



rotork[®]

Keeping the World Flowing
for Future Generations

Application Focus:
**Storage Tank
Overfill Protection**

Storage Tank Processes

Oil and gas tank farms use different kinds of tanks to store highly flammable liquids and gases including oil, petroleum, natural gas, liquefied natural gas (LNG), liquefied petroleum gas (LPG) and other petrochemical fractions.

Depending on the medium stored, tank designs include; fixed roof, floating roof and pressurised systems. All designs require certified safety systems for filling, emptying, level monitoring and overfill protection. A typical tank installation will include:

- Inlet isolating valve
- Outlet isolating valve
- Multiple level limit switches for overfill protection
- Tank gauging system:
 - Level measurement instrument
 - Multi-RTD temperature sensor
 - Interface sensors and pressure sensors

Storage tanks in large unmanned plants have inlets and outlets controlled by Motor Operated Valves (MOVs). These are usually on/off and isolation valves, however control valves may be used for more accurate flow control.

Filling Process

The outlet isolation valve is closed, the inlet isolation valve is open and the media is pumped into the tank. Flow rate is controlled by an inlet control valve (or on/off valve). Once the required capacity is reached, determined by the level measurement system, the inlet isolation valve is closed by the operator to stop the flow into the tank.

Tank Level Measurement

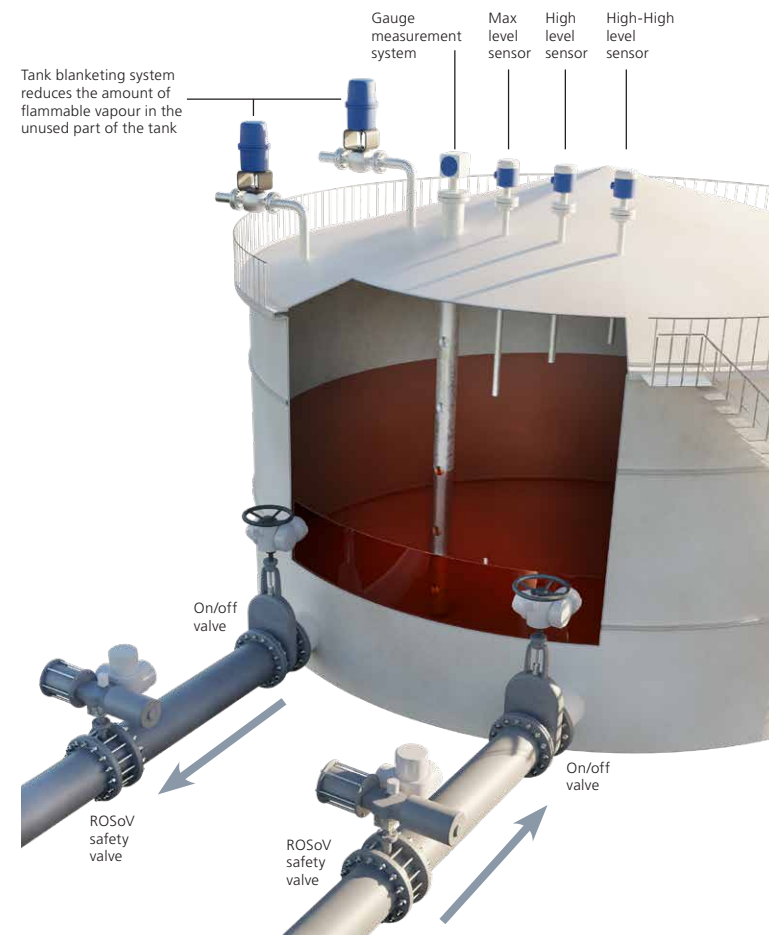
Limit switches are set at the maximum fill set point. If the operator fails to close the isolation valve, the limit switch is triggered and closes the inlet valve. Emergency Shutdown (ESD) limit switches are set at High and High-High level positions and operate if the maximum level switch fails.

