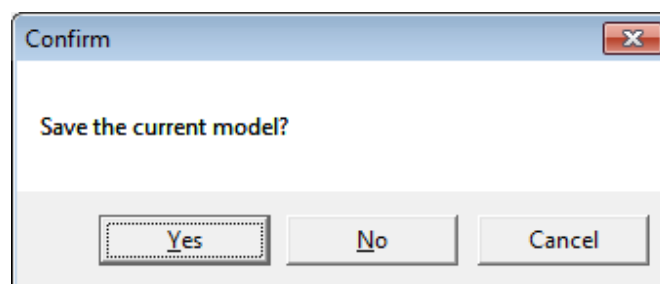
The full license option is only available on systems that have one following:

- a. AutoPIPE Advanced License
- b. AutoPIPE Nuclear License

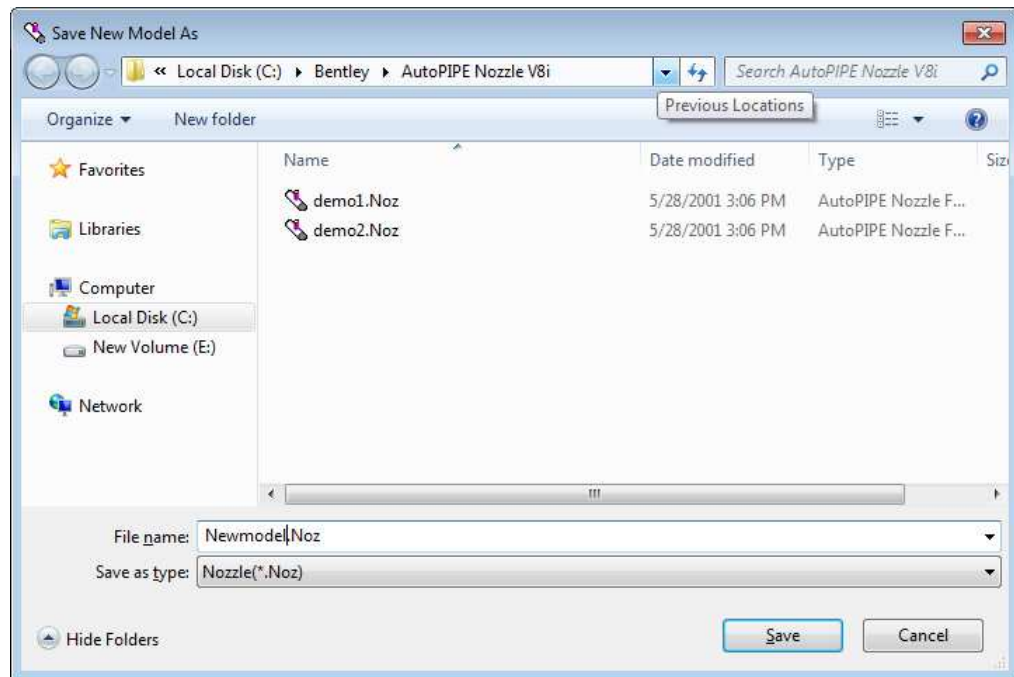
The program will default to demo mode if only AutoPIPE Standard license is available. Check LMT (License Management Tool)> License Checkout tab to verify what licenses are available. Again, the program will only function if AutoPIPE Advanced / Nuclear license(s) are listed. Otherwise it will revert to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

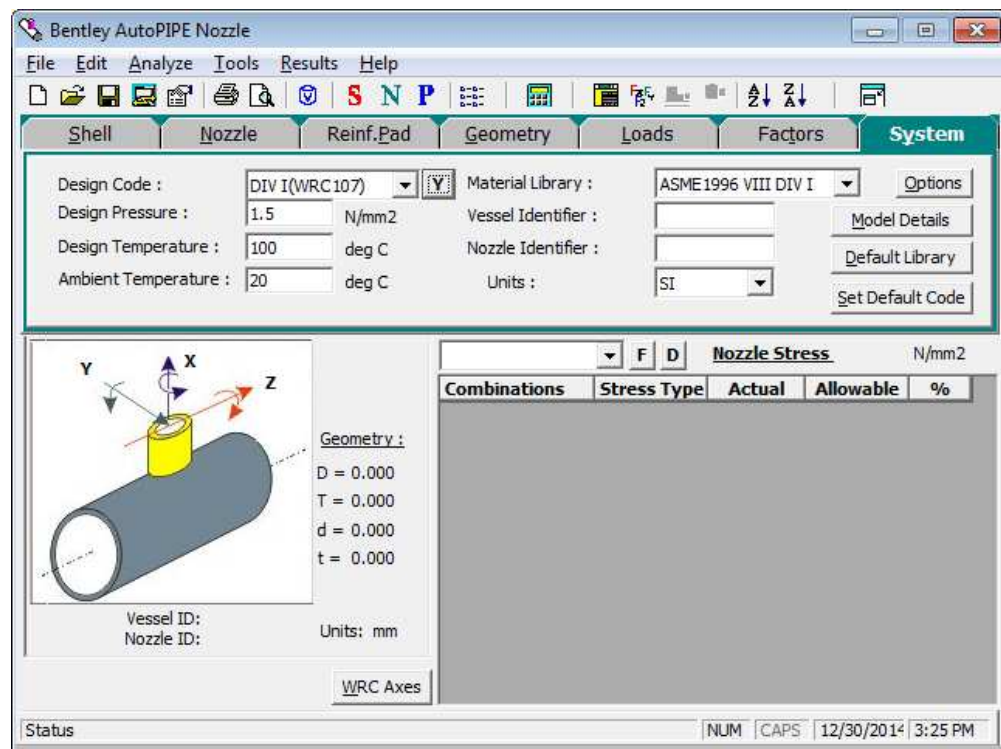


Navigate to the appropriate folder, enter the name of the model to the "File name" field, and press <Save> button.

