PIPENET™ NEWS

VOLUME 2 ï ISSUE 5 Summer - 2008

LEADING THE WAY IN FLUID FLOW ANALYSIS

Welcome to the PIPENET e-newsletter!

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NEWS!

PIPENET Vision 1.32 is now available!

Download it from www.sunrise-sys.com.

All PIPENET users with valid Maintenance, Updates and Support can register.

Visit the Registration Page of www.sunrise-sys.com and add the words 'Service Pack' in the comments box.

Spray/Sprinkler Autolayout is a new feature requested by Fire Protection experts. Network modelling is now astoundingly fast with a choice of instant tank configurations and general area protection. Autolayout is an automated schematic tool.

PIPENET Vision 1.32 *out now*

Please see page 2 for full details of the exciting new range of feature additions and enhancements now available to **PIPENET** users.

Also included in this edition are further articles on how to make the most of your PIPENET software to avoid water hammer, or model pipe reductions.

Instant global editing will allow you to work rapidly and effectively as will the new Spray/Sprinkler auto layout facility.

Donï forget that previous editions packed with news and advice can be found on our website www.sunrise-sys.com

PIPENET Vision 1.32 *includes…*

New features in **PIPENET Vision 1.32** in the **Graphical User Interface**

- **Spray/Sprinkler Autolayout** facilitates the rapid layout of nozzles for a choice of tank configurations and general area protection.
- **Improved display of characters**, particularly superscripts, in Far Eastern languages, for example, Chinese or Korean.
- **Maximum number of Spray/Sprinkler nozzle types** increased from 50 to 150 in the PIPENET library.
- **Transient Switch Components** now allow the use of mass flow units.
- **The Transient check valve** now uses a pressure difference unit for the trigger pressure.
- **Standard and Spray/Sprinkler Modules** benefit from an improved display of internal node pressure specification in the results files.
- **Improved range of font sizes** and line thickness available for the schematic.

New features in **PIPENET Vision 1.32** in the **Calculator**

- **Standard and Spray/Sprinkler Modules** have an improved fan/filter model with reverse flow.
- **The Transient Module** calculator benefits from an improved interior position calculation in the pipe for the pressure extreme.
- **Transient Vacuum Breaker Model** is improved. The diameter of the air inlet valve can be zero to become a pure air release valve.

How can AUTOCAD be imported and exported into PIPENET Vision?

1. Import the AutoCAD drawing (such as a plot, plan or general arrangement drawing) into **PIPENET** as a .wmf or .dxf file.

2. Draw the **PIPENET** schematic on top of the imported drawing.

3. Optimise the **PIPENET** design and perform the necessary calculations.

4. This new schematic and other data are exported to AutoCAD by choosing from the **PIPENET** tool bar, **'tools', 'export to .dxf'** and finalising the exported schematic as a piping drawing.

5. Remember - the attribute data in **PIPENET** can be changed by the fire protection engineer if required.

Global Editing in PIPENET Vision at the click of a mouse

1. This is the Data Window before the pipe type is selected:

Data | Graphs | Result Graphs | Tables | Forces

	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	No pipe type	1260	YES
2	2	6	8	12	100	0	0.0018	0	No pipe type	1260	YES
3	3	8	9	10	50	0	0.0018	0	No pipe type	1260	NO
4	4	8	9	10	50	0	0.0018	0	No pipe type	1260	NO
5	5	9	10	12	100	0	0.0018	0	No pipe type	1260	YES
6	6	11	13	12	10	0	0.0018	0	No pipe type	1260	YES
7	8	13	15	12	20	0	0.0018	0	No pipe type	1260	NO
8	9	15	16	10	20	0	0.0018	0	No pipe type	1260	YES
9	10	15	17	12	20	0	0.0018	0	No pipe type	1260	NO
10	11	17	18	3	20	0	0.0018	0	No pipe type	1260	NO
11	12	17	19	12	20	0	0.0018	0	No pipe type	1260	NO
12	13	19	20	3	20	0	0.0018	0	No pipe type	1260	NO
13	14	19	21	12	20	0	0.0018	0	No pipe type	1260	NO
14	15	21	22	3	20	0	0.0018	0	No pipe type	1260	NO
15	16	21	23	12	20	0	0.0018	0	No pipe type	1260	NO
16	17	23	24	6	20	0	0.0018	0	No pipe type	1260	YES
17	18	23	25	12	20	0	0.0018	0	No pipe type	1260	NO
18	19	25	26	6	20	0	0.0018	0	No pipe type	1260	NO
19	20	25	27	6	40	0	0.0018	0	No pipe type	1260	NO
20	7	13	16	3	20	0	0.0018	0	No pipe type	1260	NO
21	21	16	18	12	20	0	0.0018	0	No pipe type	1260	NO
22	22	18	20	12	20	0	0.0018	0	No pipe type	1260	NO
23	23	20	22	12	20	0	0.0018	0	No pipe type	1260	NO
24	24	22	24	12	20	0	0.0018	0	No pipe type	1260	NO
25	25	24	26	12	20	0	0.0018	0	No pipe type	1260	NO
26	26	26	27	12	20	0	0.0018	0	No pipe type	1260	NO
27	27	27	14	12	50	0	0.0018	0	No pipe type	1260	YES

2. Select the pipe type for one pipe in the data window:

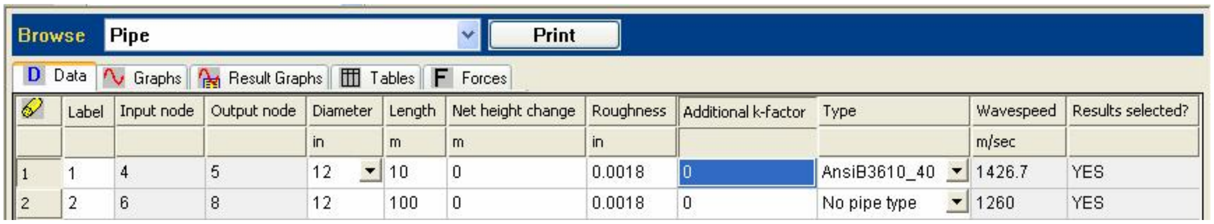
This assumes that the pipe type was selected in the **options menu** of **PIPENET** (after downloading the network from PDMS, which would not have had a pipe type)

Browse | Pipe | Print

Data | Graphs | Result Graphs | Tables | Forces

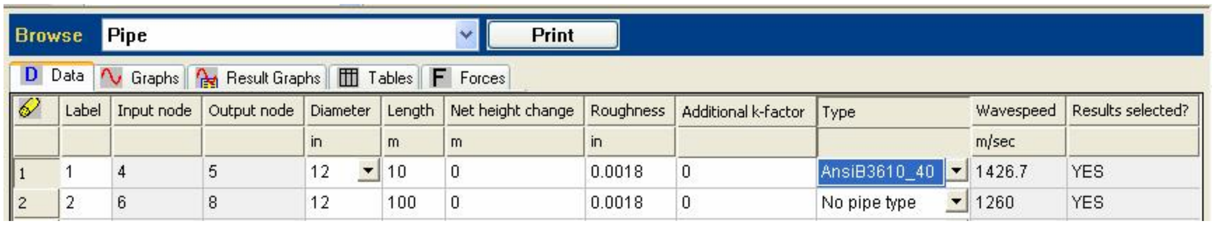
	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	No pipe type	1260	YES
2	2	6	8	12	100	0	0.0018	0	No pipe type	1260	YES
3	3	8	9	10	50	0	0.0018	0	AnsiB3610_40	1260	NO
4	4	8	9	10	50	0	0.0018	0	No pipe type	1260	NO

