Application Bulletin
PIPENET® LNG Applications

SURGE ANALYSIS OF THE FIREWATER SYSTEM ON AN FLNG

BACKGROUND

This PIPENET Transient module Application Bulletin shows its use in performing surge analysis of the firewater system on the FLNG development in Africa. The FLNG facility will be a turret moored double-hull floating vessel, on which gas receiving, processing, liquefaction, and offloading facilities will be mounted together with LNG and condensate storage.

The purpose of this document is to show some of the capabilities of PIPENET Transient module for performing surge analysis of the firewater system on the FLNG. The document also shows how PIPENET Transient module could be used in finding a method of bringing the pressure surge down to an acceptable level.

The firewater system on this FLNG had a number of high points for the purpose of supplying hydrants. The scenario which is being considered is the deluge system start up. It is assumed that the hydrants at the high points may be treated as dead ends. This makes the system susceptible to cavity formation. When cavities collapse the result could be very high pressure surges.

Two cases are considered and a method of eliminating the high pressure surge is pinpointed.

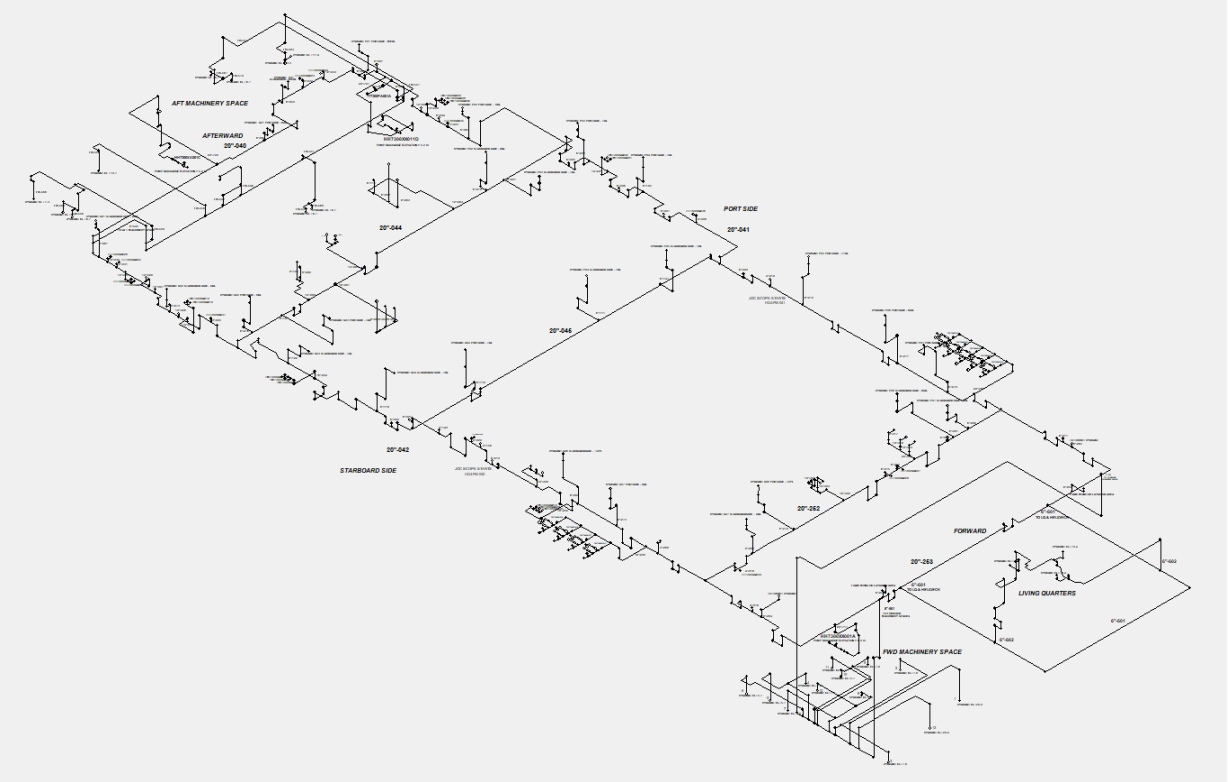
Case 1: This is the basic system without the installation of surge alleviation devices.

