Case Study

Tank terminal demonstrates the electrically operated solution for Emergency Shutdown valves

Industry: Reception Terminals
Client: HES International, The Netherlands
Product: Skilmatic SI, IQ, Pakscan

Summary

In order to avoid a disaster such as the Buncefield fuel depot fire in 2005, HES International wanted to enhance the safety procedures in place at their Botlek Tank Terminal in Rotterdam. Rotork IQ range intelligent electric actuators and other Rotork products were selected in order to meet this requirement.

Overview

Since the disastrous fire at the Buncefield fuel depot in 2005, much has been done to ensure that such a catastrophic accident should not happen again.

Led by COMAH (Competent Authority/Industry Standards Task Group), safeguards have been put in place by the petroleum industry to provide additional safety and environmental protection to tank storage installations. Endorsing the recommendations of the Buncefield Standards Task Group, a key feature of these safeguards is the installation of Remote Operated Shut-off Valves (ROSoV) with fail-safe actuation for Emergency Shutdown (ESD) duties.

Challenge

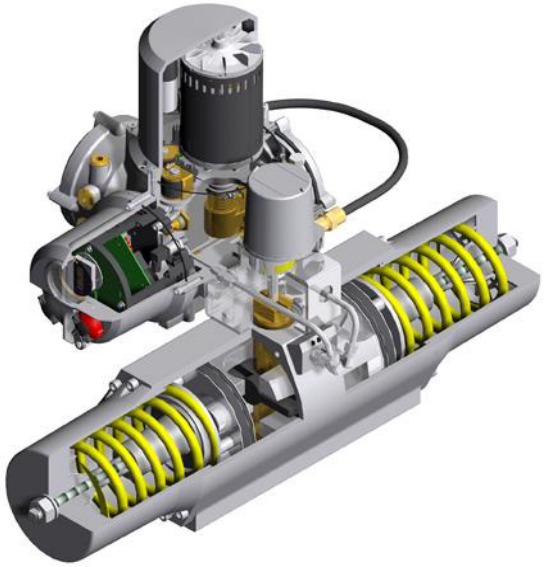
The majority of ROSoV relevant valves are situated on the inlet and outlet ports of the fuel storage tanks and are designed to isolate individual tanks in the event of a potential emergency. The predominant tank farm actuation technology is electric, which suits the very spacious environments which typify these sites. Within such environments it would be very expensive to install a pneumatic ring main, whilst an electrical source for control and indication is traditionally available on these installations.

It therefore makes economic and practical sense to use electricity to power the ESD actuators as well.

Designed and built since the Buncefield fire, the Botlek Tank Terminal (BTT) in Rotterdam is a state-of-the-art example of an installation that has adopted an electric solution for all the valve actuation functions associated with routine operations and safety related duties.

Solution

The BTT has 34 storage tanks, providing a combined storage capacity of 200,000 cubic metres, of which 130,000 cubic metres is earmarked for clean fuels and the rest is for edible oils and biodiesel. The terminal has deepwater berths including a 420 metre jetty that can



Skilmatic actuators operate on a pump and bleed principle utilising a motorised vane pump to provide hydraulic pressure in one direction and spring-return in the opposite (bleed) direction.

simultaneously accommodate two seagoing vessels and two barges, operating 24 hours-a-day.

The terminal utilises Rotork's electric valve actuation technologies for automated flow control and vital safety related duties associated with the import, export and storage of a varied range of liquid bulk products. Over 250 Rotork IQ multi-turn and part-turn intelligent electric actuators have been installed to operate the valves that control the routine movement of liquids throughout the site. A further 55 Rotork Skilmatic SI self-contained electro-hydraulic actuators have been installed in strategic areas on valves that provide failsafe ESD protection from potential accidents and spillages. The Skilmatic actuators are situated on the inlet and outlet ports of the fuel storage tanks and on the marine and truck loading bays in order to isolate individual tanks and areas in the eventof a potential emergency. They are key components in the Safety Instrumented System (SIS) that operates with dedicated level and flow sensors and ESD logic solvers to provide the Botlek site's Safety Instrumented Function (SIF).