3. After selecting the pipe type, click on any cell other than the pipe type cell:



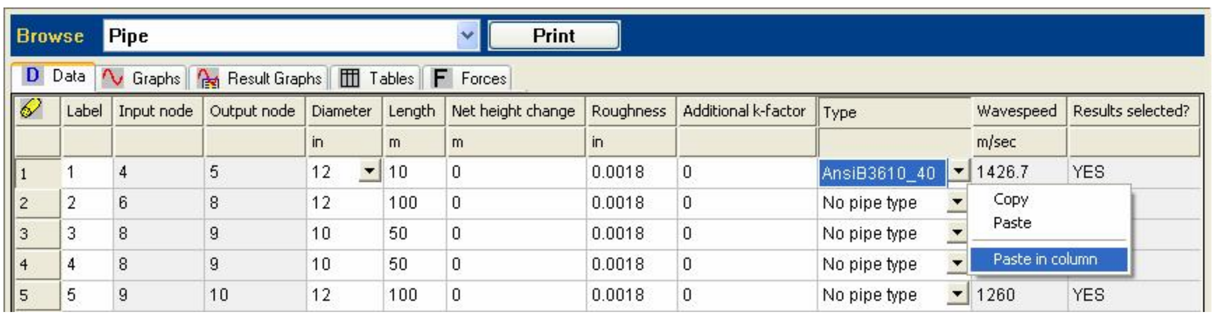
	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	AnsiB3610_40	1426.7	YES
2	2	6	8	12	100	0	0.0018	0	No pipe type	1260	YES

4. Click on the cell with the pipe type and make it active:



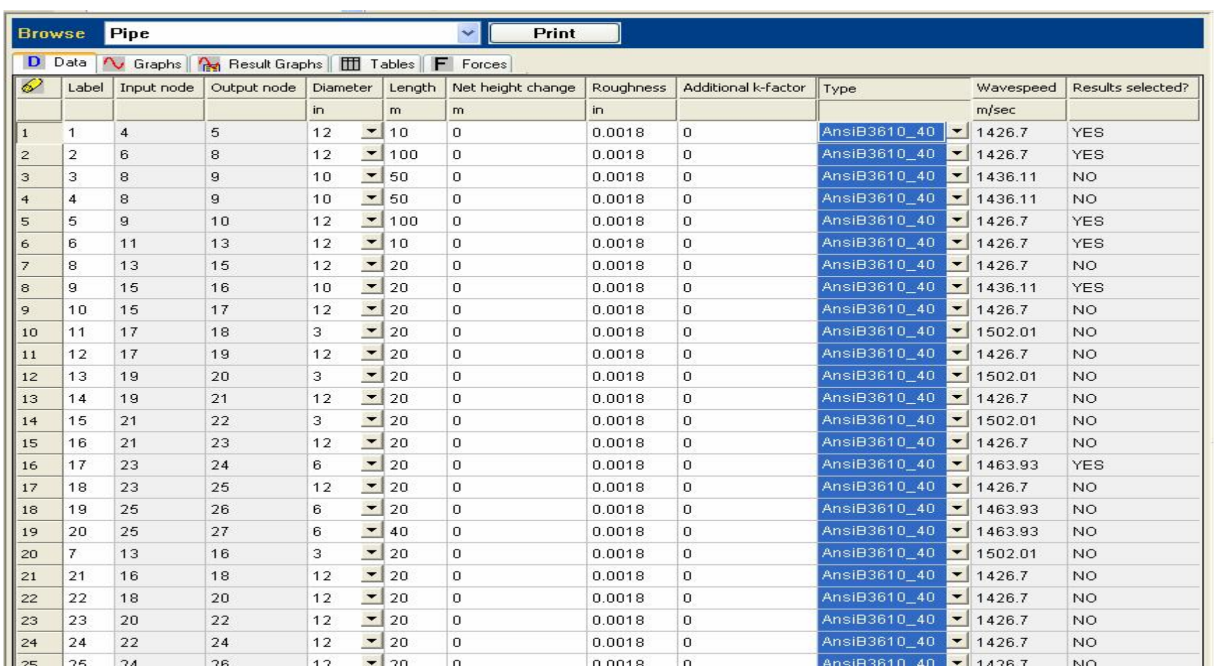
	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	AnsiB3610_40	1426.7	YES
2	2	6	8	12	100	0	0.0018	0	No pipe type	1260	YES

5. Right click on the cell and select paste in column:



	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	AnsiB3610_40	1426.7	YES
2	2	6	8	12	100	0	0.0018	0	No pipe type		
3	3	8	9	10	50	0	0.0018	0	No pipe type		
4	4	8	9	10	50	0	0.0018	0	No pipe type		
5	5	9	10	12	100	0	0.0018	0	No pipe type	1260	YES

6. Sit back and relax!!



	Label	Input node	Output node	Diameter	Length	Net height change	Roughness	Additional k-factor	Type	Wavespeed	Results selected?
				in	m	m	in			m/sec	
1	1	4	5	12	10	0	0.0018	0	AnsiB3610_40	1426.7	YES
2	2	6	8	12	100	0	0.0018	0	AnsiB3610_40	1426.7	YES
3	3	8	9	10	50	0	0.0018	0	AnsiB3610_40	1436.11	NO
4	4	8	9	10	50	0	0.0018	0	AnsiB3610_40	1436.11	NO
5	5	9	10	12	100	0	0.0018	0	AnsiB3610_40	1426.7	YES
6	6	11	13	12	10	0	0.0018	0	AnsiB3610_40	1426.7	YES
7	8	13	15	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
8	9	15	16	10	20	0	0.0018	0	AnsiB3610_40	1436.11	YES
9	10	15	17	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
10	11	17	18	3	20	0	0.0018	0	AnsiB3610_40	1502.01	NO
11	12	17	19	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
12	13	19	20	3	20	0	0.0018	0	AnsiB3610_40	1502.01	NO
13	14	19	21	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
14	15	21	22	3	20	0	0.0018	0	AnsiB3610_40	1502.01	NO
15	16	21	23	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
16	17	23	24	6	20	0	0.0018	0	AnsiB3610_40	1463.93	YES
17	18	23	25	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
18	19	25	26	6	20	0	0.0018	0	AnsiB3610_40	1463.93	NO
19	20	25	27	6	40	0	0.0018	0	AnsiB3610_40	1463.93	NO
20	7	13	16	3	20	0	0.0018	0	AnsiB3610_40	1502.01	NO
21	21	16	18	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
22	22	18	20	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
23	23	20	22	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
24	24	22	24	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO
25	25	24	26	12	20	0	0.0018	0	AnsiB3610_40	1426.7	NO

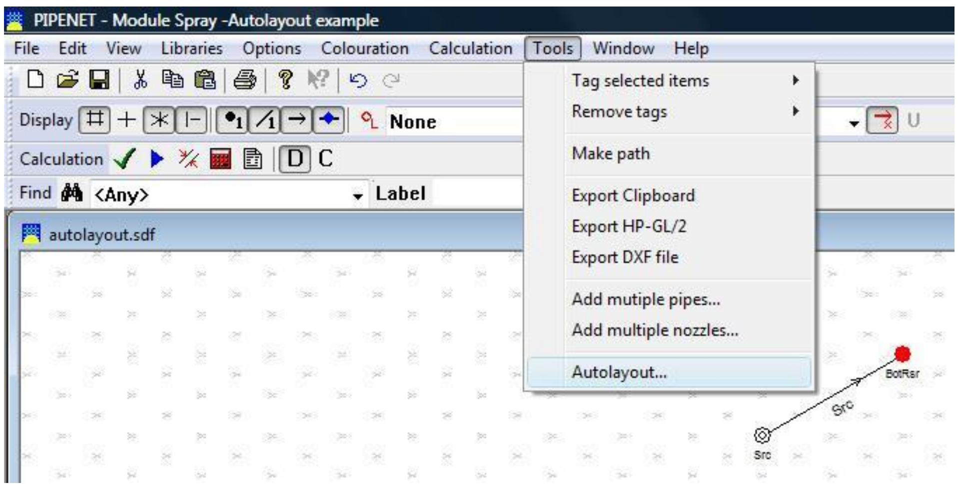
Creating sprinkler networks using the Autolayout tool

The Autolayout tool, available in the PIPENET spray/sprinkler module, automates the task of designing spray/sprinkler systems for vessels or for area protection. Autolayout accelerates the design process!

