# The Complete Guide to

# API 2350

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# Content

# An Introduction to API 2350

Tank overfills are a major concern to the petroleum industry. In the best case, you have to clean it up. In the worst case, you go out of business, and end up in court. As a response to this, the industry has worked jointly to create a new API/ANSI Standard 2350 Edition 4: "Overfill Protection for Storage Tanks in Petroleum Facilities". This new standard is a description of the minimum requirements required to comply with modern best practices in this specific application. Obviously the main purpose is to prevent overfills, but another common result of applying this standard is increased operational efficiency and higher tank utilization.

API 2350 was created by the industry for the industry with contributions from a wide range of industry representatives including: tank owners and operators, transporters, manufacturers, and safety experts. This together with the fact that it singles out a specific application (non-pressurized aboveground large petroleum storage tanks) and a specific use-case (overfill prevention) make this standard unique. And it does not compete with other more generic safety standards, but is intended to compliment them. Using Safety Instrumented Systems (SIS) designed in accordance with IEC61511 is one example of how to fulfill some of the requirements in API 2350.

The industry adoption rate to this standard is expected to be very high because of the obvious benefits, combined with the world's ever-increasing need for more safety. The question for a tank owner or operator is whether they can afford not to implement API 2350. And because of the standard's generic nature, it is expected to be also applied to nearby tanks outside the standard's specific scope, containing, for example, chemicals or Class 3[1] petroleum liquids.

Tank operations are similar across the world, and many companies operate in a multinational environment. API 2350, despite the reference to 'America', has been written from an international perspective. It is intended to be equally valid and applicable worldwide.

This guide will provide the basic elements for a petroleum tank owner/operator to apply API 2350 to new or existing tank facilities with minimal effort and maximal gains. You should read it because this new standard is expected to become a game-changer, and by reading it you can benefit from applying the latest best practices for overfill prevention. The standard itself is available for a small fee from API's web site (www.api.org).

[1] NFPA National Fire Protection Association. Class 1 liquid has a flash point below 100°F . Class 2 liquid has a flash point at or above 100°F and below 140°F. Class 3 liquids have flash points above 140°F.

## Purpose

The target audience for this document is owners and operators of fuel distribution terminals, refineries, chemical plants and any other facilities which receive petroleum or chemical products into storage. The key industry change related to tank overfills this year is the publication of a new version of API 2350 "Overfill Protection for Storage Tanks in Petroleum Facilities", the 4th edition published in May 2012. The goal is then to understand which changes have emerged in this new standard and how to apply them for the purpose of adoption and compliance with API 2350. Anyone responsible for safe operations at fuel marketing, distribution terminals, refineries, oil handling, or pipeline companies should take advantage of the state of the art in tank overfill prevention as discussed in this guide. While the scope of API 2350 applies to the filling of petroleum-based products associated with marketing, refining, pipeline and terminal facilities, its principles may be applied to any tank operation where there is a risk of overfilling the tank.

Most applications under API 2350 involve atmospheric or slightly pressurized tanks, but the principles of API 2350 can be used for higher pressure storage as well. The scope of API 2350 applies to overfill protection for NFPA[2] Class 1 and Class 2 liquids and recommends compliance for Class 3 liquids. The "Scope of API 2350" (see below) presents a more detailed breakdown. For flammable liquids classified by fire codes (called Class 1 liquids) API 2350 can mitigate the likelihood of spilling these hazardous products and the likely resulting facility fire. Since spills of non-volatile organic liquids such as lube oils or heavy asphaltic products are often considered an environmental hazard, overfills of these products are also addressed by the new API 2350.

### Scope of API 2350 (4th Edition)

API 2350 applies to petroleum storage tanks associated with marketing, refining, pipeline, terminals and similar facilities containing Class I or Class II petroleum liquids. API 2350 recommends including Class III liquids.

**API 2350 does not apply to:**

- Underground storage tanks
- Aboveground tanks of 1320 US gallons (5000 liters) or less
- Aboveground tanks which comply with PEI 600
- Tanks (process tanks or similar flow through tanks) that are integral to a process.
- Tanks containing non-petroleum liquids
- Tanks storing LPG and LNG
- Tanks at Service Stations
- Loading or delivery from wheeled vehicles (such as tank trucks or railroad tank cars)

PEI RP 600 Recommended Practices for Overfill Prevention for Shop-Fabricated Aboveground Tanks for overfill protection where applicable for aboveground tanks falling outside the scope of API 2350.

[2] NFPA National Fire Protection Association. Class 1 liquid has a flash point below 100°F . Class 2 liquid has a flash point at or above 100°F and below 140°F. Class 3 liquids have flash points above 140°F.

## Fourth generation of API 2350

The current API 2350[3] (4th edition published May 2012) applies to filling tanks with petroleum-based products for the purpose of preventing overfills. Embracing radical changes compared to previous versions, this new standard deserves a close review. Also, between the last edition and the current edition, important new safety standards that apply directly to tank operations have been introduced into the public domain. The current edition of API 2350 builds on best practices from both the petroleum industry and from other industries and applies them directly to tank overfill protection. An example of a major change introduced by the new version of API 2350 is the requirement for a safety management system. As a result of the sweeping changes to this standard, understanding and using it will require some patience and guidance.

A key and influential event that shaped the current edition of API 2350 was the Buncefield conflagration arising from a petroleum tank overfill at the Hertsfordshire Oil Storage Terminal (HOSL) near Heathrow Airport. On December 11th 2005, the fire engulfed 20 tanks resulting in the total destruction of the terminal and nearby facilities. This fire was the worst in Europe since World War II. The Buncefield incident was also one of the most intensely studied tank overfill events of all time. Fortunately, the lessons learned from this incident have been captured by the United Kingdom's HSE[4] in reports[5] covering this incident.

API 2350 represents today's minimum best practices so tank owners and operators can now prepare for what will undoubtedly be the benchmark for generally recognized good practice in the petroleum storage business.

## Learning from past experiences

The following quote from the United Kingdom's Health Safety Executive Buncefield investigation shows unsurprisingly, that faults in management systems are a key root cause of tank overfill incidents.

> *"Management systems in place at HOSL relating to tank filling were both deficient and not properly followed, despite the fact that the systems were independently audited.*
>
> *Pressures on staff had been increasing before the incident. The site was fed by three pipelines, two of which control room staff had little control over in terms of flow rates and timing of receipt. This meant that staff did not have sufficient information easily available to them to manage precisely the storage of incoming fuel.*
>
> *Throughput had increased at the site. This put more pressure on site management and staff and further degraded their ability to monitor the receipt and storage of fuel. The pressure on staff was made worse by a lack of engineering support from Head Office."*

Unfortunately, the scenarios described above leading to this incident are all too common. But fortunately, the API Committee developing the new API 2350 4th edition, fully integrated the lessons learned from Buncefield as well as other incidents and combined them with the best practices for tank filling operations from every sector of the petroleum industry. In fact, the United Kingdom's HSE was one of the committee members to ensure that all lessons learned from Buncefield were captured in the 4th edition of API 2350.

[3] Overfill Protection for Storage Tanks in Petroleum Facilities, ANSI/API Standard 2350-2012, Fourth Edition, May 2012

[4] HSE Health Safety Executive is a governmental safety agency in the United Kingdom responsible for public and worker health and safety

[5] http://www.buncefieldinvestigation.gov.uk/reports/index.htm

The API committee is a consensus-based standards development organization and the current edition of API 2350 ensures a worldwide perspective on tank overfill protection. The worldwide best practices from international countries, regulatory agencies and companies have been studied and compiled into the new edition of API 2350.

# Motivating Robust Overfill Protection

## Reducing liabilities

Clearly, the prevention of overfills is a significant, and obvious benefit, to tank owners/operators. All tank owners/operators know that protection of public and worker health and safety, the environment, and assets are important. But what may not be so obvious to them is that the benefits that can result by applying the latest thinking related to tank overfills. The new management system practices encouraged by API 2350 may actually improve the normal day-to-day operations and efficiency for a facility.

The previous editions of API 2350 can be considered a list of the good equipment and operating practices that are needed to prevent overfills. Indeed, such lists have value, but eliminating the tank overfill requires much more than just the use of such lists. Eliminating overfills requires a formal and comprehensive safety management system.

Tank overfills are relatively rare events so why are these rare events of concern? The reason is that the consequences of overfills can exceed most, if not all other potential scenarios at a petroleum facility. While rare, serious incidents usually yield risks to the tank owners/operators that are deemed unacceptable. The fact that there may be property damage and injuries or fatalities is only the beginning of the accident scenario. Liabilities of various kinds can go on for pages as a review of the Buncefield incident reports shows. In some cases being forced out of business is the end result as in the case of Caribbean Petroleum in the Puerto Rico (October 23, 2009) incident.

## Other benefits

In addition to reducing liabilities, there are benefits impacting overall facility operational efficiency and reliability as mentioned above. Since API 2350 uses the latest principles of management systems, operational improvements in general may result from:

- Simplified and clarified response to alarms
- More usable tank capacity (explained later)
- Generalized understanding and use of the Management of Change (MOC) process
- Operator training and qualification
- Inspection, maintenance and testing
- Procedures for normal and abnormal conditions
- Lessons learned used to evolve better operational, maintenance and facility practices

## Major components of API 2350 (past and present)

The key elements of API 2350 may be considered to comprise the following elements:

- Management System (Overfill Prevention Process or OPP)
- Risk Assessment system
- Operating Parameters
  - Levels of Concern (LOCs) and Alarms
  - Categories
  - Response time
  - Attendance
- Procedures
- Equipment Systems

The first two elements are major additions that were absent in previous editions. API 2350 defines the Management System to be the Overfill Prevention Process (OPP). In other words, when you read or hear the term OPP, just think of the management system concept.

Next, Operating Parameters was a term coined to designate the tank specific data required to use the standard. These include the Levels of Concern (LOCs) value of important liquid levels such as Critical High (CH), High High Tank (HH) and Maximum Working Level (MW). Also included are the Categories of overfill protection systems which are designated by the type and configuration of equipment being used for overfill protection. Another operating parameter are the Response Time (RT) and Attendance. All of these operating parameters are all discussed in detail later. They should be thought of as the data about tank facilities required to use API 2350 efficiently.

The procedures and equipment system elements are similar to past editions and were updated to reflect the changes above as well as to apply some improvements over past editions.

Finally, perhaps the least applied but biggest change is the adoption of guidance applicable to Safety Instrumented Systems which can automate the termination of a receipt in the event that the HH LOC is exceeded. Such systems are sometimes called “automated safety shutdown systems” or “safety instrumented systems”, but in API 2350 these are called “Automated Overfill Protection Systems (AOPS)”.

## Management systems

A Management System allows an organization to manage its processes, or activities, so that its products or services meet the objectives it has set for itself. The objectives can vary from satisfying the customer’s quality requirements, to complying with regulations, or to meeting environmental objectives and such a system often has multiple objectives. Many companies use management systems to reduce safety, health and environmental incidents to as low a rate as possible, given the state of the art for business operations best practices today.

Management systems are at the heart of the new edition of API 2350. API 2350 lines up with the current industry thinking by requiring the application of the Overfill Prevention Process (OPP). OPP is the people and equipment associated with tank filling operations to maintain an optimally tuned system for high performance without overfills. The inclusion of OPP is significant in that the standard is no longer just talking about how to design, operate and maintain such systems, but is talking about how the company should run its processes and procedures associated with tank filling operations.

Although API 2350 requires a management system for overfill prevention and protection, it does not specify how to develop or implement one. Organizations typically rely upon management systems that have been developed as a result of serious incidents in the past. These management systems are relatively common among large and mid size organizations. These organizations have learned to use these systems to systematically reduce, control and manage incidents as well as to improve other aspects of their businesses. In order to be effective, these systems must be integrated into the "corporate culture" and must be fit for purpose. Even the simplest of such systems require lots of time, energy and resources and must be actively supported by the very top level of the organization. Without top management active support and promotion, there is no hope for a working management system.

It is recommended that organizations which do not use any form of safety management system consider development and implementation of a basic, fit for purpose safety management system. Then they ensure that the safety management system incorporates the relevant principles from API 2350. This recommendation is especially important for those companies that are growing or those that are acquiring other companies in their growth cycle. Any acquisition is potentially high risk until all of its management systems as well as its equipment systems and operations are integrated.

## Risk assessment

API 2350 requires the use of a risk assessment system. Each tank under this standard must have a risk assessment performed to determine whether risk reduction is required. Risk assessment is a means of combining the consequence and likelihood of an overfill or other accident, usually for two purposes. First, a common scale or ranking methodology needs to be applied to the many different possible accident or loss scenarios that a facility is subject to. For example, the risk of a rogue employee attempting to sabotage a facility is different than the risk of a tank overfill. Without risk assessment there is no rational way to understand which scenario may be worse. Second, since resources are always scarce, risk assessment, through the risk management process, allows a company to compare and prioritize these risks for the purpose of allocation of budgets and resources to mitigate them in such a way that the most serious risks are mitigated first.

Unfortunately, API 2350 requires that the tank owner/operator use a risk assessment sy"stem to address risk, but does not provide any information or guidance on how to develop or use such a system. While this may seem strange, it is the only way that a general industry standard can be written for a general population of highly variable facilities and tank owners, each with differing perceptions of risk threats and differing corporate value schemes.

A good starting point for risk assessment resources can be found in IEC 61511-3 Part 3: "Guidance for the determination of the required safety integrity levels – informative" and IEC/ISO 31010 "Risk Management – Risk Assessment Techniques."

# Implementation of API 2350

## Overview

The primary enabling mechanism that allows adoption of API 2350 is top management endorsement and support to motivate the safety management system (OPP). This means that formal processes for all of the elements covered in "Management Systems" (see below) will be documented, created, revised and formally set into motion using a formal corporate program structure.

### Management Systems

**Specific Elements of the Management Systems for Overfill Prevention**

- Formal written operating procedures and practices including safety procedures and emergency response procedures
- Trained and qualified operating personnel
- Functional equipment systems, tested and maintained by qualified personnel
- Scheduled inspection and maintenance programs for overfill instrumentation and equipment
- Systems to address both normal and abnormal operating conditions
- A management of change (MOC) process which includes personnel and equipment changes
- A system to identify, investigate, and communicate overfill near misses and incidents,
- A system to share lessons learned
- A follow-up system to address any needed mitigation of circumstances leading to near misses or incidents
- Communication systems protocols within the Owner/Operator organization and between the Transporter and the Owner/Operator that that are designed to function under abnormal as well as normal conditions

**Benefits of Management Systems**

- Safety and environmental protection
- Optimization of the work place and operating practices
- Inspection, testing, and maintenance
- Equipment and system selection and installation
- Safe work practices, emergency procedures and training
- Management of change programs relative to tank overfill protection
- Inclusion of current technology and practices related to process control and automated safety instrumented systems

Figure 1 (see below) - "Conceptual Management Plan for Implementation of API 2350" - gives the overall concept associated with implementation of API 2350. A first step is setting up a process for data management associated with the tank overfill protection program. The existing tank configuration must be understood. The tank configuration is the type of instrumentation that the tank has, its LOCs, alarm and gauging systems and the operating parameters including any relevant information to the OPP. This means that all relevant data for each tank needs to be collected and a process for keeping it up to date established. "Risk Considerations for Risk Analysis" (see page 12) examines some of the information considerations needed to establish risk. The database (1)(2) involves all tanks within scope to be included in the tank overfill protection program.