A specialised electric actuator design is necessary to achieve the swift fail-safe operation demanded by the ESD duty. Experience has shown that this can be successfully delivered through the electro-hydraulic route. Electro-hydraulic actuators use a simple and therefore very reliable mechanical spring to provide fail-safe valve movement, whilst precise and swift valve movement in the opposite direction is achieved hydraulically by means of an integral electrically powered pump. With this design, reliable fail-safe performance can be combined with the benefits of the latest electric actuation technologies, facilitating a high level of asset management encompassing accurate control, monitoring and alarm signalling, operational data logging and diagnostics. Further savings in capital and maintenance costs are achieved by the simplification of the overall plant control system that is facilitated by the all-electric solution.

All Rotork actuators at BTT feature ATEX explosionproof certification and IP68 double-sealed watertight enclosures designed for harsh and exposed environments. They are monitored and controlled on fully redundant Rotork Pakscan digital bus loops, linked by three Pakscan P3 Master Stations to the site's central SCADA system. All the actuators at BTT share Rotork's IQ non-intrusive setting, commissioning and data communication technologies. A handheld, intrinsically safe, setting tool enables safe and rapid non-intrusive commissioning by means of easy to follow 'point and shoot' menus. The same setting tool also enables actuator configuration and data logger files to be transferred from the field to the office for diagnostics, analysis and storage.

In combination with Rotork IQ-Insight software, this data can help to maximise plant utilisation by identifying potential valve wear problems and facilitating predictive maintenance.

*Pakscan Master Stations **monitoring and controlling the IQ and Skilmatic SI actuators at BTT on three separate bus networks. Designed specifically for the valve actuation environment,** Pakscan **incorporates secure field communications with inbuilt network redundancy to maintain control even in the event of equipment or cable failure.***

IQ intelligent actuator technology is capable of providing a proliferation of data, recording all the activity with an immense amount of detail, including the number of valve operations, alarms, failure to respond events, valve torque profiles, unauthorised operation attempts and many other events. The ability to objectively analyse this information and identify the key areas that are important for each individual site's specific requirements is an essential requirement for effective asset management.

For example, there are many different styles of valve and they each have their own unique torque demand curve. Capturing the torque demand curve from a newly installed and calibrated valve actuator assembly provides a reference point against which future curves can be measured. As the valve ages it becomes more difficult to open and close because of internal and external factors. This could be a threaded stem on a rising stem gate valve that has not been lubricated. By identifying issues such as these the software can be used to plan inspection and maintenance without interrupting the plant and improve overall asset management.

The incorporation of IQ technology into the Skilmatic SI actuator introduces a high level of control and monitoring functionality, combined with a hardware ESD input for the safety system. Settings such as internal hydraulic pressure, position, limits, control options, alarm and indication functions can be accessed and adjusted. Actuator status, control and alarm icons are viewable on the illuminated LCD display which also provides access to real-time information including pressure, diagnostics and help screens.

The Skilmatic control module enables demanding operator requirements to be met, including compatibility with the site's Pakscan digital network control system. Certified to the requirements of IEC61508-2:2010 for use in safety systems performing safety functions up to SIL2 and SIL3, the actuators are also capable of partial stroke testing, enabling isolating valves to be tested without interrupting the process. This is of particular importance to minimise process shut downs when testing safety critical valves. All key components within the actuator including the hydraulic pressure and movement are tested to confirm availability for shutdown on demand. The test can be initiated either remotely or locally with the setting tool. The partial stroke position against stroke time is measured and compared to the original position to stroke time recorded at the commissioning stage. A pass or fail is displayed and, if enabled, a failure alarm will be activated. The alarm is one of three that can be configured to customer specific alarm and status requirements or for general group alarms. A monitor relay is also provided to monitor the power supply and any hardware errors.

