Application Bulletin – Process Industry
PIPENET® Transient Module Case Study

JETTY LOADING SYSTEM

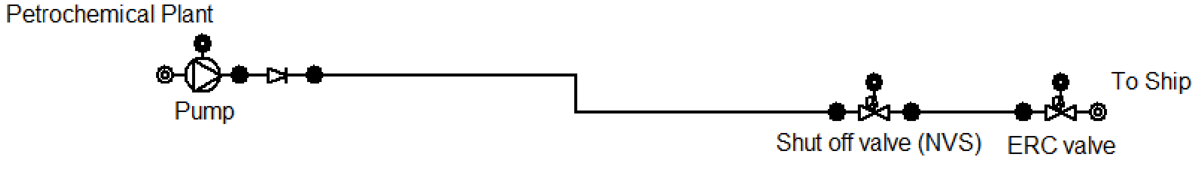
BACKGROUND

The modelling of loading systems is a major application for PIPENET VISION Transient Module. Loading systems are often susceptible to suffer from pressure-surge problems. Furthermore, as such systems are usually located near the sea, a leak of hydrocarbon material could potentially lead to an environmental disaster. The use of GRE (glass reinforced epoxy) pipes, which are less elastic than steel and use adhesives which potentially lead to weaker joints, can further increase the need for careful analysis.

This study was conducted for a Korean engineering company, who needed to design a 6 km steel pipeline from a refinery out along a jetty to a tanker ship. Carrying Lube Oil, the maximum pressure permitted was 15 barg.

Loading systems normally have two valves, which can be the source of problems. The normal shut-off valve (NSV) operates on a daily basis, closing when the tanker is full. Another valve, the Emergency Relief Coupling (ERC) valve, operates when the system needs to be shut down in an emergency such as a storm. Usually located at the end of the jetty, the ERC valve is designed to close quickly and disconnect the hose that leads to the ship.

This is the network schematic as drawn in PIPENET:



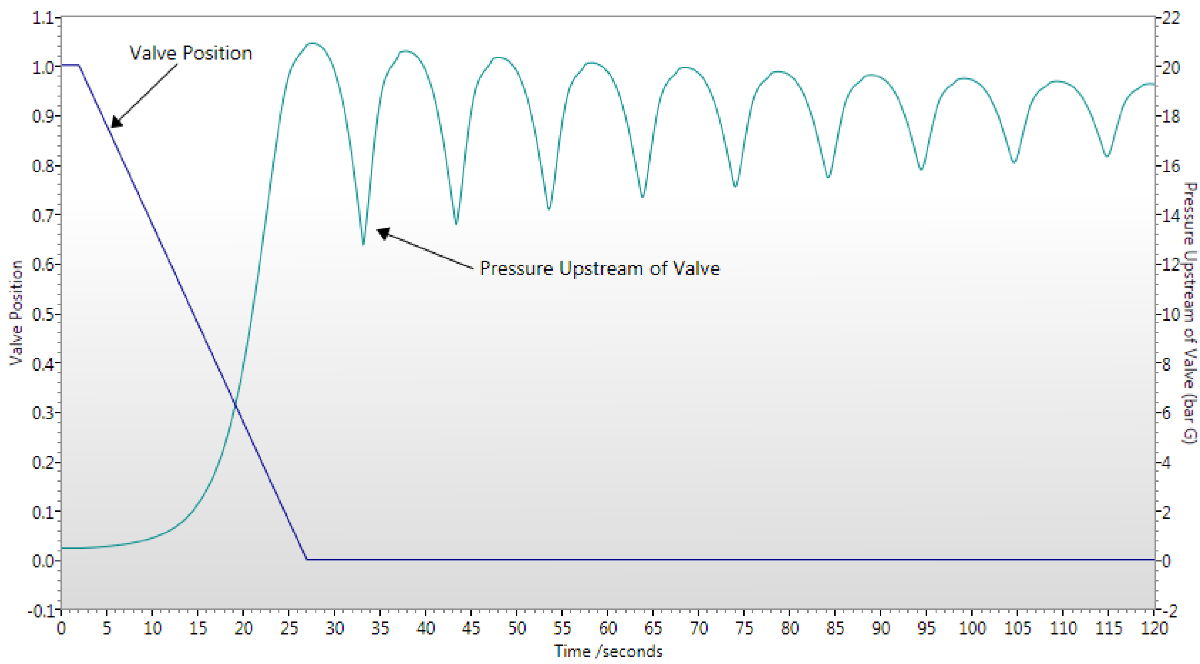
For the purposes of this article we will just study the planned shut down case, with the following brief:

- To establish whether the pressure surges experienced by the existing valves (due to valve closures) are below the allowable limit.
- To examine alternative strategies for reducing the pressure surge:
  - Using a surge relief valve, optimising its size and placement,
  - Using an accumulator, optimising its size

SCENARIO 1 - The Base Case - System with no Protection

We asked PIPENET to calculate what pressures we would see at the valve inlet if the shut-off valve was closed in a linear pattern over 25 seconds. These are the results:

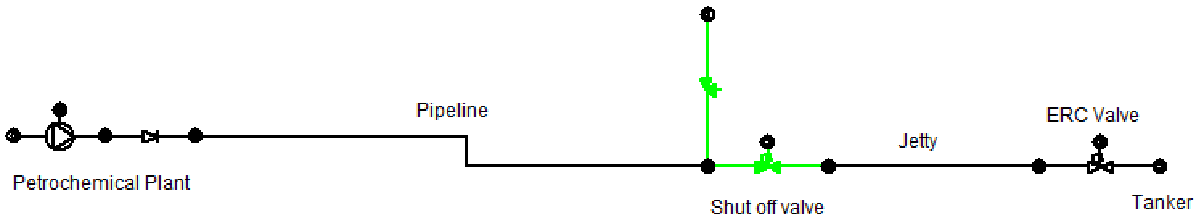
Graph 1: Base Case - No Protection



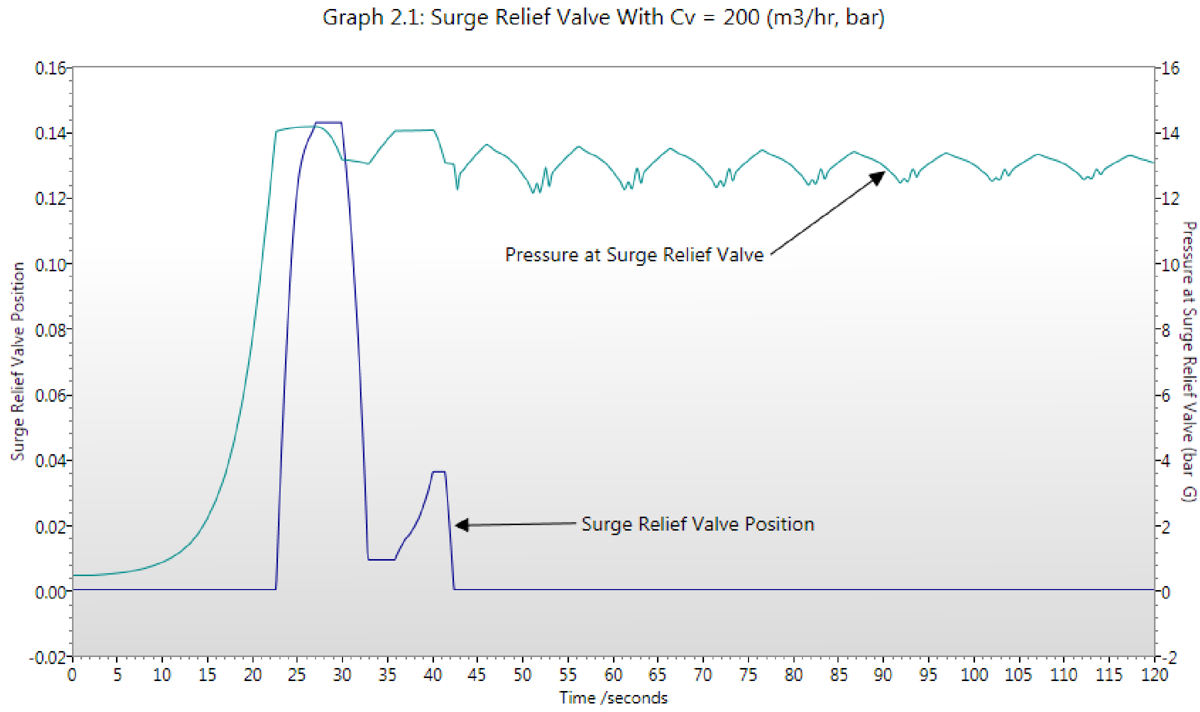
This is not acceptable, with the inlet pressure oscillations peaking at 21 barg against our limit of 15 barg.

SCENARIO 2 - Surge Relief Valve

In a first scenario to bring the pressure maxima down to acceptable limits, we introduce a surge relief valve with C_v = 200 (m^3/hr, bar).