Now enter the data for the following tabs.

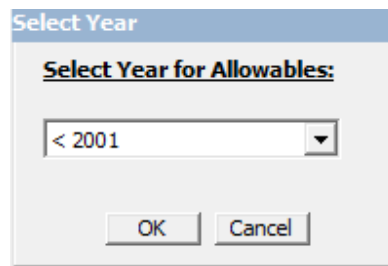
Data for System tab

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	$^{\circ}\text{C}$	100
Ambient Temperature	$^{\circ}\text{C}$	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:

The screenshot shows the Bentley AutoPIPE Nozzle software interface for 'Exercise1.NoZ'. The 'Shell' tab is active, displaying various configuration fields. The 'Shell Type' is set to 'Cylinder'. The 'Shell Material' is empty. The 'STD Nominal' is 450 mm. The 'Shell Thickness' is 20 mm. The 'Ambient Stress' and 'Design Stress' are both 103.4 N/mm². The 'STD Schedule' is 'STD'. The 'Diameter OD' is 2000 mm. The 'Nozzle Axis' is 'X' and the 'Shell Axis' is 'Y'. The 'Weld Efficiency' is 1. The 'Corrosion Allow.' is 0 mm. A 3D model of a cylinder with a nozzle is shown on the left. The 'Geometry' section lists: D = 457.200, T = 20.000, d = 0.000, t = 0.000. The 'Units' are mm. The 'WRC Axes' button is at the bottom. The 'Nozzle Stress' section is empty. The status bar at the bottom shows 'NUM', 'CAPS', '1/1/2015', and '11:33 AM'.

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:

The screenshot shows the Bentley AutoPIPE Nozzle software interface for 'Exercise1.NoZ'. The 'Nozzle' tab is selected, displaying various input fields for nozzle configuration. The 'Nozzle Type' is set to 'Hollow-Pipe'. The 'Nozzle Material' is set to 'N'. The 'STD Nominal' is 150 mm, and the 'Nozzle Thickness' is 12 mm. The 'STD Schedule' is 55, and the 'Nozzle O.D.' is 267 mm. The 'Ambient Stress' and 'Design Stress' are both set to 0 N/mm². The 'Weld Efficiency' is set to 1. The 'Rectangular Length' and 'Rectangular Width' are both set to 0 mm. A 3D model of a nozzle attached to a vessel is shown on the left, with a coordinate system (X, Y, Z) and dimensions (D = 457.200, T = 20.000, d = 267.000, t = 2.769). The 'Vessel ID' and 'Nozzle ID' are both empty. The 'Units' are set to 'mm'. The 'WRC Axes' button is visible at the bottom. On the right, the 'Nozzle Stress' section is partially visible, showing a table with columns for 'Combinations', 'Stress Type', 'Actual', 'Allowable', and '%'. The 'Actual' column is highlighted in blue.

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:

Bentley AutoPIPE Nozzle - Exercise1.Noz

File Edit Analyze Tools Results Help

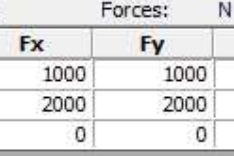
Shell Nozzle Reinf.Pad Geometry Loads Factors System

Units: Forces: N Moments: N-m

Case	Fx	Fy	Fz	Mx	My	Mz
GR	1000	1000	1000	5000	5000	5000
T1	2000	2000	2000	2000	10000	10000
P1	0	0	0	0	0	0

Thermal 1
Seismic 0
Wind 0
Pressure 1

Reset Combinations



Geometry :

- D = 457.200
- T = 20.000
- d = 267.000
- t = 2.769

Vessel ID:
Nozzle ID:

Units: mm

WRC Axes

Nozzle Stress N/mm²

Combinations	Stress Type	Actual	Allowable	%

Status NUM CAPS 1/1/2015 11:36 AM

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).

The screenshot shows the 'Load Combinations' dialog box with the 'Load Cases' tab selected. The 'Load Cases' section has a table with columns 'Load Cases', 'Selected', and 'Total'. The table contains two rows: 'GR' and 'T1'. Both are checked. There is a checkbox for 'Include Pressure Thrust in GR, HY Case' which is unchecked. The 'Selected' and 'Total' counts are both 3. The 'Help', 'Ok', and 'Cancel' buttons are at the top right.

Load Cases	Selected	Total
GR	3	3
T1	3	3

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

The screenshot shows the 'Load Combinations' dialog box with the 'Auto Combinations' tab selected. The 'Static Combinations' section has a table with columns 'Static Combinations', 'Selected', and 'Total'. The table contains two rows: 'GR' and 'GRP1+T1'. Both are checked. There is a checkbox for 'Exclude -ve Wind, Seismic' which is unchecked. The 'Selected' and 'Total' counts are both 2. The 'Help', 'Ok', and 'Cancel' buttons are at the top right.

Static Combinations	Selected	Total
GR	2	2
GRP1+T1	2	2

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.