Electro-hydraulic ESD valve operation

When the actuator is commanded to open from the closed limit, the bleed solenoid valves are energised. The motorised vane pump is started under no-load condition as a result of the delay in energising the by-pass solenoid valve. With the by-pass solenoid energised, the system pressure acts against a spring opposed piston to drive the actuator in the open direction. When the actuator is commanded to stop or reaches the open limit, the by-pass solenoid valve is de-energised, followed by the motorised vane pump after a preset time unless a new command is given. The bleed solenoid valves remain energised and the system pressure is maintained to hold the actuator position.

When the actuator is commanded to close or receives the ESD signal, the by-pass solenoid valve, bleed solenoid valves and motorised vane pump are de-energised

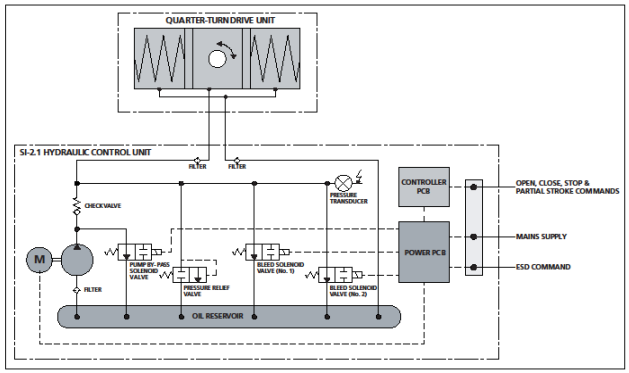
Pressure is released; the hydraulic fluid returns to the reservoir and the spring returns the drive shaft to the closed or safe position.

Skilmatic SI actuators are equipped with integral circuitry designed to receive a separately hardwired discrete ESD alarm signal that will override any other input and move the actuator to the pre-determined safe position, even in the event of electrical power failure.

The ESD signal can be configured to control the shutdown through a hardwired circuit by-passing the internal

Option 1 SI-2.1-Qxx-01x-xx-xx

Standard Hardware Dual internal solenoids



Schematic of internal operation of Skilmatic SI actuator.

processor. This processor circuit monitors the position and internal hydraulic pressure and provides alarm monitoring but the ESD circuit is independent, thereby providing priority to an ESD command. In the ESD scenario the actuator will immediately return to the predetermined safe position and will be ready to operate on the next command when the ESD signal is reinstated. As an added safeguard, an optional ESD manual reset can be enabled to restrict the actuator from operating until locally reset at the actuator or with an externally mounted switch. Closing speeds can be adjusted to meet the specific requirements of the application.

This schematic illustrates the Safety Instrumented System (SIS) as applied to prevent over filling of a tank, which is one of the Skilmatic functions at BTT. The tank and pump are controlled by the DCS (Distributed Control System) and the installation is physically contained within a bund. The signal from the gauge system is feeding back to the PLC in the DCS which controls the pump and the IQ and Skilmatic actuators via the Pakscan network. A fault with the gauge system leaves the tank vulnerable to overfilling.

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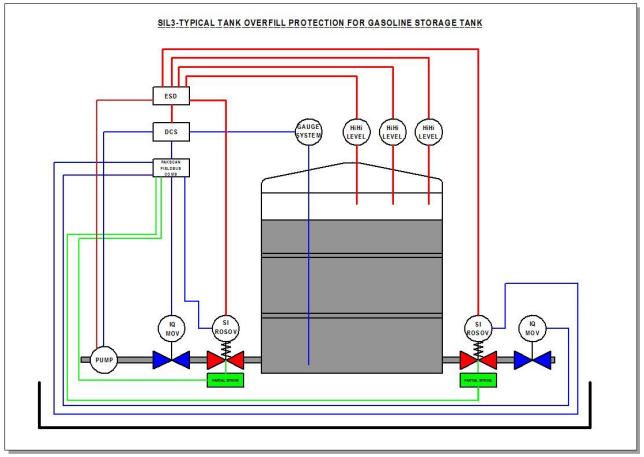
To account for this, the SIS is added, consisting of separate level sensors and an ESD logic solver to control the Skilmatic actuators, which are the final elements under the control of the SIS. The ESD signal is independent to other control signals and ensures the valve in the safe position, providing a Safety Instrumented Function (SIF) for the ESD duty.



Safety Instrumented System to prevent tank over-filling.