Case 2: One standard method of reducing pressure surges in firewater systems is the installation of vacuum breaker/air released valve. In this case 17 vacuum breakers are assumed to be installed.

1. The Scenario

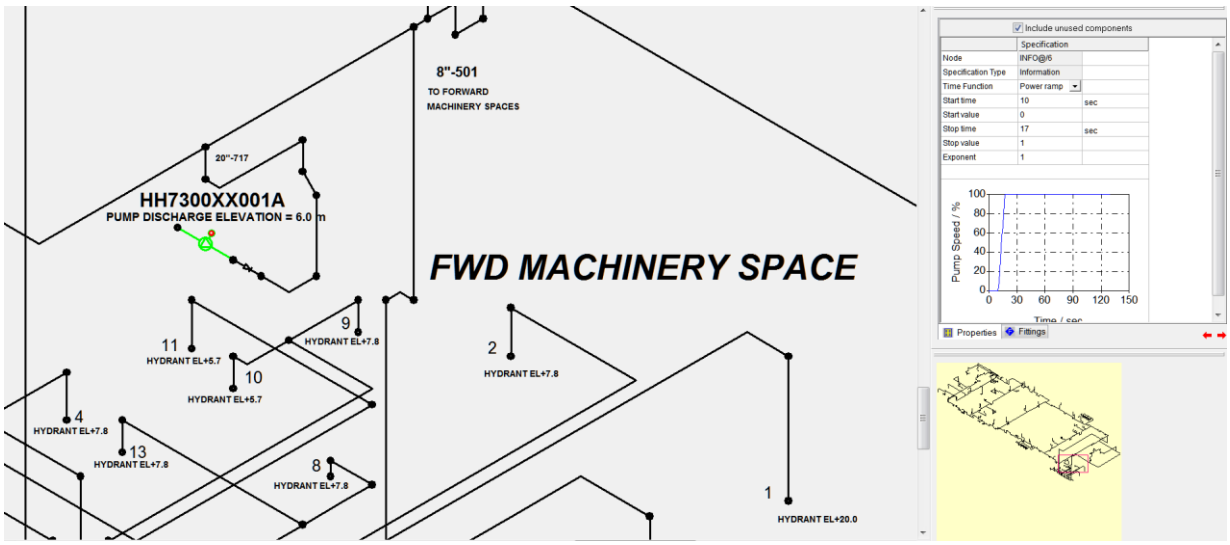
The firewater system has one forward fire pump and two aft fire pumps. The scenario which is being considered in this bulletin is the maximum forward firewater demand. In this scenario 10 deluge systems start, 5 on the port side and 5 on the starboard side. One of aft pumps starts at 5 secs and runs up in 7 secs. The forward pump starts at 10 secs and runs up in 7 secs. The deluge valves which operate are of the elastomeric type which is intended to maintain the inlet pressure at the deluge system. It is assumed that the deluge systems start operating at 5 secs and it takes 15 secs for the systems to reach full flow. PIPENET Transient module can be used for calculating the deluge system filling time accurately but that is not considered in this Application Bulletin.

