SIMPLIFIED PROOF TESTING OF RADAR LEVEL GAUGES

AnnCharlott Enberg from Emerson explains how proof testing of the latest non-contacting radar level gauges within overfill prevention systems can be performed remotely, improving worker safety and increasing tank availability.

01

SAFETY MUST always be the top priority at tank terminals where hazardous, flammable or explosive materials are stored. Accidents can have catastrophic consequences.

To minimise the risk of safety incidents occurring, it is essential for tanks to have in place a robust overfill prevention system (OPS), designed and implemented in compliance with the relevant industry standards. An OPS safety loop typically consists of a level sensor, a logic solver and a final control element in the form of actuated valve technology. The complete safety loop must be regularly proof tested to ensure it will work correctly when there is a safety demand.

Proof tests are operational procedures, conducted in accordance with a safety manual to verify that a device fulfils its safety requirements in an OPS and achieves its required safety integrity level (SIL) for the application. A safety loop's probability of failure on demand (PFD) – i.e., the risk of it failing to perform its intended function – increases over time after commissioning. Performing a proof test resets the PFD to a lower value and ensures the safety loop provides the risk reduction it was designed to do.

PROOF TEST COVERAGE

Advanced level measurement devices for overfill prevention applications incorporate diagnostic software that identifies a failure and then takes the device to a safe state. However, some failures are not detected by the diagnostics. These are called dangerous undetected failures (DUs) and are revealed during proof testing. The effectiveness of a proof test in finding DUs is known as the proof test coverage factor, which should ideally be as high as possible.

STANDARDS

To create consistency in their approach to safety, many tank terminal owners and managers apply both the American Petroleum Institute's API 2350 standard, which addresses overfill prevention for large petroleum storage tanks, and the International Electrotechnical Commission's IEC 61511 standard for designing an OPS.

Both standards place great importance on regular proof testing. IEC 61511 specifies that the entire OPS must be proof tested periodically, and the frequency of testing is determined by the PFD of the safety loop. API 2350 states that all components of an OPS that are required to terminate receipt must be tested annually, with continuous level sensors to be tested once a year, and point level sensors semi-annually. However, the interval between tests can be extended if there is a technical justification, such as the PFD calculation, to support it. Both standards require organisations to provide written procedures, schedules and documentation of proof testing.

Two types of proof test, comprehensive and partial, may be performed in compliance with API 2350 and IEC 61511.

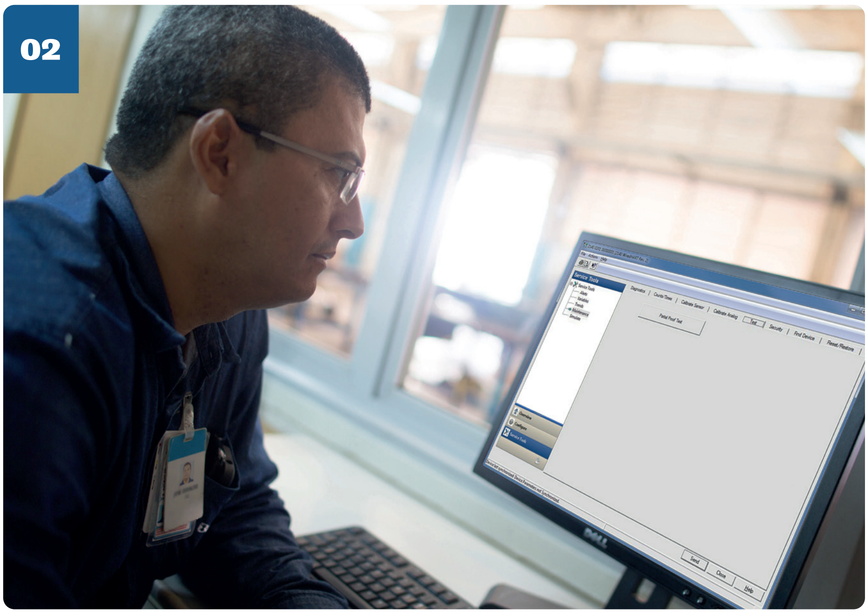
COMPREHENSIVE PROOF TESTING

Comprehensive proof tests involve testing the entire safety loop in a single procedure, to ensure all its parts are functioning correctly. This will return the PFD of the safety loop back to, or very close to, its original level. Comprehensive proof testing is carried out manually by technicians in the field, with another worker stationed in the control room to verify the reaction of the system. There are two different ways in which a comprehensive proof test can be performed.

In the first method, the level in the tank can be raised to the activation point of the level sensor being tested to provide proof that the instrument is functioning correctly. The danger of this approach is that if the device is a high-level sensor and it fails to activate during the test, this can lead to a spill that would constitute a safety risk. Having to fill a tank just to test the instrument is also time-consuming, requires operators to monitor the tank level, and can interrupt normal tank operations, causing costly downtime. Performing proof tests in this way has been an acceptable practice in the past, but the latest version of API 2350 does not recommend that the tank level be raised above the maximum working level.

The alternative approach is to remove the instrument from the tank and

02



perform a simulated test in an alternative environment such as a bucket, for example. A significant disadvantage of this method is that it can involve workers having to climb tanks to access an instrument, thereby exposing them to a hazardous environment and putting their safety at risk. Performing proof tests in this way is also prone to human errors and can lead to tanks being taken out of service for an extended period, thus affecting profitability. In addition, if the instrument is removed from a tank containing a hazardous or unpleasant product, the test would be performed using water instead. This would fail to prove that the device would work in the specific application.