1. Launching Autolayout

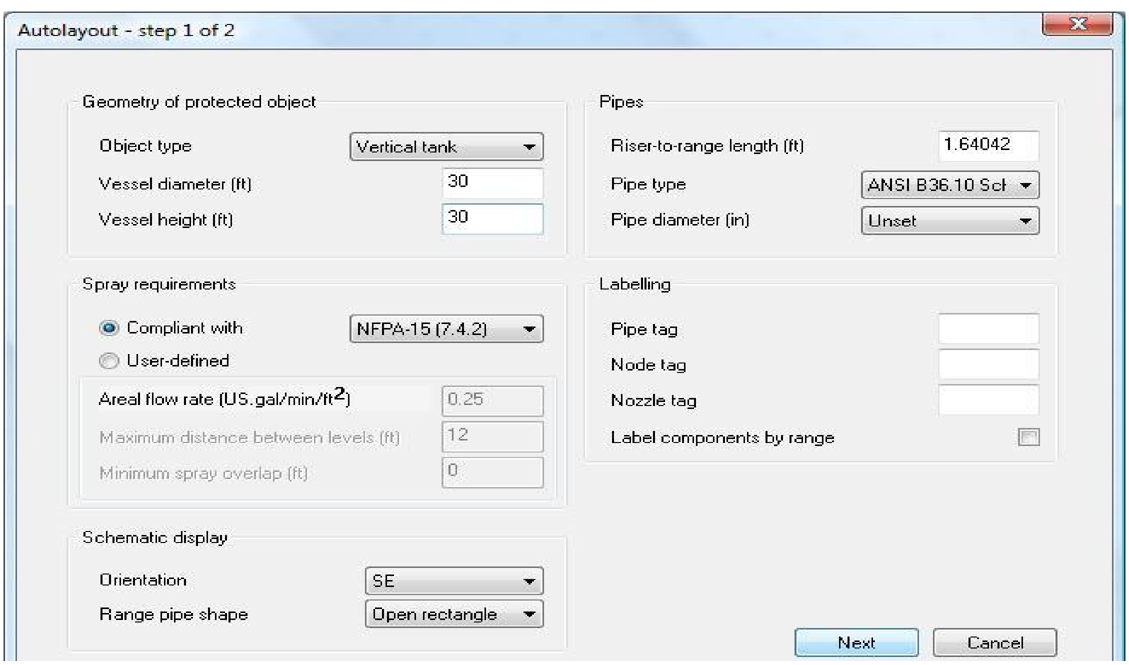
1a.Select pipe types and nozzle libraries,

1b.Select Autolayout from the Tools menu bar item:



If an existing node is selected when the tool is launched, it will offer to join the new sub-network which is about to be generated to that node.

2. Dimensions and spray requirements

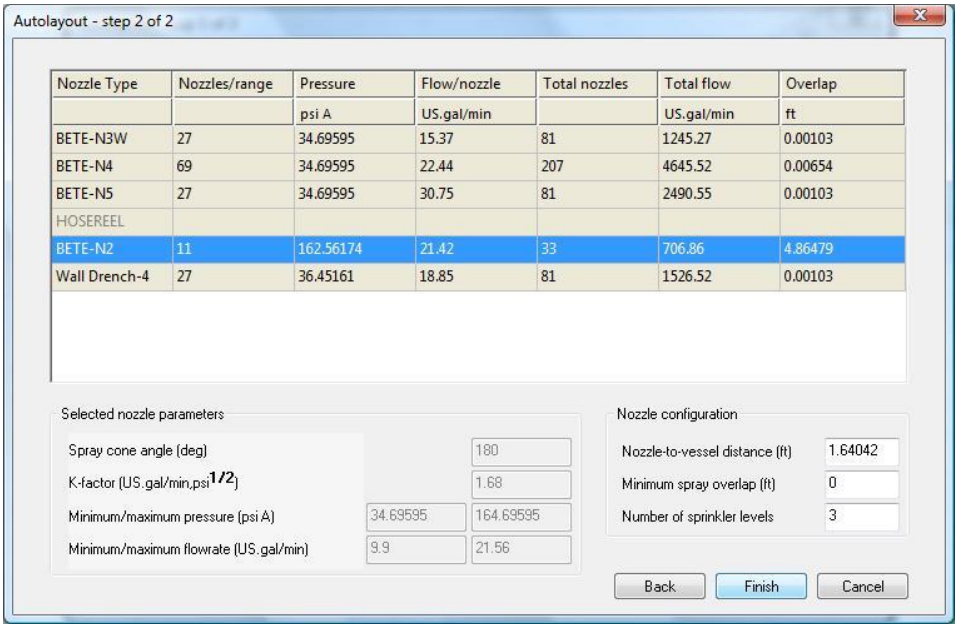


2**. Specify** the **shape** and **size** of the object to be protected, **spray density** and **nozzle layout** requirements (which can be selected to be compliant with a built-in fire-authority standard), **pipe parameters**, and **component labels**.

In the example on page 5, the diameter and height of the vessel were entered but all other parameters were left at their default values

3. Nozzle configuration

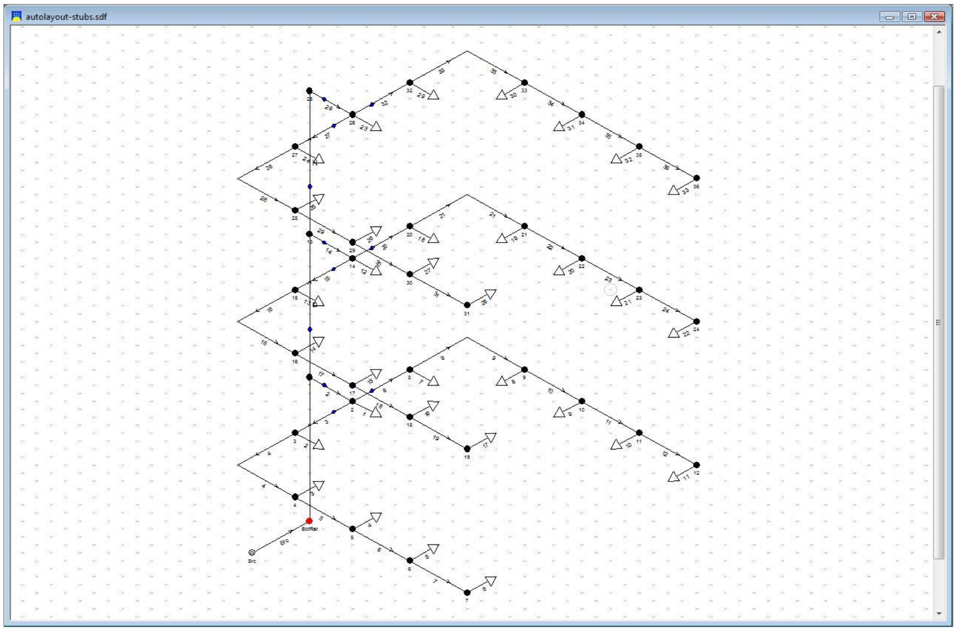
This makes it very easy to compare different nozzles in order to optimize the network according to your design criteria



Select the required nozzle from the list, and adjust the nozzle configuration if required.
Next, click the Finish button!