2. The Network



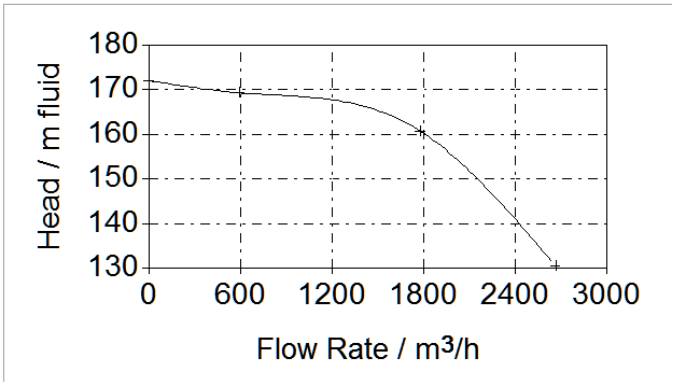
3. Salient Features of the System

3.1. Forward fire pump starts at 10 secs and runs up in 7 secs. The inlet pressure of the pump is constant at 0.46 barg.

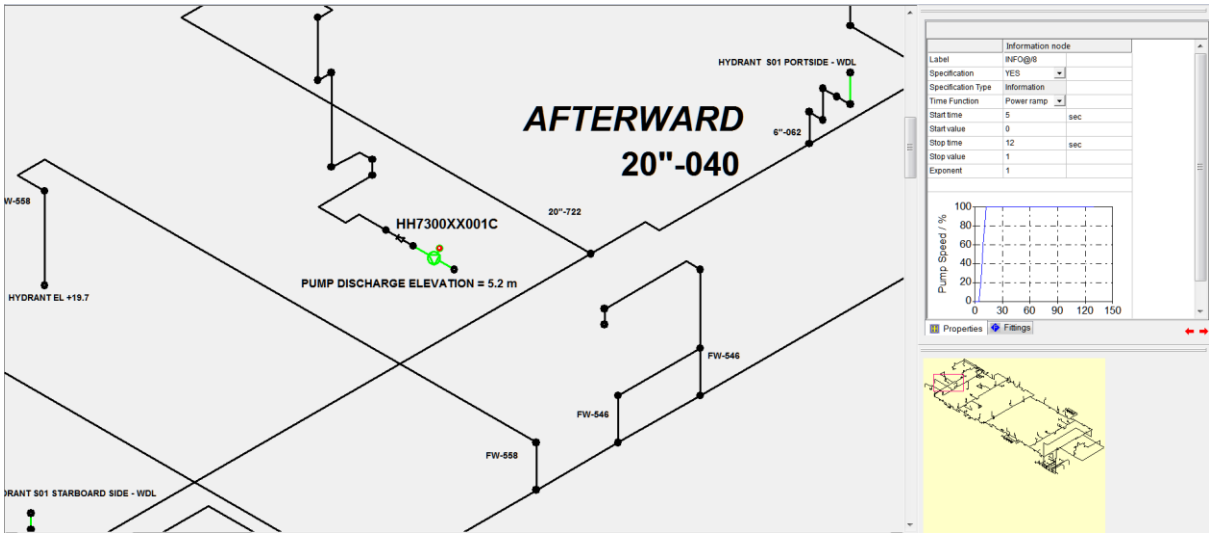


This forward pump has the following performance curve.

Flow rate	Head (input)	Head (curve)	Head (calculation)
m³/h	m	m	m
0	172	172	172
589.1	169.3	169.3	169.3
1777	160.7	160.7	160.7
2665.5	130.6	130.6	130.6

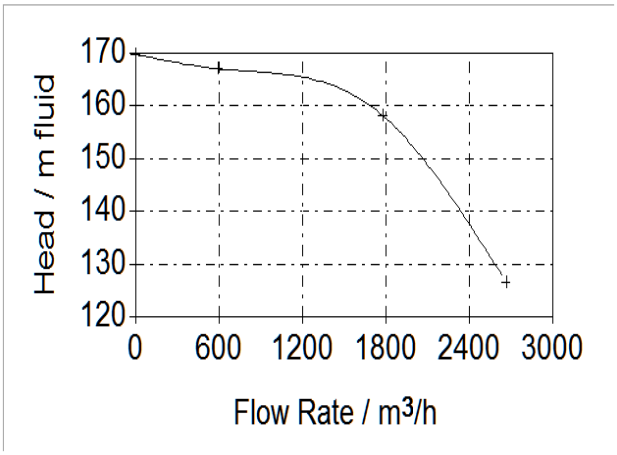


3.2. One of the two aft pumps starts at 5 secs and runs up in 7 secs. The inlet pressure of the pump is constant at 0.55 barg.



This aft pump has the following performance curve.