Bentley AutoPIPE Nozzle - Exercise1.Noz

File Edit Analyze Tools Results Help

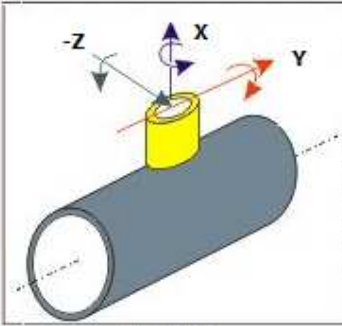
Shell Nozzle Reinf.Pad Geometry **Loads** Factors System

Units: Forces: N Moments: N-m

Case	Fx	Fy	Fz	Mx	My	Mz
GR	1000	1000	1000	5000	5000	5000
T1	2000	2000	2000	2000	10000	10000
P1	0	0	0	0	0	0

Thermal 1
Seismic 0
Wind 0
Pressure 1

Reset Combinations



Geometry:
D = 2000.00
T = 20.000
d = 267.000
t = 12.000

Vessel ID:
Nozzle ID:

Units: mm

WRC Axes

GR D **Edge of Nozzle** N/mm²

Combinations	Stress Type	Actual	Allowable	%
Pressure	Membrane	74.4	103.4	72%
GR	Membrane	87.5	155.1	56%
GR	Combined	137.5	310.3	44%
GRP1+T1	Membrane	113.4	310.3	37%
GRP1+T1	Combined	263.5	310.3	85%

Status NUM CAPS 1/1/2015 11:37 AM

View Detail stress value

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

AutoPIPE Nozzle Stress Details

Shell stresses : At Edge of Attachment

< 100 > ? Print Cancel

Stresses in	N/mm2		Nozzle	Shell	Shell					
Int. Pressure	Material	Vessel Type	Nozzle Type	ro (mm)	Rm (mm)	T (mm)	Gamma	kn	kb	
1500 N/mm2		Cylinder	Cyl-Hol	133.50	990.00	20.00	43.5	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(Na)	8.166 \ 6.761	0.118	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
P(Ma)	0.066 \ 0.102		1.0	-1.0	1.0	-1.0	1.5	-1.5	1.5	-1.5
MC(Na)	1.857		0.0	0.0	0.0	0.0	-4.0	-4.0	4.0	4.0
MC(Ma)	0.089		0.0	0.0	0.0	0.0	-57.1	57.1	57.1	-57.1
ML(Na)	5.808		12.6	12.6	-12.6	-12.6	0.0	0.0	0.0	0.0
ML(Ma)	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.

Printer - Reports

Ok Cancel

☒ Input ☒ Detailed Stresses

☒ Warnings ☒ 1-Page Summary

☐ Sorted Summary Stresses ☒ Summary Stresses

☐ Print all detailed stress combinations

Screen

On Clicking OK a print preview dialog box will appear.

Print Preview Physical Page Show Guides Current Page Setup Print Setup Cancel

2/7

Project :

Company Name :		Engineer :	
Contract Name :		Checked By :	
Contract No. :		File Name :	
Description :		Calculation No.	
		Rev No.	

1.0 System :

Design Code : DIV (WRC107) Material Library : ASME1998 VIII DIV1
Code Year : < 2001 Vessel Identifier :
Design Pressure : (N/mm2) 1.5 Nozzle Identifier :
Design Temperature : (deg C) 100 Units : SI
Ambient Temperature : (deg C) 20

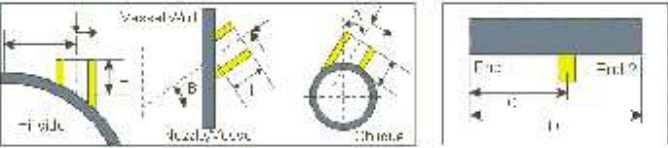
Property	Shell	Nozzle	Red
Type	Cylinder	Hollow Pipe	n/a
Nominal	450	150	n/a
O.D (mm)	497.200	273.10	n/a
Schedule	n/a	STD	n/a
Thickness (mm)	20	7.112	n/a
Corrosion (mm)	0	0	n/a
Weld Efficiency	1	1.000	n/a
Material Specification			n/a
Material Section	Pipes	Plates	n/a
Material Young's Modulus, E (N/mm2)	202.016	202.016	n/a
Allowable Stress (Ambient) (N/mm2)	103.4	0.0 <	n/a
Allowable Stress (Design) (N/mm2)	103.4	0.0 <	n/a
Yield Stress (Ambient) (N/mm2)	241	241	n/a
Yield Stress (Design) (N/mm2)	0	0	n/a

* User defined material, < User defined allowable stresses

2.0 Factors :

Other Factors	Operational Factors	Code Stress Factors	Nozzle	Red
Membrane Stress Conc., R_n :	1.000	Load Case U1 :	1	1
Bending Stress Conc., R_b :	1.000	Load Case U2 :	1	1
Pressure Stress Conc., R_p :	1.000	Load Case U3 :	1	1
		Primary Combined :	1.5	1.5
		Secondary Combined :	3	3
	Weld Factor (mm) :	Welding :	0	0

3.0 Geometry :



Nozzle Inside Proj :	0	mm
Nozzle/Vessel Angle (B) :	0	deg
Hillside Offset from Shell Axis :	0	mm
Nozzle Oblique Angle (A) :	0	deg
External Projection (L) :	0	mm
Nozzle Location (C) :	0.0	mm
Cylinder Length (D) :	0.0	mm

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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.

Anchor dialog box fields:

- Point Name : A00
- Tag No. :
- Anchor type : Rigid
- Trans. stiff. - X: Rigid Y: Rigid Z: Rigid
- Rot. stiff. - X: Rigid Y: Rigid Z: Rigid
- Release for hanger selection - X: ☐ Y: ☐ Z: ☐
RX: ☐ RY: ☐ RZ: ☐
- Thermal anchor movements :
Select cases: 1 to 1
- T1 : DX: 0.000 DY: 0.000 DZ: 0.000 RX: 0.000 RY: 0.000 RZ: 0.000
- Report Anchor Results to AutoPIPE Nozzle/AutoPIPE Vessel: ☒
- Buttons: OK, Cancel, Help