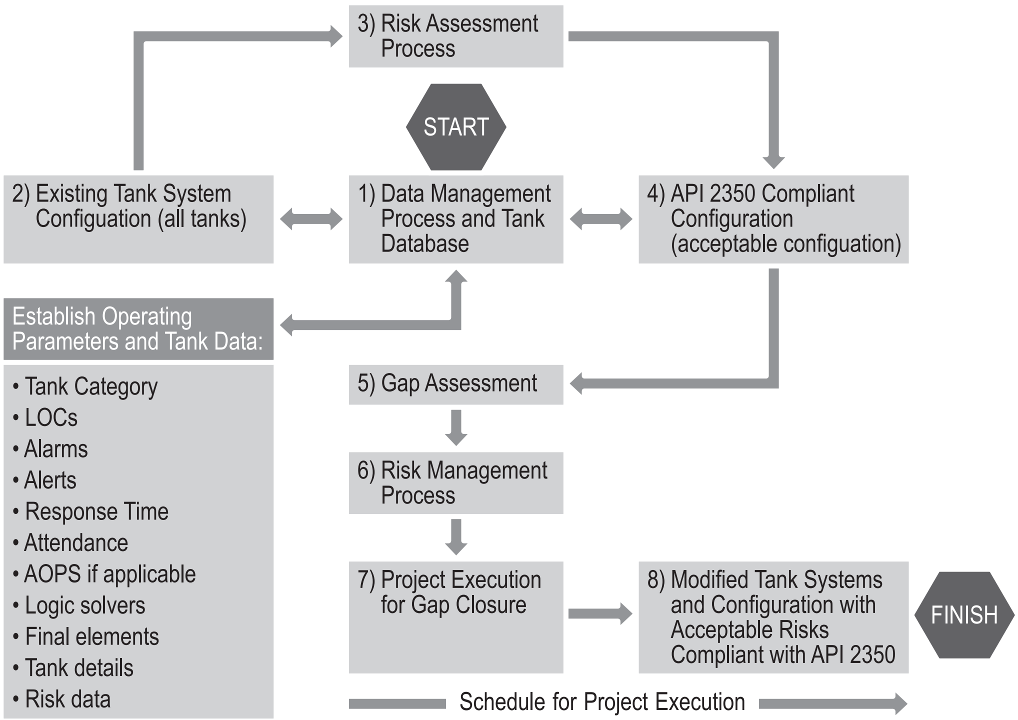



**Figure 1: Conceptual Management Plan for Implementation of API 2350**
(Note: Diagram shows conceptually how one may approach managing the process of bringing a population of existing and proposed new tanks for existing facilities into compliance with the 4th edition of API 2350)

The data will provide information about operating parameters and tank specific information and any other information relevant to establishing compliance with the standard. While some tank configurations may have acceptable residual risk others may not. It is only after a risk assessment process (3) is applied to each tank that the acceptable configuration can be established. Each tank overfill system will then be classified (4) as either compliant or non-compliant with API 2350. In other words, the risk is either acceptable or unacceptable.

The classification results in the ability to do a gap assessment plan (5) which will show what changes are needed to bring the tanks to/within acceptable risk and into compliance with API 2350. Once the scale of changes needed to bring the tank system into compliance is understood, a risk management process (6) can be used to prioritize risks and to determine how much funding is required to close the gap and make all tanks compliant.

### Risk Considerations for Risk Analysis

**Probability or Likelihood Factors**

- Frequency, rate and duration of filling
- Systems used to properly measure and size receipts to tanks
- Accurate tank calibration (both strapping and verified Critical High)
- Systems used to monitor receipts
- Extent of monitoring / supervision of manual and automatic tank gauging
- Impact of complexity and operating environment on the ability of Operating Personnel to execute overfill prevention tasks
  - Filling multiple tanks simultaneously
  - Switching tanks during receipt.

**Consequence Factors – Impact of Hazardous Material Release on Vulnerable Exposures Hazard characteristics of material (product) in tank volatility, flammability, dispersion, VCE potential**

- Number of people onsite who might be affected by a tank overflowing
- Number of people offsite who might be affected by a tank overflowing
- Possibility of a tank overflowing resulting in (escalation) of hazardous events onsite or offsite
- Possibility of impact to nearby sensitive environmental receptors
- Physical and chemical properties of product released during overflowing
- Maximum potential overfill flow rates and duration

Once the risk management process (6) is completed, the project engineering and execution phases (7) for implementation of changes can begin. Closing the gap will take some time and it is a fundamental principle of risk management that the worst risks should be reduced first. The gap closure plan should be built with this principle in mind. Ultimately, the process aims to keep the owner/operator in compliance (8).

The process above will also address proposed new tanks that are added to the system. They must be evaluated to the same criteria and run through the process, but unlike existing tanks they will normally be built to be compliant during construction.

The project execution phase should, of course, use the Management of Change (MOC) processes and interact with the data management system to ensure that information in the tank database is updated when changes are made.

More detail on these steps follows.

# Operating Parameters

## Initialization

Part of the data management process is determination of what API 2350 calls operating parameters. Tank owners/operators who adopt API 2350 must establish or validate the tank operating parameters. These include knowing the tank categories, Level of Concerns (LOCs), alarms, alerts, Automatic Overfill Prevention System (AOPS) (if applicable), and attendance type.

## Categories

All tanks must be categorized according to API 2350. Refer to Figure 2 (see below) - "Definition of Overfill Protection System Categories" . Categories are a means of grouping all of the many different possible tank overfill gauging configurations into three broad configuration categories. While the standard says nothing about which category is "better" we state that given all things equal, the higher the category the more reliable is the gauging and alarm system.

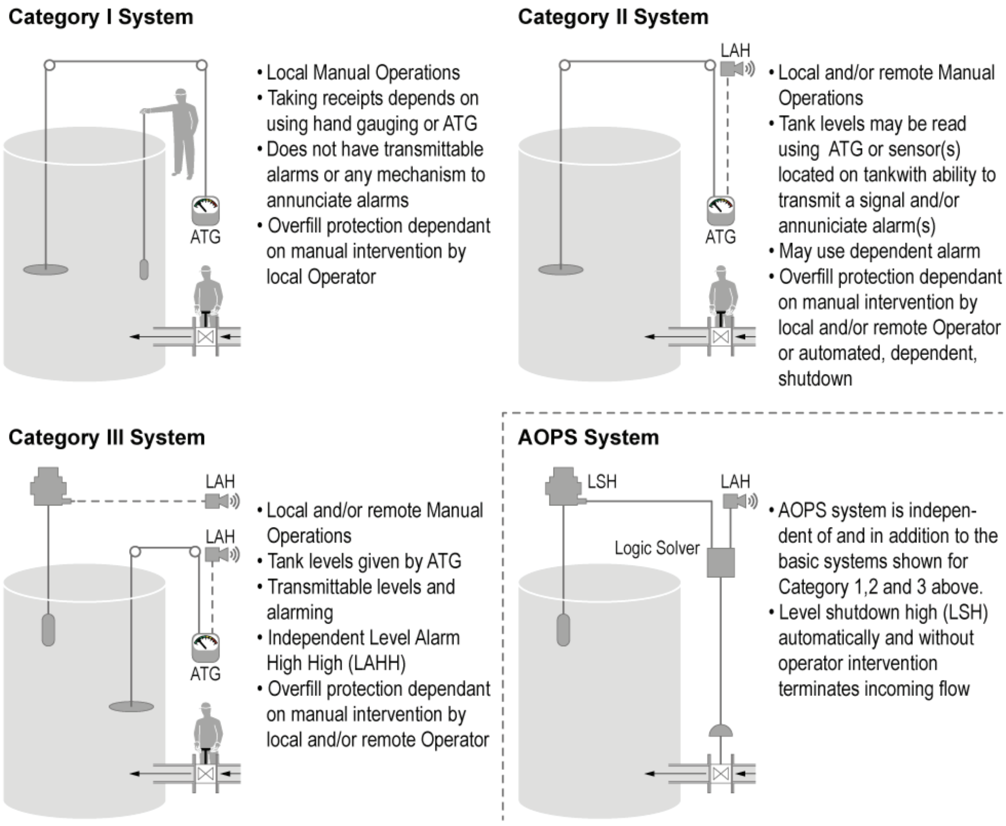



**Figure 2:** Definition of Overfill Protection System Categories

## Category I

Category 1 systems are essentially manual systems such as measurement of the level by "sticking", insertion of a tape or rod which indicates the level of oil on it. While an Automatic Tank Gauging (ATG) may be at the tank and used for level measurement, it has no capability to transmit level signals so all information about level is localized to the tank. This category should only be used when the risks are low (no Class 1 liquids), the receipt operation is infrequent, the rate of level rise is slow and where the operation is so simple that an operator has virtually no chance of making a mistake. Category 1 systems may only be used for a fully attended operation.

## Category 2

Category 2 systems have the ability to transmit level and alarm information to a centralized or remote control center. But the alarm is dependent so that an ATG failure can cause total loss of information about the tank levels as well as the alarms. Category 2 systems have no redundancy and so should only be used if the failure rate of the ATG and level system is extremely low (i.e. the best possible technology available). Category 2 is permitted only for attended and semi-attended facilities. While most tank facilities are fitted with Category 2 systems, most are also fitted with unreliable automatic tank gauges making these particularly vulnerable to an overfill event.

## Category 3

Category 3 systems are like Category 2 systems but are characterized by having an independent alarm. The independent alarm ensures that an ATG failure will not cause a failure of the alarm function. Category 3 systems are considered the best available configuration and technology for tank filling operations and alarm systems. They may be used at a facility which is attended, semi-attended or unattended.

## Automatic Overfill Prevention System (AOPS)

Note that AOPS is a system which is independent of the Basic Process Control System or BPCS (which in most cases is the operations) and is independent of and in addition to the BPCS. The AOPS in Figure 2 (page 17) can be combined with any of the categories, however, in most cases, it would make sense  to combine it with either a Category 2 or 3 overfill prevention system. Sometimes AOPS is also called "Category 4".

## Other Configurations

API 2350 makes a broad classification of systems but cannot cover all cases. For example, some tank owners/operators use 2 ATGs in lieu of a single ATG and point-level alarm. These configurations should be considered Category 3 since this configuration is used in the same way as a Category 3 system. However, it is more robust because of the extra level information available. For example, a dual ATG system cannot only alarm at HH but on a variation between the two ATGs providing another dimension of reliability.

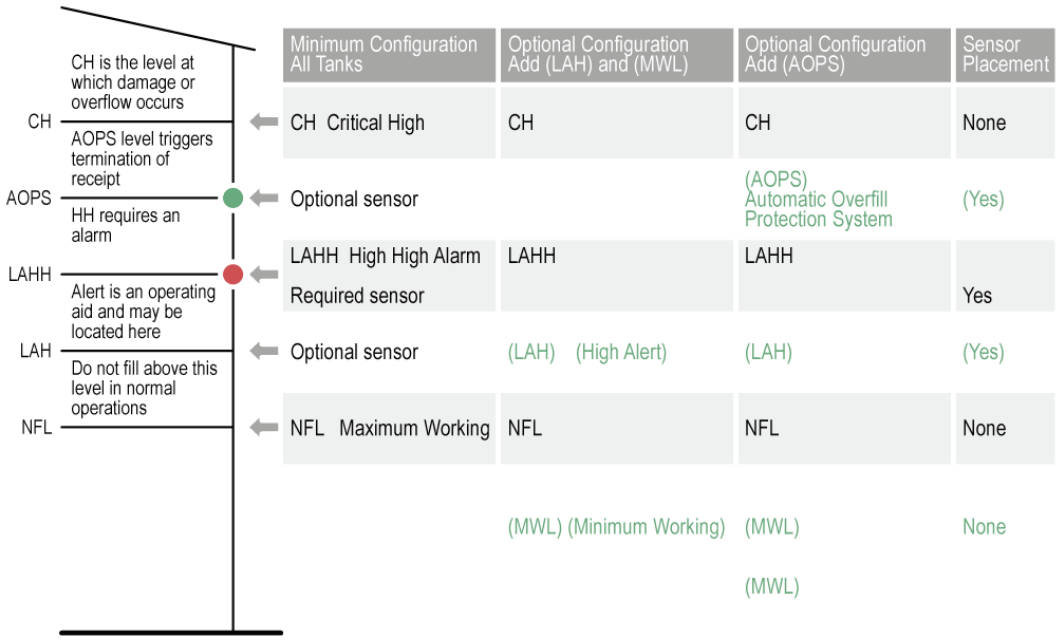
API 2350 acknowledges that it cannot cover all cases and the principles established in API 2350 should serve as a guide when these situations arise.

## Level of Concerns (LOCs)

LOCs are theoretical levels. That is, they do not have to have equipment associated with them. They are just liquid level positions that are recorded in the operators documentation such as in strap tables, in the control room displays or procedures.

## Critical High

For example, let us start with the highest LOC. This is the liquid level at which an overflow or damage can occur and is called the Critical High (CH). See Figure 3 below. Note that there is no equipment related to tank gauging placed at this level.




**Notes:**
1. It is recommended that a Minimum Working Level (MWL) be established for all tanks.
2. It is recommended to consider low level control procedures for low level control.
3. Unless the tank gauging and alarm system is highly reliable, both LAH and LAHH should be applied.
4. Only an LAH alert is shown, but as many alerts at any location may be installed as desired.
5. AOPS when selected as a means of risk reduction must comply with API 2350 requirements.
6. AOPS is added independently to Category 2 or 3 systems.
7. When used AOPS shall be set at or above LAHH.

**Figure 3: API 2350 Tank Levels of Concern (LOCs) – Category 2 and 3 Configurations**

## High High

Moving down to the next LOC we have High High (HH). This is the alarm for high level. It is also the only alarm required by API 2350. Currently, most operators use both a High and High High alarm. API 2350 now requires only one alarm. An "alert" may be used in lieu of the High alarm if so desired. The reason for dispensing with the second alarm is a long story, but may be summarized by stating that the High High is a critical alarm and procedures must reflect this fact. It must always result in a specific action by the operator to terminate the receipt. Human Factors Engineering shows that having the second alarm really does not appreciably change the overall system integrity.

Having said this, one specific reason to stick with the older method of two alarms may be due to the unreliability of the alarm sensors. If they are not highly reliable, then the second sensor gives the operator a "second chance" by still alarming even though one of the sensors has failed.

This improved reliability was introduced into the tank business in previous editions of API 2350 as well as the NFPA[6] 30 Fire Code which used the concept of redundancy of sensor systems. However, using the highly reliable sensors that can be found today, a single high reliability alarm can be better than two unreliable alarms and so only one alarm is needed and required. The decision to take advantage of the one-alarm requirement should be based on many factors, but perhaps, most importantly, on a formal management of change for the tank overfill systems.

## Maximum Working (MW) Level

Moving down again, the MW level may or may not have any level sensors. An alert may or may not be used at this level if the operator chooses.

## Automated Overfill Protection System (AOPS) Level

If an AOPS is applied then it will be set at or above the HH. The level at which the AOPS is set is called the AOPS level

## Updating and Management of Change (MOC)

According to the OPP the LOCs must be periodically reviewed and updated. An MOC shall be used whenever changes such as those listed in “Some Management of Change (MOC) Triggers” (see below) occur.