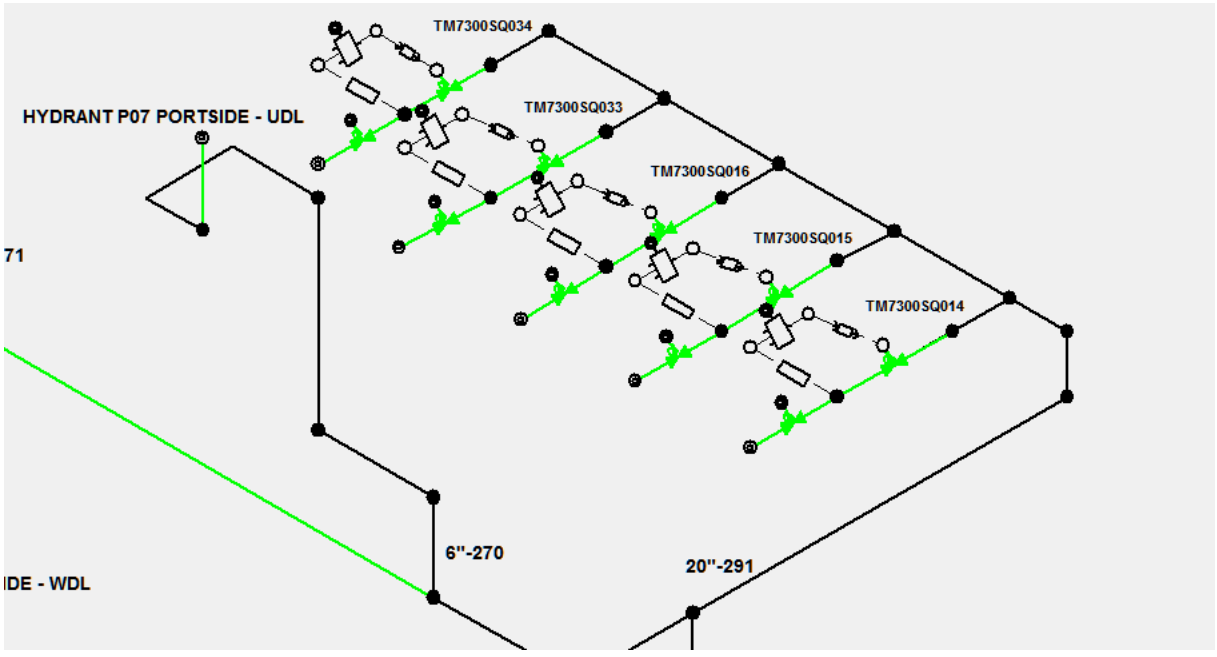
Flow rate	Head (input)	Head (curve)	Head (calculation)
m³/h	m	m	m
0	169.7	169.7	169.7
589.1	167	167	167
1777	158.1	158.1	158.1
2665.5	126.7	126.7	126.7



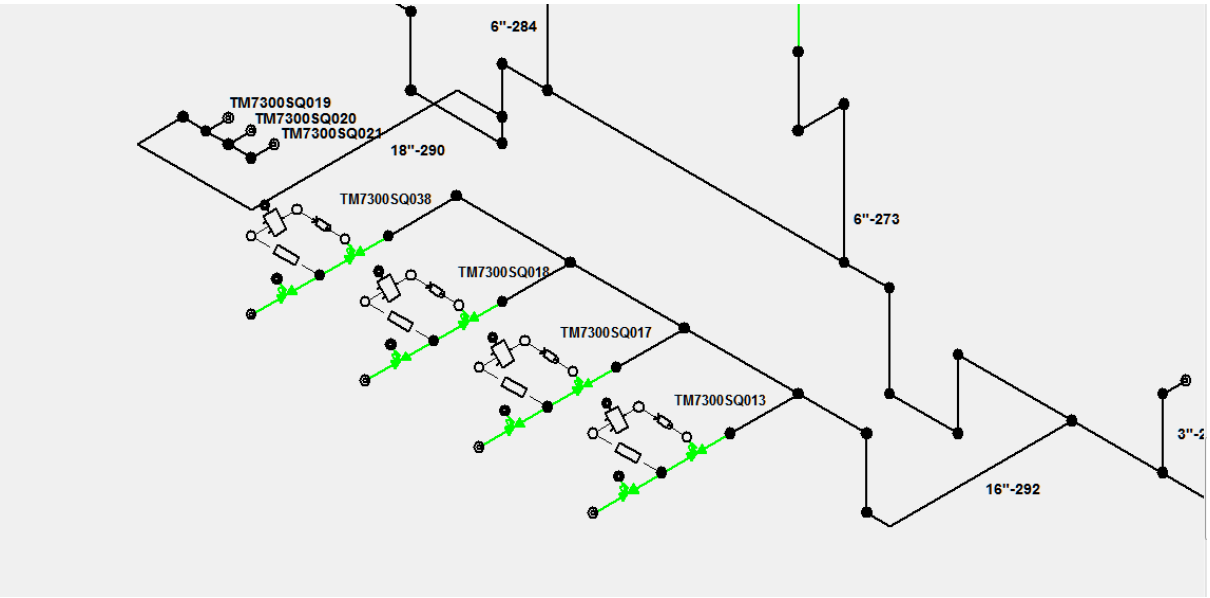
3.3. Deluge Systems:

There are different ways of modelling deluge valves. This model uses a pressure sensor, cascade PID controller and a transfer function.