The generated Layout

The generated sub-network appears on the schematic grid ready for further editing!
All the generated pipes have appropriate elevations and fittings, and pipe-sizing can be performed in the usual way if the pipe diameter was left at its default value of ñUnsetòin the first dialogue.



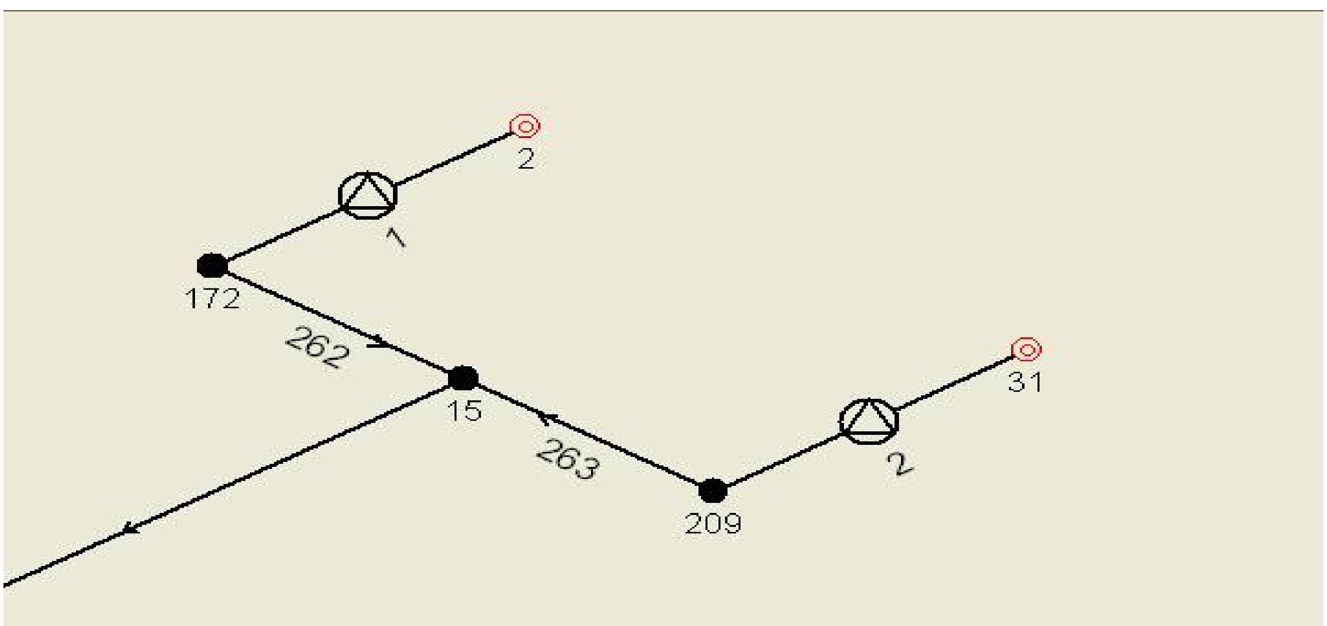
Seven mouse-clicks and the entry of two numbers generated this example!

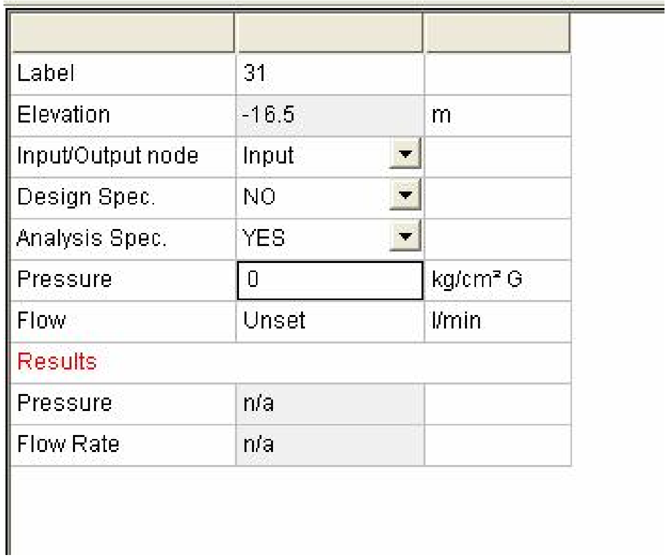
Modelling a Network with Two Inputs Combining Into One Single Pipe with PIPENET Vision

Normally, the inlet pressures of the pumps are known. The pumps will pump as much water as they can through the nozzles. The question is usually:

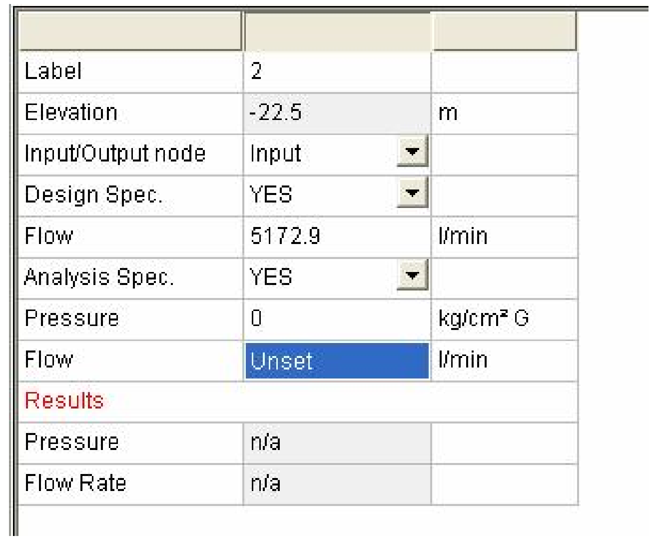
How much water will flow through the nozzles when two pumps are working?

In this example the inlet pressures of the pumps are both 0 bar G. The modelling can be done as follows:

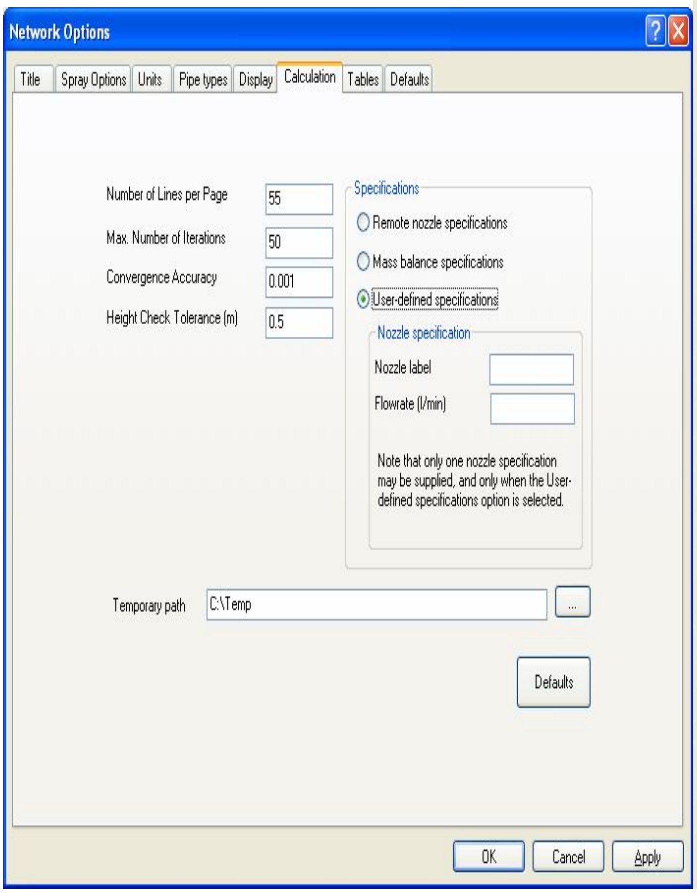


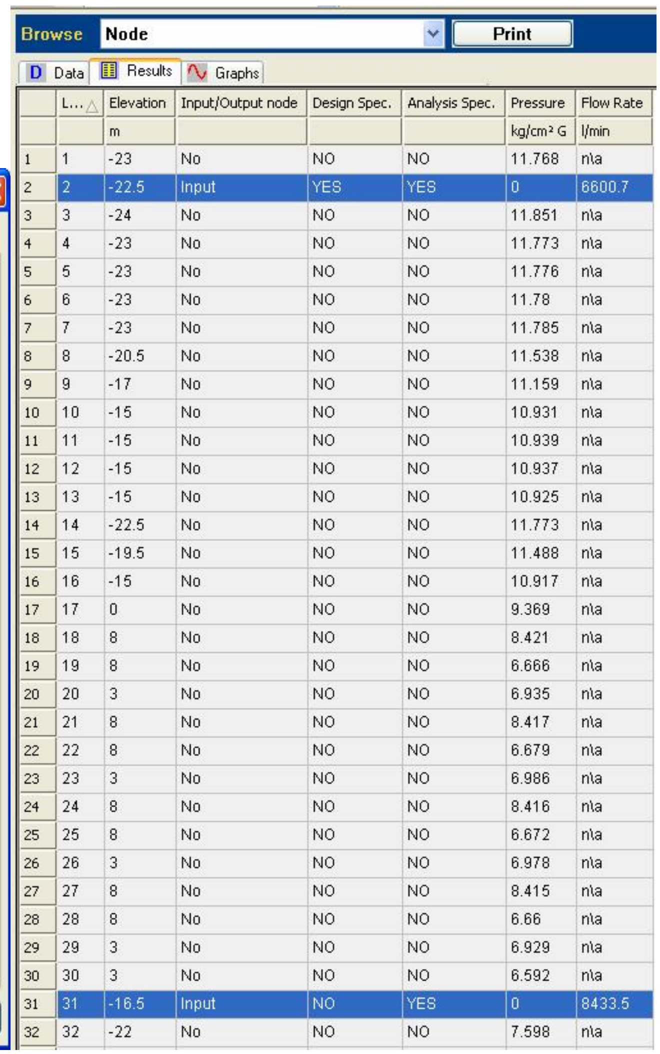


Label	31	
Elevation	-16.5	m
Input/Output node	Input	
Design Spec.	NO	
Analysis Spec.	YES	
Pressure	0	kg/cm² G
Flow	Unset	l/min
Results		
Pressure	n/a	
Flow Rate	n/a	



Label	2	
Elevation	-22.5	m
Input/Output node	Input	
Design Spec.	YES	
Flow	5172.9	l/min
Analysis Spec.	YES	
Pressure	0	kg/cm² G
Flow	Unset	l/min
Results		
Pressure	n/a	
Flow Rate	n/a	





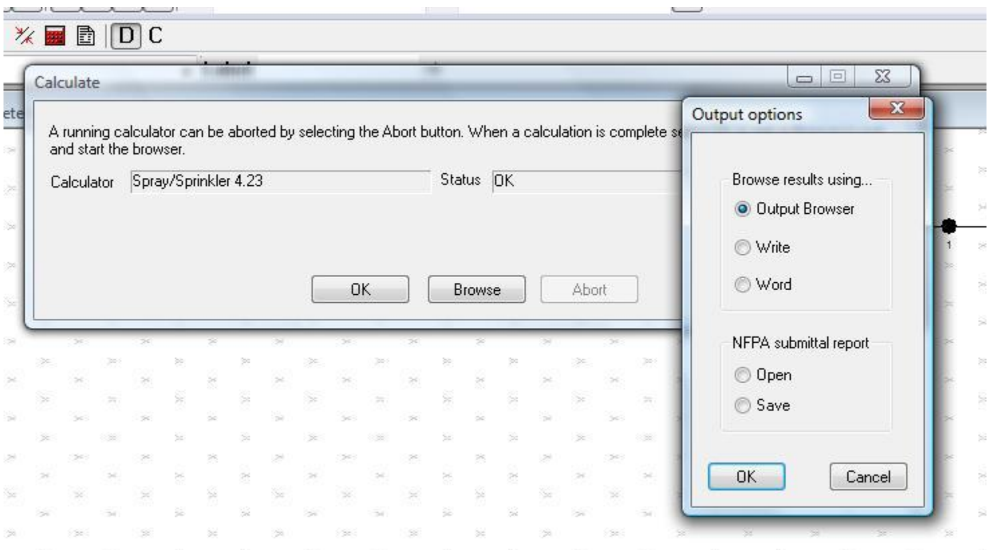
	L...	Elevation	Input/Output node	Design Spec.	Analysis Spec.	Pressure	Flow Rate
		m				kg/cm² G	l/min
1	1	-23	No	NO	NO	11.768	n\a
2	2	-22.5	Input	YES	YES	0	6600.7
3	3	-24	No	NO	NO	11.851	n\a
4	4	-23	No	NO	NO	11.773	n\a
5	5	-23	No	NO	NO	11.776	n\a
6	6	-23	No	NO	NO	11.78	n\a
7	7	-23	No	NO	NO	11.785	n\a
8	8	-20.5	No	NO	NO	11.538	n\a
9	9	-17	No	NO	NO	11.159	n\a
10	10	-15	No	NO	NO	10.931	n\a
11	11	-15	No	NO	NO	10.939	n\a
12	12	-15	No	NO	NO	10.937	n\a
13	13	-15	No	NO	NO	10.925	n\a
14	14	-22.5	No	NO	NO	11.773	n\a
15	15	-19.5	No	NO	NO	11.488	n\a
16	16	-15	No	NO	NO	10.917	n\a
17	17	0	No	NO	NO	9.369	n\a
18	18	8	No	NO	NO	8.421	n\a
19	19	8	No	NO	NO	6.666	n\a
20	20	3	No	NO	NO	6.935	n\a
21	21	8	No	NO	NO	8.417	n\a
22	22	8	No	NO	NO	6.679	n\a
23	23	3	No	NO	NO	6.986	n\a
24	24	8	No	NO	NO	8.416	n\a
25	25	8	No	NO	NO	6.672	n\a
26	26	3	No	NO	NO	6.978	n\a
27	27	8	No	NO	NO	8.415	n\a
28	28	8	No	NO	NO	6.66	n\a
29	29	3	No	NO	NO	6.929	n\a
30	30	3	No	NO	NO	6.592	n\a
31	31	-16.5	Input	NO	YES	0	8433.5
32	32	-22	No	NO	NO	7.598	n\a

It is also possible, but not advisable for good design, to perform the calculation by using the most remote nozzle option.

