PRIORITISING SURFACE SAFETY

Roel Hooiveld, NOV, The Netherlands, discusses the importance of maintaining surface safety valves in producing wells.

A producing well is dangerous by its nature. Highly flammable fluids under high pressure are being handled by complex equipment in a hostile environment. Safety valves are installed in a producing well to permit flow during normal conditions but provide a complete well shutdown in case of abnormal well conditions. Abnormal well conditions can be caused by fire, explosions, material malfunction, sabotage, accidents, or circumstances beyond human control like earthquakes. The safety valves are installed to protect people, the environment, and equipment. Safety valves can be divided into two major types:

- A surface safety valve (SSV) located on the Christmas tree. This is a hydraulically actuated fail-safe gate valve-type actuator that closes when it is de-energised. The National Oilwell Varco (NOV) hydraulic actuator, shown in Figure 1, employs fewer parts to improve field performance.
- A surface-controlled subsurface safety valve, often simply called a downhole safety valve, is located approximately 100 m downhole in the production string. This is typically a flapper-type valve designed to be held open by hydraulic pressure. Loss of hydraulic pressure will force the valve to close. The NOV subsurface safety valve is shown in Figure 2.

History of surface safety

In the early 1940s, the trend toward producing oil and gas wells from deeper zones, with subsequent higher shut-in wellhead pressure, continued. These wells, because of their high flowing potentials, were equipped with automatic shut-off devices on the surface. Technology at that time was limited to flowline devices and/or wing valve installations. In the late 1940s, the automatic gate valve/actuator combination was developed and applied.

An NOV hydraulic self-contained safety system – the system is designed specifically for remote locations with no external power sources.

During the 1960s both the pneumatic and the hydraulic-operated, fail-close SSV were developed. These valves allowed all systems to be fail-safe. Although technology has moved on and electrical features like indicators and remote-control devices have been added, the basics of the surface safety valves have remained the same.

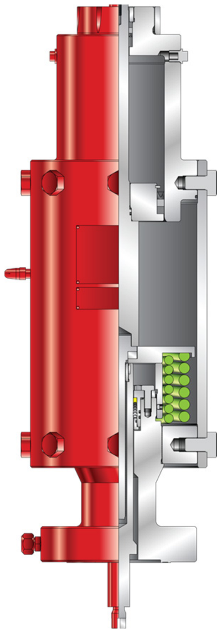

Figure 1. *NOV's new type hydraulic actuator. The actuator's stem packing stack is contained in a packing retainer assembly that can easily be removed from the bonnet without needing to remove the bonnet itself.*

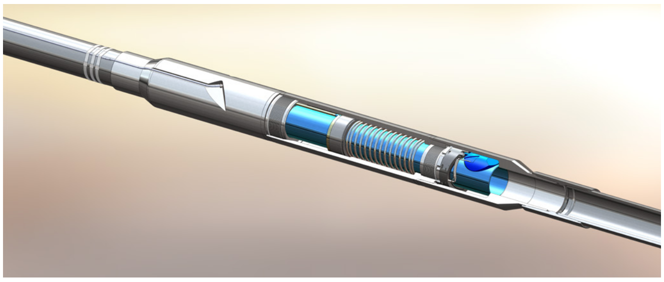

Figure 2. *NOV's subsurface safety valve meets the rigorous quality standards set forth in API Specification 14A and is tested beyond the specifications in Revision 12, including Annex H, which specifically addresses the verification and validation requirements for use in HPHT environments.*

Figure 3. *Two NOV service technicians inspect a fail-safe pneumatic actuator.*

Journey of the product line

Otis Engineering has supplied surface safety systems since the early 1940s. In 1993, Halliburton merged its 10 semi-autonomous energy services units, including Halliburton Services and Otis Engineering, into a single group called Halliburton Energy Services. A merger between Halliburton and Dresser Industries Inc. was announced in 1998, which added the AVA and Axelson brands to the company. In 2014, Halliburton sold the assets and business related to SSV systems to NOV, who has continued to operate in the space since.

Principle of operation

The SSV is a full-opening, pressure-actuated, normally closed gate valve. When control pressure is released, the valve is designed to close even when subjected to high flowline pressure. The valve closes completely and rapidly as the control pressure is released. Flowline fluid does not enter the operator mechanism, nor exhaust to the atmosphere when the valve operates.