Import Loads

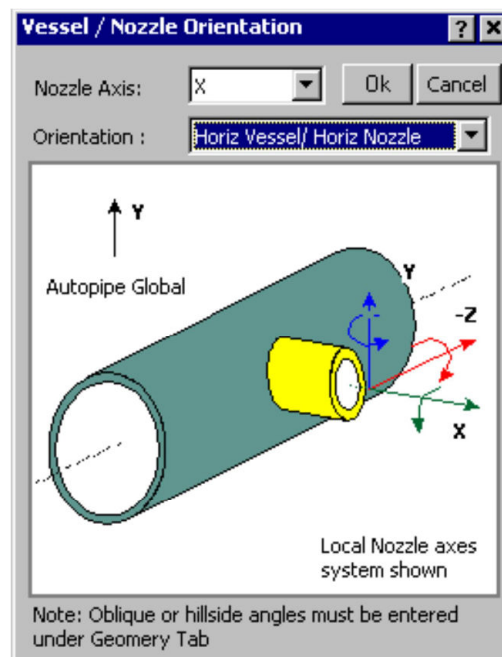
From within AutoPIPE, select [Analysis] option from menu bar of AutoPIPE and select **Static** option. After performing the static analysis, select [File] > [export] > [Nozzle Loads to AutoPIPE Nozzle] to export the loads to AutoPIPE Nozzle. The AutoPIPE Nozzle will start automatically, and you can see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

Importing Autopipe Nozzles dialog box fields:

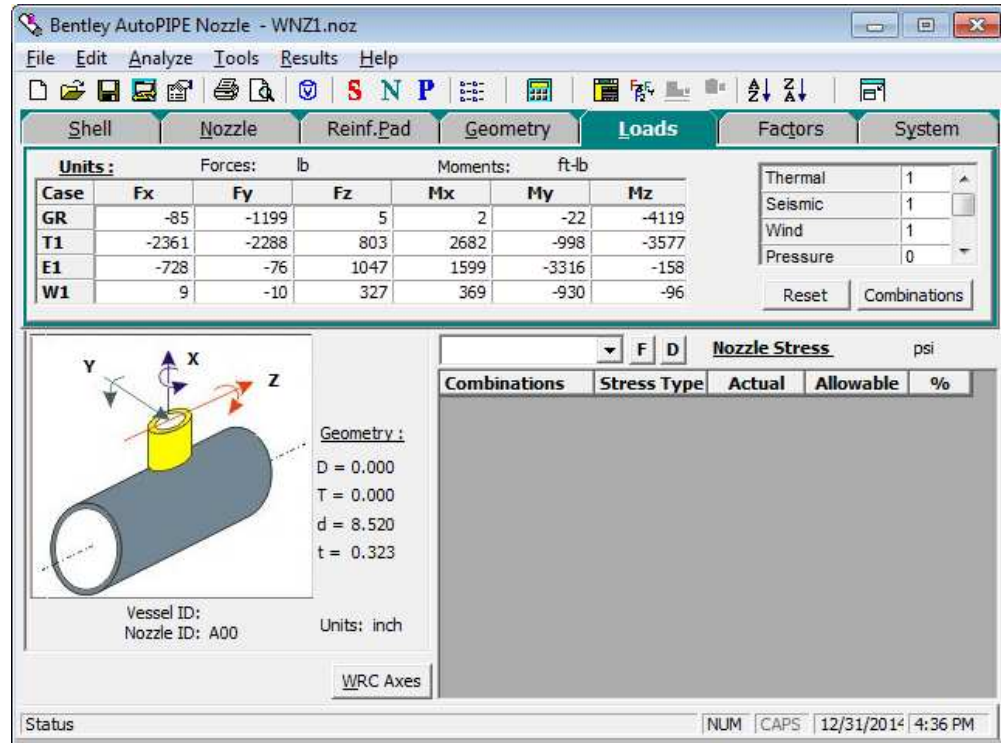
- Select Nozzle PXF File: WALKTHRU
- Select Nozzle ID: A00
- Analysis Set Number : All (Default)
- ☒ Import Loads into existing model
- Buttons: Update, OK, Cancel
- Note: Currently only the Nozzle geometry i.e nominal size & thickness and piping loads are imported from Autopipe.

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	°C	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

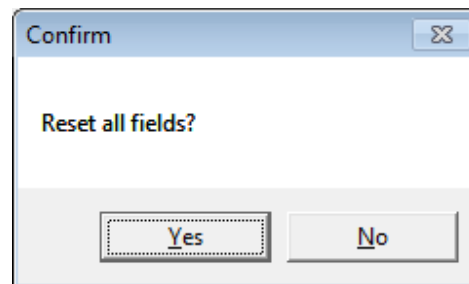
Piping load

Case	F _x	F _y	F _z	M _x	M _y	M _z
	(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

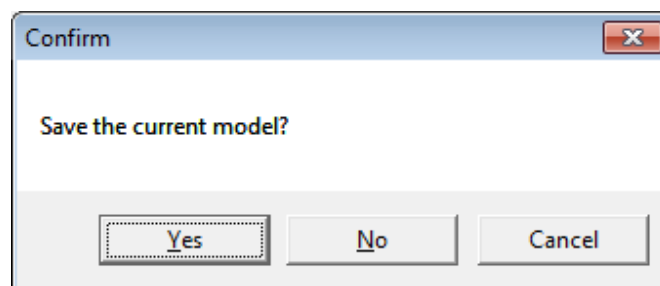
Note: Load values are not the actual data in the example.