Tank Blanketing

Inert nitrogen gas, under slight positive pressure, is used to fill the empty space in a partially filled tank, suppressing flammable vapours given off by the stored hydrocarbon.

Emptying Process

The inlet isolation valve is closed, the outlet isolation valve is open and the media flows out of the tank. Flow rate is controlled by the outlet control valve (or on/off valve) to ensure correct flow and pressure is maintained.



Rotork deliver reliable safety related flow control solutions for tank storage

Products designed with safety, integrity and industry leading lifespans

Explosionproof, watertight, SIL 2/3 rated and suitable for use in SIS systems

Rotork reliability reduces maintenance, improves efficiency and increases productivity

In this document we explain the flow control processes and identify the main challenges where modern, reliable equipment provides solutions for storage tanks.

Safety Systems and Industry Standard Compliance

Storage tanks for hazardous and volatile materials require multiple safety and control systems. They must be designed with compliance to industry safety standards.

Safety Instrumented System (SIS)

SIS are used on tank farms to monitor plant parameters and keep them within operational limits. Should these limits be exceeded, the SIS will activate alarms and place the tank farm in a safe or shutdown condition.

Tank farms will have a SIS made up of a number of Safety Instrumented Functions (SIF). A SIF consists of three sections: Sensors, logic solver and final elements. Final elements are process control devices such as valves and actuators that implement the physical action necessary to achieve or maintain a safe state.

Safety Integrity Level (SIL)

SIL is an established system of measurement standards to indicate the performance required of a safety system. It is part of a functional safety plan that includes techniques, technologies, standards and procedures that help operators protect against hazards. Once established, ongoing testing and verification of safety system performance is required for the operational lifetime of the plant.

Partial Stroke Testing (PST)

PST is a technique used in safety systems that allows the owner or operator to periodically test a percentage of the possible failure modes of a shutdown valve. This test can be performed as part of SIL and SIS compliance, without the need to physically close the valve. The procedure allows the user to identify any faults which could potentially prevent the actuated valve from performing its safety function.

ESD Control Systems

Tank filling and emptying is normally controlled via a programmable logic controller (PLC) using a control network such as Rotork's *Pakscan*™. For ESD functions the system is controlled via a SIS.

Multiple sensors are used with differing technologies to monitor levels within the tank. This is to eliminate systemic failures associated with similar technologies. The level sensors are typically used for three alarm tiers:

Max level – Level 1 point when the filling process will be stopped by the PLC. Under normal operating conditions this will be the only level reached.

High Alarm – Level 2 point when the product inside the tank has gone past the normal max level and may indicate a failure of the max level sensor.

High-High Alarm – Critical point is reached. The system is shut down using the dedicated ESD system because at least one of the sensors' levels has been passed.

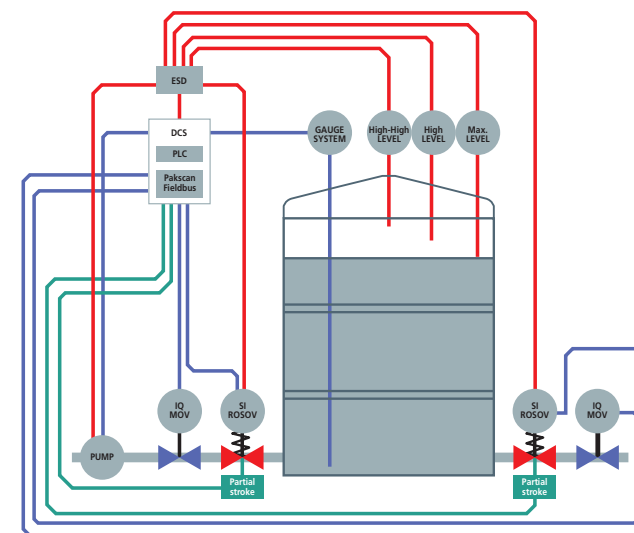
Remotely Operated Shutoff Valves (ROSoV)

ROSoV valves are designed and installed for the purpose of quickly isolating plant processes which are used for the storage of hazardous substances. They play a major role within the SIS.