Deluge Systems on the port side



Deluge Systems on the starboard side



4. Simulation Results:

Case 1: The basic system without the installation of surge alleviation devices.

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PRESSURE EXTREMA
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Maximum pressure is 152.309 bar G
          on pipe 900 at the outlet
          at time 21.00000 seconds

Minimum pressure is -0.971250 bar G
          on pipe 845 at the outlet
          at time 5.200000 seconds
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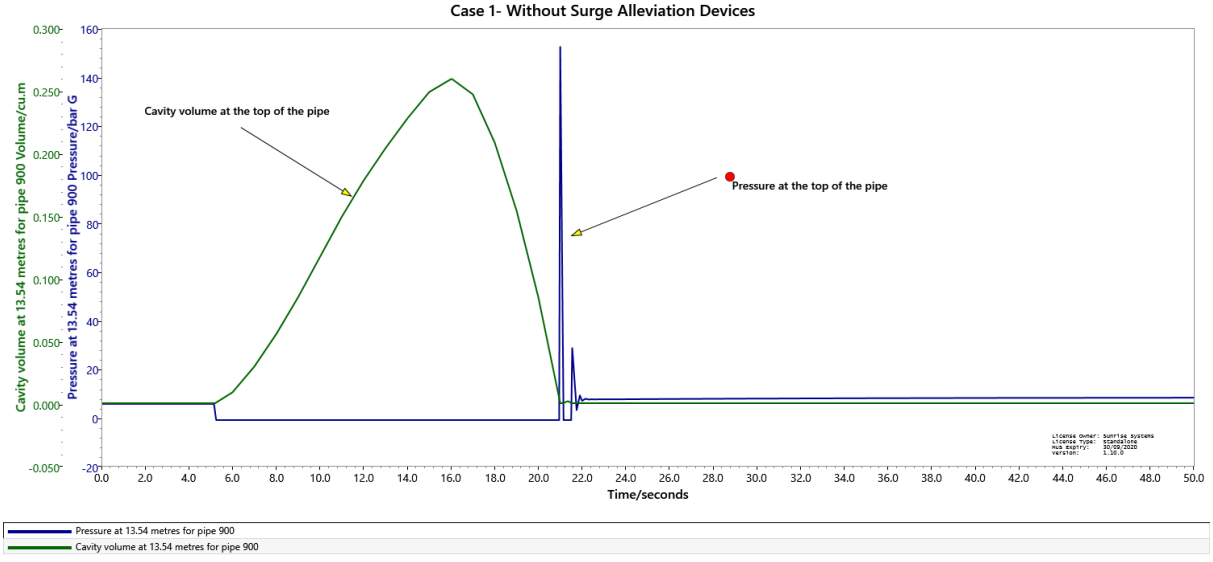
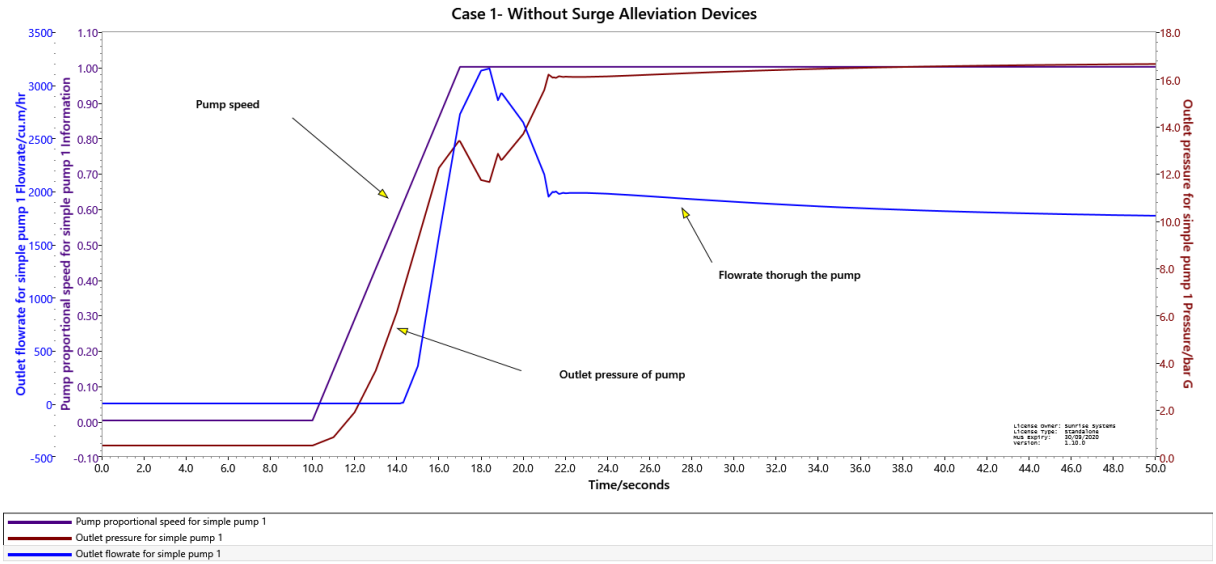
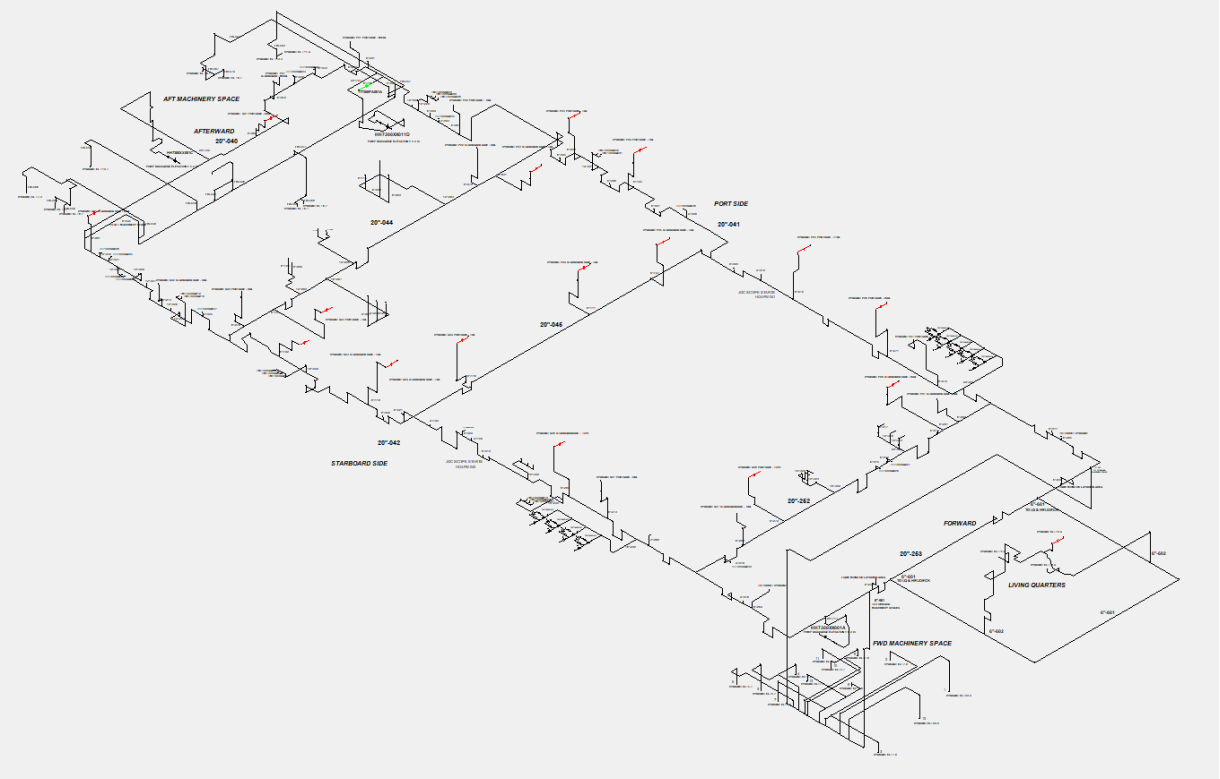




