Enhancement of pipeline integrity through proper valve commissioning

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The first few months of a valve's lifespan are its most critical, as this is the time when the valve's components are most likely to be damaged. These premature failures – which can occur during valve handling, hauling, testing, installation, and commissioning – have a negative impact on a project's schedule and can be very costly. Some extra care and attention at this critical stage will add years and even decades to the valve's in-service lifespan. The savings can be in the millions of dollars in preventing start-up delays and unexpected outages when valve seals fail in an in-service pipeline. This article summarises the common root causes of valve failure based on field experience, and provides a guideline for mitigation of premature failure during the different stages of valve commissioning.

Valves are the most common mechanical device on any pipeline and yet are the most neglected piece of moving equipment. Usually, very little attention is paid to this component until it is absolutely necessary, often in an emergency situation.

New large-diameter pipeline construction costs vary from approximately $1.5 million dollars per mile up to $4 million dollars per mile or higher. Block valve stations are typically positioned every 48–80 km. Recent estimates for full-service new valve commissioning, including actuator installation, are approximately $10,000 per valve, and this includes revisiting every valve site several times throughout the construction and commissioning of the new pipeline. This indicates an additional cost of approximately 0.0004 per cent – an extremely small price to pay for ensuring valve integrity and a trouble-free handover at start-up.

Prior to pre-commissioning activities

To ensure successful pipeline valve commissioning, the following elements need to be available prior to the commencement of any pre-commissioning and commissioning activities:

- *Pipeline valve commissioning procedure* – Every commissioning job presents unique challenges, and the task procedure depends on the types of valve and actuator used, the logistical situation, construction and testing timetables, above- or below-ground considerations, etc. Personnel judgment could cause serious damage to the valve components. Hence, a written procedure should be developed prior to commencement of any activities. The procedure can be part of the pipeline design package or can be developed by the construction contractor. The procedure should be used as a guideline for proper valve handling, transport, storage, hydrotesting, and installation.
- *Commissioning contractor* – The procedure should be executed by qualified technicians that have the basic knowledge allowing them to deal with valves, and hence it is recommended that commissioning activities be subcontracted to a specialised contractor. Assigning a valve-commissioning specialist to oversee valve integrity during construction not only helps prevent serious seal damage from occurring, but also helps to identify which contractor is doing something that may harm the valve, before they do the same thing to every valve. Waiting until after start-up may be leaving it too late.

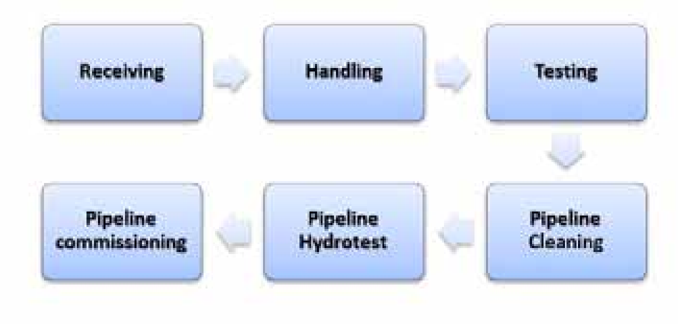

Figure 1: Different stages of valve commissioning.

In the case where commissioning activities are to be conducted by the same construction contractor, the first step is to train specific personnel to perform routine maintenance and preventative maintenance, new valve inspection, and proper handling and installation procedures. It is critically important to empower these technicians with the authority to ensure the many different construction contractors do not do anything that may damage a valve. The best results are achieved when the valve-commissioning technician has the authority of an inspector, putting the valve's best interests first and working directly for and reporting to the pipeline operator, not as a sub-contractor of the prime contractor where there is a likelihood of a conflict of interest when a work stoppage interferes with construction scheduling.

Pre-commissioning activities

Valve receiving and incoming inspection

It is always recommended that the valve is inspected upon arrival. Look for visible signs of transportation damage, and check the integrity of the caps, external fittings, and other visible conditions. Verify the end covers are intact and no dirt or sand has entered the valve body, verify that all hydrotest water has been drained, confirm the valve is still in the full-open position, replace and secure the end covers, and record the serial number and valve ID number. Figure 2 shows samples of defects that can be detected upon receipt.

Valve handling, transport, and storage

Damage due to improper valve handling is fairly common and is invariably due to not following proper procedures.

Figure 2: Example of identified damages during valve receiving inspection: (a) actuator damage; (b) damage to a valve's external coating; (c) flange cover damage; (d) uniform corrosion in the valve cavity due to improper drainage procedure; (e) pitting corrosion in a ball service; and (f) valve riser damage.