Industry standards IEC 61511 and IEC 61508 recommend that ROSoV installations are periodically tested to ensure availability of the complete valve and actuator assembly. If a failure is reported as a result of the test, this detected failure can be immediately addressed and a potential failure has now been avoided.

Rotork can provide flow control products certified to SIL 2/3 and engineering services that help establish, maintain and verify the final elements of a SIS.

Our products and services help to reduce plant operating costs, unplanned maintenance and plant downtime.



This diagram shows a typical hydrocarbon storage tank and associated flow control systems. It shows the two ROSoV valves and their partial stroke testing connections, MOV valves (on/off or control valves), network control system, tank measurement system and tank fill level sensors.

Design Challenges for Storage Tank Overfill Protection

Challenge:

Durability, reliability and cost reduction

Operation of ROSoV and on/off valves on storage tanks must be cost effective for implementation, setup, ongoing operation, long term reliability and maintenance.

Solution

Electric power is better suited than pneumatic control air for tank storage valve actuators as it is more reliable and more cost effective to implement. Pneumatic actuators can suffer from dust and water ingress, compromising reliability and leading to costly false alarms and unplanned shutdowns.

Rotork products are highly reliable and deliver reduced cost of ownership over their extended lifetimes. We regularly see actuators that were installed more than 60 years ago and are still operating within their original design parameters.

Rotork IQ electric actuators are suited for tank storage on/off isolation valves. They continually monitor valve performance and torque requirements, communicating with network control and safety systems.

Rotork CVA and CMA electric actuators are used where control valves are specified instead of on/off valves. They are highly accurate modulating actuators that exceed the performance of traditional pneumatic devices.

Rotork SI electro-hydraulic actuators are used on ROSoV valves and are certified to SIL 2/3 for use in SIF and SIS systems. They are highly reliable and capable of closing valves within 0.5 seconds should the process require it.

Challenge:

SIL, ESD and water hammer prevention

Flow control solutions must comply with industry standards for safety systems. They must integrate with network control systems and have built-in safety features to prevent ESD pipeline damage.

Solution

A specialised electric actuator design is necessary to achieve the swift, but controlled fail-safe operation demanded by ESD applications. Rotork has demonstrated that this can be successfully delivered through our SI Range of electro-hydraulic valve actuators.

Electro-hydraulic actuators use a simple and very reliable mechanical spring to provide fail-safe valve movement, whilst movement in the opposite direction is achieved hydraulically by means of an integral electrical pump.

Rotork SI electro-hydraulic actuators are certified for SIL 2/3 applications and are specified for use in ESD systems. A configurable interrupter timer pulses the closure of the valve to prevent hydraulic shock (water hammer) and flow surges in the pipeline during an ESD event.

SI actuators deliver high levels of safety and reliability while intelligent on-board systems provide asset management data including accurate control, monitoring, alarm signalling, operational data logging and diagnostics.

Challenge:

On-demand operational reliability

SIS systems use SIL certified equipment in SIF sections. This must be periodically tested to verify the operational validity of the SIF in order to maintain SIS integrity and overall SIL certification.

Solution

To validate the integrity and SIL certification of the SIS loop, valve actuators must have advanced diagnostics, Partial Stroke Testing (PST) functionality and the flexibility to accommodate different configuration requirements. Maintaining SIL certification can have the added benefit of significantly reducing insurance costs.