### Some Management of Change (MOC) Triggers

**Tank Modifications That Trigger MOC**

- New tank
- Change in floating roof tank seals
- Installation of geodesic domes or other kinds of fixed roofs (e.g. when external floating roof tanks receive retrofit covers).
- New internal or external floating roof
- Side vent changes
- Shell extensions
- New tank bottom
- Addition of ancillary equipment such as foam chambers
- Recalibration or re-strapping of the tank
- Change of tank gauging equipment
- Addition of a gauge tube with datum or change in datum/strike plate

**Operating Changes Trigger MOC**

- Change in product
- Change in incoming or outgoing lines
- Change in flow rates,
- Change in service if it impacts structural integrity (corrosion, temporary repairs, etc.)
- Change in operations, such as: parallel tank, floating or high suction, continuous mixer operation
- Change in response time resulting from staffing, operation or equipment changes

[6] National Fire Protection Association 30 Flammable and Combustible Liquids

## Attendance

Tanks facilities are grouped according to whether assigned personnel are on the premises continuously during the entire receipt operation (fully attended), on the premises just during the beginning and ending of the receipt (semi-attended) or not present during any part of the receipt (unattended). The tank owner/operator must ensure that the facility operation is consistent with this definition so that the correct category of tank described next can be assigned to these attendance levels. Table 1 (see below) - "Monitoring Product Receipt" - presents attendance requirements for monitoring receipts.

### Table 1: Monitoring Product Receipt

**Categories vs Attendance Level**

| Category 1 Facilities | Category 2 Facilities | Category 3 Facilities |
|---|---|---|
| Must Be Attended | IF Semi-Attended | IF Unattended |
| | Emergency conditions (equipment malfunction or power failure) may require operation as a Category 1 facility (see 4.5.3.6) | Emergency conditions (equipment malfunction or power failure) may require operation as a Category 1 facility (see 4.5.3.6) |
| Continuously during first hour of receipt | Continuously during the first 30 minutes of receipt | No local monitoring requirements. For unattended facilities, continuous monitoring during receipt by the Operator, Transporter, or by computer. |
| Every hour during receipt | hourly not applicable | see above |
| Continuously during the last hour of receipt | Continuously during the last 30 minutes of receipt | see above |

## Response Time

Response time is the time necessary for the operator under most operating conditions to terminate a receipt after the HH alarm initiates. The response time should be carefully documented and established for each tank. Many operators will choose to use a set fixed time, such as 15 minutes to terminate the receipt if the longest response time is less than 15 minutes since this simplifies the operating procedures. However, until the response time is formally established API 2350 requires very long response times as given in Table 2 (see page 18) - "Default Minimum High-High Response Time". Because of this it is clear that computing and auditing the actual response time will pay off in the long run. It is also required for the long term and only makes sense.

## Table 2: Default Minimum High-High (HH) Response Time

Time allocated for operations to terminate a receipt prior to reaching either AOPS if it exists or critical high (CH.

**Minimum High-High Tank (HH) Response Time (if not calculated)**

| Category | Time in Minutes |
|---|---|
| 1 | 45 |
| 2 | 30 |
| 3 | 15 |

These values may be reduced only if the actual response times are validated.

# Equipment and Operations

## Procedures

A most important aspect of procedures is that the Overfill Prevention System (OPS) components should be tested rigorously according to the standard. There are several types of tests outlined in API 2350 and it is important that each test be done properly. This one aspect of OPS may be the single most important in terms of providing a high degree of reliability for the OPS systems and for the operator.

## Equipment

Significant progress in the design and reliability of tank gauging and alarm systems has been made in recent years. One reason that API 2350 only requires one alarm is that the ATGs and alarm system can be so reliable that they far exceed the reliability of any ATGs when previous editions of API 2350 were written. However, there is a significant Caveat. API 2350 does not get into which equipment or technology should be used, so it is quite possible that some tank owner/operators wanting to increase capacity will eliminate the High alert, and depend solely on the one alarm, but not use the best possible technology. Unfortunately, this is a recipe for disaster since alarm reliability must be extremely good in the case that there is no redundancy.

## Proof Testing

The importance of proof testing cannot be over emphasized. When systems such as tank alerts, alarms or AOPS fail the failures are for the most part unrevealed. For example, suppose an operator depends on a sensor located at HH to the alarm in case there is a failure to terminate the receipt. If this alarm is failed then there will most likely be an overfill. This type of failure is referred to as a dangerous, undetected failure if the purpose of the alarm system is for safety. While great advances have been made for self diagnostic electronic sensors and ATGS which monitor many if not most of the failure modes and output a diagnostic alarm in such cases, no system has a 100% probability of diagnosing system faults. The only way to positively find all potential dangerous undetected faults is to proof test the entire loop from the sensor to the final output (sensor, logic solver, and final element or valve). It is recommended that proof testing requirements as specified for AOPS be applied to all alarms as well.

API 2350 requires all components involved to terminate a receipt to be proof-tested at least annually, unless otherwise supported by a technical justification (i.e. a probability of failure on demand calculation). Point-level sensors shall be conducted semi-annually. Testing of hand gauges shall comply with the requirements in API MPMS Ch. 3.1A, and continuous level gauges shall comply with API MPMS Ch. 3.1A.

# Automated Overfill Prevention System

## General considerations

Although currently Automated Overfill Prevention Systems (AOPS) is infrequently found in current tank filling operations, they will become an important tool in the toolbox of overfill prevention. In the world of safety instrumented systems, specific industry standards have been developed which apply to electrical and/or electronic and/or programmable electronic devices to control dangerous processes. These standards cover possible hazards caused by failure of the safety functions by the safety-related systems. These standards represent the best possible methodologies to ensure that safety systems operate as intended. These safety instrumented systems are applied to railway signaling systems, remote monitoring and operation of process plants, emergency shutdown systems, burner management systems and many more. By their very construct, when combined with normal operating systems and basic process control systems, they can achieve a level or risk reduction that cannot be achieved without them. So why the hesitancy to use them?

One key reason is that if they are improperly designed a pipeline can be ruptured by closing off a flowing tank receipt delivering from pipeline. In order to do this without significant problems, the valve closure time must be sufficient so that there is no possibility of a line rupture. A significant amount of data collection and engineering analysis is required to prevent the risk of a pipeline rupture. On marine receipts, the temporary hoses that connect ship to terminal can disengage or rupture due to hydraulic transients and a spill over water is generally more serious than a spill in the terminal. Great care must be exercised when applying AOPS to any marine or pipeline operation.

Thinking about AOPS as a kind of insurance policy is useful. The AOPS should never be used if operations are sufficiently good that no overfills occur. But if not, the AOPS will kick in and bring the tank filling process to a safe state, basically paying out the premium for these systems. Things are complicated by the fact that the pipeline delivery company is a separate business entity from the terminal, so the question becomes “Where do you want the incident to occur?”. The terminal operator most likely does not want a spill on his property and likewise the pipeline operator would rather have the spill in the terminal than somewhere offsite in the pipeline. Serious discussion and negotiation is required by both the pipeline operator and the terminal operator to determine if and how an AOPS will be used and a careful agreement negotiated that maximizes the benefits to all parties. While use of AOPS can reduce risk, it can also increase it if not properly applied and designed meaning that all of the requirements of IEC 61511 are totally complied with.

## Two options for AOPS (existing and new tank systems)

There are two options for installing AOPS on tank overfill systems. When the facilities are existing then Appendix A of API 2350 is required as a minimum. The appendix is a compilation of best practices that should achieve a risk reduction comparable to SIL 1 (safety integrity level 1 per IEC 61511) or a risk reduction factor of 10 to 100. This option was included because it is simply not practical to attempt to apply IEC 61511 to older tank facilities.

# Summary and Conclusions

For new facilities, the use of IEC 61511 is required. Any required minimum Safety Integrity Level (SIL) has however not been specified, although there were members in the committee advocating this to be done. It is likely that future revisions of this standard will come with a requirement for minimum SIL2, and it is therefore wise to use this as a guidance when designing new AOPS.
Adopting the new API 2350 is a significant challenge and effort. But the payoff can be worth the effort because many of the processes such as the use of safety management systems and risk assessment are already accepted by the industry as the most efficient and appropriate way to deal with risk. The data collection effort is an important one because it is the first step to assessing the overall system risk that the tank filling operations pose in your facilities. In addition, once data is collected about the system then the high risk facilities can be identified and risk reduction started. For example, a simple requirement to ensure that all tank alarms are tested and that the alarm response is mandated to be actionable as required by API 2350 will significantly reduce risks if these practices are not already being followed. A simple survey can be used to start identifying what kinds of equipment are in place.

But beyond these low hanging fruit there are resources and costs that must be allocated to the worthy cause of eliminating overfills from your portfolio of tank facilities. They are just too serious a threat to ignore.

Many tank overfill incidents resulted from faulty instrumentation. In addition, when the alarms have been working, it is not uncommon that operators did not believe the alarms because of past problems with the instrumentation systems. In either case, overfills resulted. Today, the high-tech, self-diagnostic equipment available has outstanding reliability. It is worth considering a migration process where the highest risk tank facilities are systematically upgraded to the best overfill prevention equipment.

## For additional information:

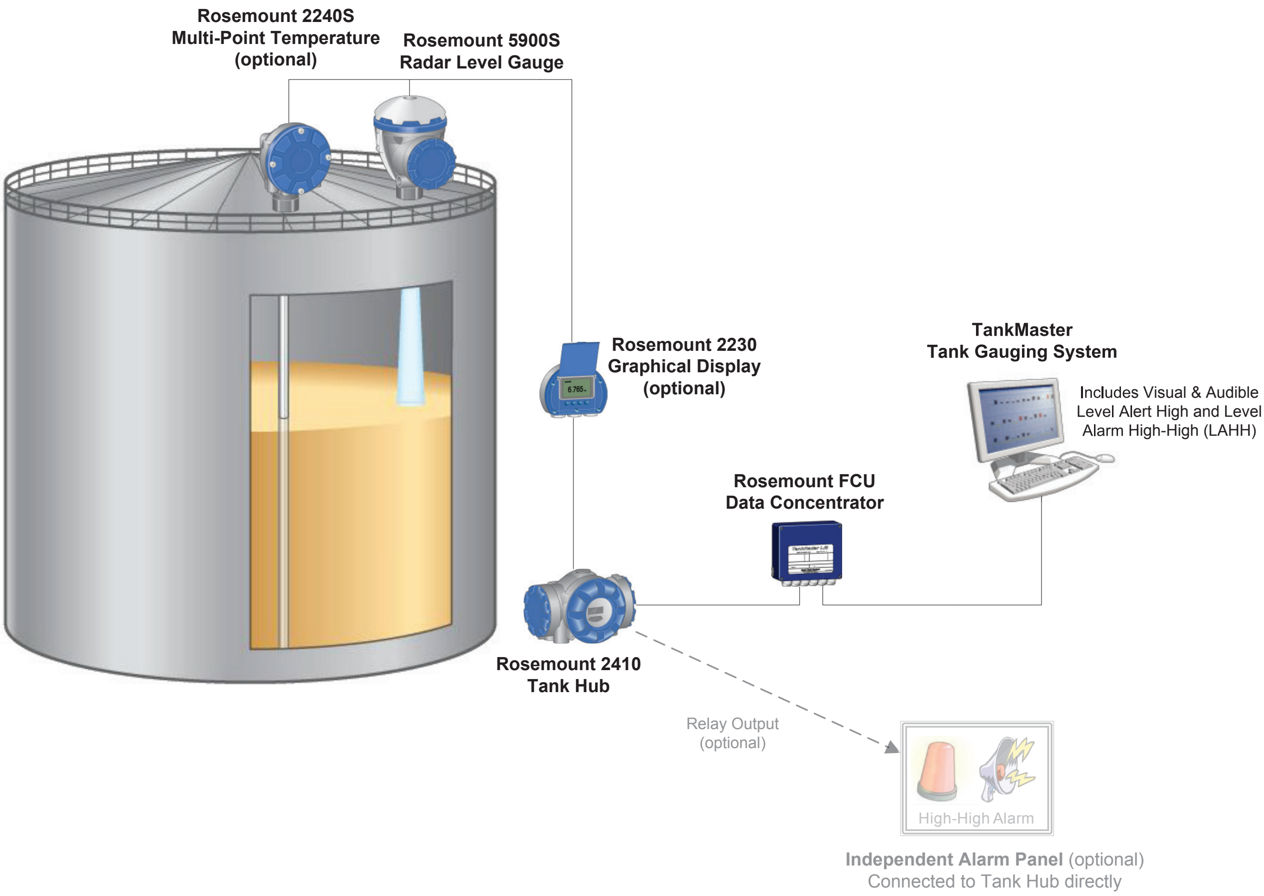
- In the Appendix you will find a API 2350-compliance checklist and some examples of different API 2350-compliant equipment solutions
- Download the standard from www.api.org
- Visit www.rosemount-tg.com/safety
- Contact your local Emerson representative

# Appendix

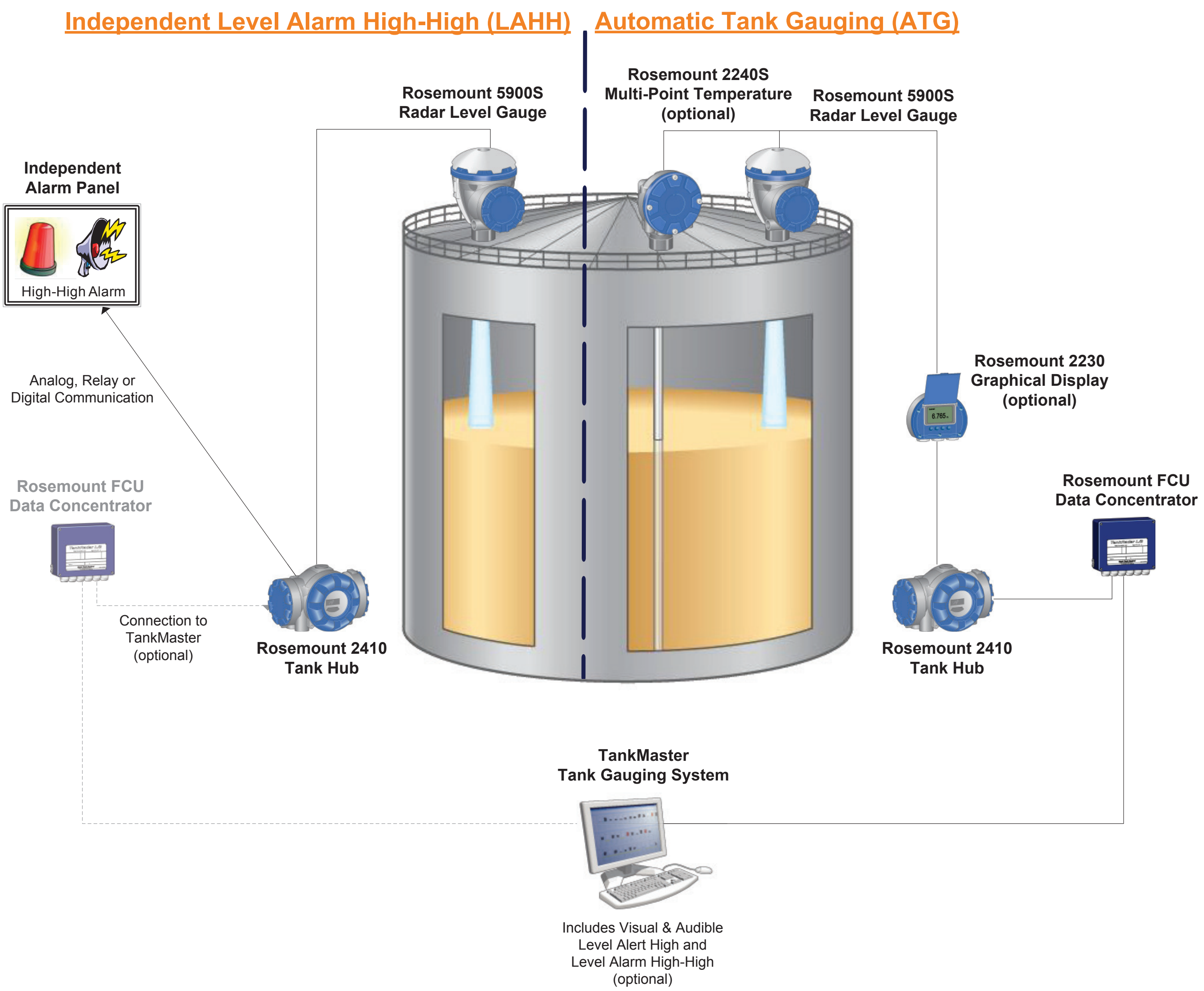
A. Equipment Solutions
B. API 2350 Compliance Checklist
C. Frequently Asked Questions
D. About the Authors