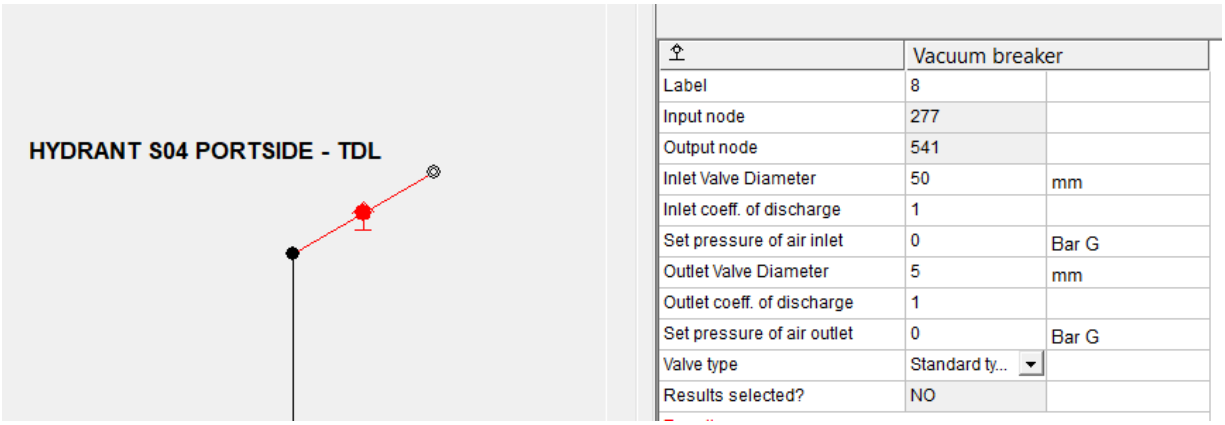
Case 2 – Install Vacuum Breakers at High Points in the System

A total of 17 vacuum breakers were installed. The air inlet was 50 mm and the air outlet was 5 mm. The firewater network had vacuum breakers at high points. In this scenario deluge system start up is being considered. For that reason, hydrants at high levels were considered to be dead ends. A vacuum breaker was installed at every such dead end which was more than 25 m above the datum.

The vacuum breakers are shown in the following schematic in red. They can be seen more clearly by zooming in to 200% magnification.



A typical vacuum breaker and its attributes are shown in the graphic below.