Input of the System Data

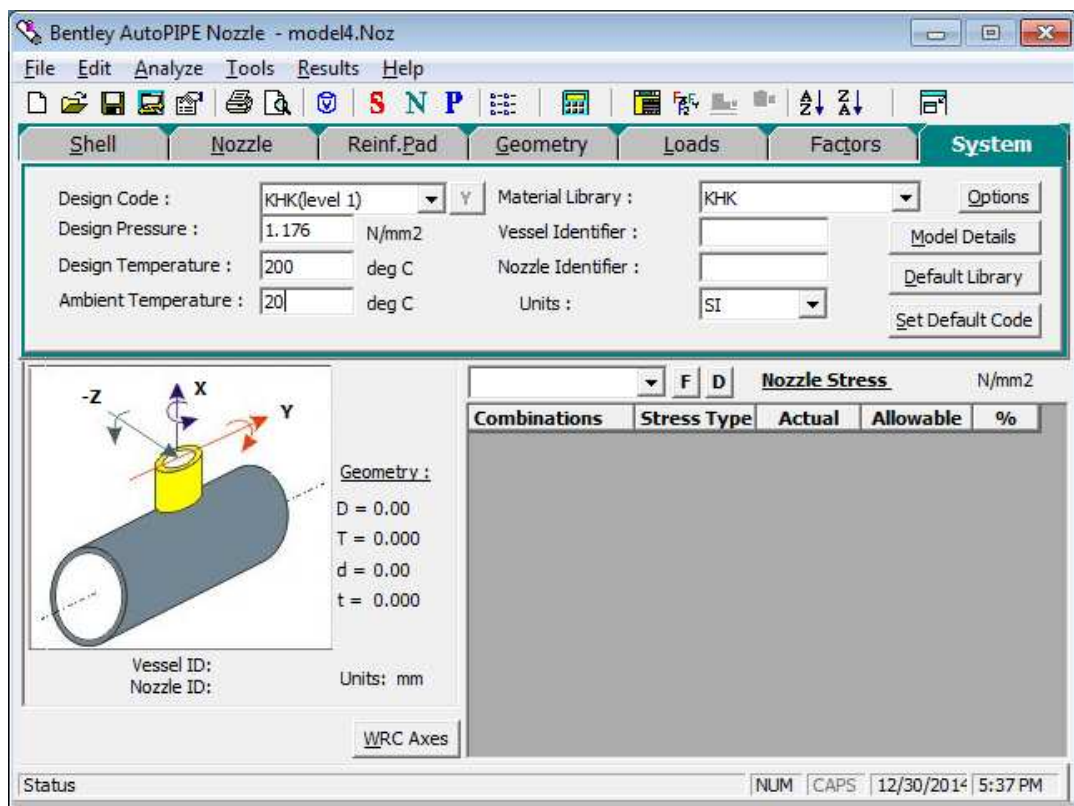
Click the **System** tab, and then select the KHK (Level 1) from Design Code field. After changing the Design Code, the following dialog box will display, click <Yes> button.



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	°C	200
Ambient Temperature	°C	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.

The screenshot shows the 'Shell Material' dialog box with the following settings:

- Section Type:** Plates
- Material Type:** Carbon / Low Alloy
- Material:** SB410
- Properties:**
 - Elastic Modulus:** 191000 N/mm2
 - Temperature Range:** 0.0 to 450.0 deg C
 - Alloy Designation UNS No:** (empty)
 - Production Type:** (empty)
 - Grade:** (empty)
 - Composition:** (empty)
 - External Pressure Chart:** (empty)
 - Average Temp expan.:** 2.202 mm/m
 - Minimum Tensile Stress:** .00 N/mm2
 - Minimum Yield Stress:** 225.0 N/mm2
 - Design Yield Stress:** 189.0 N/mm2
 - Thickness range:** (empty)
 - Class/Condition:** (empty)

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:

Bentley AutoPIPE Nozzle - Exercise3.Noz

File Edit Analyze Tools Results Help

Shell Nozzle Reinf.Pad Geometry Loads Factors System

Shell Type : Cylinder L Ambient Stress : 103.0 N/mm2 Nozzle Axis : X

Shell Material : SB410 S Design Stress : 103.0 N/mm2 Shell Axis : Y

STD Nominal : 450 mm STD Schedule : STD Weld Efficiency : 1

Shell Thickness : 20 mm OD : Diameter OD : 2000 mm Corrosion Allow. : 0 mm

Geometry :

D = 457.200

T = 20.000

d = 0.000

t = 0.000

Vessel ID:

Nozzle ID:

Units: mm

WRC Axes

Nozzle Stress N/mm2

Combinations	Stress Type	Actual	Allowable	%

Status NUM CAPS 1/1/2015 11:42 AM

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.

Shell Nozzle Reinf.Pad Geometry Loads Factors System

Nozzle Type: Hollow-Pipe A Ambient Stress: 92.0 N/mm2

Nozzle Material : STS370-S N Design Stress : 92.0 N/mm2 Weld Efficiency : 1

JIS Nominal : 175 mm JIS Schedule : SGP Rectangular Length : 0 mm

Nozzle Thickness: 12 mm Nozzle O.D : 267.4 mm Rectangular Width : 0 mm

Nozzle Material

Ok Cancel

Section Type : Pipes Material Type: Carbon / Low Alloy

Reset Material: STPG370-S

Properties :

Elastic Modulus : 191000 N/mm2

Temperature Range : -10.0 to 350.0 deg C

Alloy Designation UNS No :

Production Type :

Grade :

Composition :

External Pressure Chart :

Average Temp expans. : 2.202 mm/m

Minimum Tensile Stress : .00 N/mm2

Minimum Yield Stress : 215.0 N/mm2

Design Yield Stress : 178.0 N/mm2

Thickness range :

Class/Condition :

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:

Bentley AutoPIPE Nozzle - Exercise3.Noz

File Edit Analyze Tools Results Help

Shell Nozzle Reinf. Pad Geometry **Loads** Factors System

Units: Forces: N Moments: N-m

Case	Fx	Fy	Fz	Mx	My	Mz
T1	2000	2000	2000	2000	2000	2000
E1	3000	3000	3000	3000	3000	3000
E2	4000	4000	4000	4000	4000	4000
E3						

Hydrotest 0
Harmonic 0
Sam 2
Response 0

Reset Combinations

Geometry:

D = 2000.00
T = 20.000
d = 267.000
t = 10.312

Vessel ID:
Nozzle ID:

Units: mm

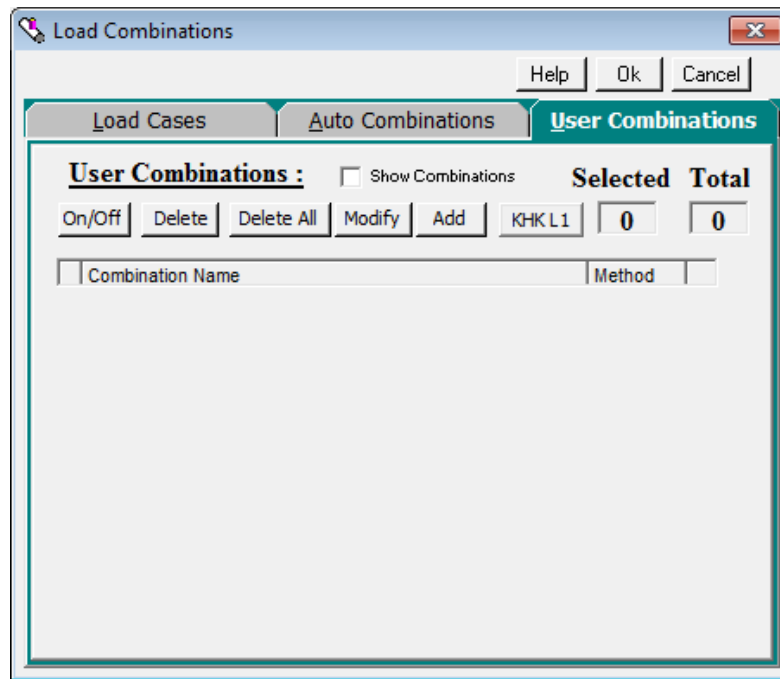
WRC Axes

Nozzle Stress N/mm²

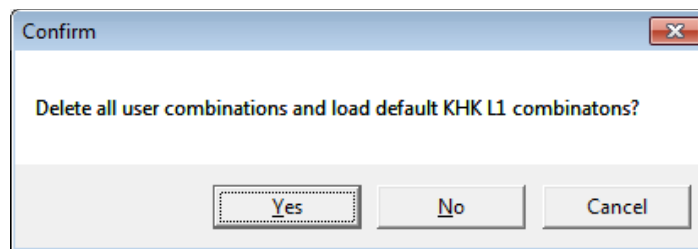
Combinations	Stress Type	Actual	Allowable	%

Status NUM CAPS 1/1/2015 11:47 AM

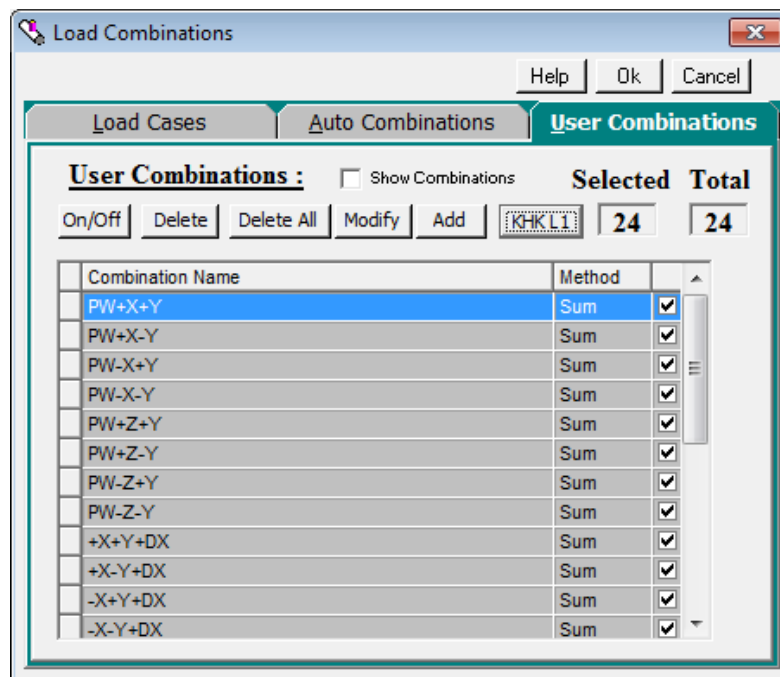
Then, press the <**Combinations**> button, a new dialog box “**Load Combination**” will appear, now click the **User Combinations** tab and press the <**KHK L1**> button.



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.

The screenshot shows the Bentley AutoPIPE Nozzle software interface. The 'Loads' tab is active, displaying a table of forces and moments for three cases (T1, E1, E2, E3). The 'Edge of Nozzle' section shows a table of combinations and stress types. The 'Geometry' section shows a 3D model of a nozzle attached to a vessel.

Units: Forces: N, Moments: N-m

Case	Fx	Fy	Fz	Mx	My	Mz
T1	2000	2000	2000	2000	2000	2000
E1	3000	3000	3000	3000	3000	3000
E2	4000	4000	4000	4000	4000	4000
E3						

Geometry:
D = 2000.00
T = 20.000
d = 267.000
t = 12.000
Units: mm

Edge of Nozzle (N/mm2)

Combinations	Stress Type	Actual	Allowable	%
Pressure	Membrane	58.3	170.1	34%
(PW+X+Y)	Membrane	70.1	255.2	27%
(PW+X-Y)	Membrane	70.1	255.2	27%
(PW-X+Y)	Membrane	62.6	255.2	25%
(PW-X-Y)	Membrane	62.6	255.2	25%
(PW+Z+Y)	Membrane	73.0	255.2	29%
(PW+Z-Y)	Membrane	73.0	255.2	29%
(PW-Z+Y)	Membrane	64.7	255.2	25%
(PW-Z-Y)	Membrane	64.7	255.2	25%
(+X+Y+DX)	Combined	84.7	378.0	22%
(+X-Y+DX)	Combined	84.7	378.0	22%
(-X+Y+DX)	Combined	84.7	378.0	22%

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

The screenshot shows the AutoPIPE Nozzle Stress Details software interface. The 'Shell stresses : Edge of Attachment' section is active, displaying a detailed table of stress components for a specific combination (PW-X+Y).

