FAIL to plan.

Phil Edwards, Technical Manager, Atmos International, UK, discusses how the key elements within a trainer system can prepare pipeline operators for the many challenges they face.

It can be a challenge exposing pipeline operators to abnormal operating conditions, such as a leak situation. Pipeline control room staff are typically only trained using a real pipeline system and on average are asked to control different pipelines every three years.[1] Hands on training in isolation is inadequate and places limits on an operator's level of preparation when they eventually encounter transient activities like a pump or compressor trip or a leak.

A transient is a change in the flow and pressure in a pipeline. While it can be caused by routine activities, such as the starting of a pump or the closing of a valve, it can also be caused by a leak or equipment failure.

A variety of new challenges face pipeline operators as we move towards net-zero, so pipeline companies ask the following questions when considering a training simulator to optimise operations:

- How can we provide a safe environment for operators to understand the behaviour of a pipeline leak and the consequences of actions taken?
- How will new pipelines behave, particularly carbon dioxide (CO_2) ones, and what operating practices should we have?


plan to FAIL

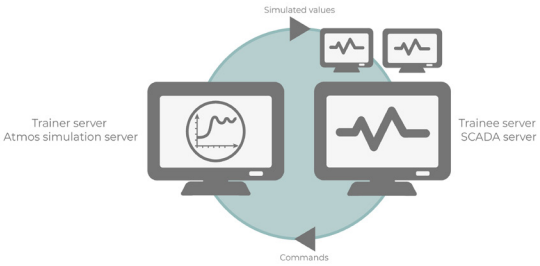

Figure 1. Basic architecture for a generic training system.

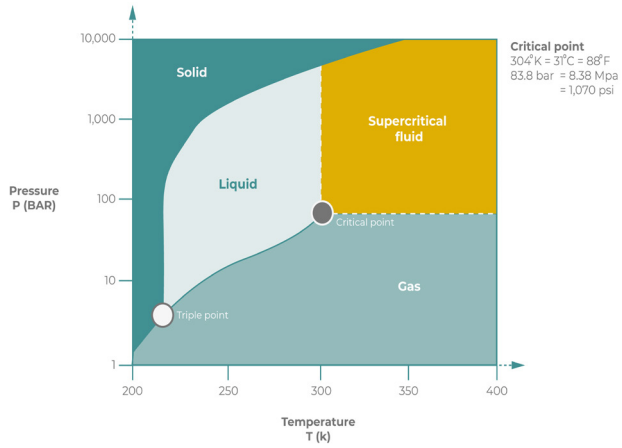

Figure 2. A graph outlining CO_2 as a supercritical fluid.

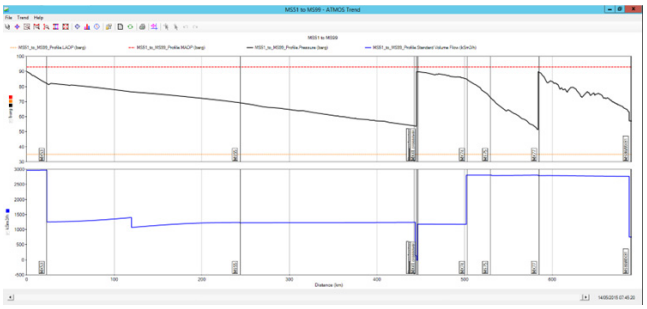

Figure 3. An example of a training system's distance based trend showing the hydraulic profile along the full pipeline.

- How can operators be prepared for new pipeline operations when hydrogen blends are introduced and what is the effect of hydrogen on the pipeline capacity?
- How can the overall risk to real pipelines be reduced?

This article discusses these challenges and how the key elements within a trainer system can prepare pipeline operators for the challenges they face.

Understanding the behaviour of a pipeline leak and the consequences of actions taken

A pipeline leak sets into motion a range of events both inside and outside the pipeline, from negative pressure waves propagating in both directions of the pipeline to the integrity of the pipeline weakening as the leak worsens. Instead of relying on lessons learned after the fact, it's important for pipeline operators to understand the behaviour of a pipeline leak before it occurs.