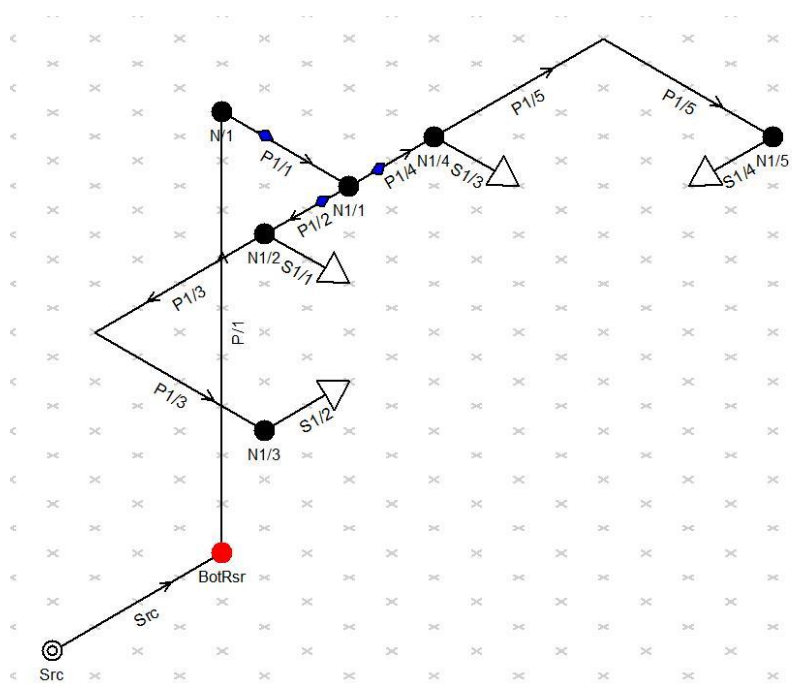
Generating tables for an NFPA report

In the PIPENET Spray/Sprinkler module, hydraulic calculation details can now be written to a file in tabular form in order to assist in the preparation of a fire protection submittal of the kind required by the NFPA. The output file is written in rich text format. The calculation results are presented in the form of ñNode analysisò and ñPipe informationò tables, which are designed to comply with the format specified in the 2007 Edition of NFPA-13 and are suitable for inclusion in a submittal report.

This new facility is made available through additional options in the browser dialogue, which can be opened from the calculate dialogue or the calculation toolbar:



By way of illustration, the tables generated for the following simple network are shown below:



Summary Values

Title	NFPA Example
Calculation date	24-Sep-2008 11:23
Calculator	PIPENET Vision Spray calculator, version 4.23
Friction loss formula	Hazen-Williams
Design standard	NFPA 1996/2001
Total number of sprinkler heads	4
Number of sprinkler heads on	4
Total sprinkler discharge (US.gal/min)	56.825
Total non-sprinkler output flow (US.gal/min)	0.000
Total input flow (US.gal/min)	56.825
Highest fluid velocity (ft/sec)	8.955
Pressure at input nodes	See NODE ANALYSIS table

Node Analysis

Node tag	**Elevation** (ft)	**Node Type**	**Pressure** (psi A)	**Discharge** (US.gal/min)	**Notes**
BOTRSR/0	0.00		94.422	0.000	
N/1	12.00		87.891	0.000	
N1/1	12.00		87.262	0.000	
N1/2	12.00	Sprinkler	86.869	14.272	Nozzle label: S1/1
N1/3	12.00	Sprinkler	85.536	14.140	Nozzle label: S1/2
N1/4	12.00	Sprinkler	86.869	14.272	Nozzle label: S1/3
N1/5	12.00	Sprinkler	85.536	14.140	Nozzle label: S1/4
SRC/0	0.00	Input	95.538	0.000	

Pipe Information

Node 1 **Node 2**	**Elev 1** (ft) **Elev 2** (ft)	**K factor** **Pipe label Nozzle label**	**Flow added (q)** (US.gal/min) **Total flow (Q)** (US.gal/min)	**Nominal ID** (inches) **Actual ID** (in)	**Fittings -** quantity, type, and equivalent length (ft)	**L** (ft) **F** (ft) **T** (ft)	**C factor** **Pf per ft** (psi)	**Pt** (psi A) **Pe** (psi) **Pf** (psi)	**Notes**
BOTRSR/0 N/1	0.00 12.00	 P/1	 56.825	1.5 1.610		12.001 0.000 12.001	120.0 0.112	73.195 -5.193 1.338	Vel = 8.955 ft/sec
N/1 N1/1	12.00 12.00	 P1/1	 56.825	1.5 1.610	1xE=4.00	1.640 3.999 5.640	120.0 0.112	72.566 0.000 0.629	Vel = 8.955 ft/sec
N1/1 N1/2	12.00 12.00	1.68 P1/2 S1/1	 28.412	1.25 1.380	1xE=3.00	3.000 3.000 6.000	120.0 0.066	72.173 0.000 0.393	Vel = 6.095 ft/sec
N1/2 N1/3	12.00 12.00	1.68 P1/3 S1/2	 14.140	0.75 0.824		6.001 0.000 6.001	120.0 0.222	70.840 0.000 1.332	Vel = 8.507 ft/sec
N1/1 N1/4	12.00 12.00	1.68 P1/4 S1/3	 28.412	1.25 1.380	1xE=3.00	3.000 3.000 6.000	120.0 0.066	72.173 0.000 0.393	Vel = 6.095 ft/sec
N1/4 N1/5	12.00 12.00	1.68 P1/5 S1/4	 14.140	0.75 0.824		6.001 0.000 6.001	120.0 0.222	70.840 0.000 1.332	Vel = 8.507 ft/sec
SRC/0 BOTRSR/0	0.00 0.00	 SRC/0	56.825 56.825	1.5 1.610		10.000 0.000 10.000	120.0 0.112	79.726 0.000 1.115	Vel = 8.955 ft/sec

Solving Liquid Hammer Problems, Using PIPENET and CAESAR II

By: Farhad Salehi of Alpha Afzaar Inc.

Liquid hammer - A Destructive force

Liquid hammer is the destructive force causing pounding noises and vibration in a piping system when liquid flowing through a pipeline is stopped abruptly. When sudden changes in flow occur, the energy associated with the flowing liquid is suddenly transformed into pressure at that location. This excess pressure is known as surge pressure and is greater with large changes in velocity. Characteristics of the pipe such as the materials used in construction, the wall thickness, and the temperature of the pipe, all affect the elastic properties of the pipe and how it will respond to surge pressures.

The thicker pipe wall and stronger pipes and fittings the faster the shock wave. Thin walled plastic pipe will only bounce a shock wave back at 914 m/s while heavy wall steel pipe will bounce a shock wave back at 2438 m/s.

Liquid does not actually travel down a pipe line at these speeds. For example 1.5 to 2 meters per second is very fast for water to flow in a pipeline. A pressure wave or shock wave in liquid happens when one liquid molecule pushes on another liquid molecule and the second molecule pushes on a third and so on. If you have a pipeline 1,000 meters long full of water, injecting a thimble full of water in one end of the pipe will cause another thimble of water to almost instantaneously come out of the other end of the pipe. The non compressible nature of most liquids is what transmits a shock wave through pipelines at such unimaginable speeds. Stronger or thicker walled pipe and fittings are better able to withstand the repeated impacts of liquid hammer but, as the strength of the pipe and fittings increases, the velocity of the shock wave increases causing more damage.

Causes of Liquid Hammer

The causes of liquid hammer are varied. There are, however, four common events that typically induce large changes in pressure:

1. Pump start-up can induce the rapid collapse of a void space that exists downstream from a starting pump. This generates high pressures.
2. Pump power failure can create a rapid change in flow, which causes a pressure up-surge on the suction side and a pressure down-surge on the discharge side. The down-surge is usually the major problem. The pressure on the discharge side reaches vapour pressure, resulting in vapour column separation.
3. Valve opening and closing is fundamental to safe pipeline operation. Closing a valve at the downstream end of a pipeline creates a pressure wave that moves toward the reservoir. Closing a valve in less time than it takes for the pressure surge to travel to the end of the pipeline and back is

called ñsudden valve closure.ò Sudden valve closure will change velocity quickly and can result in a pressure surge. The pressure surge resulting from a sudden valve opening is usually not as excessive.