Shell stresses : Edge of Attachment

Stresses in	N/mm2	Material	Vessel Type	Nozzle Type	ro (mm)	Rm (mm)	T (mm)	Gamma	kn	kb
Int. Pressure	1.176	SB410	Cylinder	Cyl-Hol	133.50	390.00	20.00	43.5	1.000	1.000
Combination	Max.Membrane	62.6		Radial,P	Long,VL	Circ,VC	Circ,MC	Long,ML	Tors,MT	
(PW-X+Y)	Max.Combined			2000	2000	2000	-2000	2000	-2000	
	Fig.Value	Beta		Au	AL	Bu	BL	Cu	CL	Du
P(Ne)	8.166 \ 6.761	0.118		-0.8	-0.8	-0.8	-0.8	-0.7	-0.7	-0.7
P(Me)	0.066 \ 0.102									
MC(Ne)	1.857						1.6	1.6	-1.6	-1.6
MC(Me)	0.083									
ML(Ne)	5.808				-5.0	-5.0	5.0	5.0		
ML(Me)	0.033									
Pressure	Stress			58.3	58.3	58.3	58.3	58.3	58.3	58.3
Circ.Membrane	Sum Stress			52.5	52.5	62.5	62.5	59.3	59.3	56.0
Circumferential										
P(Nx)	6.761 \ 8.166	0.118		-0.7	-0.7	-0.7	-0.7	-0.8	-0.8	-0.8
P(Mx)	0.102 \ 0.066									
MC(Nx)	2.819						2.4	2.4	-2.4	-2.4
MC(Mx)	0.048									

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	°C	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.

Anchor

Point Name : A00

Tag No. :

Anchor type : Rigid

Trans. stiff. - X: Rigid Y: Rigid Z: Rigid

Rot. stiff. - X: Rigid Y: Rigid Z: Rigid

Release for hanger selection - X: ☐ Y: ☐ Z: ☐
RX: ☐ RY: ☐ RZ: ☐

Thermal anchor movements :

Select cases: 1 to 1

	DX	DY	DZ	RX	RY	RZ
T1 :	0.000	0.000	0.000	0.000	0.000	0.000

Report Anchor Results to AutoPIPE Nozzle/AutoPIPE Vessel: ☒

OK Cancel Help

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.

Importing Autopipe Nozzles

Select Nozzle PXF File: MODEL2 Browse

Select Nozzle ID: A00

Analysis Set Number : All (Default)

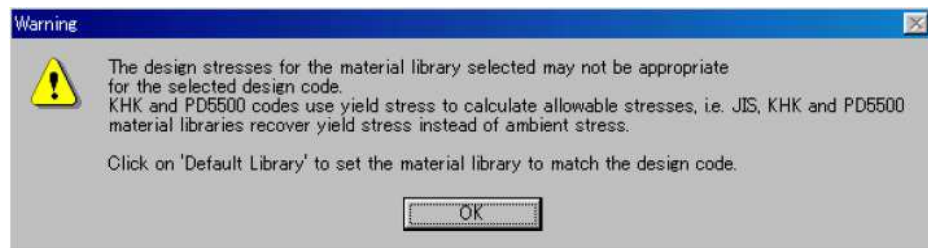
☐ Import Loads into existing model.

Update OK Cancel

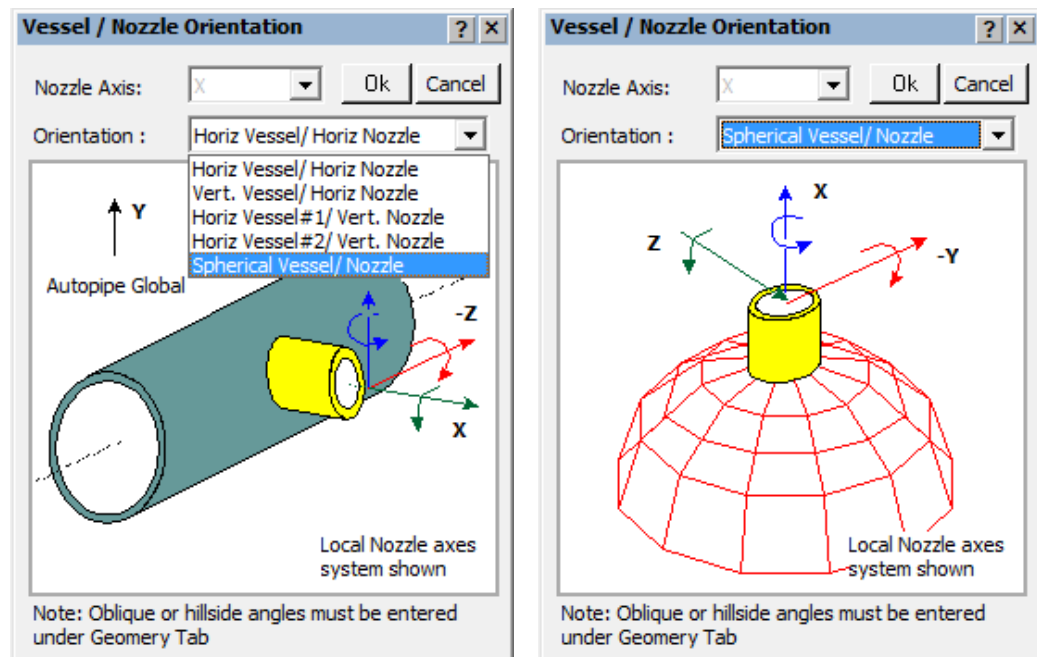
Note: Currently only the Nozzle geometry i.e nominal size & thickness and piping loads are imported from Autopipe.