# A. Equipment Solutions

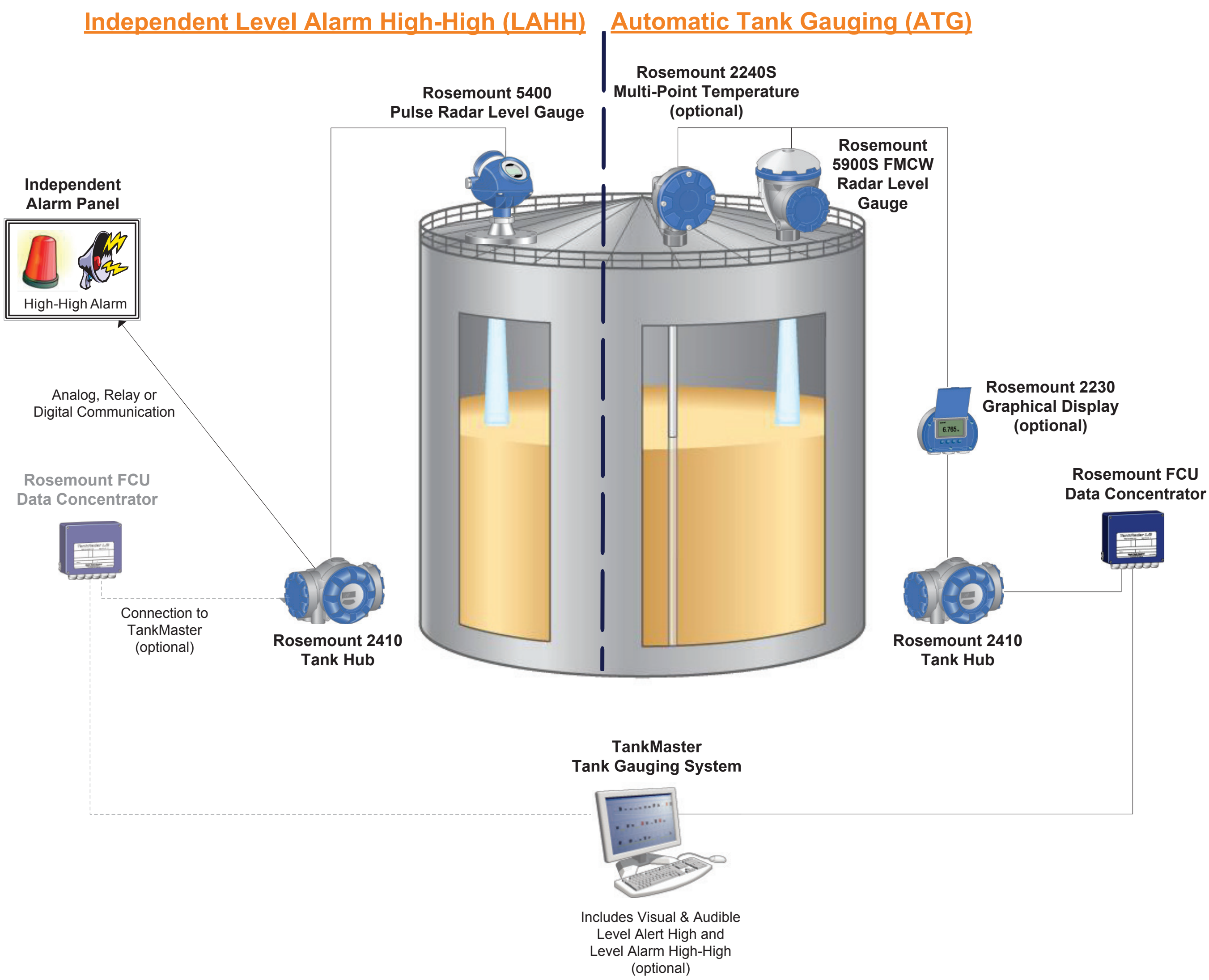
## Solution 1: Category #2 System per API 2350 Edition 4



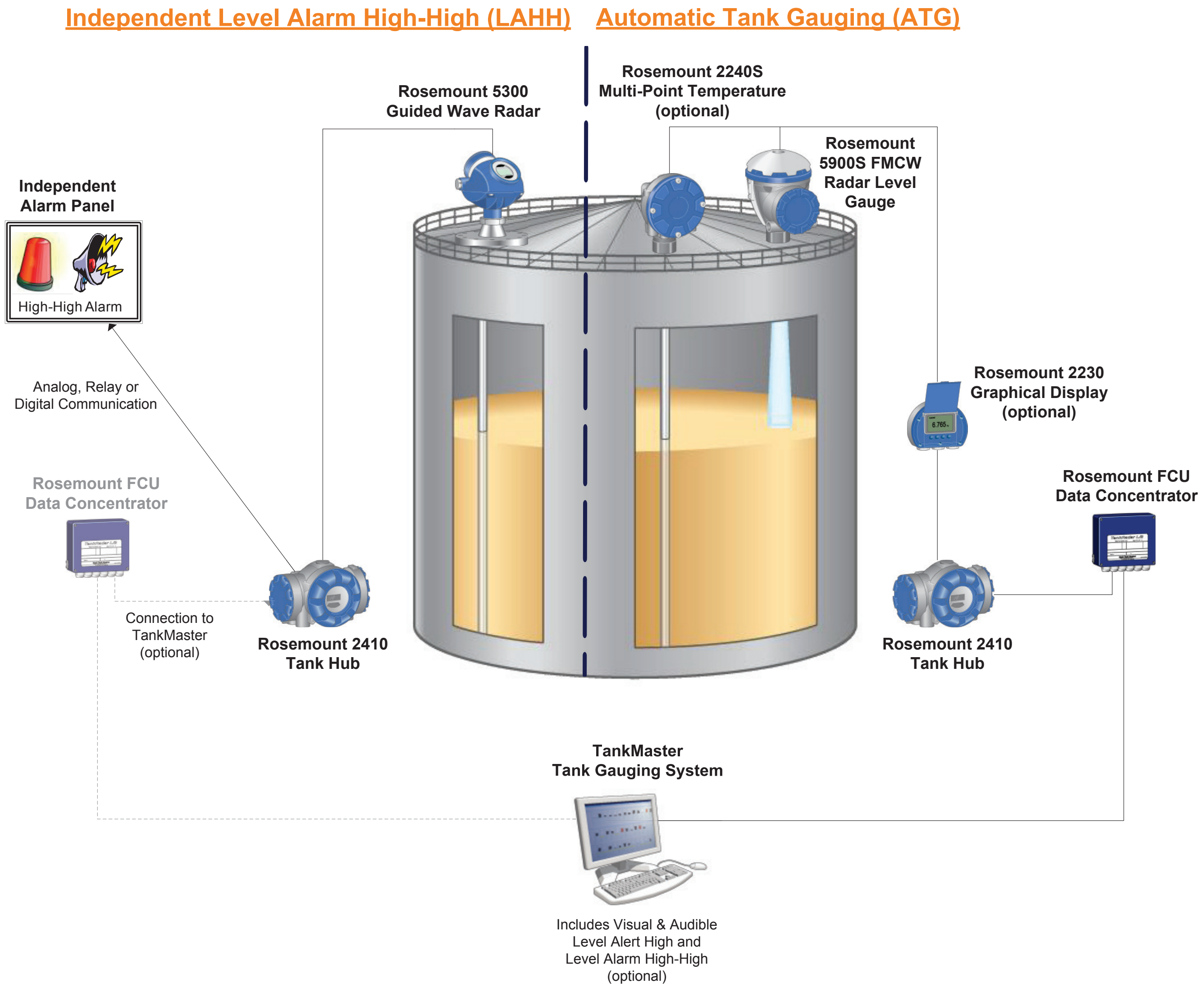
## Solution 2: Category #3 System per API 2350 Edition 4



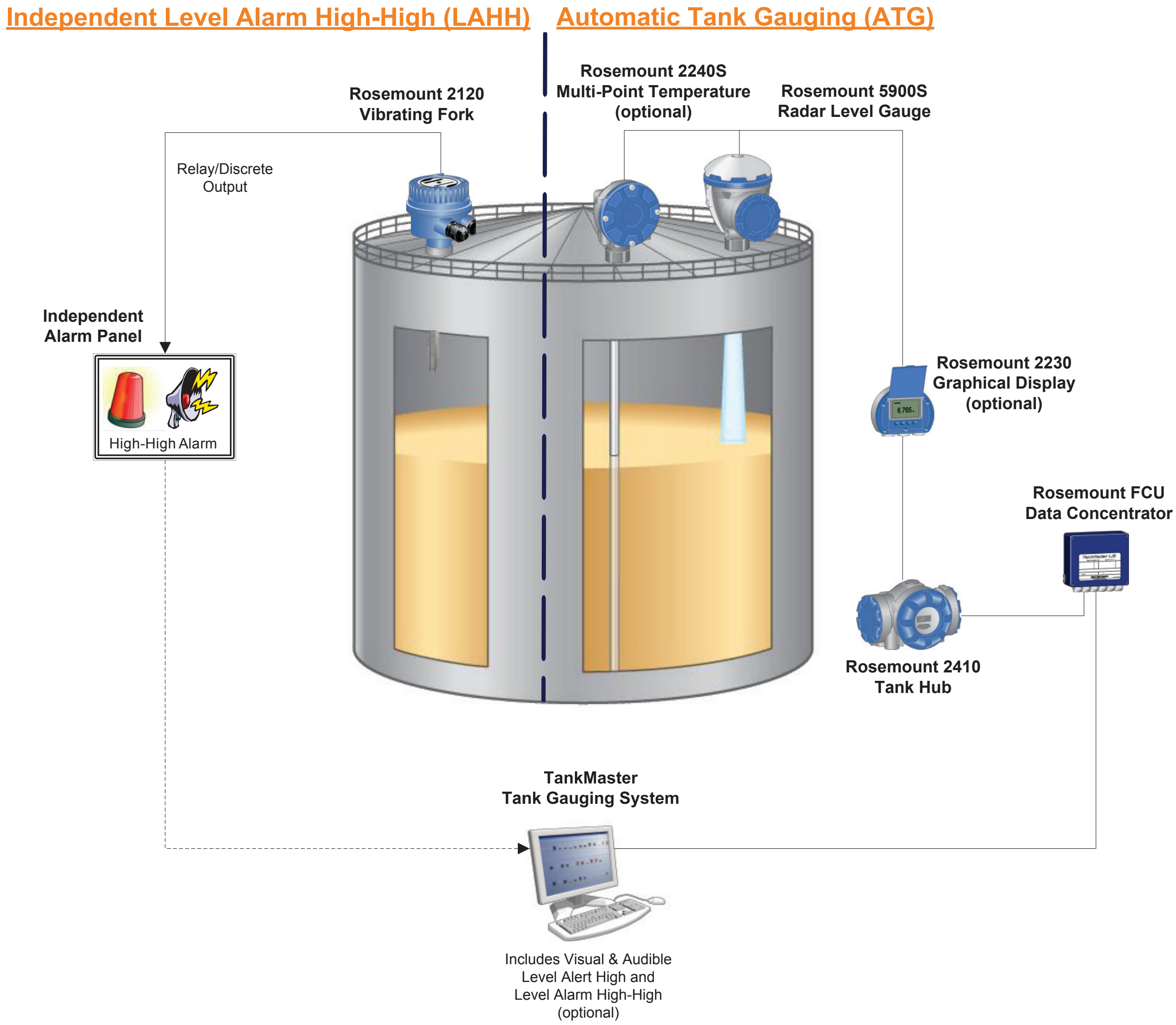
## Solution 3: Category #3 System per API 2350 Edition 4



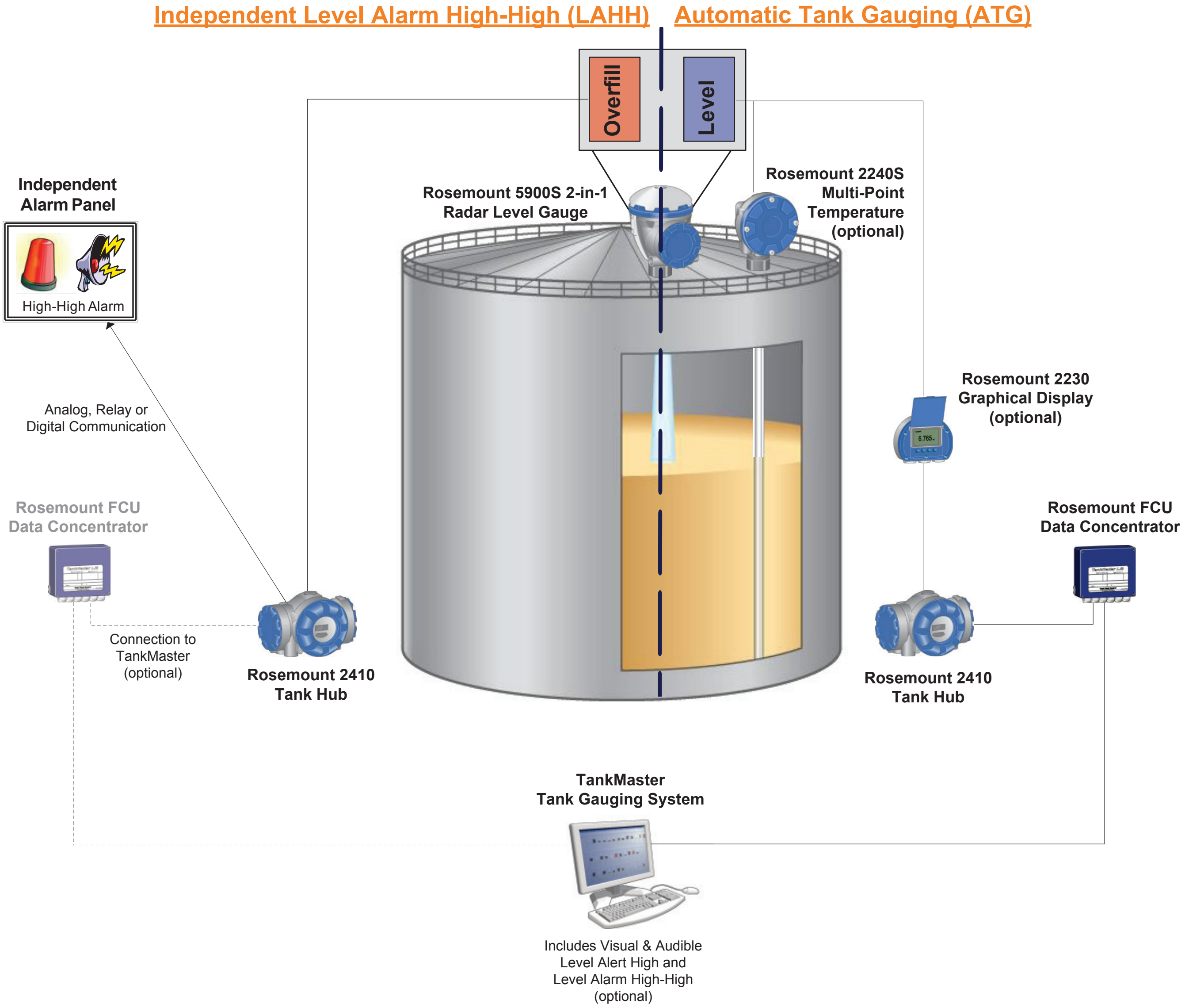
## Solution 4: Category #3 System per API 2350 Edition 4