4. Improper operation or incorporation of surge protection devices can do more harm than good. An example is over sizing the surge relief valve or improperly selecting the vacuum breaker-air relief valve. Another example is to try to incorporate some means of preventing liquid hammer when it may not be a problem.

Manual Load Calculation

$$dp = \rho . c . dv$$

Where:

dp ï is the pressure rise due to the fluidõs ñinstantaneousò stopping.
ρ ï is the fluid density.
c ï is the speed of sound in the fluid.
dv ï is the change in velocity of the fluid.

The speed of sound in the fluid can be estimated from:

$$c = [E_f / (\rho + \rho(E_f / E)\ (d/t)\ )]^{0.5}$$

Where:

E_f ï is the bulk modulus of the fluid.
E ï is the modulus of elasticity of the pipe.
d ï is the pipe mean diameter.
t ï is the pipe wall thickness.
ρ ï is the fluid density.

The magnitude of unbalanced load can be computed from:

$$F = dp\ .\ Area$$

PIPENET Model

In the following example, the water hammer phenomenon happens when the stop valve closes in 4 seconds. **PIPENET** Transient simulates pressure surge in piping systems.

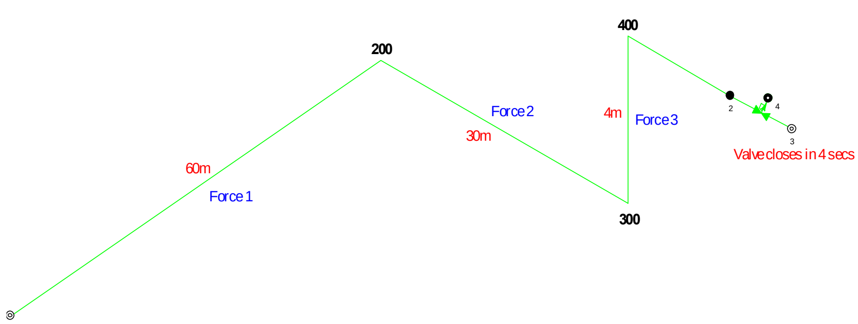


Figure 1 ï piping system for analysis - This is a 10 inch, Std. WT, A106-B pipe. Water is flowing through the pipe with 11.2 bar pressure and 20°C temperature. Suddenly, the valve closes in 4 seconds.

Label	4	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	0	sec
Start value	1	
Stop time	4	sec
Stop value	0	
Exponent	1	

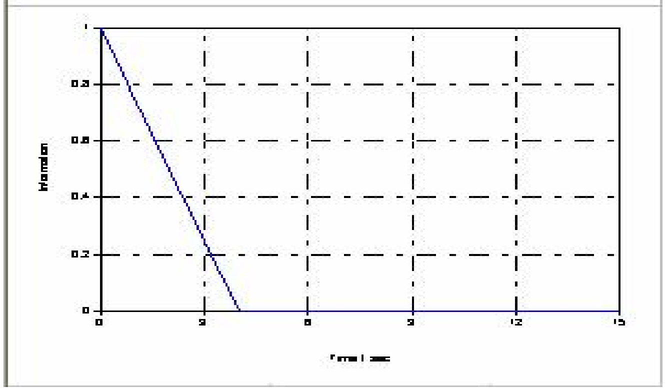


Figure 2 - the specification applied to valve closure with power-ramp time function.

It is most likely that the water hammer load will be found in segment 200-300 (force 2), shown in figure 1. The magnitude of applied dynamic force due to a pressure surge in elbow-elbow pair 200-300 is illustrated in figure 3 below. This load spectrum is a uni-axial force along the pipe. The direction must be specified in the CAESAR II dynamic model correctly, later.

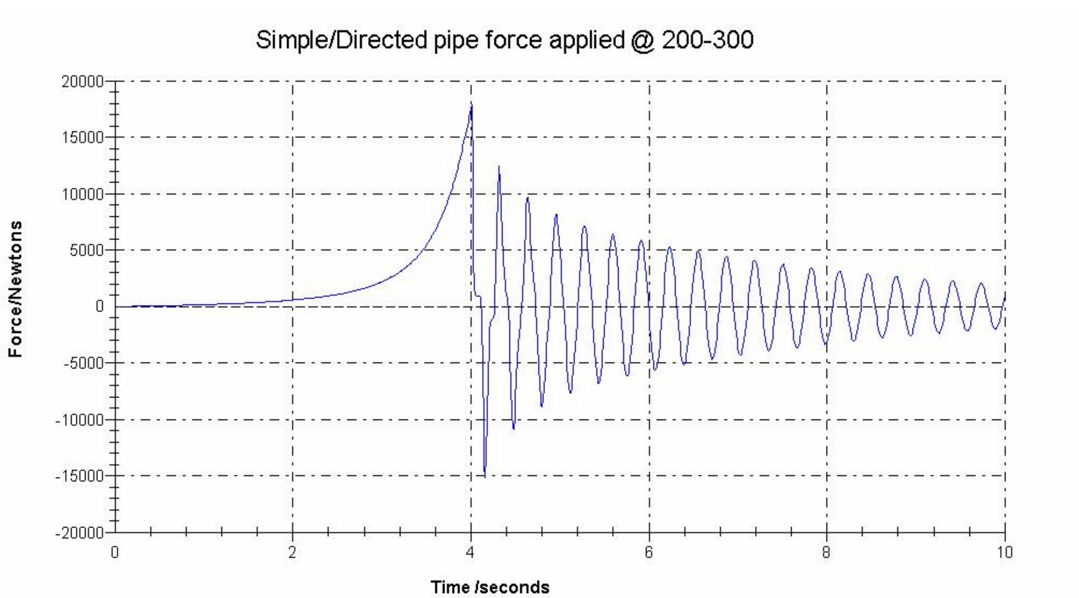


Figure 3

CAESAR II Model:

After creating the same model in CAESAR II and performing static analysis shown in figure 4, we see that the support loads and the maximum stress are very low and acceptable. (Code Stress Ratio is 13.0 at Node 410 LOADCASE: 2 (SUS) W+P1)

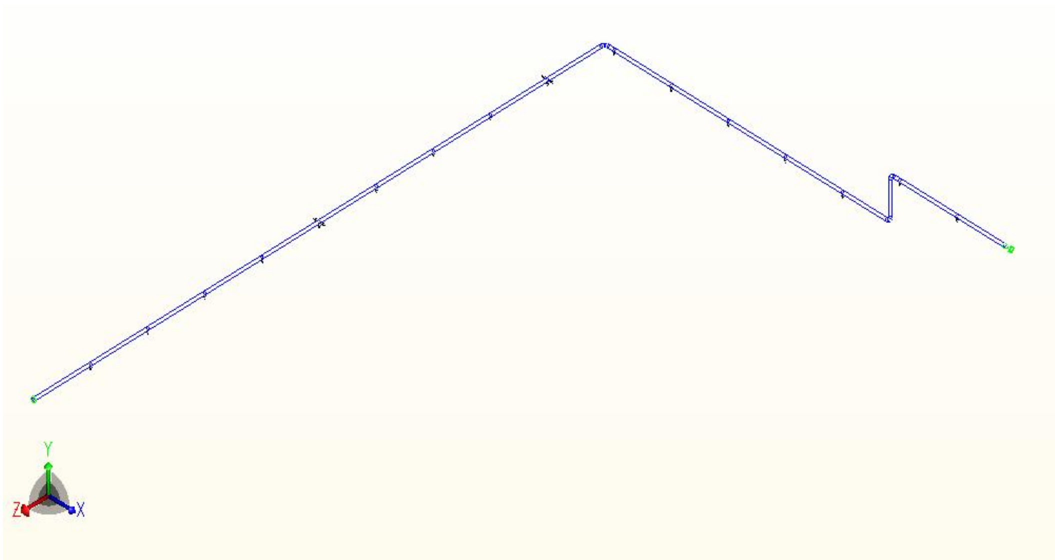


Figure 4

PERFORMING DYNAMIC CALCULATION:

PIPENET creates an .FRC file for each defined force in the model. CAESAR II can read .FRC files and create a dynamic input file automatically. We can import an .FRC file in CAESAR II by using Tools>External Interfaces> **PIPENET** from CAESAR II main menu. After performing dynamic analysis, we'll see stress failure and excessive forces on some of the pipe supports shown below.