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 Axis** 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.

Shell	Nozzle	Reinf.Pad	Geometry	Loads	Factors	System
Design Code :		KHK(level 2)		Material Library :		KHK
Design Pressure :		1.0 N/mm ²		Vessel Identifier :		
Design Temperature :		40 deg C		Nozzle Identifier :		A00
Ambient Temperature :		20 deg C		Units :		SI
						Options
						Model Details
						Default Library
						Set Default Code

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	°C	40
Ambient Temperature	°C	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.

Field	Value	Unit
Shell Type	Sphere	-
Shell Material	SPV490 T<=50	-
JIS Nominal	450	mm
Shell Thickness	15	mm
Ambient Stress	152.0	N/mm ²
Design Stress	152.0	N/mm ²
JIS Schedule	STD	-
Diameter ID	2000	mm
Nozzle Axis	X	-
Normal Axis	Y	-
Weld Efficiency	1.000	-
Corrosion Allow.	0.00	mm

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:

Field	Value	Unit
Section Type	Plates	-
Material Type	Carbon / Low Alloy	-
Material	SPV490 T<=50	-
Elastic Modulus	201800	N/mm ²
Temperature Range	-10.0 to 350.0	deg C
Alloy Designation UNS No		-
Production Type		-
Grade		-
Composition		-
External Pressure Chart		-
Average Temp expan.	0.220	mm/m
Minimum Tensile Stress	.00	N/mm ²
Minimum Yield Stress	490.0	N/mm ²
Design Yield Stress	490.0	N/mm ²
Thickness range		-
Class/Condition		-

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.

Nozzle Material [?] [X]

Ok Cancel

Section Type : Pipes Material Type: Carbon / Low Alloy

Reset Material: STPG370-E

Properties :

Elastic Modulus : 201800 N/mm2

Temperature Range : -10.0 to 350.0 deg C

Alloy Designation UNS No :

Production Type :

Grade :

Composition :

External Pressure Chart :

Average Temp expan. : 0.220 mm/m

Minimum Tensile Stress : .00 N/mm2

Minimum Yield Stress : 215.0 N/mm2

Design Yield Stress : 215.0 N/mm2

Thickness range :

Class/Condition :

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:

Shell **Nozzle** Reinf.Pad Geometry Loads Factors System

Nozzle Type: Hollow-Pipe A Ambient Stress: 78.0 N/mm2

Nozzle Material : STPG370-E N Design Stress : 78.0 N/mm2 Weld Efficiency : 1.0

JIS Nominal : 450 mm JIS Schedule : Rectangular Length : 0 mm

Nozzle Thickness: 9 mm Nozzle O.D : 457.20 mm Rectangular Width : 0 mm

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.

Units :		Forces: N		Moments: N-m			
Case	Fx	Fy	Fz	Mx	My	Mz	
PW+X+Y	709	596	5219	6017	-5166	-153	
PW+X-Y	-1994	182	5772	5896	-5054	55	
PW-X+Y	871	-811	-5290	-5933	5137	-838	
PW-X-Y	-1833	-1225	-4737	-6054	5250	-629	

Thermal 0
 Seismic 0
 Wind 0
 Pressure 0

Reset Combinations

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

Bentley AutoPIPE Nozzle - WN22.noz
 File Edit Analyze Tools Results Help

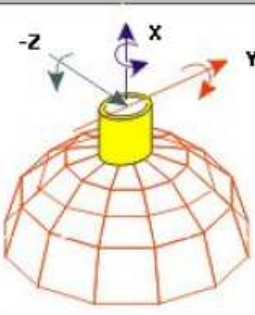
Shell Nozzle Reinf.Pad Geometry **Loads** Factors System

Units: Forces: N Moments: N-m

Case	Fx	Fy	Fz	Mx	My	Mz
PW+X+Y	709	596	5219	6017	-5166	-153
PW+X-Y	-1994	182	5772	5896	-5054	55
PW-X+Y	871	-811	-5290	-5933	5137	-838
PW-X-Y	-1833	-1225	-4737	-6054	5250	-629

Thermal 0
 Seismic 0
 Wind 0
 Pressure 0

Reset Combinations



Geometry :
 D = 2000.00
 T = 15.000
 d = 457.200
 t = 9.000
 Vessel ID:
 Nozzle ID: A00
 Units: mm

PW+X+Y Edge of Nozzle N/mm2

Combinations	Stress Type	Actual	Allowable	%
PW+X+Y	Membrane	46.9	1094.4	4%
PW+X-Y	Membrane	45.7	1094.4	4%
PW-X+Y	Membrane	46.9	1094.4	4%
PW-X-Y	Membrane	46.2	1094.4	4%
PW+Z+Y	Membrane	41.7	1094.4	4%
PW+Z-Y	Membrane	41.3	1094.4	4%
PW-Z+Y	Membrane	42.5	1094.4	4%
PW-Z-Y	Membrane	41.0	1094.4	4%
+X+Y+DX	Combined	379.4	1960.0	19%
+X-Y+DX	Combined	379.0	1960.0	19%
-X+Y+DX	Combined	291.0	1960.0	15%
-X-Y+DX	Combined	290.2	1960.0	15%

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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.

AutoPIPE Nozzle Stress Details

Shell stresses : At Edge of Attachment

< 100 >
?
Print
Cancel

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	
	SPV430 T<=50	Sphere	Cyl-Hol	228.60	1007.50	15.00	24.30	1.000	1.000	1.67	
Combination	Max.Membrane			Loads	(N)		Moments	(N-m)			
+X+Y+DX	Max.Combined	379.4	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			0.3	0.3	-0.3	-0.3				
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							159.3	-159.3	-159.3	159.3