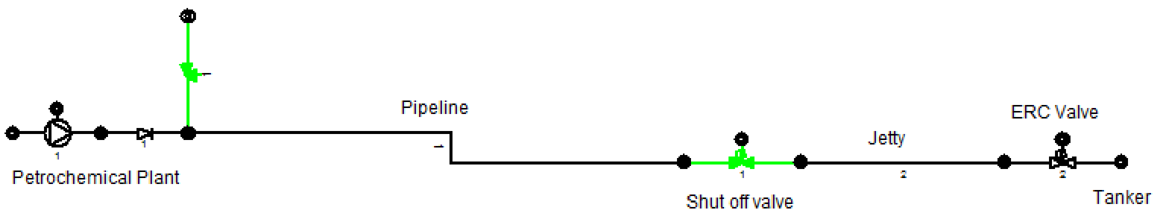


PIPENET now produces the following results:



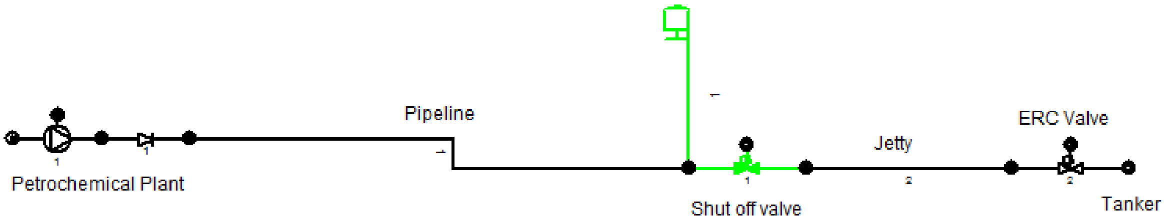
We can see that this has brought the pressure maxima down into our acceptable range. The design can be improved on, though – the left hand axis is telling us that the valve only opens to about 15% of its maximum. Further experimentation (which we will not show here) determines that a less expensive surge relief valve with C_v = 50 (m^3/hr, bar) will also keep the pressure surges in range, opening to 54%.

We can also experiment with changing the location of the surge relief valve – for example, this configuration performed much less well:

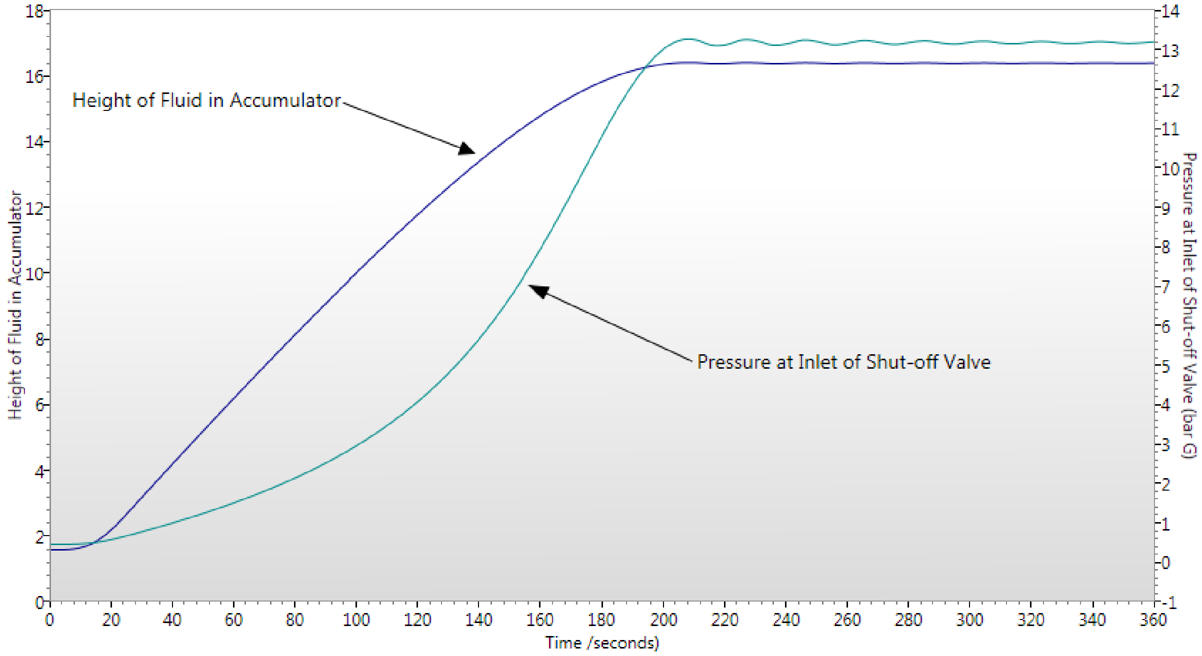


SCENARIO 3 – Accumulator

Another possibility to reduce the pressure would be to add an accumulator to the network. Again, questions of sizing, positioning, and performance can be answered by PIPENET. Here is a configuration using an accumulator with diameter = 1m, length = 20m, which achieved the design objective by reducing the maximum pressure at the inlet to the shut-off valve to 13.2 barg:



Graph 3.1: Accumulator With Diameter = 1 m, Length = 20 m

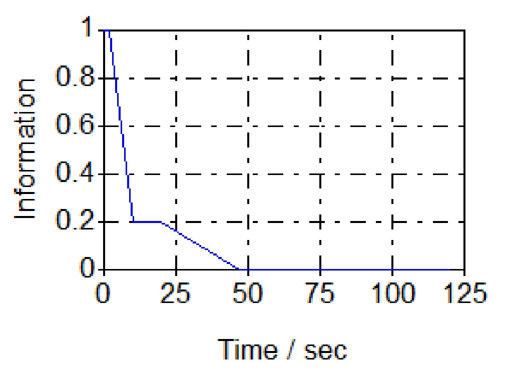


Note that as well as the pressure at the valve, PIPENET is able to tell us the height of the fluid in the accumulator.

SCENARIO 4 - Two-stage Valve Closure

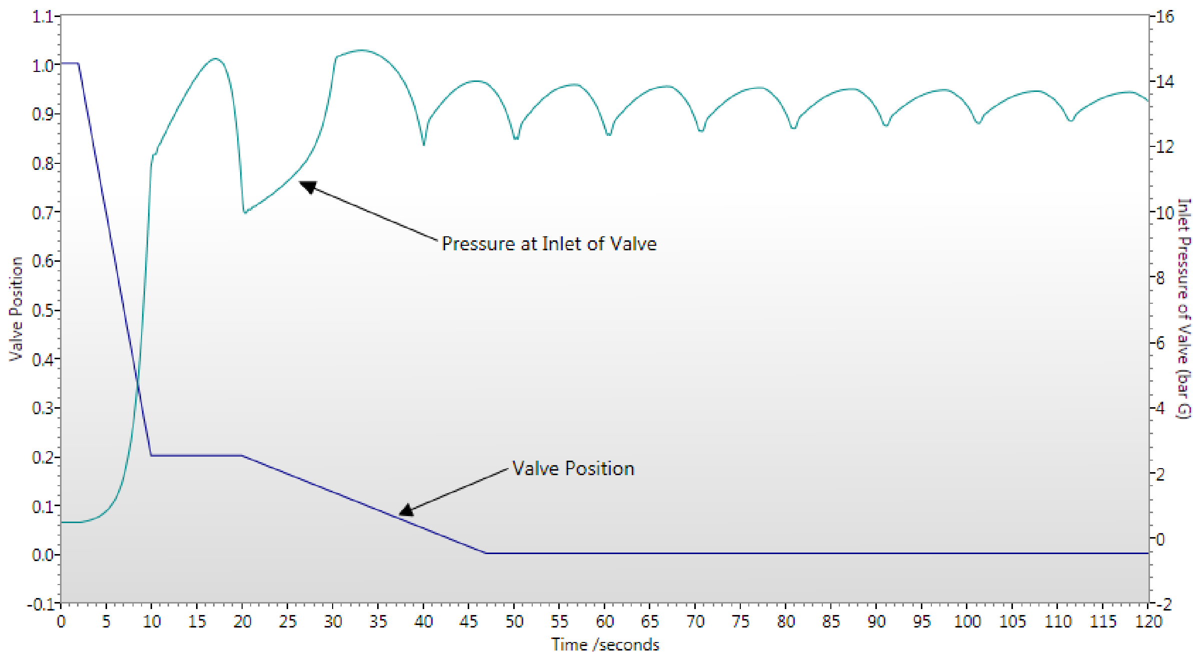
PIPENET gives you very flexible control over how the valve is closed. In this case, this helped the design engineer find a creative way to meet the objectives. A two-stage closure profile was created for the valve, as follows:

Label	i/2	
Specification	YES	
Specification Type	Information	
Time Function	Linear profile	
(Double click graph to edit profile)		



This had the desired effect on the pressure maxima:

Graph 4.1: Two-stage Valve Closure Type 1



We should however note that although this is an elegant solution for the NSV valve, we still have the ERC valve to consider and for that reason we are still likely to require a surge protection device.

CONCLUSION

We have presented here a small selection of the scenarios and outputs that the customer produced in the course of ensuring that a cost-effective and safe design was produced for the loading system.

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