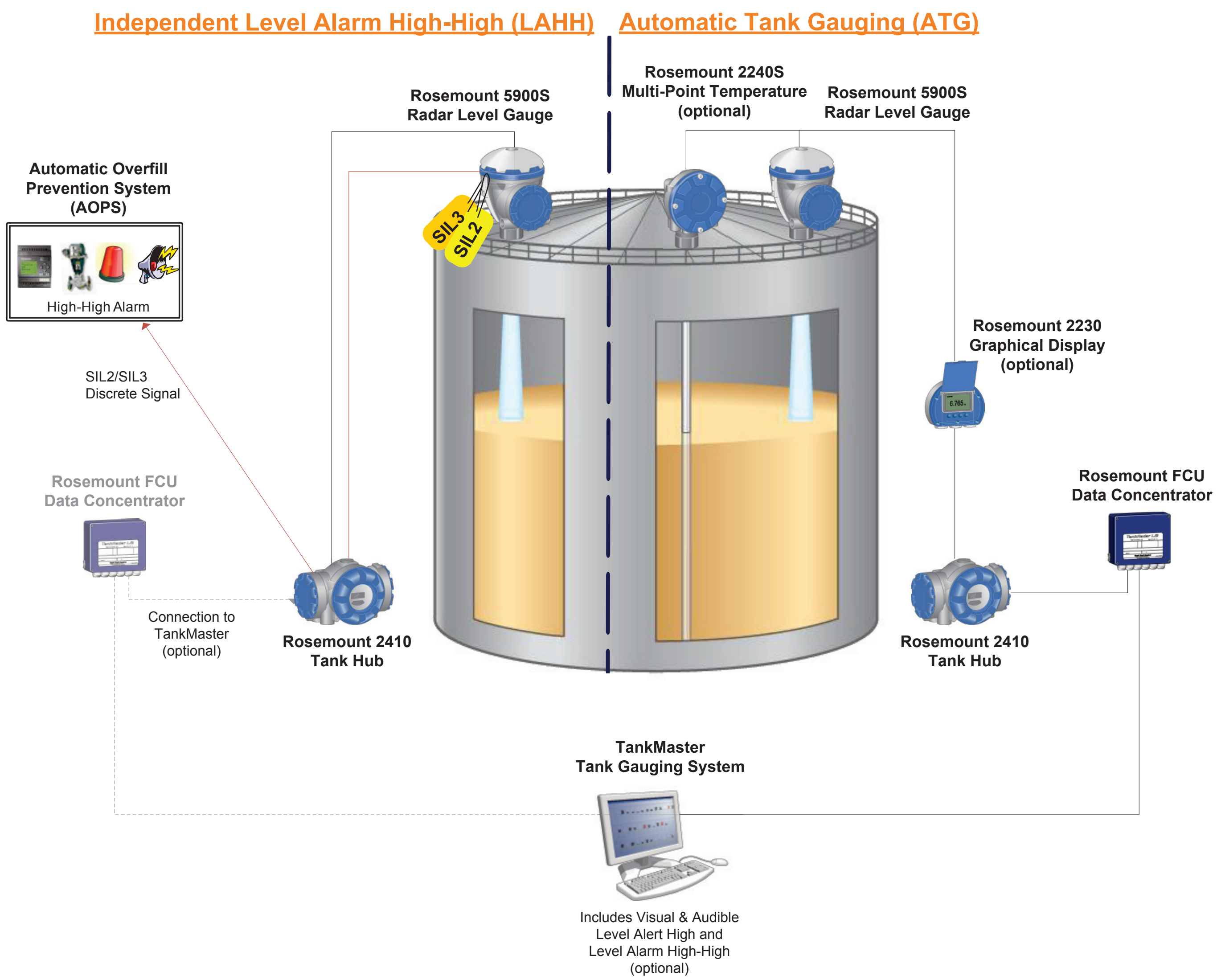
## Solution 5: Category #3 System per API 2350 Edition 4



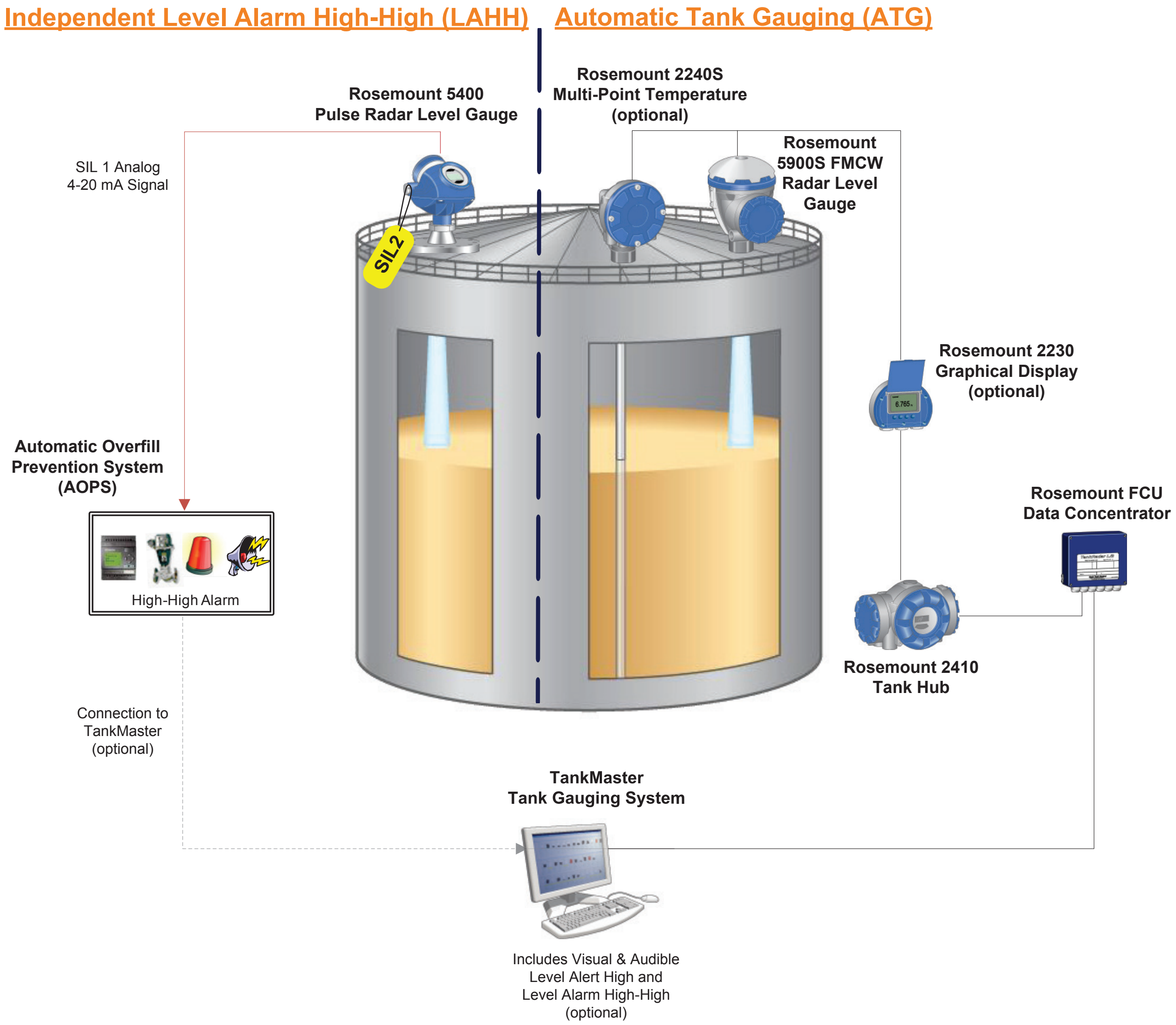
# Solution 6: Category #3 System per API 2350 Edition 4



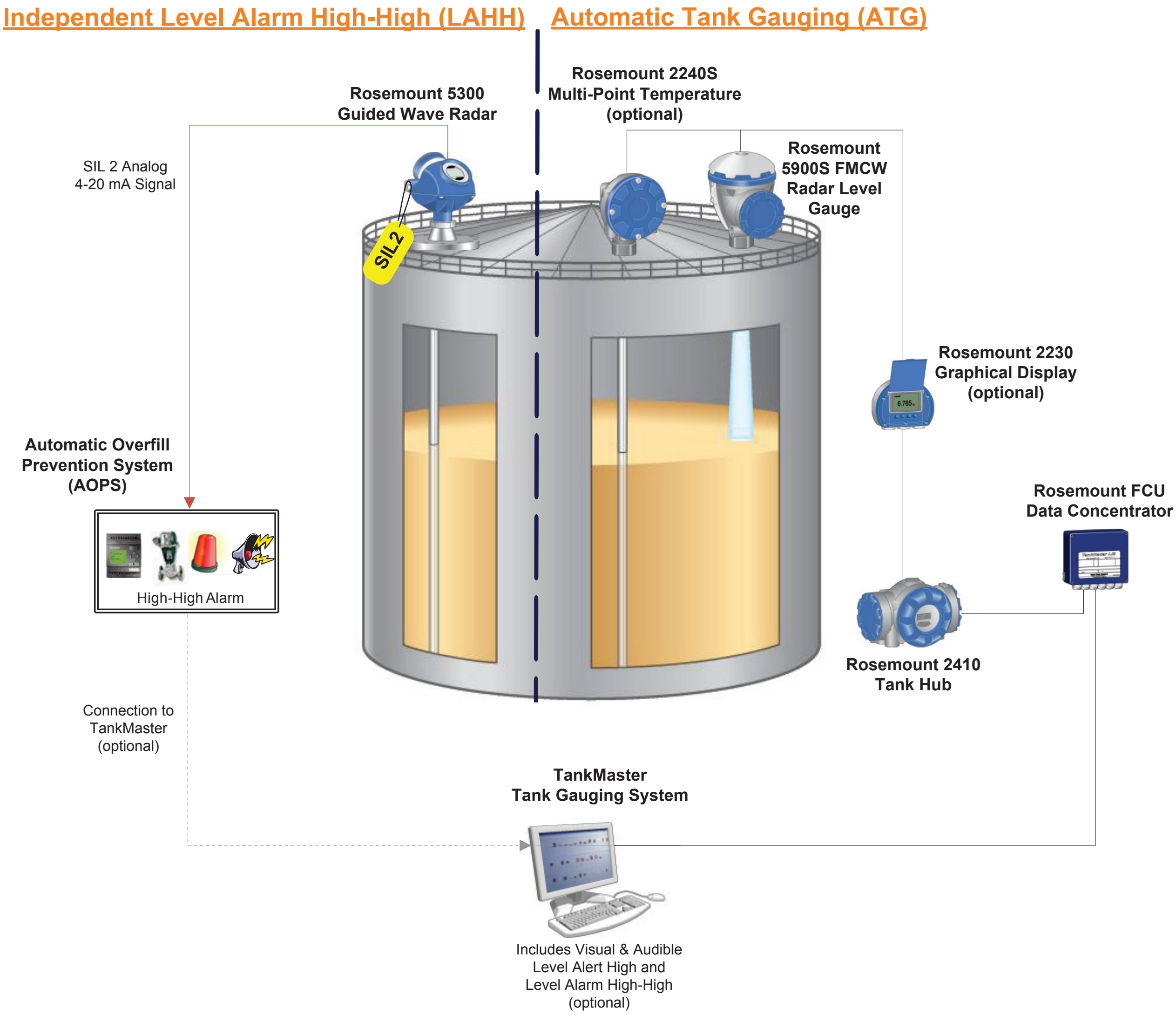
## Solution 7: AOPS (Category #4) per API 2350 Edition 4



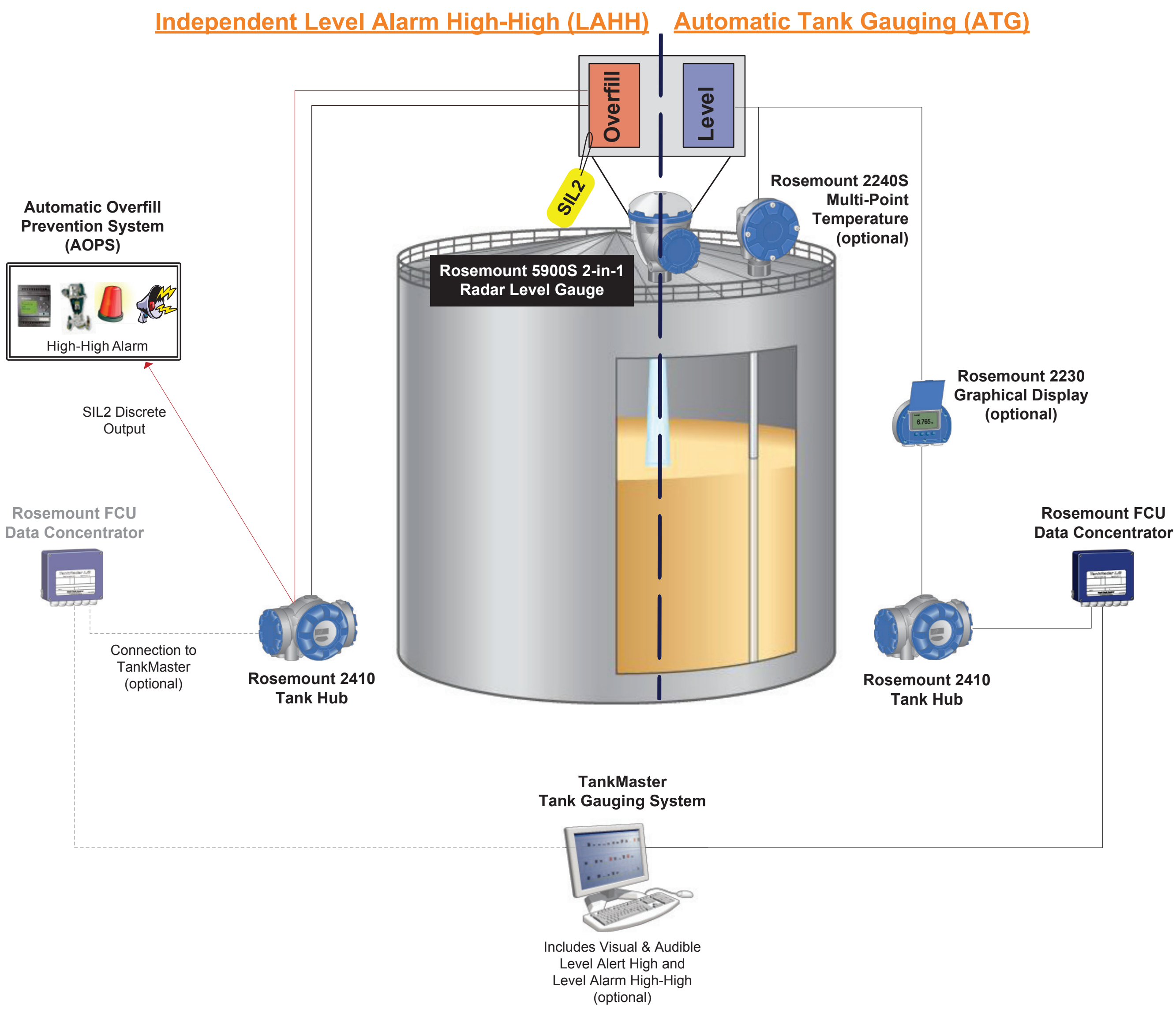
## **Solution 8:** AOPS (Category #4) per API 2350 Edition 4