Below are some of the key considerations for proper valve handling:

- Valves should be transported in the recommended open/closed position depending on the type of valve; never transport valves in a partially open position.
- Valves must be restrained from movement during transportation. Small valves should be positioned carefully to prevent any damage. Failures can occur during unloading of the valve at the job site.
- Valve lifting and handling should be carried out by appropriate equipment and trained personnel. Valves should be lifted using the designated lift points. Hand wheels, stems, gears, and actuators should never be used as lifting points.
- Valves should be stored in the manufacturer's recommended position. The storage area should provide a means of protection against severe weather conditions which can affect valve integrity, such as sand encroachment and rain. Valves should also be supported off the ground using a wooden pallet or timbers.
- One other issue to keep in mind is that the lubricant can dry out with time. It is always recommended not to operate the valve in a dry condition since it can cause damage to the seat area. In order to avoid such failure it always recommended to 'top-up' the valve prior to any cycling. This will also help to push away any foreign debris that may have become stuck in the grease from the seal face. Any abrasive contaminants will do far less damage if well lubricated.
- Avoid unnecessary cycling, and in the case of valves with lever handles or hand wheels on gearboxes, consider removing the handle and chaining it to the valve.

Figure 3 illustrates some examples of improper valve handling.

Site testing

Some client-construction contractors adapted site testing as a method of checking valve integrity, to ensure that no damage has occurred during transportation, handling, or storage. From experience, this is not a good practice and could cause serious damage to the valve's internal components.

The reason this could occur is because, at site, there is little or no control over the test environment and water quality. The test is also usually conducted manually, without proper tools such as bolts, blinds and gaskets, pressure gauges, relief valves, etc. Failing to follow proper test procedures, such as dewatering and drying, have also proved to be major contributors to premature failure.

Figure 3: Examples of improper valve handling: (a) improper loading; (b) improper transportation; (c) improper packing; and (d) improper storage.

A better alternative to onsite hydrotesting is the 'inside-out air-seat' test. This test is a simple yet effective method of verifying the valve seal integrity, and is performed by inducing low-air pressure into the body cavity; if compressed air is not available, bottled nitrogen gas can be used.

The valve is pressured up, the inlet valve is closed, and the pressure gauge is observed: the pressure should not drop if the seals are intact. The test can be conducted while the valve is in the fully open or fully closed position.

This simple test can be repeated every time a contractor handles the valve in any way. This is also an easy way to verify that the valve stops are set correctly.

It is also recommended to conduct a functional test for the seat sealant system by injecting a light synthetic lubricant: replace any faulty, unsafe, or non-standard valve fittings, remove any excess lubricant from the inside of the valve, and then manually fill the gap between the ball and seat rings, as well as at the tail of the seat ring, with light synthetic lubricant such as Sealweld *Equa-Lube 80*.

Commissioning activities

Valve installation

Installation is the most crucial phase, as during this stage, the valve's internal components can be exposed to construction leftover, including welding slag, splatter, hand tools, metal shavings, dirt, rocks, etc.

Weather conditions must be taken into consideration; installation should not be performed during rainy or windy days, or during sand or snow storms. It is always recommended that the protective end covers remain until just prior to welding the valve onto the pipeline.

In case of weld-end connections, extra care needs to be taken to avoid damage to the valve soft seals. It is always recommended to order the valve with an extended pup piece, as the factory has better control of the welding processes. This will ensure that the

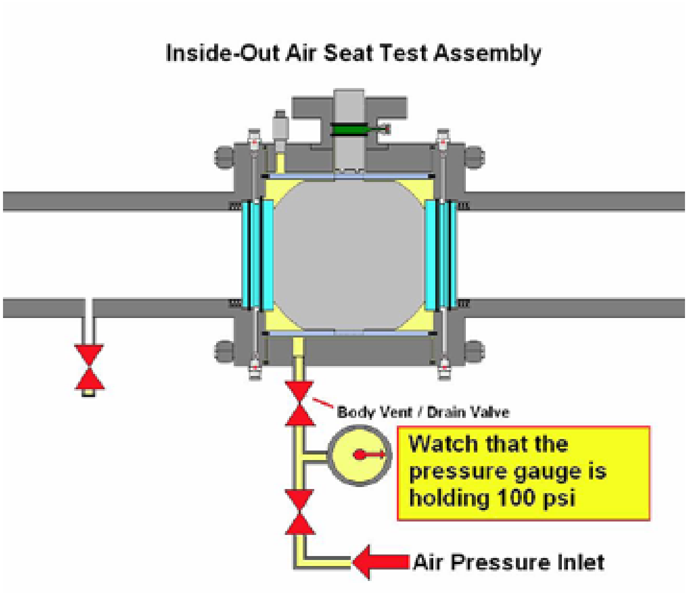

Figure 4: Illustration of the inside-out air-seat test setup.

valve components are far enough from the heat-affected zone to avoid damage.

In cases where preheating is required, it is critically important to ensure that the valve component does not become overheated, as this can cause permanent damage to the soft insert as shown in Figure 6.

