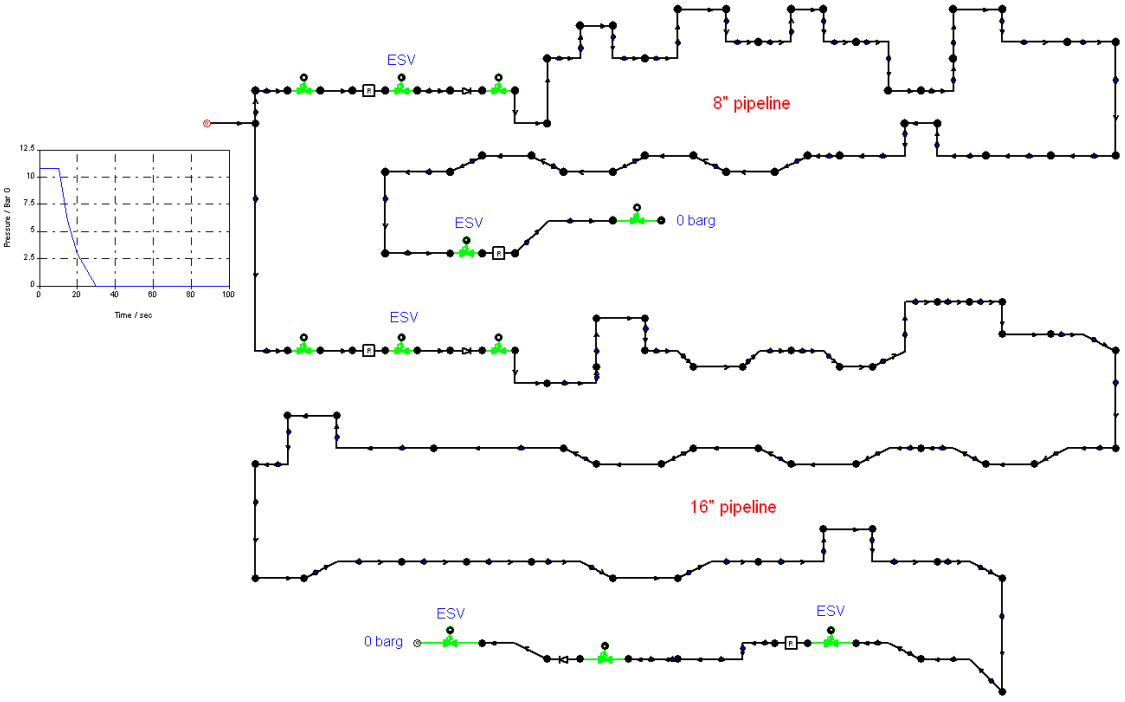
Application Bulletin 7 – Process Industry
PIPENET® Transient Module Case Study

OPTIMIZED ESV OPERATION IN A LONG OIL PIPELINE

BACKGROUND

This project concerns an oil pipeline in Qatar. From a common source tie-in, the pipeline supplies two locations at distances of 5.77 km and 6.76 km, via 8” and 16” pipes respectively. The maximum design pressure is 18.3 barg, and there is to be no cavitation. Here is the PIPENET model:



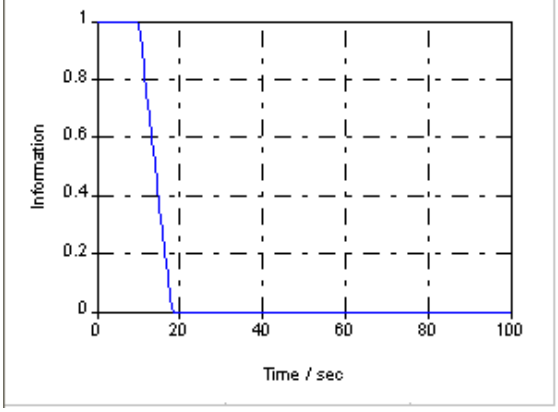
Emergency Shutdown Valves are located at various locations in the pipeline. The customer needed to know how to optimize the speed and sequence of valve closure in order to:

- Reduce fire risk
- Reduce pressure surges
- Prevent cavitation

SCENARIO 1 – ESV valves close synchronously with normal speed

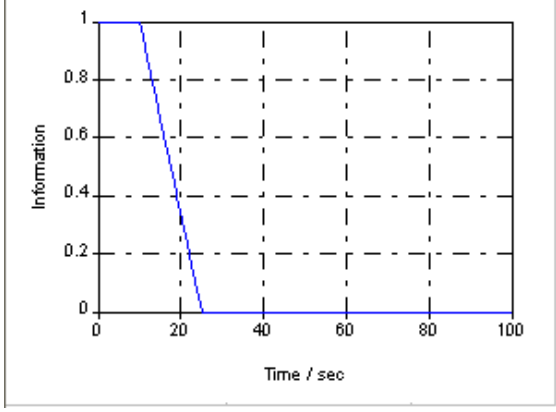
All ESV valves must be closed immediately when any fire threatens the safety of the pipeline. Ideally the valves should be closed as fast as possible but the actual closing speed must consider the pressure surge during valve closure. If the ESV valves are closed in normal speed (8 seconds for the 8” valves and 15 seconds for the 16” valves) PIPENET shows that the maximum pressure can reach 24.5 barg which exceeds the design pressure 18.3 barg.

Label	10	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	18	sec
Stop value	0	
Exponent	1	

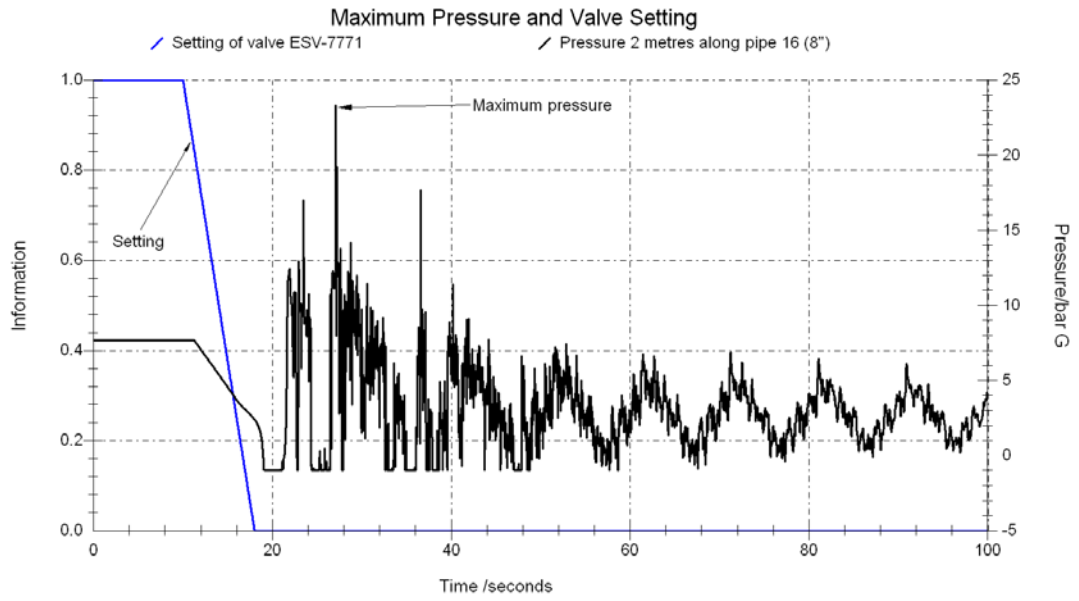


8” ESD Valve Closure Curve

Label	62	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	25	sec
Stop value	0	
Exponent	1	



16” ESD Valve Closure Curve

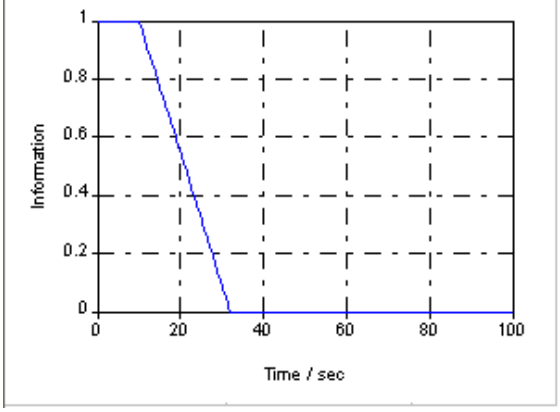


SCENARIO 2 – ESV valves close synchronously with slow speed

We expect the pressure surge to reduce if we close the ESV valves more slowly. So in this scenario, all ESV valves are closed more slowly, over 22 seconds for both the 8” and 16” valves. The calculated maximum pressure does indeed decrease to 10.8 barg. However, the

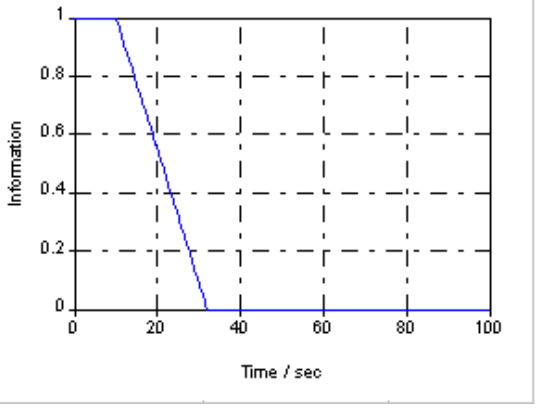
minimum pressure is still vapour pressure (-1.00325 barg) which indicates that cavitation will occur in the pipeline.