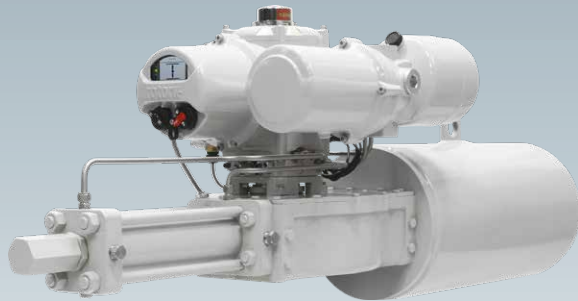
Reliability is key to ensuring operational validity at any time. Advanced diagnostics like the data logger on the IQ and SI can be used for predicting early failures by analysing torque variation in valve operation over time. This allows controlled, planned maintenance with minimal unplanned downtime.

Our entire product range has one thing in common - reliability. The founding principle of Rotork was to deliver simplified and reliable automated valve control.

Rotork IQ and SI actuators with inbuilt data loggers deliver reliability with modern connectivity. They continually monitor valve performance and torque requirements, communicating with network control systems to assist plant management programmes.

Our product range is highly suitable for the design and service demands of storage tanks and their safety systems.

SI Range Intelligent Self-Contained Electro-Hydraulic Actuators



ROSoV valve operation and diagnostics

Safety and ESD Shutdown Capabilities

- Provide fail-safe actuation for ESD applications
- Fast shut-down response protects your investments
- SIL 2/3 compliant for use in SIS to IEC 61508
- Partial Stroke Testing (PST) capability
- Integral interrupter timer eliminates risk of water hammer effect during emergency valve closure
- Designed to meet today's control and safety needs
- Double-sealing design reduces affects of humidity, improves reliability and reduces downtime

CVA/CMA Ranges Part-Turn, Rotary and Linear Electric Actuators



On/off valve control and diagnostics

Reliability and Diagnostics

- Provides accurate, reliable actuation of multiple valve types
- Robust and reliable isolation duty
- Compact, minimal weight to power ratio
- Built for reliable control as part of an ESD system
- Data logger monitoring of valve performance, preventing unplanned shutdowns
- SIL 2/3 compliant for use in SIS to IEC 61508
- Partial Stroke Testing (PST) capability

CVA/CMA Ranges Part-Turn and Linear Electric Control Valve Actuators



Inlet/outlet product pipeline control valves and nitrogen tank blanketing control valves

Accuracy and Repeatable Performance

- Precise actuation of control valves to regulate the pressure and flow for tank inlet and outlet pipes and onward processes
- Used to accurately control the inlet and outlet flow of nitrogen in tank blanketing systems
- Compact, powerful and highly accurate with a 0.1% resolution capability
- Designed to maintain tight process specifications
- Internal fail-safe super-capacitors available on some models

Model 11 Low Pressure Pneumatic Regulators



Nitrogen tank blanketing system

Precision Control to a Set Pressure

- Precision flow regulator controls pressure of nitrogen used to fill unused space in smaller storage tanks
- Sensitivity of 0.05" WC for precision control in low pressure applications
- Relief valve provides high exhaust flows
- An aspirator tub compensates for downstream pressure drop under flow conditions
- Simple, reliable regulation with compact design
- Low maintenance and cost effective

Control and Communication



Tank farm valve control and monitoring

Reliable Network Control with Reduced Cabling Complexity

- Multiple options available for control and communication between the PLC and actuators
- From simple, effective hard-wired digital control, to variable 4-20 mA and high-end digital networks with options including Profibus®, Modbus®, Foundation Fieldbus® and Rotork's proprietary Pakscan™ network
- Network options reduce the need for multiple cable runs
- Minimised cabling costs
- Maintained integrity

Service and Aftermarket Solutions



All plant operations

Lifetime Management

A complete solution to the risks associated with the life cycle of your equipment

Intelligent Asset Management

Advanced analytics to improve reliability and availability of key assets

Spares

Comprehensive OEM spares available worldwide

Life Cycle Management

Controlled strategies for managing the risks of ageing equipment



A full listing of our worldwide sales and service network is available on our website

www.rotork.com

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