



API 2350 (5th edition) Standard

LEVEL INSTRUMENTS FOR TANK OVERFILL PREVENTION



SPECIAL APPLICATION SERIES

Tank Overfill Prevention: Standard Practice for Level Control



In recent years tank overfill incidents have resulted in loss of life and billions of dollars in damages to petroleum facilities worldwide. One of the worst incidents — the overflow of a gasoline storage tank at Buncefield Oil Depot (U.K.) — has been traced to the failure of the level control equipment which resulted in loss of containment of the flammable liquid. More common are minor spills that cause significant environmental impact and result in millions of dollars in clean-up fees and environmental agency fines.

In order to keep standards relevant, the American Petroleum Institute's (API) 2350 (5th edition), the most widely accepted guideline for overfill protection of petroleum storage tanks, has been revised. The fifth edition is finalized by API and combines the prescriptive standards of API 2350 (5th edition) with the functional safety standards of Safety Instrumented Systems (SIS) as described in IEC 61511.

Vital to these new requirements is the application of level instrumentation as one part of a comprehensive Overfill Prevention Process (OPP).

Introduction to API 2350

API 2350 addresses the variety of instrumentation that Magnetrol has provided for decades; however, complying with API 2350 is not just about the equipment being used to avoid overfilling vessels. The 5th edition of API 2350 now addresses operational processes, including capabilities and response times. In addition to the environmental consequences of tank overfills, they can also produce vapor clouds that may escape the secondary containment and reach an ignition source; this scenario results in a vapor cloud explosion (VCE).

The following are guidelines standardized per API 2350 (5th edition) to mitigate the potential for overfill.

- Verify that all tanks have level control equipment and operational procedures that comply with API 2350 (5th edition)
- Review with senior leaders to embrace the principles of safety & environmental protection as well as each being held accountable in mitigating risk.
- Employ a management system including a formal approach to;

Training

Risk assessment

Scheduled inspections

Periodic testing

Equipment maintenance programs

API 2350 (5th edition) requires implementation of an Overfill Prevention Process (OPP)—in other words, operating parameters for every tank; including Equipment category, Level of Concern (LOCs), response times & alarm procedures. Implementation of a risk assessment system is a key step in this process, and Magnetrol can support you. Although the 5th edition of API 2350 does provide an example of a risk assessment, they do not provide instruction on how to perform the risk assessment. It is also required that written procedures for operating under normal, abnormal, startup and shutdown conditions be performed.

Lastly, communications between the supply facility and receiving facility should also be formally reviewed and available as written documents.

Risk Assessment

Risk management is a process put in place to reduce risk to an acceptable level by managing probability and consequence of potential hazardous events.

$$\text{Risk} = \text{Probability} \times \text{Consequence}$$

(Likelihood) (Severity)

If the risk seems to be deemed unacceptable, the risk must be reduced by taking the necessary steps outlined as short falls i.e. procedures, Instrumentation, training or documentation.

When evaluating the consequences, a qualitative or quantitative approach can be taken. The use of descriptors such as, minor or severe injury can be based on experience or the potential outcomes such as, jet

fuel fire, flash fire, vapor cloud explosion (VCE), boiling liquid expanding vapor explosion (BLEVE), and/or spills to better estimate the consequences.

If the risk assessment covers multiple tanks, a risk screening activity may assist with prioritizing and focusing resources on the highest risks first. Screening can point out areas that are higher in priority and suggest which tanks or operating equipment merit first consideration and resources.

More than one risk assessment is recommended, as the review is considered subjective by the personnel who performs the assessment and each assessment is to be simply a tool to aid in making informed and educated decisions.

Key Points of API 2350 (5th edition)

APPLICABILITY

Above ground Atmospheric Storage Tanks with capabilities greater than 1320 gallons (5,000 liters) that store class I or class II flammable or combustible liquids, and that receive liquids from mainline pipelines or marine vessels.

SCOPE

The purpose of the standard is to assist Owner/Operators and operating personnel in the prevention of tank overfilling by implementation of a comprehensive overfill prevention system (OPS). The goal is to receive accurate and timely product information for the intended storage tank without overfilling or mechanical damage.

OVERFILL PREVENTION SYSTEM (OPS)

The OPS consists of several components. Typically, this includes an alarm signal system and allied support systems-shutdown or diversion valves, communications, sensors and logic solvers. An OPS should be on an uninterruptible power supply.

INDEPENDENCE

A significant feature of API 2350 5th edition is that sensors and alarms used for High High tank level shall not be used for tank filling operations. In addition, the High High level sensor on category 3 tanks must be independent. Having a common entry point for the High High alarm is not deemed as independent.

PROOF TESTING

All OPS equipment required to terminate receipt shall be tested annually unless the proof test interval is based on the published proof test coverage factor from the Instruments Safety manual.