Label	10	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	32	sec
Stop value	0	
Exponent	1	

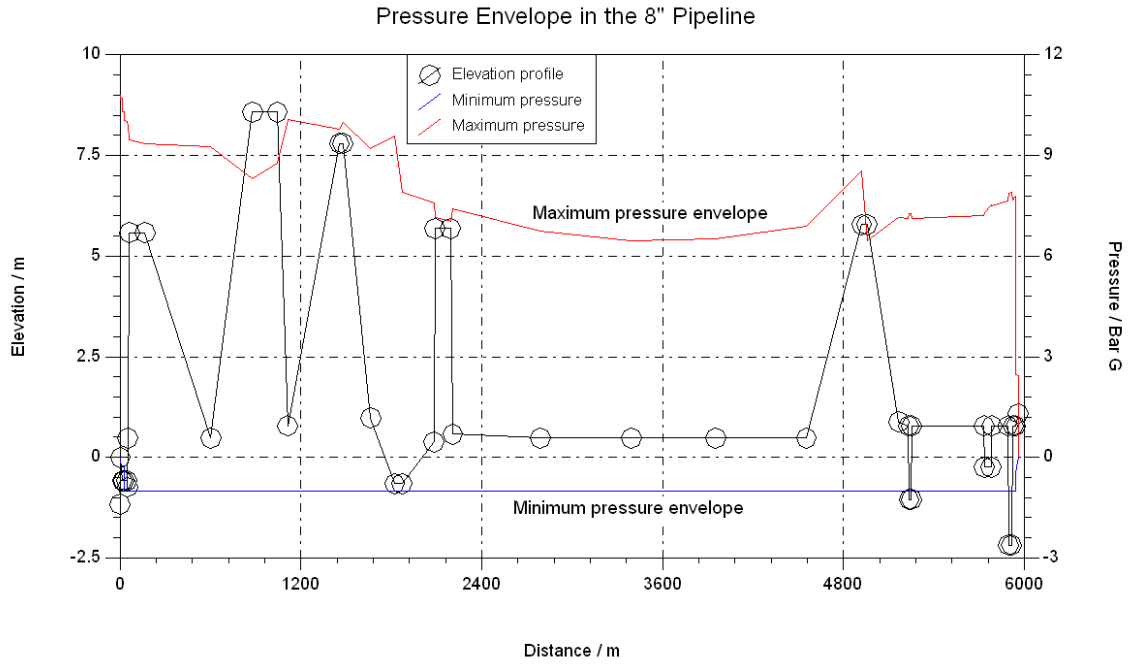


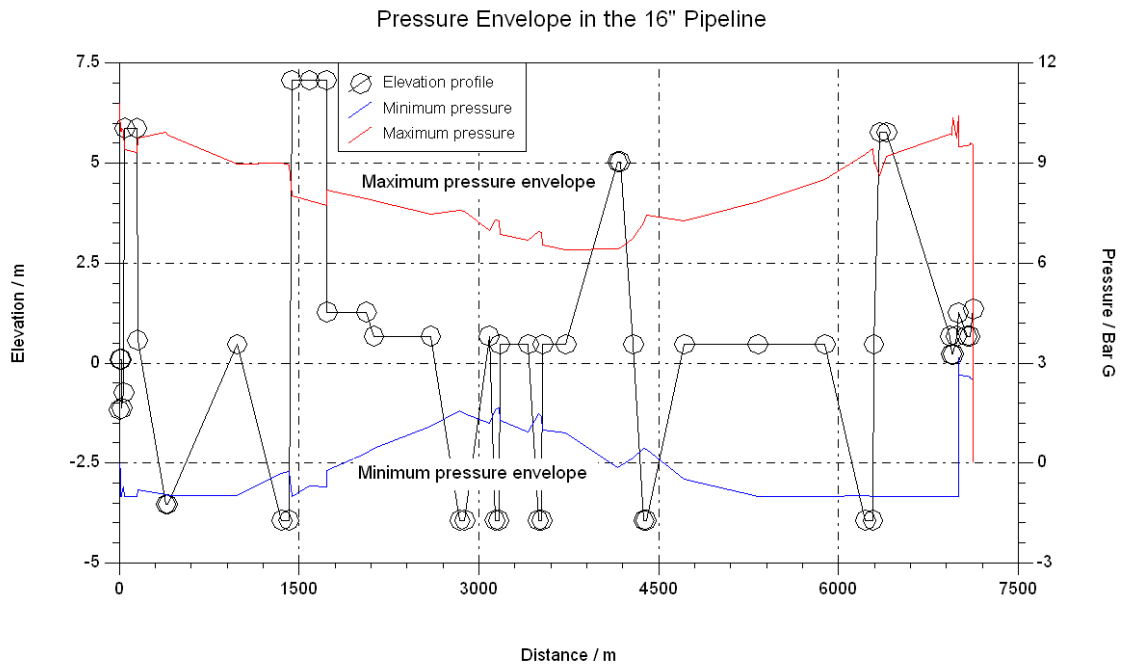
8" ESD Valve Closure Curve

Label	62	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	32	sec
Stop value	0	
Exponent	1	



16" ESD Valve Closure Curve

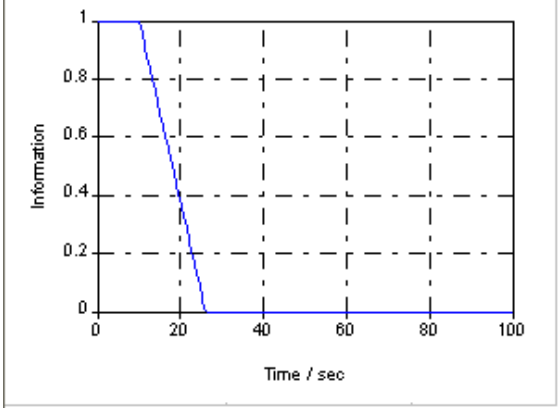




SCENARIO 3 – ESV valves close in optimized speed and sequence

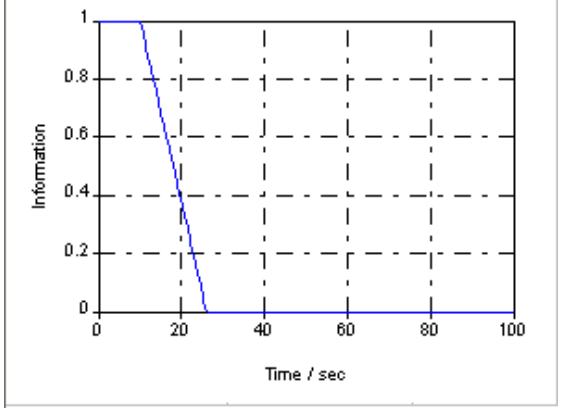
There are many possible solutions to control the pressure surge within the allowed range, e.g. vacuum breaker, accumulator etc. However, the simplest and least costly method may just be to control the closure speed and sequence of the valves. So in this scenario the upstream ESV valves are closed slowly as in scenario 2 (22 seconds) and the downstream ESV valves are closed faster, in 16 seconds. Now the calculated maximum pressure is 14.88 barg and the minimum pressure is above vapour pressure -0.89 barg. Success!

Label	57	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	26	sec
Stop value	0	
Exponent	1	