Training systems provide a safe environment for operators to better understand the pipeline hydraulics and how their actions, or lack of actions, will impact it. Training sessions can be repeated multiple times until the operator has followed the correct steps. Abnormal operations can also be introduced, which would never or rarely happen on an actual pipeline but prepare operators nonetheless.

Preparing for the behaviour of new pipelines and setting up the correct operating practices

With carbon capture and storage (CCS) becoming a popular method for reducing emissions from industrial processes, pipelines will be crucial in the transportation of CO_2 to storage sites during the CCS process, which means leak detection will be too.

CO_2 transported in these pipelines can take many states, such as a gas or a supercritical fluid at extremely high pressure. Compared with a natural gas pipeline, the explosive decompression of a CO_2 pipeline is faster. Leak detection is vital in this case to limit damage to the pipeline's integrity and reduce interruption to pipeline operations.

CO_2 is also one of the most damaging greenhouse gases, meaning a leak on a CCS pipeline can cause groundwater contamination, health hazards and a threat to life as well as releasing greenhouse gases back into the environment.[2]

Applying a training system for a CO_2 pipeline would use simulation software to replicate the hydraulic behaviour of the pipeline in the form of a model which represents the network, its instrumentation and equipment, such as pumps and valves. The trainees would receive a front-end view of the simulated values and issue commands, providing them with the necessary training on how to operate a CO_2 pipeline before they come into direct contact with the real pipeline (Figure 1). An instructor can also trigger abnormal operating conditions (eg. pump/compressor trips, leaks, station shutdowns, etc) which reduces the likelihood of a poorly handled leak event on the real pipeline.

Preparing for new pipeline operations with the introduction of hydrogen blends

The introduction of hydrogen (H_2) and hydrogen blends to existing pipeline networks will have a range of impacts on a pipeline network. For example, the molecular makeup of hydrogen is smaller than other natural gases', meaning product can escape more easily in the event of a leak.[3]

Pipeline operators need to be able to reskill quickly to fulfil these new pipeline operations, learn how to simultaneously maintain security of supply and accommodate changes in demand and prioritise leak detection. Since hydrogen has a lower energy density than natural gas, its impact on pipeline capacity needs to be understood in order to manage the pipeline operations effectively. Because the introduction of hydrogen to gas pipelines will expose knowledge gaps in both new operators and existing operators, training simulation software has never been more important.

Training systems enable trainees to understand pipeline hydraulics. Distance based trending can present the user with a view of the hydraulic profile along the full pipeline so flow or pressure changes caused by the introduction of hydrogen and hydrogen blends can be viewed in an interactive format. For example, a UK-based Atmos customer with a pipeline containing multiple inlets and outlets, recently deployed a training simulator to test their SCADA system in an offline environment, simulating the pipeline hydraulics for their network and the programmable logic controller for more than 20 stations.[4]

Reducing overall risk to real pipelines

Because a primary goal of training is increased performance levels, pipeline training systems are flexible to the needs of the pipeline company. If the instructor in charge of the training session wants to stop pumps or compressors unexpectedly or implement a full station shutdown, open pre-configured leak points, training systems typically allow for this level of customisation. This reduces the overall risk to real pipelines in the event of a leak or other abnormal operation, because trainees can be exposed to risks in a range of contexts before encountering them in situ.

An operator scoring module often features in a training system, so operators can receive automatic grading based on predefined conditions, such as leaks identified, response to pump trips or amount of time taken to take actions. Paired with a training system's customisation options, the risk to real pipelines is significantly reduced if used appropriately.

Fail to plan, plan to fail

Failure to implement a training system before pipeline operators begin operating a real pipeline exposes a pipeline operation, colleagues and the surrounding environment to unnecessary risk, which can all be avoided by planning in advance.

As well as supporting with realistic training of all operational scenarios, training systems provide documented evidence of training sessions, performance and training history, which is particularly beneficial in the USA where federal regulations require companies to provide evidence that operators are sufficiently trained to recognise and react to abnormal operating conditions.

Additionally, confidence and performance are known to improve in pipeline operators after using a training system, owing to the availability of more interactive training that reduces risk to real pipelines.

References

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