The SSV assembly consists of a hydraulic or pneumatic actuator, which operates a reverse-acting gate valve. The actuator design makes it an integral part of the valve assembly by adapting directly to the valve bonnet. Pressure applied above the piston pushes the piston, stem, and gate down. This downward movement opens the gate in reverse-acting gate valves. Pressure in the valve body is sealed at the lower stem and prevented from entering the actuator assembly. The area below the piston is vented to the atmosphere. When control pressure above the piston is exhausted by the operation of the pilot system, the valve closes. Valve body pressure works across the area of the lower stem to force it out of the valve body, drawing the gate into the closed position.

Should an emergency occur during a wireline operation, time may not permit the removal of the wireline tool string. Wire cutting type actuators are designed to supply the gate valve with a closing force, designed to cut wireline and shut in the well.

Reliability versus safety

The SSVs supplied by NOV have, through years of use, proven to be reliable in continued operations. Though reliability is typically regarded as a benefit, in a unique sense reliability can also be a risk. This is a world where the industry rules are dictated by safety – where every job is securely planned using risk analyses and where procedures are written to make sure every step along the way is covered. In this world, there may be a tendency to over rely on an item like an SSV, which is often not considered a potential hazard.

Closing times

Due to decreasing well pressure of existing wells, the closing times for surface safety actuators have become a major problem for many wellsites. The well pressure acts upon the lower stem area of the actuator, forcing it to close when hydraulic control line pressure is exhausted. Closing times are dependent on the volume of the actuator, the spring force, the wellhead pressure, the length and the diameter of the control line, and the viscosity of the hydraulic fluid. NOV offers various solutions to decrease closing times, including installation of quick exhaust valves or an additional spring module on top of the valve. In addition, practical advice, like what type of hydraulic oil should be used, helps ensure operating personnel understand the equipment and how to safely use and maintain it.

Run to failure

Many operators use the run-to-failure principle when thinking about valve maintenance. This practice generally does not work with SSVs for a variety of reasons.

- Hydraulic oil leakage is a failure that could damage the environment. After extensive service, the internal seals could start to leak. Although the seals are selected based upon proven reliability, the impact of the hydraulic oil and the possible contamination from the hydraulic control panel could influence the seals' lifespan.

- Corrosion could cause the actuator to fail and not close during an emergency.
- Not closing in time could be a serious failure. The operator must also check if the valve does not close in time according to regulations or, in the worst-case scenario, with enough time to avoid a blowout.

The run-to-failure principle is not recommended for applications where equipment failure creates a safety risk and where equipment availability is necessary. It is also undesirable for assets where total maintenance costs would be reduced with a more proactive approach, such as preventive or predictive maintenance strategies. There is also the issue of cost versus safety. The SSV is one of the two valves that should close in case of an emergency. An emergency situation where the valve does not close cannot be justified by stating that cost has been the driver for less maintenance to the valves.

Maintenance

There is a specific installation and maintenance manual for every SSV provided. Some operators choose to perform repair or maintenance activities themselves, and some NOV designs are straightforward and require no specific knowledge of the product. However, most of the valves currently installed in the field feature springs to enable rapid or strong return to close. These springs are compressed and generate up to 6000 lb of force, which could be acting against the operator when trying to disassemble the unit. Some springs have enough force to push somebody to the other side of the shop. It is critical to follow the steps mentioned in the manual and the operating instructions closely to be as safe as possible.

Because there are no regulations that specify a certain maintenance interval for SSVs, some actuators have not been serviced for over 30 years. As some operators only come to the original equipment manufacturer when there are problems with the valve, it could very well be that there are actuators in the field that are even older than that. Twenty years ago, maintenance requirements were not part of the product manual. Based on this, it would seem there was a misconception about the longevity of the units, with people unaware that they would be able to last so long.

Replacing existing actuators while leaving bonnet and stem in place

NOV has recently developed a design that can replace existing actuators while leaving the bonnet and stem in place. This will enable the operator to easily replace the actuators without the need to set a plug in the production string, which will allow major cost savings, especially for offshore applications.

What can operators do?

There is no need for SSVs to be redressed within the first 5 years in service, but replacing the cylinder seals every 10 years is suggested. The bonnet seals do not have to be replaced unless they are leaking. The valves can either be repaired on location or sent to NOV's repair facilities. If required, the old valves can be swapped out for new ones so that production is not affected.

Summary

Over the years there has been a noticeable tendency for operators to put less effort toward maintaining their SSVs. This issue could simply be that they have proven to be so reliable that they are no longer seen as a potential risk. The run-to-failure principle is cost-driven and not recommended for a valve designed to close in case of an emergency.