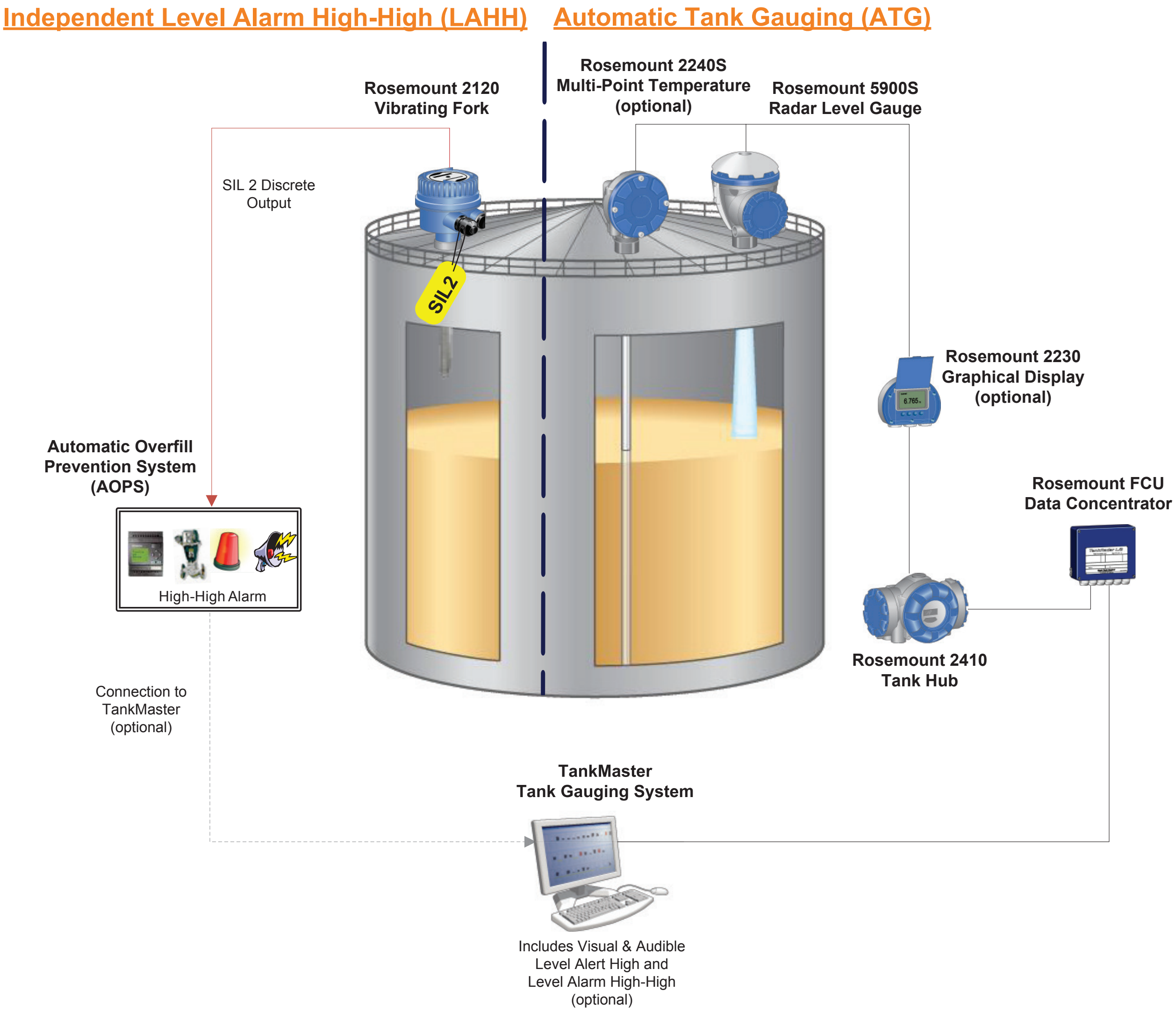
# **Solution 9:** AOPS (Category #4) per API 2350 Edition 4



# Solution 10: AOPS (Category #4) per API 2350 Edition 4



# Solution 11: AOPS (Category #4) per API 2350 Edition 4



# B. API 2350 Edition 4 Compliance Checklist

## Introduction

This checklist provides a tool for verification of compliance with the new standard for overfill prevention: API 2350, Edition 4, May 2012. It can also help you to better understand the requirements and recommended practices that comprise the new standard. The checklist is intended to be applied on a tank by tank basis. Duplicate the checklist for usage with multiple tanks (e.g. for assessment of an entire tank farm). The checklist is organized into four consecutive steps (see figure B1):

**Step 1: Management System**
**Step 2: Risk Assessment**
**Step 3: Tank & Operations**
**Step 4: Compliance Summary**

Each step is briefly described below. Additional information can be found in "The Complete Guide to API 2350" available at http://www.api-2350.com. For a complete list of all requirements, refer to the standard itself. You can obtain the API 2350 standard at http://publications.api.org.

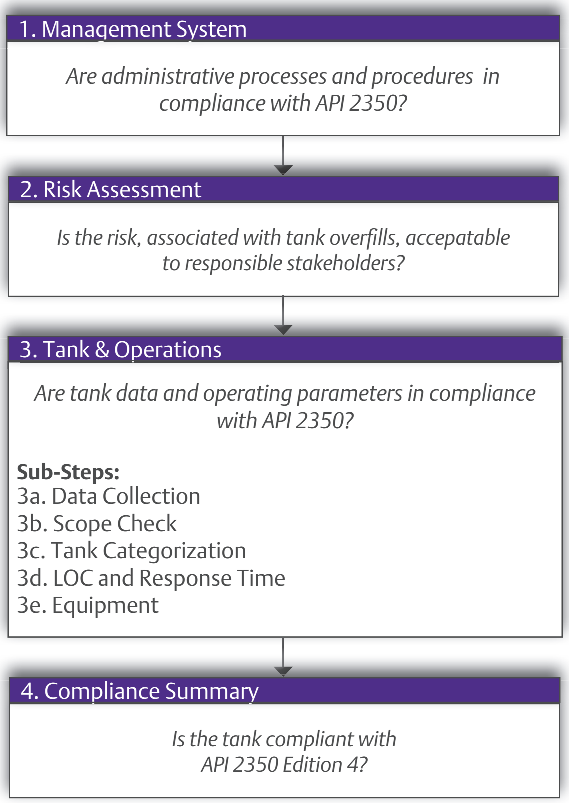
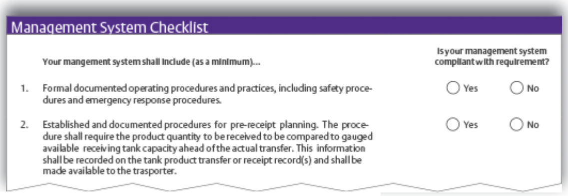



*Figure B.1: Checklist step by step overview*

### Management System (MS)

A management system is defined as the framework of administrative processes and procedures used to enable the owner and operator to fulfill the tasks required to reduce overfills to an acceptable level. A management system is required for conformance with API 2350, but the standard does not specify how to implement such a system.

The first step of the checklist outlines all the elements required by API 2350 to be included in a management system. Your management system must meet all of the requirements in the checklist to be compliant with the standard.

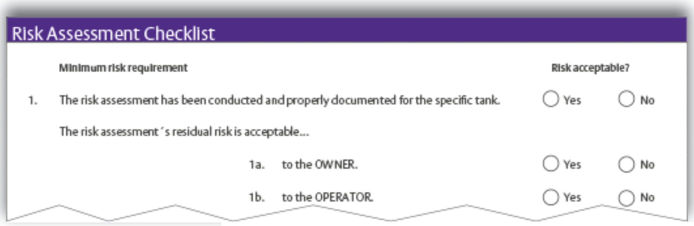

Management System Checklist

| | Your mangement system shall include (as a minimum)... | Is your management system compliant with requirement? |
|---|---|---|
| 1. | Formal documented operating procedures and practices, including safety procedures and emergency response procedures. | ◯ Yes ◯ No |
| 2. | Established and documented procedures for pre-receipt planning. The procedure shall require the product quantity to be received to be compared to gauged available receiving tank capacity ahead of the actual transfer. This information shall be recorded on the tank product transfer or receipt record(s) and shall be made available to the trasporter. | ◯ Yes ◯ No |

## Risk Assessment (RA)

API 2350 requires a risk assessment, associated with tank overfills, to be conducted and properly documented. The standard does not however specify how the risk assessment should be conducted, only that it shall exist, and ultimately that the residual risk is acceptable to responsible stakeholders.

The Risk Assessment Checklist (see page XVII) is outlined as either meeting or not meeting criteria set by stakeholders. Stakeholders taken into consideration are owners, operators, employees, authorities, transporters and public. If any of the stakeholders find that the risk is unacceptable, then risk reduction is required. This may be accomplished by a change of operating characteristic (i.e. receipt flow rates), by a change of operating procedures and practices (e.g. attendance), a change of equipment systems and alarms, additional automation of systems through the transporter or the installation of an AOPS.



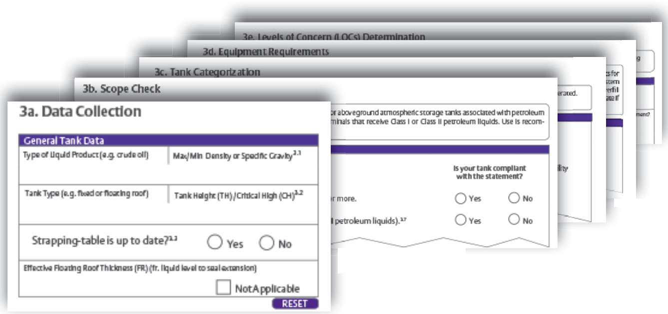

The risk assessment process shall be conducted by people who are familiar with tank facilities and operations as well as the risk assessment process. The checklist is intended for one tank only. Duplicate the checklist for usage with multiple tanks.

## Tank & Operations (TO)

The third step concerns tank configuration for conformance with API 2350. Here, specific tank data and operating parameters are collected and compared with the requirements in API 2350. This is required for each tank within scope of the API 2350 compliance program.

The Tank & Operations Checklist (see page XIX) is divided into five sub-steps. The first step is intended for tank data collection only. This data is then used in subsequent steps to assess the tank´s compliance with API 2350. More specific, the data helps you to answer questions such as: Is your tank within the scope of API 2350? What pre-defined category is your tank? and, Does your tank meet the equipment requirements for selected category?

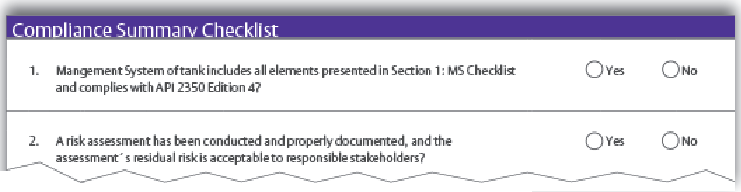
API 2350 also requires, as a minimum, three Levels of Concern (LOCs) to be established. Each of these three shall be defined in level, ullage and volume separately. The exact values depend on operating parameters such as fill rate and response time.




## Compliance Summary (CS)

The final section constitutes a Compliance Summary for the specific tank. The Compliance Summary Checklist (see page XXV) serves as a final verification of this tank´s compliance with API 2350. Your summary must meet all of the requirements to be compliant with the standard.

In case the tank is non-compliant with API 2350, the collected information can be used to perform a gap assessment, which should be followed by a compliance project. This process is further described in The Complete Guide to API 2350, where figure 1 (see page 11) provides an overview of the entire verification and implementation process.


Compliance Summary Checklist

1. Mangement System of tank includes all elements presented in Section 1: MS Checklist and complies with API 2350 Edition 4? ◯ Yes ◯ No

2. A risk assessment has been conducted and properly documented, and the assessment´s residual risk is acceptable to responsible stakeholders? ◯ Yes ◯ No

## Recommendations

It is advisable, but not required, to initiate the following activities before starting the verification process:

- Create an experienced assessment team with competent people spanning all disciplines required (e.g. design, operation,  maintenance, instrumentation, safety, quality departments)
- Set up / Clarify responsibilities
- Define the scope and timeline of the tank compliance program
- Create procedures for managing the data obtained and created during the compliance process
- Acquire a copy of the API 2350 standard at http://publications.api.org

Note that API 2350 is a standard of minimum requirements. Alternate approaches that provide equivalent or more robust overfill prevention are accepted and recommended by the standard itself. For example, Emerson always advocates the usage of the highest category equipment (automatic tank gauging + independent overfill alarm) for all tanks within the scope of this standard, since the cost difference is usually minimal.

Also note that this checklist summarizes the requirements in API 2350, and does not necessarily reflect Emerson’s view. If any discrepancies or unclarities occur, always refer to the original source. There may also be additional local regulation (e.g. country, federal, state laws) that must be taken into consideration. Ultimately, this is the responsibility of the tank farm owner/operator.

In case you need assistance, or have any suggestions, please contact your local Rosemount Tank Gauging representative or mailto: sales.rtg@emerson.com.