Hydrotesting

As a system integrity check, the pipeline is subjected to hydrotesting at 1.5 times the maximum operating pressure. Due to negative experiences during this stage, as well as subsequent valve performance issues, many end users elect not to install the valves until just prior to valve commissioning. This is ideal but costly, and sometimes not practical.

Figure 5: Accumulation of mud, sand, and plastic particles inside the valve cavity.

Figure 6: Melting of the soft seat insert during preheating.

Risk can be minimised by following proper hydrotesting procedure. The following are key points to consider:

- If the pipeline is tested using untreated water/seawater then this need to be taken into account during the material selection phase. Suitable valve-trim material must be selected. Critical areas such as the seat pocket and the stem seal must also be overlaid with corrosion-resistant material to avoid crevice-type corrosion. Figure 7 shows examples of damage due to improper control of the test fluid.
- During pipeline filling, valves should be in a fully open position. This is to ensure that debris does not fall into the bottom of the valve body where it could plug the body vent or body bleed fitting.
- Prior to pressurising the pipeline, valves should be rotated to the half-closed/half-open position to prevent the possibility of a pressure differential in the valve body during hydrostatic testing. As cycling the valve at this stage might cause damage to the soft seat, a better method is to use the jumper hose assembly method, where a jumper hose is installed between the pipeline and the valve body cavity, as well as through the body drain/vent valve. This way, as the pipeline fills with water, so too will the body cavity.
- No matter how clean the pipe appears during construction, there will always be debris that flows down the pipeline as it is filled with water. Keeping the ball valve in the open position during hydrotesting can prevent pipeline debris from collecting in the bottom of the body cavity. Open the bleeder plug near the top of the valve body to vent any trapped air.
- After pipeline hydrotesting, it is recommended to top-up the valve by injecting a light synthetic lubricant to push away any remaining moisture in the seat pocket area. It is highly recommended to spray the valve cavity with suitable corrosion inhibitors.

Chemical cleaning

In most cases, the pipeline is dewatered by conducting pigging operations, which pushes all water downstream. The pig assembly may also include batches of methanol and/or other chemicals between pigs to absorb any moisture that is present.

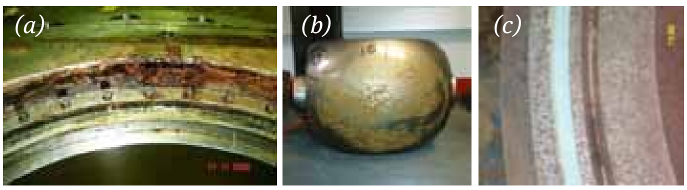

Figure 7: Examples of damage due to improper test fluid control: (a) a severe corrosion attack at the seat pocket area; (b) galvanic corrosion due to testing by untreated seawater; and (c) pitting corrosion in a 56 inch diameter ball valve, which was tested using water with a high chloride content.

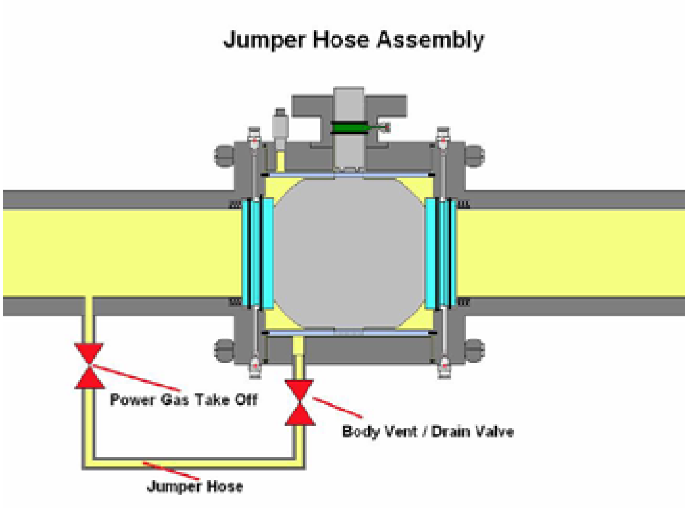

Figure 8: A jumper hose assembly.

Figure 9: Examples of damage due to pipeline chemical cleaning: (a) chemicals attack the cover seal gasket, causing an external leak from a plug valve; and (b) chemical attack of a ball valve soft-seat insert.

Gel-type pig 'trains' may be utilised to internally treat the inside of the pipeline for corrosion. The pig train is normally propelled by high-pressure nitrogen or natural gas. The compatibility of the used chemical with the valve soft insert needs to be checked. Figure 9 demonstrates examples of damage which can occur from chemical pipeline cleaning.

Similar to when hydrotesting the pipeline, all mainline valves need to be kept in a fully open position. Top-up is recommended after completing the operation.

The valve commissioning specialist should keep written records of all activities performed on the valves during construction and commissioning. This is especially important with the results of the inside-out air-seat test and, if possible, the high-pressure seat test.

Conclusion

To avoid the associated costs and negative project schedule impacts of premature valve failure, it is important to follow proper procedures based on industry standards and best practices.