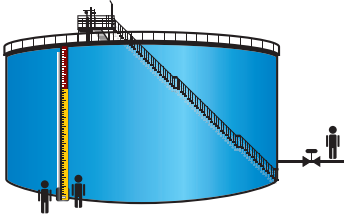
MANAGEMENT SYSTEM

API 2350 recommends a formal approach to training and procedures that comprise an Overfill Prevention Process (OPP) this is a management system with formal operating procedures and practices risk assessment, scheduled inspections, periodic testing and equipment maintenance programs.

Tank Categories & Recommended Instrumentation

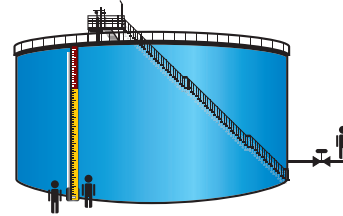
API 2350 categorizes storage tanks by the extent to which personnel are in attendance during receiving operations. The overflow prevention methodology is based upon the tank category.

Category 0 Fully Attended



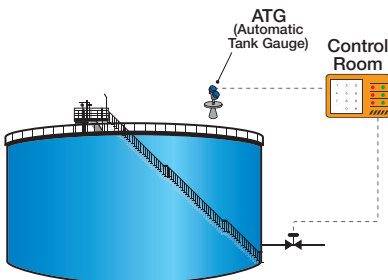
- Personnel must always be on site during the receipt of product, must monitor the receipt continuously during the first and last hours, and must verify receipt each hour.
- Termination of receipt is done manually by site personnel or by the transporter as instructed by site personnel.

Category 1 Fully Attended



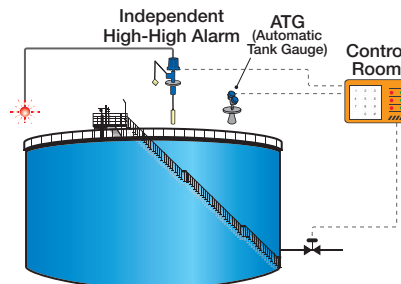
- Personnel must always be on site during the receipt of product, must monitor the receipt continuously during the first and last hours, and must verify receipt each hour.
- Level instrumentation is not required but may be used. Output will be local only. Alarms may be point or continuous level devices.
- Termination of receipt is done manually by site personnel or by the transporter as instructed by site personnel.
- Tanks where operator distraction or complex receipt is possible shall not be classified as Category 1

Category 2 Semi-Attended



- Personnel must be present during the initial and final 30 minutes of the receipt. The transporter must assist in monitoring the high-high alarm.
- Tanks must be equipped with an Automatic Tank Gauge System (ATGS) that includes a high-high alarm and has a transmittable output signal. A single sensor may be used for both level and high-high alarm. If a separate sensor is used for high-high level it may be point or continuous.
- The control center has the ability to terminate receipt.

Category 3 Unattended



- Personnel are not required to be present during receiving operations but are remotely located at a control center. The transporter must monitor both the level and high-high alarm.
- Tanks must be equipped with an ATGS consisting of a level sensor and independent high-high sensor. The output of both instruments must be transmitted to a control center in “real time.” The level sensor will be continuous. The high-high level sensor may be continuous or point. Sensors with self-diagnostics are preferred.
- The control center has the ability to terminate receipt. In addition, the HH sensor must automatically terminate flow to the tank or alert the transporter to terminate receipt. Failure of the ATGS must, also, automatically terminate flow.

Levels of Concern (LOCs)



Levels of Concern are calculated product levels in the tank upon which all alarm and alert positions and response times are based. Careful calculation of LOCs ensures the success of the OPS.

Level	Explanation	Required Action
Critical High Level (CH) - Required	Highest level before tank damage or product overflow	Spill Management Emergency Response
Automated Overfill Prevention System (AOPS) Activation Level — Required with AOPS	Maximum level at which termination can be automatically initiated without level reaching CH	AOPS Activation
High-High (HH) — Required	Maximum level at which termination can be initiated manually without level reaching CH	Alarm & Shutdown Responses
Maximum Working Level (MW) — Required	Highest level to which tank may be filled during normal operation	None
Minimum Working Level (Optional)	Lowest tank level permitted during normal operation	None

Response Time

Time required from initiation of termination of receipt to prevent next higher alarm from triggering, based upon communication time, personnel response time, system response time, and safety factors.

Minimum High-High (HH) Level Response Time (if not calculated)			
Category 0 Time in Minutes: 60	Category 1 Time in Minutes: 45	Category 2 Time in Minutes: 30	Category 3 Time in Minutes: 15

Roof Types



Fixed Roof or Floating Roof with Instrument Well

Recommended Equipment:

- SIL Certified Eclipse® Model 706 Guided Wave Radar Transmitter
- Pulsar® Model R86 Radar Transmitter
- Jupiter® Model JM4 Magnetostrictive Transmitter (Orion Instruments®)
- Echotel® Model 961/962 Ultrasonic Switch
- Model A15 Displacer Switch



Internal Floating Roof

Recommended Equipment:

- Pulsar® Model R86 Radar Transmitter
- Model A15 Displacer Switch



External Floating Roof

Recommended Equipment:

- Pulsar® Model R86 Radar Transmitter
- Model A15 Displacer Switch

Recommended Level Switches

Point Level Sensors

Point level sensors actuate at one or more discrete levels. These types of instruments may be used as the HH sensor and may be of a mechanical or electronic technology. Sensors used on floating roof tanks must detect the roof as well as the liquid should the roof become submerged. Additional point sensors may be used for additional alarms or alerts as determined by the operator. Full FMEDA reports are available upon request.



