Agenda Item 625-2ITV

For Review by both SCOPV and SCAST

Title: Performance Requirements for In-Tank-Valves

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Revision: G

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Purpose: Definition of a minimum requirement for In-Tank-Valves as a benchmark for the specification.

Source: Proposed by Thorsten Schaper (PROTEGO) based on project experience.

Impact: Neutral. Enables buyers to describe the essential requirements and facilitates the comparison of technically different solutions.

Rationale: In-tank valves in accordance with API 625 are shut-off valves for emergency cases. The valves available on the market are very different in design and are very difficult for the specifying engineer to compare in detail. For example, the definition of the leakage rate as per API 598 (Standard for shut-off valves) is not expedient, as the in-tank valves do not have an actuator with a hold-closed function like valves according to API 598.

Proposed Changes in API 625:

Section 3 – Terms and Definitions

3.2.2.27

Thermal safety relief valve

A pressure relief device provided to protect a blocked-in liquid volume from overpressure resulting from thermal expansion or vaporization of the trapped liquid.

See F.2.14

Section 5 – Storage Concepts

5.5 Double or Full Containment-with-Penetrations Tank System

d) in-tank valves ~~are provided~~ conforming to the requirements of Annex F are provided ~~7.5~~ ~~7.3.1.4.2 b~~) for all penetrations except the following:

5.7 Membrane Containment Type M-CC with Penetrations Tank System

d) In-tank valves ~~are provided~~ conforming to the requirements of Annex F are provided 7.5 ~~7.3.1.4.2 b~~)

SECTION 7 – ACCESSORIES AND APPURTENANCES

…

7.3.1.4.2

(b) In-tank valves shall be considered when bottom or shell process lines are used. In-tank valves, when provided, shall conform to the requirements of Annex F. ~~The in-tank valves shall be automatically activated due to failure of external piping and shall also be automatically activated during a loss of electrical power and shall be capable of being activated from a remote location. The design and installation of an in-tank valve shall be such that any failure of the penetrating nozzle resulting from external pipe strain is beyond the shutoff seats of the internal valve itself.~~

Annex F (Normative)

In-Tank Valves

F.1. General

F.1.1 This annex provides minimum performance requirements for in-tank valves
F.1.2 The design and installation of an in-tank valve shall be such that any failure of the penetrating nozzle resulting from external pipe strain is beyond the shutoff seats of the internal valve itself. A risk assessment shall be conducted (see Annexes C and D).

F.2 Design Considerations

F.2.1 In-tank valves shall be designed for the full-service life of the storage tank without the need for maintenance or intervention.

F.2.2 In-tank valves shall be automatically activated due to failure of external piping and shall also be automatically activated during a loss of electrical power or process air.

F.2.3 In-tank valves shall be capable of being activated from a remote location.

F.2.4 Materials of construction shall be suitable for the stored product and operating conditions, including temperature, and shall provide adequate resistance to corrosion, erosion, and environmental degradation.

F.2.5 Moving components shall be designed to prevent wear, galling, seizure, or malfunction under all operating conditions, including the presence of solids, ice, hydrates, or other contaminants.

F.2.6 In-tank valves shall be fully compatible with the tank design, including thermal movements, settlement, and structural deformations, without imposing unintended loads on the tank system.

F.2.7 The valve design shall meet specified internal and external leak rate criteria under all operating and emergency conditions.

F.2.8 Where soft sealing elements are used, their design life and replacement philosophy shall be defined and agreed between the purchaser and the manufacturer. Replacement shall not require tank entry unless explicitly accepted.

F.2.9 The valve and its support system shall be designed to prevent the transfer of thermally induced stresses (including cooldown and transient thermal gradients) from the tank bottom to the tank wall or other critical tank components.

F.2.10 The internal flow path for the valve shall avoid abrupt cross-sectional area reductions and geometric discontinuities that may induce cavitation, vapor formation, or flow instability. Vortex-breaking or anti-vortex features shall be incorporated where applicable.

F.2.11 Where liquid may be trapped between the in-tank valve and downstream isolation devices, the valve shall be capable of relieving thermal expansion or vapor generation back into the tank without loss of containment integrity.

F.2.12 The valve shall be designed to minimize pressure transients associated with rapid closure (including water hammer). Where upstream or downstream transients occur, the valve shall be capable of relieving or withstanding resulting pressure excursions without damage or loss of function.

F.2.13 The required safety integrity level (SIL), where applicable, shall be defined based on system hazard analysis and shall be consistent with the safety functions assigned to the tank system instrumentation and shutdown philosophy.