# Step 1: Management System (MS) Checklist

Assessment for **TANK NO.**

**Is your MS compliant with API 2350 Ed.4 ?**
Fill out the following form to check if your management system is compliant with API 2350. This sheet is intended for one tank only. Duplicate the sheet for multiple usage. For additional information, see "The Complete Guide to API 2350".

| Tank Location | |
|---|---|
| Tank-farm | Facility/Site |

| Issue | | |
|---|---|---|
| Date | Revision | Data Storage Location |

| Assessment Team | | | |
|---|---|---|---|
| 1. Name | Position | 4. Name | Position |
| 2. Name | Position | 5. Name | Position |
| 3. Name | Position | 6. Name | Position |

Reset

## Management System Checklist

| | **Your management system shall include (as a minimum)...** | **Is your management system compliant with requirement?** | |
|---|---|---|---|
| 1. | Formal documented operating procedures and practices, including safety procedures and emergency response procedures. | Yes | No |
| 2. | Established and documented procedures for pre-receipt planning. The procedure shall require the product quantity to be received to be compared to gauged available receiving tank capacity ahead of the actual transfer. This information shall be recorded on the tank product transfer or receipt record(s) and shall be made available to the transporter. | Yes | No |
| 3. | Established and documented procedures for activities during the receipt. The standard requires regularly scheduled comparisons of product levels during receipts. | Yes | No |
| 4. | Documented procedure for post receipt activities (e.g. close valves). | Yes | No |
| 5. | Written procedures which establish the minimum local attendance levels during receipt.[1.1] | Yes | No |
| 6. | Policies and procedures shall prohibit the use of High-high tank level alarms and AOPS for routine operation or control of tank filling operations. | Yes | No |
| 7. | Records showing that all personnel involved in the product transfer are competent[1.2] and have received adequate training for the specific task are required. | Yes | No |
| 8. | Functional equipment systems, tested and maintained by competent[1.2] personnel. | Yes | No |
| 9. | Drawings, operating instructions, inspections, testing and maintenance plans shall be established and documented for the tank gauging system, overfill prevention system and other equipment as applicable. Documentation relating to inspection and maintenance of systems shall be maintained for a minimum of one year. | Yes | No |

*Section 4.2 and 4.5*
http://publications.api.org

| | | |
|---|---|---|
| 10. Systems and procedures to address both normal and abnormal operating conditions. | Yes | No |
| 11. A Management of Change (MOC) process that includes personnel, equipment and procedural changes. | Yes | No |
| 12. A system to identify, investigate, and communicate overfill near misses and incidents. | Yes | No |
| 13. A follow-up system to share lessons learned and to address any needed mitigation of circumstances leading to near misses or incidents. | Yes | No |
| 14. Documented communication protocols within the owner and operator organization and between the transporter and the owner and operator that are designed to function under abnormal as well as normal conditions. | Yes | No |
| 15. Procedures for periodic review of the Level of Concerns (LOCs). Max review time is five years. | Yes | No |

| | | | |
|---|---|---|---|
| If all of the answers are equal to yes, then your management system is compliant with the requirements in API 2350 Edition 4. | Is your management system compliant with API 2350? | Yes | No |

Reset

Note 1.1: Category 1: Local attendance on-site continously during the first and last hour of receipt, and at a minimum hourly during the receipt. Category 2: May be semi-attended, but requires attendance continously during the first and last 30 minutes of receipt. Category 3: No local monitoring requirements.

Note 1.2: API 2350 defines a competent person as "an individual who is capable and able to perform the assigned duties as determined by management in a specific area of operations." (3.10)

*Section 4.2 and 4.5*
http://publications.api.org

# Step 2: Risk Assessment (RA) Checklist

EMERSON
Process Management

**Is the RA acceptable to stakeholders?**
Fill out the following form to check if the risk assessment is compliant with API 2350 requirements. This sheet is intended for one tank only. Duplicate the sheet for multiple usage. For additional information, see "The Complete Guide to API 2350".

Assessment for **TANK NO.**

| Tank Location | |
|---|---|
| Tank-farm | Facility/Site |

| Issue | | |
|---|---|---|
| Date | Revision | Data Storage Location |

| Assessment Team | | | |
|---|---|---|---|
| 1. Name | Position | 4. Name | Position |
| 2. Name | Position | 5. Name | Position |
| 3. Name | Position | 6. Name | Position |

Reset

**Is risk, associated to tank overfills, acceptable to responsible stakeholders?** API2350 requires a risk assessment to be conducted and properly documented. The standard does however not specify how the risk assessment should be conducted, only that it shall exist, and ultimately that the residual risk is acceptable to the owner, operator and other responsible stakeholders. Acording to API 2350, it is the responsibility of the owner and operator to conduct a risk assessment covering the risks associated with potential tank overfills.

## Risk Assessment Checklist

| | Minimum risk requirement | Risk acceptable? | |
|---|---|---|---|
| 1. | The risk assessment has been conducted and properly documented for the specific tank. | Yes | No |
| 2. | The risk assessment´s residual risk is acceptable... | | |
| | 2a. to the OWNER. | Yes | No |
| | 2b. to the OPERATOR. | Yes | No |
| | 2c. to the EMPLOYEES. | Yes | No |
| | 2d. to the AUTHORITIES / REGULATION. | Yes | No |
| | 2e. to the TRANSPORTER. | Yes | No |
| | 2f. to the PUBLIC. | Yes | No |

| | | | |
|---|---|---|---|
| If all of the answers are equal to yes, then the risk assessment is compliant with the requirements in API 2350 Edition 4.[2.1] | Is the risk acceptable to responsible stakeholders? | Yes | No |

Reset

Note 2.1: If the stakeholders find that the risks do not meet the gap assessment criteria, then risk reduction is required. This may be accomplished by a change of operating characteristic (i.e. receipt flow rates), by a change of operating procedures and practices (i.e. attendance), a change of equipment systems and alarms, additional automation of systems through the transporter or the installation of an AOPS.

*Section 4.3*
http://publications.api.org

API2350 does not specify how the risk assessment should be conducted, only that it shall exist. But generally, risk is a combination of consequence multiplied by the probability for a specific event or scenario that results in harm or damage. Therefore the standard (see Annex E) recommends that at least the following probability and consequence factors are considered in the risk assessment.

## Probability and Consequence Factors (Optional Section)

| | **Probability Factors** | **Factor considered in the risk assessment?** | |
|---|---|---|---|
| A.1 | Frequency, rate and duration of filling. | ◯ Yes | ◯ No |
| A.2 | Systems used to properly measure and size receipts to tanks. | ◯ Yes | ◯ No |
| A.3 | Accurate tank calibration (both strapping and verified Critical High level. | ◯ Yes | ◯ No |
| A.4 | Systems used to monitoring and supervision of manual and automatic tank gauging. | ◯ Yes | ◯ No |
| A.5 | Extent of monitoring and supervision of manual and automatic tank gauging. | ◯ Yes | ◯ No |
| A.6 | Impact of complexity and operating environment. | ◯ Yes | ◯ No |
| A.7 | Filling multiple tanks simultaneoulsy. | ◯ Yes | ◯ No |
| A.8 | Switching tanks during receipt. | ◯ Yes | ◯ No |

| | **Consequence Factors** | **Factor considered in the risk assessment?** | |
|---|---|---|---|
| B.1 | Hazard characteristic of material (product) in tank. | ◯ Yes | ◯ No |
| B.2 | Volatility, flammability, dispersion, VCE potential. | ◯ Yes | ◯ No |
| B.3 | Number of people onsite who may be affected by a tank overflowing. | ◯ Yes | ◯ No |
| B.4 | Number of people offsite who may be affected by a tank overflowing. | ◯ Yes | ◯ No |
| B.5 | Possibility of a tank overflowing resulting in (escalation) of hazardous events onsite or offsite. | ◯ Yes | ◯ No |
| B.6 | Possibility of impact to nearby sensitive environmental receptors. | ◯ Yes | ◯ No |
| B.7 | Physical and chemical properties of product released during overflowing. | ◯ Yes | ◯ No |
| B.8 | Maximum potential overfill flow rates and duration. | ◯ Yes | ◯ No |

Reset

*Section 4.3 and Annex C*
http://publications.api.org

# Step 3: Tank & Operations (TO) Checklist

| Assessment for TANK NO. | |
|---|---|

**Is your TO compliant with API 2350 Ed.4 ?** Fill out the following form to define and configure your tank according to API 2350. This sheet is intended for one tank only. Duplicate the sheet for multiple usage. For additional information, see “The Complete Guide to API 2350”.

**Tank Location**

| Tank-farm | Facility/Site |
|---|---|
| | |

**Issue**

| Date | Revision | Data Storage Location |
|---|---|---|
| | | |

**Assessment Team**

| | | | |
|---|---|---|---|
| 1. Name | Position | 4. Name | Position |
| 2. Name | Position | 5. Name | Position |
| 3. Name | Position | 6. Name | Position |

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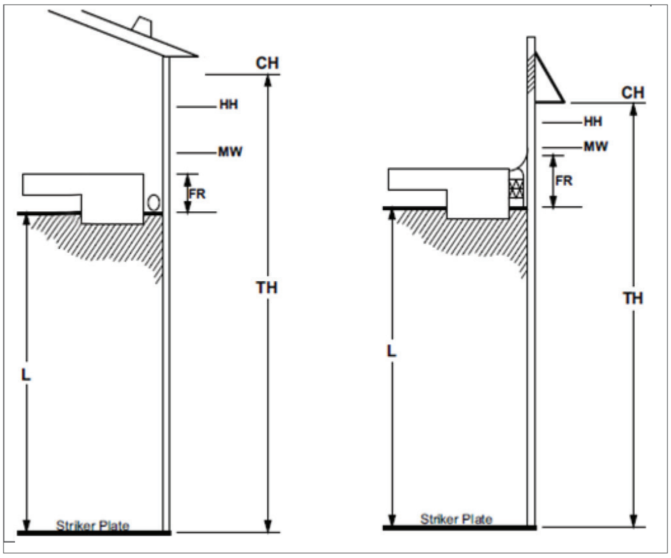


## 3a. Data Collection

**General Tank Data**

| | |
|---|---|
| Type of Liquid Product (e.g. crude oil) | Max/Min Density or Specific Gravity[3.1] |
| Tank Type (e.g. fixed or floating roof) | Tank Height (TH) /Critical High (CH)[3.2] |

Strapping-table is up to date?[3.3] ◯ Yes ◯ No

Effective Floating Roof Thickness (FR) (from liquid level to top seal extension)

☐ Not Applicable

Reset

*Figure 1: Overview tank parameters, internal /external floating roof tanks respectively*

**Operational Tank Data**

| Max Fill Rate | Max Working Level (MW) | High-High Level (HH) | Worst Case Response Time (RT)[3.4] |
|---|---|---|---|
| | | | |

Note 3.1: Density can influence Critical High (CH) and Effective Floating Roof Thickness (FR).

Note 3.2: According to API2350 3.13: Critical High (CH) is the highest level in the tank that product can reach without detrimental impacts (i.e. product overflow or tank damage). For additional information, see API 2350 Annex D.

Note 3.3 Max15 year interval for unchanged tanks according to API Manual of Petroleum Measurement Standards (MPMS) 2.2.

Note 3.4: Response Time is the period of time required to terminate a receipt. API 2350 4.4.2.5 provides guidance on how this can be calculated. Alternatively, the default response rates defined by the standard can be used, see section 3e. Levels of Concern (LOCs) Determination.

**Tank Gauging System**

Type of applied Tank Gauging System?

◯ Automatic Tank Gauging (ATG) ◯ None / Manual Tank Gauging (section N/A)

| Description of ATG Level Measurement | ATG Tag Name | Technology (e.g. radar) |
|---|---|---|
| | | |

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| | | | |
|---|---|---|---|
| Data communication to local or remote control exists? | Yes / No | Operational Experience (e.g. replacements, alarms, etc.) | |
| Documented verification test procedure exists? | Yes / No | Verification Interval (months) | Most Recent Verification Result and Test Date |

Reset

## Independent Overfill Prevention System

Type of applied Overfill Prevention System?

Manual Overfill Prevention System (MOPS)[3.5] | Automatic Overfill Prevention System (AOPS)[3.6] | None (section N/A)

| | | |
|---|---|---|
| Type of Level Alarm High-High Sensor | Actuator: Alarm Signal System | Operational Experience (e.g. replacements, alarms, etc.) |
| Type of Logic Solver | Actuator: Final Element | |
| Documented proof-test procedure exists? Yes / No | Proof-test Interval (months) | Most Recent Proof-test Result and Date |

Reset

Note 3.5: An overfill prevention system requiring operating personnel action to function (API 2350 3.29).

Note 3.6: An overfill prevention system not requiring the intervention of operating personnel action to function (API 2350 3.6).

## 3b. Scope Check

**Is your tank within the scope of API 2350?** The scope of API2350 is intended for aboveground atmospheric storage tanks associated with petroleum facilities including refineries, marketing terminals, bulk plants and pipeline terminals that receive Class I or Class II petroleum liquids. Use is recommended for Class III petroleum liquids.[3.7]

### Scope of API 2350

| | **The Tank is...** | **Is your tank compliant with the statement?** | |
|---|---|---|---|
| 1. | An aboveground storage tank of 1320 US gallons (5000 liters) or more. | Yes | No |
| 2. | Containing Class I or Class II petroleum liquids (optional: Class III petroleum liquids).[3.7] | Yes | No |
| | **The Tank is NOT...** | **Is your tank compliant with the statement?** | |
| 3. | A pressure vessel. | Yes | No |
| 4. | Shop-fabricated or compliant with PEI 600[3.8]. | Yes | No |
| 5. | Located at a service station. | Yes | No |
| 6. | Filled exclusively from wheeled vehicles (i.e. tank trucks or railroad tank cars). | Yes | No |
| 7. | Storing LPG or LNG. | Yes | No |

| | | | |
|---|---|---|---|
| If all of the answers are equal to yes, then the tank is within the scope of API 2350 Edition 4. | Is your tank within the scope of API 2350? | Yes | No |

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Note 3.7: NFPA 30-2008 defines classes of liquids. Class I liquid: a flammable liquid with a closed cup flash point below 100 °F (37.8 °C) and a reid vapor pressure not exceeding 40 pounds per square inch absolute (2068 millimeters of mercury) at 100 °F (37.8 °C). Class II liquid: a combustible liquid with a closed cup flash point at or above 100 °F (37.8 °C) and below 140 °F (60 °C). Class III liquid: a liquid with flash points above 140 °F (60 °C).

Note 3.8: PEI 600 Recommended Practices for Overfill Prevention for Shop-fabricated Aboveground Tanks is available at http://www.pei.org.

*Section 1.1*
http://publications.api.org

## 3c. Tank Categorization

**Which API 2350 pre-defined category does your tank belong to?** API 2350 requires each tank to be categorized according to how it is operated. Most modern facilities are operated remotely from a control center and will therefore fall under tank category 3.

**Tank Categorization**

| | Category 1 | Category 2 | Category 3 |
|---|---|---|---|
| **Attendance** | ○ Cat.1: Fully attended facility (locally monitored) | ○ Cat.2: Semi-attended facility (locally and remotely monitored) | ○ Cat.3: Unattended facility (remotely monitored) |
| **Monitoring** | ○ Cat.1: Continuously during first and last hour of receipt and once every hour during receipt | ○ Cat.2: Continuously during the first and last 30 minutes of receipt | ○ Cat.3: Monitored from local or remote control center |
| **Operator** | ○ Cat.1: Full focus on one receipt at a time, and not distracted by other duties. | ○ Cat.2: Focus on multiple tanks/ receipts simultaneously, or operator may be distracted by other duties | ○ Cat.3: Same requirement as in category 2 |

Tank is categorized as..?
(equals the highest category selected above)  ○ Category 1  ○ Category 2  ○ Category 3

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## 3d. Equipment Requirements

**Does your tank meet the equipment requirements?** The way the tank is operated, or equally its category, determines the minimum requirements for the overfill prevention system. Given all things equal, a higher category overfill prevention system (e.g. category 3) is safer than a lower category system (e.g. 2). A higher category system also allows for more efficient tank operations with less personnel and higher tank utilization. A higher category overfill prevention system than required can be used since it is a standard of minimum requirements. Select the preferred tank category below, and evaluate if your tank fulfills the minimum requirements. Example of equipment solutions can be found in "The Complete Guide to API 2350", Appendix A.