RESTRAINT REPORT, Loads on Restraints
(OCC)COMBINATION # 1

	------Forces(N.)-------			-----Moments(N.m.)-----			
NODE	FX	FY	FZ	MX	MY	MZ	
100	4140	2063	1451	2063	21443	23	Rigid ANC
250	0	14733	0	0	0	0	Rigid +Y
410	0	10935	0	0	0	0	Rigid +Y
600	13618	7591	1164	1308	8335	7723	Rigid ANC

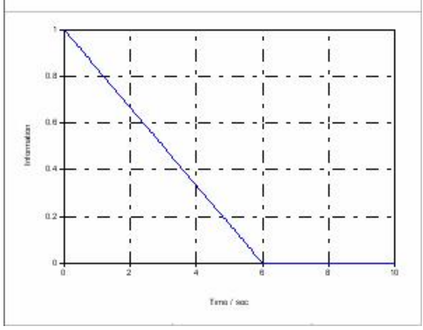
```
****  B31.3 -2006, May 31, 2007
****  CODE STRESS CHECK FAILED

 HIGHEST STRESSES: (    KPa     )
    CODE STRESS %:              106.1  @NODE  298
           STRESS:           194578.8  ALLOWABLE:   183401.
    BENDING STRESS:          183613.0  @NODE  298
    TORSIONAL STRESS:          5011.1  @NODE  300
    AXIAL STRESS:             11947.4  @NODE  298
    3D MAX INTENSITY:        201337.9  @NODE  299
```

The Fix

1. In long pipelines, surge can be relieved with a tank of water directly connected to the pipeline called a ñsurge tank.ò When a surge is encountered, the tank will act to relieve the pressure, and can store excess liquid, giving the flow alternative storage better than that provided by expansion of the pipe wall and compression of the fluid. Surge tanks can serve for both positive and negative pressure fluctuations.
2. Air chambers are installed in areas where water hammer is encountered frequently, and are typically seen behind sink and tub fixtures. Shaped like thin, upside-down bottles with a small orifice connection to the pipe, they are air-filled. The air compresses to absorb the shock, protecting the fixture and piping.
3. In this situation, the best form of water hammer prevention is to have automatically-controlled valves, which close slowly. Closing the valve slowly can moderate the rise in the pressure when the down surge wave - resulting from the valve closing - returns from the source or reservoir.

Label	4	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	0	sec
Start value	1	
Stop time	6	sec
Stop value	0	
Exponent	1	



Going back to the **PIPENET** model and changing the valve closure time to 6 sec. (figure 5) will cause fewer water hammer loads, as shown in figure 6.

Figure 5

NOTE: Lower values of the exponent cause the majority of the flow cut off to occur at the end of closure, while larger values of the closure exponent cause the majority of flow cut off to occur at the beginning of closure.

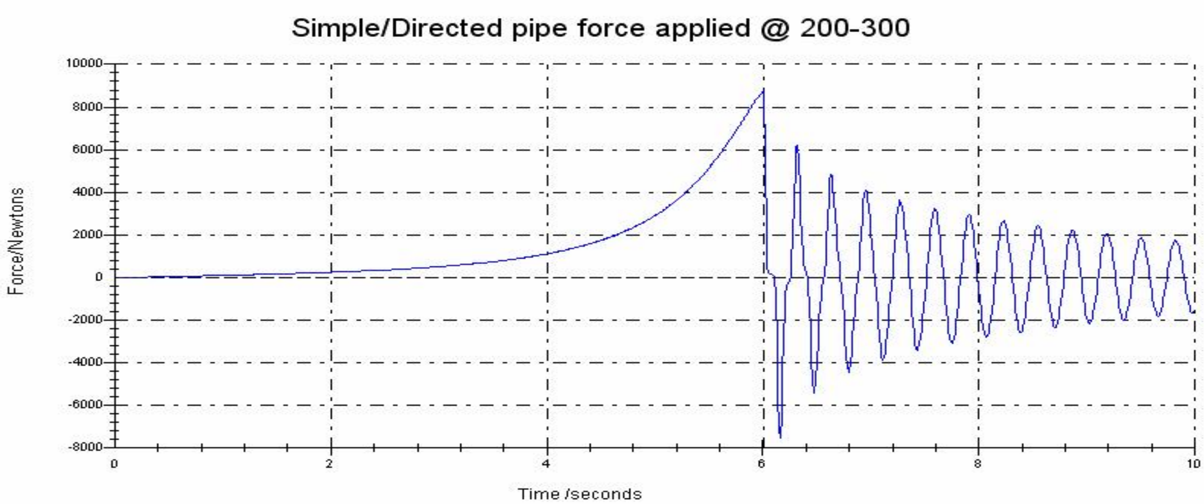


Figure 6

Now, dynamic analysis is performed for this model again with the new .FRC file. At this time, support loads are far better than in the previous situation and the code stress also passed as shown below.

```
RESTRAINT REPORT, Loads on Restraints
  (OCC)COMBINATION #  1

        ------Forces( N.)-------      -----Moments( N.m. )-----
  NODE      FX        FY        FZ        MX        MY        MZ
   100     1991      2063       701      2063     10648        18   Rigid ANC
   250        0      9607         0         0         0         0   Rigid +Y
   410        0      8885         0         0         0         0   Rigid +Y
   600     6844      6824       584       680      4230      5943   Rigid ANC


****  B31.3 -2006, May 31, 2007
****  CODE STRESS CHECK PASSED

 HIGHEST STRESSES: (    KPa    )
    CODE STRESS %:               57.0  @NODE  298
           STRESS:           104517.9  ALLOWABLE:   183401.
    BENDING STRESS:           94708.5  @NODE  298
    TORSIONAL STRESS:          2521.1  @NODE  300
    AXIAL STRESS:             10331.8  @NODE  399
    3D MAX INTENSITY:        110781.1  @NODE  299
```

Conclusion

Liquid hammer will continue to pose a challenge because it is associated with systems that cannot be exactly defined. By knowing how to avoid situations that will create liquid hammer, a lot of problems with failed valves and equipment and costly downtime can be avoided.

PIPENET NEWS

If you would like to be added to the **PIPENET NEWS** circulation list, please email: sales@sunrise-sys.com. (If you would prefer to be removed from the circulation list, please email ôNoô to the same address. Thank you.)

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Our Development Team is currently working towards **PIPENET Vision 1.40**. It will incorporate even more features requested by our users, including more options on autolayout and even better presentation of results. If you would like to comment, please contact us by emailing sales@sunrise-sys.com.

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