F.2.14 The In-Tank Valve system shall be designed such that liquid trapped between the closed In-Tank Valve and an external isolation valve can relieve pressure resulting from thermal expansion or vaporization back into the storage tank without the use of a separate Thermal Safety Relief Valve.

F.2.15 The manufacturer shall provide the design basis and calculated static and dynamic loads imposed by the valve and connected piping on the tank bottom, nozzle, and roof for all relevant load cases, including installation, operation, upset, and seismic conditions.

F.2.16 The valve shall be designed with a defined fail-closed fail-safe position.

F.2.17 The actuation system (manual, hydraulic, pneumatic, or electric) shall be defined and shall be compatible with emergency shutdown (ESD) requirements. The system shall be capable of reliable operation under all design conditions, including loss of power, low temperature, and emergency scenarios.

F.2.18 The valve and associated components shall be designed to prevent malfunction due to ice formation, hydrate formation, or freezing of trapped fluids under normal and upset conditions.

F.2.19 The design shall allow for verification of operability and critical functional checks without requiring tank entry, unless explicitly accepted by the purchaser.

F.2.20 The valve shall maintain functionality under applicable external hazard conditions, including fire exposure, consistent with the overall tank fire protection and emergency response philosophy.

F.3 Factory Acceptance Testing (FAT)

F.3.1 FAT General

F.3.1.1 A factory acceptance test (FAT) shall be performed by the In-Tank Valve manufacturer using water as the test medium, unless otherwise agreed between the purchaser and the manufacturer. The FAT shall demonstrate functional performance, leak tightness, and operability.

F.3.1.2 Each In-Tank Valve shall be subjected to the hydraulic load and pressure transient test, valve seat leak rate test, functional (stroke) test, actuation system performance test, fail-safe test, and visual inspection specified in this Annex, except as permitted by F.3.1.3. Visual inspection shall be performed before and after testing to confirm that there is no damage, deformation, or degradation of components.

F.3.1.3 As an exception to F.3.1.2, the hydraulic load and pressure transient test may be performed as a qualification test on a representative In-Tank Valve of the same design, size, pressure rating, materials of construction, and actuation configuration. The qualification test results may be applied to identical valves manufactured to the qualified design. Changes that could affect hydraulic, structural, or functional performance shall require evaluation to determine whether requalification testing is required.

F.3.2 Pressure / Hydraulic Load Test

F.3.2.1 The valve shall be subjected to internal pressure conditions representative of maximum operating and transient conditions, including hydraulic impact where applicable.

F.3.2.2 The test shall verify structural integrity and continued operability following the test.

F.3.2.3 Acceptance criteria shall be defined by the manufacturer and agreed with the purchaser.

F.3.3 Valve Seat Leak Rate Test

F.3.3.1 Each In-Tank Valve shall be tested using water at a minimum differential pressure of 3.0 bar(g) [45 psi(g)].

F.3.3.2 The minimum test duration shall be five (5) minutes after stabilization of pressure.

F.3.3.3 The measured leakage rate shall not exceed 50 cm^3/min [3 in^3/min].

F.3.3.4 Leakage measurement methodology shall be defined and shall ensure adequate accuracy and repeatability.

F.3.3.5 Where more stringent leak rate criteria are specified by the purchaser or required by project-specific safety or regulatory requirements, those criteria shall govern.

F.3.3.6 Any modification to the above acceptance criteria shall require documented agreement between the tank designer, purchaser, and valve manufacturer.

F.3.4 Functional (Stroke) Test

F.3.4.1 The stroke test shall consist of at least one full cycle from fully open to fully closed and return to fully open.

F.3.4.2 The test shall verify full travel without obstruction or abnormal resistance, stroke time within specified limits, proper seating in the closed position, and stable operation without chatter, binding, or delay.

F.3.4.3 The test shall be repeated as necessary to demonstrate consistent and repeatable performance.

F.3.5 Fail-Safe and Loss-of-Power Verification

F.3.5.1 The valve shall be tested to confirm achievement of the specified fail-safe position upon loss of electrical power, control signal, and process air or hydraulic supply, as applicable.

F.3.5.2 The response time to reach the fail-safe position shall be recorded.

F.3.5.3 The valve shall achieve and maintain the fail-safe position without external intervention.

F.3.6 Documentation

F.3.6.1 The FAT report shall include, at a minimum, the following:

F.3.6.2 Test procedures;

F.3.6.3 Test conditions, including pressure, medium, and temperature;

F.3.6.4 Measured results, including leak rates, stroke times, and pressures;

F.3.6.5 Acceptance criteria;

F.3.6.6 non-conformances and corrective actions; and

F.3.6.7 Certification of Compliance.