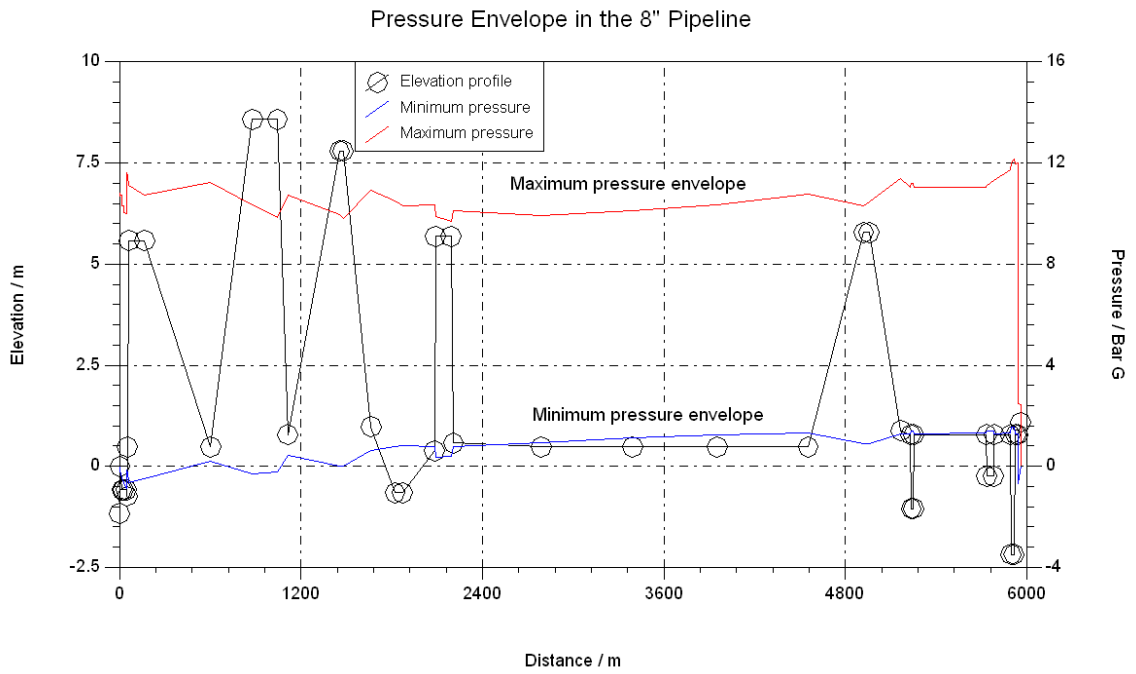


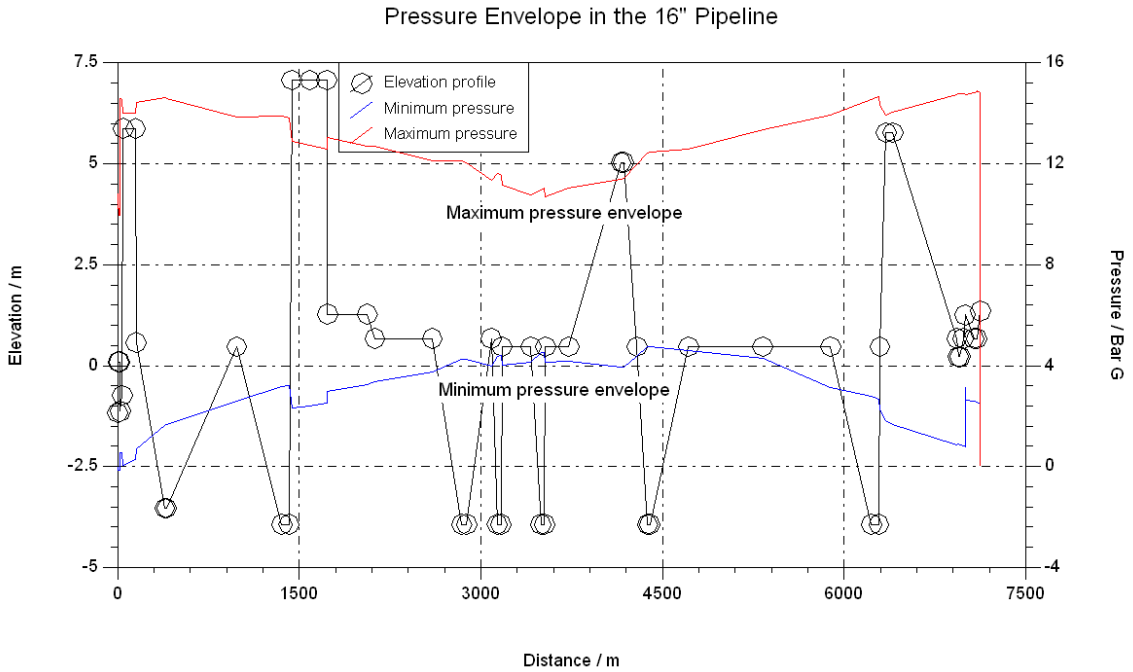
Downstream 8” ESD Valve Closure Curve

Label	119	
Specification	YES	
Specification Type	Information	
Time Function	Power ramp	
Start time	10	sec
Start value	1	
Stop time	26	sec
Stop value	0	
Exponent	1	



Downstream 16” ESD Valve Closure Curve





CONCLUSIONS

Unacceptable pressure surges and cavitation are certainly possible in this network. However, PIPENET has demonstrated that optimizing the operating speed and sequence of the valves will keep the transient effects within acceptable limits, without the need to install costly extra devices.

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

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