**Tank Equipment Requirements**

| | ○ Category 1 | ○ Category 2 | ○ Category 3 |
|---|---|---|---|
| **ATG-System** | ☐ Not required | ☐ Yes (requirement) | ☐ Yes (requirement) |
| **Independent LAHH Sensor** | ☐ Not required | ☐ Not required | ☐ Yes (requirement) |
| **Availability of measured level data** | ☐ No data communication with control center required | ☐ Liquid level is transmitted to control center | ☐ Liquid level and independent LAHH is transmitted to control center |

Tank fulfills requirements for selected category?
(Yes, if all boxes are checked for selected category)  ○ Yes  ○ No

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## Automatic Tank Gauging (ATG) System - applies to category 2 and 3

Tank equipped with ATG system?

○ Yes ○ No (section N/A)

The ATG system is one of the most critical components to prevent overfills from occurring. This is recognized in API2350, and therefore the standard requires sound engineering principles to be applied also to this part of the facility. This section is mandatory for category 2 and 3 tanks, and optional for category 1.

### Automatic Tank Gauging System

| | **ATG system conforms to the following principles** | **Is your ATG system compliant with the statement?** | |
|---|---|---|---|
| 1. | The ATG system is designed and configured to initiate a distinct visual and audible alarm in case the liquid surface reaches the High high Level Alarm (LAHH) point. | ○ Yes | ○ No |
| 2. | Written maintenance and verification plans, encompassing all components in the tank gauging system, shall exist. Testing of continuous-level sensors shall comply with the requirements in API Manual of Petroleum Measurement 3.1B and the manufacturer's instructions. | ○ Yes | ○ No |
| 3. | Tank and facility shall allow for manual shutdown in case of failure (e.g. equipment or cable failures, power loss). | ○ Yes | ○ No |

| If all of the answers are equal to yes, then the ATG system is compliant with the requirements in API 2350 Edition 4. | Is your ATG system compliant with API 2350? | ○ Yes | ○ No |
|---|---|---|---|

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## Independent Overfill Prevention System (OPS) - applies to category 3

Tank equipped with independent overfill prevention system?

○ Yes ○ No (section N/A)

An independent Overfill Prevention System (OPS) is required for all tanks operated as category 3, which is the majority of tanks operating today. Traditionally, electro-mechanical point-level sensors have been used as the High-High Level Alarm (LAHH) Sensor. The usage of "continuous" type level technology is rapidly becoming the desired choice to replace "point" type switches; the obvious advantage is the 'online' level measurement which can be compared with the ATG for proof-testing.

### Independent Overfill Prevention System

| | **Independent overfill prevention system conforms to the folllowing principles** | **Is your independent OPS compliant with the principle?** | |
|---|---|---|---|
| 1. | The equipment used in the OP system shall not be a part of the ATG system | ○ Yes | ○ No |
| 2. | A distinct visual and audible alarm that is not a part of the ATG system | ○ Yes | ○ No |
| 3. | Documented proof-testing procedures and maintenance plan shall exist for all components in the overfill prevention system:<br>- High-High Level Alarm Sensor<br>- Alarm panel<br>- Logic Solver (e.g. PLC)<br>- Valves<br>- Communications equipment | ○ Yes | ○ No |
| 4. | The Proof-testing methods shall:<br>- be in compliance with the manufacturers' instructions<br>- do not put (or leave) the tank in an unsafe operating mode (e.g. it is not recommended to fill the tank above its minimum working level)<br>- for continuous level sensors: comply with the requirements in API MPMS 3.1B | ○ Yes | ○ No |

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| | | | |
|---|---|---|---|
| 5. | Result from proof-testing shall be properly documented and the test interval is maximum<br>- Point-level Sensor (if exist): 6 months<br>- All other components in the overfill prevention system: 12 months | Yes | No |
| 6. | High-High Level Alarm Sensor shall be able to also measure liquid product on top of the floating roof (if applicable) | Yes | No |

| | | | |
|---|---|---|---|
| If all of the answers are equal to yes, then the IOP system is compliant with the principles in API 2350 Edition 4. | Is your independent OPS compliant with API 2350? | Yes | No |

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### Automatic Overfill Prevention System (AOPS) - if used

Tank equipped with AOPS? Yes No (section N/A)

Automatic Overfill Prevention Systems (AOPS) are optional. But if one is being employed, then it is required to conform to the minimum requirements below.

**Automatic Overfill Prevention System: Generic Requirements**

| | AOP system conforms to the following principles | Is your AOPS compliant with the principle? | |
|---|---|---|---|
| **Existing Facilities** | Conform to Annex A in API 2350 or IEC 61511 | Yes | No |
| **New facilities** | Conform with requirements in IEC 61511 or ANSI/ISA 84.00.01-2004 | Yes | No |
| **Wireless** | AOPS does not depend on Wireless communication[3.9] | Yes | No |
| **Safe state** | All equipment shall be designed to move the process into a safe state in the event of a power loss or device failure. | Yes | No |

Note 3.9: Wireless communication is acceptable for anything but AOPS. An AOPS cannot depend solely on wireless, but it can be used as redundant communication (e.g. device configuration).

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**Automatic Overfill Prevention System: Set-point**

| AOPS Level set-point: expressed as Level | AOPS Level set-point: expressed as Volume | AOPS Level set-point: expressed as Ullage |
|---|---|---|
| | | |

| Minimum Requirement | AOPS Level is compliant with the min. requirement? |
|---|---|
| Level/Volume equivalent to distance from CH to calculated AOPS response time at max flow rate. Distance (btw. CH level and AOPS level) shall not be less than three (3) inches. | Yes No |

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## 3e. Levels of Concern (LOCs) Determination

The standard requires at a minimum the following three LOCs to be defined: Critical High Level (CH), High-High Level (HH) and Maximum Working Level (MW). Each Level of Concern shall be defined in level, ullage and volume. Usage of Hi-Alerts is optional. Figure B.2 outlines the LOCs.

**Critical High Level**

| CH Level set-point: expressed as Level | CH Level set-point: expressed as Volume | CH Level set-point: expressed as Ullage |
|---|---|---|
| | | |

| Minimum Requirement | CH Level is compliant with the minimum requirement? |
|---|---|
| Highest level in tank that product can reach without initiating overflow or tank damage. If applicable, the thickness of the floating roof shall be taken into considiration. | Yes No |

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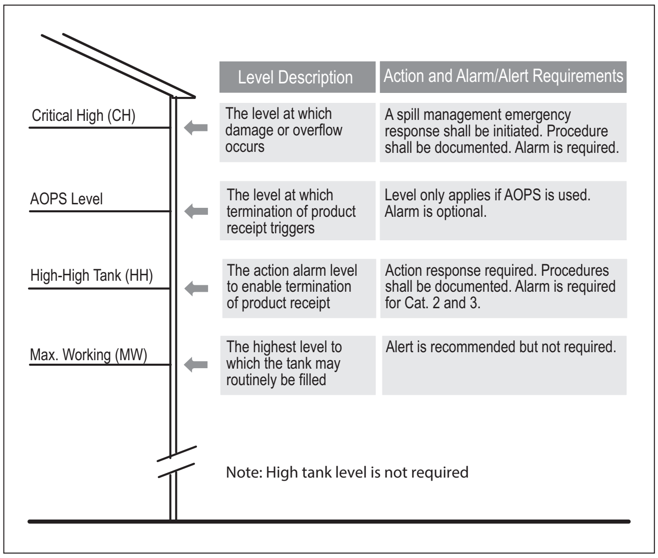


## High High Level

| HH set-point: Level | HH set-point: Volume | HH set-point: Ullage |
|---|---|---|
| | | |

Minimum Requirement

At a minimum, vertical distance between CH and HH corresponds to the following response time (at max flow rate)[3.10]:

- Category 1 = 45 minutes
- Category 2 = 30 minutes
- Category 3 = 15 minutes

Three (3) inch minimum level for all categories.

HH is compliant with the minimum requirement? Yes No

Note 3.10: These are the default response times for each category. Alternatively, the tank specific response time can be used .

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*Figure B.2: Overview Levels of Concern (LOCs)*

## Max Working Level

| MW Level set-point: expressed as Level | MW Level set-point: expressed as Volume | MW Level set-point: expressed as Ullage |
|---|---|---|
| | | |

Minimum Requirement

At a minimum. vertical distance between HH and MW corresponds to calculated facility operations response time[3.11].

MW Level compliant with min. requirement? Yes No

Note 3.11: Response time is the period of time required to terminate a receipt.

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**Are actions and procedures documented?** API 2350 requires documented actions in case the liquid product surface reaches Critical High (CH) or High-High (HH).

## Action Requirements

| Level | Required action for specified level | Requirement fulfilled? |
|---|---|---|
| Critical High (CH) | An emergency management response shall be initiated. Procedure shall be documented | Yes No |
| High High (HH) | Alarm generated and documented procedures requiring operators to initiate immediate termination<br>• Category 1: Alarm optional<br>• Category 2: Alarm generated by ATG-system.<br>• Category 3: Redundant Alarms generated by ATG and IOPS | Yes No |

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# Step 4: Compliance Summary (CS) Checklist

Emerson Process Management

**Is tank compliant with API 2350?**
Fill out the following form to verify if the tank is compliant with API 2350. This sheet is intended for one tank only. Duplicate the sheet for multiple usage. For additional information, see "The Complete Guide to API 2350".

Assessment for **TANK NO.**

| Tank Location | |
|---|---|
| Tank-farm | Facility/Site |

| Issue | | |
|---|---|---|
| Date | Revision | Data Storage Location |

| Assessment Team | | | |
|---|---|---|---|
| 1. Name | Position | 4. Name | Position |
| 2. Name | Position | 5. Name | Position |
| 3. Name | Position | 6. Name | Position |

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## Compliance Summary Checklist

| | | | | |
|---|---|---|---|---|
| 1. | Mangement System of tank includes all elements presented in Section 1, MS Checklist? | | ○ Yes | ○ No |
| 2. | A risk assessment has been conducted and properly documented, and the assessment´s residual risk is acceptable to responsible stakeholders? | | ○ Yes | ○ No |
| 3. | Data collection and tank configuration has been conducted in accordance with Section 3, TO Checklist? | | ○ Yes | ○ No |
| 3a. | Data, required for the assessment of tank, has been properly collected? | | ○ Yes | ○ No |
| 3b. | The tank is within the scope of API 2350? | | ○ Yes | ○ No |
| 3c. | The tank has been categorized in accordance with API 2350? | | ○ Yes | ○ No |
| | If yes, the specific tank is categorized as: | ○ Cat. 1 | ○ Cat. 2 | ○ Cat. 3 |
| 3d. | The tank fulfills the equipment requirements for selected category? | | ○ Yes | ○ No |
| | ATG System compliant with API 2350? | ○ N/a | ○ Yes | ○ No |
| | IOP System compliant with API 2350? | ○ N/a | ○ Yes | ○ No |
| 3e. | Levels of Concern (CH, HH and MW) have been established in accordance with API 2350? | | ○ Yes | ○ No |

| | | | |
|---|---|---|---|
| If all of the answers are equal to yes, then the tank is compliant with API 2350 Edition 4. | Is tank compliant with API 2350 Edition 4? | ○ Yes | ○ No |

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# C. Frequently Asked Questions

## Who should care about API 2350?

The purpose of the standard is to cover minimum overfill (and damage) prevention practices for aboveground storage tanks in petroleum facilities, including refineries, marketing terminals, bulk plants, and pipeline terminals that receive flammable and combustible liquids. The standard assists owner/operators and operating personnel in the prevention of tank overfills by implementation of a comprehensive overfill prevention process (OPP). The goal is to receive product into the intended storage tank without overfill or loss of containment. Anybody involved in this process benefit of understanding and applying this standard, ranging from tank owner/operators, operating and maintenance personnel, transporters, engineering, safety staff, suppliers, and government officials, just to mention a few.

## What's the scope of API 2350?

API 2350 is intended for storage tanks associated with marketing, refining, pipeline and terminals containing Class I or Class II petroleum liquids. Use is recommended for Class III petroleum liquids. API 2350 does not apply to:

- underground storage tanks;
- aboveground tanks of 1320 US gallons (5000 liters) or less;
- aboveground tanks which comply with PEI 600;
- pressure vessels;
- tanks containing non-petroleum liquids;
- tanks storing LPG and LNG;
- tanks at service stations;
- tanks filled exclusively from wheeled vehicles (i.e. tank trucks or railroad tank cars); and
- tanks covered by OSHA 29 CFR 1910.119 and EPA 40 CFR 68 or similar regulations.

## Why should API 2350 be used and not some other safety standard?

API 2350 is a safety standard for a specific use-case (overfill prevention) in a specific application (non-pressurized aboveground large petroleum storage tanks). It was created by the industry for the industry. A wide spectrum of industry representatives participated in its creation: tank owners and operators, transporters, manufacturers, and safety experts, just to mention a few. It is a compilation of the minimum requirements required to comply with modern best practices in this specific application. Obviously the main purpose is to prevent overfills, but another common result of applying this standard is increased operational efficiency and higher tank utilization. And it does not compete with other more generic safety standards, but instead acts as a complement. Using Safety Instrumented Systems (SIS) designed in accordance with IEC61511 is for example one way of fulfilling some of the requirements in API 2350.

## Is API 2350 required by any law?

API 2350 is a standard created by the industry community, and not a legal document. However, in many cases the applicable laws require the operation to be compliant with recognized industry best practices. Often, API publications are used as the benchmark, thereby indirectly referencing to API 2350 in case of tank overfills. It is however important to recognize that API 2350 does not supersede any local, state or federal laws and regulations, which always must be taken into consideration.

## What's the difference between API 2350 and 61508/61511?

IEC 61508/615011 are generic safety standards describing the use of safety instrumented systems (SIS). API 2350 on the other hand is a safety standard for a specific use-case (overfill prevention) in a specific application (non-pressurized aboveground large petroleum storage tanks). These two standards do not compete with each other, but instead act as complements, with many similarities. Using Safety Instrumented Systems (SIS) designed in accordance with IEC61511 is for example one way of fulfilling many of the requirements in API 2350.

## Is API 2350 applicable outside the US?

Tank operations are similar across the world, and many companies operate in a multinational environment. API 2350, despite the reference to 'America', has been written from an international perspective. It is intended to be equally valid and applicable worldwide.

## Where can I get API 2350?

The standard can be downloaded from www.api.org for a small fee.

## What does API 2350 say about Wireless communication?

According to API 2350, the use of wireless communication is acceptable, except for one specific use-case: "AOPS shall not rely on wireless communication to initiate diversion or termination of receipt" (Annex A). In AOPS, wired and wireless communication can however be used simultaneously, if the wireless link is used for device and diagnostics monitoring, and not to initiate diversion or termination of receipt.

# D. About the Authors

## Phil E. Myers, API 2350 Committee Chairman

Phil E. Myers has chaired numerous task groups for the American Petroleum Institute, including API 2350. Currently, he is the director of PEMY Consulting. He has also worked at Chevron Corporation where he was a mechanical integrity specialist for tanks, piping and pressure vessels specializing in safety and risk. Myers holds a BSc in Chemical Engineering from UC Berkeley and an MSc in Theoretical and Applied Statistics from California State University.

## Carl-Johan Roos, Emerson Safety Expert

Carl-Johan "CJ" Roos has over 10 years of global experience from various technical and managerial positions in the process- and tank gauging industry. Besides API2350, he has actively participated in numerous product specific IEC61508-Certifications and site specific IEC61511-related projects, besides his usual work as business development manager at Emerson's Process Level division where he often addresses national overfill prevention regulation such as TÜV/DIBt WHG in Germany. Roos has a MSc in Electrical and Computer Engineering from Georgia Tech and Chalmers University, and a MBA from the University of Gothenburg.

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