	Vacuum breaker	
Label	8	
Input node	277	
Output node	541	
Inlet Valve Diameter	50	mm
Inlet coeff. of discharge	1	
Set pressure of air inlet	0	Bar G
Outlet Valve Diameter	5	mm
Outlet coeff. of discharge	1	
Set pressure of air outlet	0	Bar G
Valve type	Standard ty...	
Results selected?	NO	

```
PRESSURE EXTREMA
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Maximum pressure is 19.3427 bar G
          on pipe 845 at the outlet
          at time 5.200000 seconds

Minimum pressure is -0.971250 bar G
          on pipe 875 at the outlet
          at time 5.250000 seconds
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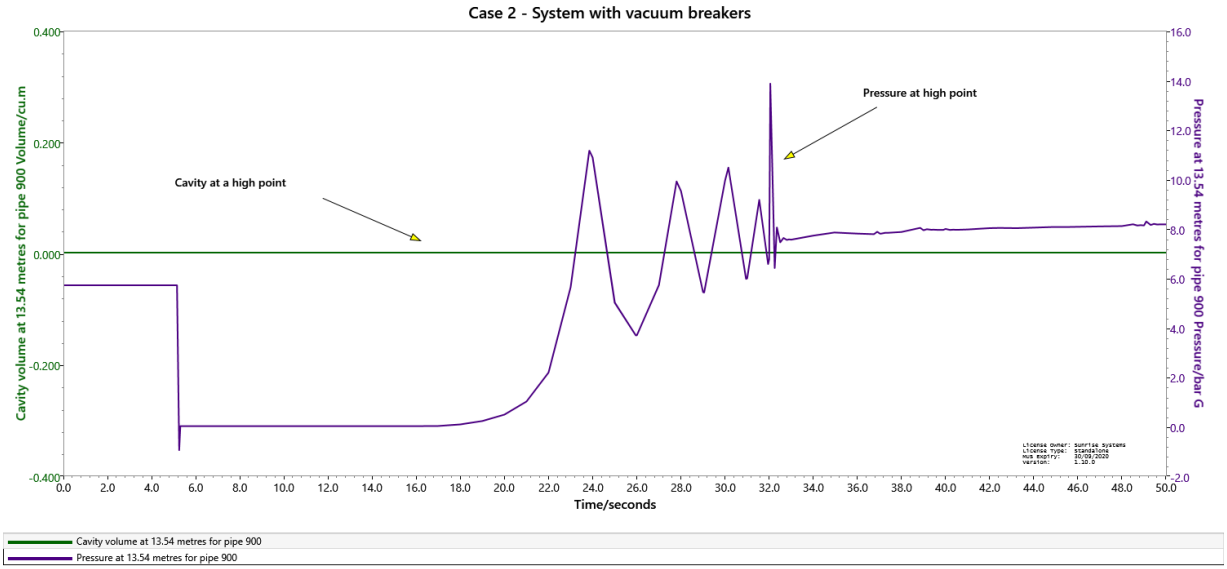

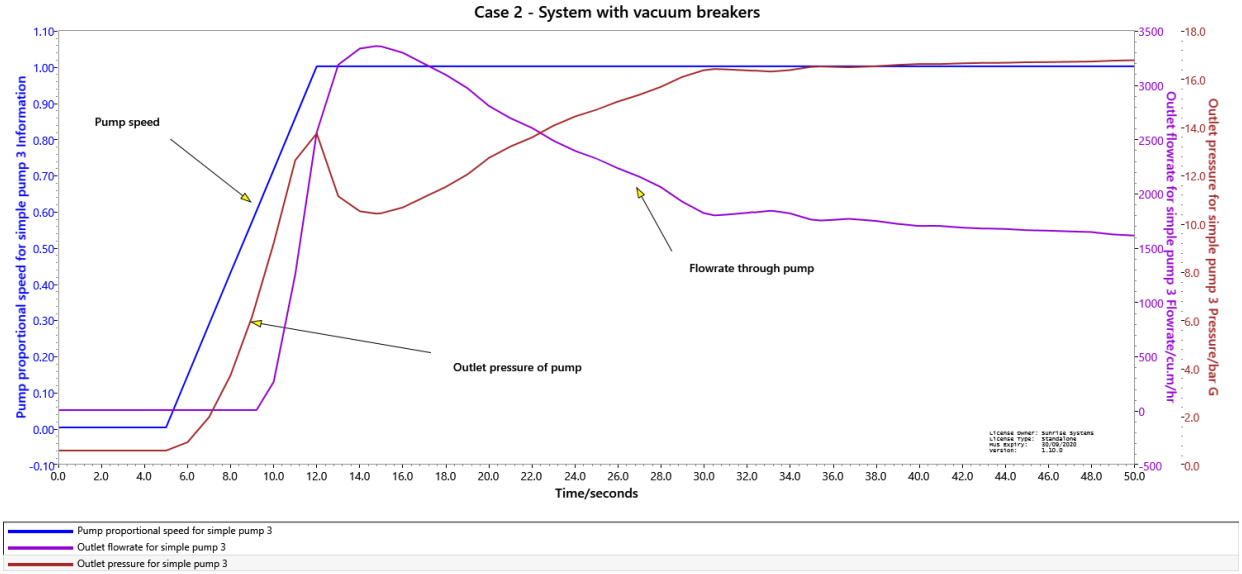

5. Conclusion:

The simulation results show that cavitation is likely unless surge alleviation devices are installed. Cavitation is likely at the high points of the system. The potential pressure surge is around 152.3 barg. By installing 17 vacuum breakers at the high points cavitation is eliminated and the pressure surge comes down to 19.3 barg

If you have any questions about this case study, or any other of PIPENET's capabilities, please email us at pipenet@sunrise-sys.com.