Single-Point Top Mount Buoyancy Displacer Switch

- Furnished with a non-sparking, hollow shell, brass displacer for dual detection of both floating roof and liquid levels
- Proof-er Manual Check easily verifies operation without the need to move tank level
- Automatic reset of proofer
- Retrofit kits available to convert your model A15 from floating roof only to dual detection as required by API 2350 (5th edition)



Single-Point Echotel Model 961 Contact Ultrasound Switch

- Continuous diagnostics of sensor, electronics and electrical noise interference
- DPDT HH level relay and SPDT dedicated diagnostic alarm relay
- Push buttons for manual testing of level and diagnostic relays
- Loop current or relay output
- Metal or plastic sensors
- SIL 2 suitable



Dual-Point Echotel Model 962 Contact Ultrasound Switch

- All the advanced features of the 961 single-point level switch, plus:
- Dual-point switch for two discrete set points through a single tank connection
 - SIL 2 suitable

Recommended Level Transmitters

Continuous Level Sensors

Continuous level sensors output an analog-type signal over a specified range of the tank height. Continuous sensors may be used as the level sensor or as the high-high alarm sensor. Additional continuous level sensors may be used to monitor additional alarm or alert points as determined by the tank operator. Full FMEDA reports are available upon request.



Eclipse® Model 706 Guided Wave Radar Transmitter

- Low dielectric media capability
- Flexible probe to 100 ft. (30 m)
- True top-of-probe level detection
- Quick connect/disconnect probe
- SIL 2/3 certified
- Modbus Communication Available



Pulsar® Model R86 Pulse Burst Radar Transmitter

- Non-contact technology
- 26 GHz operating frequency offers superior performance in long-range applications
- Activates on roof or liquid if roof sinks
- Quick connect/disconnect probe
- Continuous self diagnostics
- SIL 2 suitable



Jupiter® Model JM4 Magnetostrictive Transmitter (Orion Instruments®)

- Continuous diagnostics (electronics, sensor and float)
- Accuracy: $\pm 0.01\%$ full scale or $\pm 0.05"$ (1.3 mm) (whichever is greater)
- Repeatability: $\pm 0.005\%$ of full scale or $\pm 0.014"$ (0.36 mm) (whichever is greater)
- 33.3 feet (10 meter) span
- SIL 2 suitable
- Modbus Communication Available

Summary

Companies may ask “why should we adopt the 5th edition of API 2350?” The answer to that question is different for every organization. API 2350 made significant changes from the 3rd edition to the 4th edition and during each 5-year cycle of its review process. The current 5th edition has been less about the significant changes and more about ease of understanding what to implement to reduce risk and increase overfill prevention methods. Based on the size of your company and staffing, complying to API 2350 can be a significant task and smaller companies may require 3rd party consultants familiar with the 5th edition of API 2350 Standard.

Developing operating parameters is the first step to implementing API 2350. The operating parameters include the following required Level of Concern (LOCs): Critical High, High High, and Maximum Working. Noting the one change with the required LOCs is that the High Alarm is now optional if used as a High Alert and only if it is used as an alarm then API requires it be evaluated just as the other LOCs with response times and action steps.

Another significant change in the 4th edition brought forward in the 5th edition, is the use of categorization of tanks based on their liquid receipt shutdown process, whether the tank uses an Automatic Overfill

Prevention System (AOPS) or an operator to terminate flow. A fourth tank category, Category 0 has been added to include the implementation of fully supervised complete manual tanks.

API 2350 had a focus on the 5th edition review process to simplify the wording and description without reducing the emphasis. The new release allows for the safety standard to not only be better understood by U.S. companies desiring improved safety for employees and the community, but also a standard accepted globally. As the standard is followed, the result will be the same results for people and the environment abroad. Greater understanding leads to greater Overfill Prevention with each of the following improvements resulting in saved lives and less destruction to the environment. Understanding each of the following elements can be the beginning for your company complying to the current 5th edition of API 2350, Hazard and Risk Assessment with an analysis, complete and ongoing documentation of each Management of Change, documentation of the procedures and safe work practices, formalized training, monitoring of equipment in accordance with equipment integrity and industry standards, near miss incident investigation, your emergency response and finally the SMS/OPP oversight review including re-evaluation and continual adjustment.

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| • Mass Flow Measurement | • Tank Bridle Level Measurement |
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PLEASE NOTE: The instruments recommended in these brochures are based on field experience with similar applications and are included as a general guide to level and flow control selection. Because all applications differ, however, customers should determine suitability for their own purposes.



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