PARTIAL PROOF TESTING

A partial proof test is performed to ensure that a device has no internal problems and that all its functions are operating correctly. This type of testing may include one or several parts of the safety loop and will bring the PFD of these back to a percentage of the original level and ensure that the device fulfils its specified SIL requirement.

As a partial proof test detects only a percentage of potential failures, a comprehensive proof test must eventually be carried out after a given time interval to return the instrument to its original PFD. However, performing a partial proof test can provide justification for extending the time interval between comprehensive tests, while remaining within regulatory requirements.

REMOTE TESTING

The digital technology available in modern level measurement devices enables partial proof testing to be performed remotely rather than on location. Remote proof testing can be initiated via a command from the control room. Using this functionality, the instrument remains installed during the proof test. This is beneficial because performing tests during normal operation minimises tank downtime and reduces worker exposure to hazardous environments without sacrificing SIL capability and functional safety. It is quick and easy, and multiple devices can be tested simultaneously, thereby increasing speed and safety, and reducing operational cost.

RADAR LEVEL GAUGES IN AN OPS

Non-contacting radar level gauges, such as the Rosemount 5900 series from Emerson, are the technology of choice to serve as the automatic tank gauge (ATG) in bulk liquid storage tanks. This is a well-proven level measurement technology that provides high reliability and assured measurement accuracy. The Rosemount 5900 series is designed with functionality that enables the user to perform continuous product surface level measurement whilst undertaking remote proof testing, thus not requiring an interruption to normal tank operation.

TANK GAUGING SYSTEM SOFTWARE

An operator can perform these proof tests safely and remotely from the comfort of their control room using the powerful and easy-to-use Rosemount TankMaster inventory management software package from Emerson, which brings all the tank information together. TankMaster provides operator overview, inventory and custody transfer functions, and configuration and service for devices in the Rosemount tank gauging system and has built-in functionality that enables an operator to perform one or several proof tests. A step-by-step guide leads the operator through the various proof testing procedures, making them as straightforward as possible.

Several different proof testing options can be performed through TankMaster, either individually or in sequence. For example, the software can verify that the device's high-level alarm is functioning correctly through the use of an adjustable reference reflector that introduces a reflected radar signal, or echo, at a predefined position in the tank. The reference reflector is attached to a wire fixed to a parabolic or array antenna and is installed beneath the antenna. Alternatively, the high-level alarm can be verified using an innovative simulated reference reflector, whereby an artificial digital echo is inserted into the radar signal, which triggers the high-level alarm when detected. This eliminates the need to have a physical reference reflector, which provides the benefit of avoiding having a tank obstruction. Performing the test with either a physical or simulated reference reflector as part of a combination of partial proof tests can achieve a proof test coverage factor of 73%. Other available proof testing options include verification of automatic level measurements and testing of the analogue outputs and relay outputs of a connected Rosemount 2410 Tank Hub.

At the end of a proof test cycle, all the tests and individual results are listed in a summary report. In addition, detailed reports are automatically generated

03

2-IN-1 RADAR TECHNOLOGY

It is considered best practice for new installations to employ two radar level gauges in a tank gauging system – one providing continuous level measurements and the other acting as the OPS sensor. The use of two radar level gauges rather than, for example, one radar level gauge and one point level switch, reduces complexity and the need for device-specific training, thereby minimising the potential for human error.

For tanks with only a single opening, it can be costly and time-consuming to make modifications in order to install two separate radar level gauges. A solution to this problem is the Rosemount 5900S 2-in-1 radar level gauge. This device consists of two separate and independent electrical units and a common antenna. This enables a single level gauge to serve as both the ATG and an OPS sensor when connected with its cables separated in different cable trays and with separate power sources. This IEC 61511-compliant configuration allows for cost-efficient safety upgrades of existing tanks.

and stored for each proof test, thereby fulfilling the requirements of the relevant industry standards. Supporting effective document management, a proof test history option within the software shows information on when a test was performed and by whom it was approved. Further options within the software include proof test scheduling, enabling the user to specify when the next proof test should be performed, and the ability to set the desired type of reminder – either pop-up message or email.

CONCLUSION

Remote partial proof testing of radar level gauges, initiated through TankMaster software, enables testing to be performed more frequently because the impact on tank operation is minimal. No manual work or climbing tanks is required, the risk of human errors is drastically reduced, and time is saved. Although remote partial proof testing does not eliminate the need for comprehensive testing, it can crucially provide justification for extending the time interval between comprehensive tests, while still complying with regulatory requirements. All of this helps to improve worker safety and increase tank availability.

For more information

This article was written by AnnCharlott Enberg, functional safety manager at Emerson. Emerson.com/RosemountTankMaster.

01 Removing instruments to perform a simulated proof-test can involve workers having to climb tanks, thereby exposing them to a hazardous environment and putting their safety at risk

02 The digital technology available in modern level measurement devices enables partial proof-testing to be performed remotely, via an operator issuing a command from the control room

03 The Rosemount 5900S 2-in-1 radar level gauge consists of two separate and independent electrical units and a common antenna