Taking overfill prevention to the next level

IEC 61508/11 (SIL) certified equipment is now a requirement for automatic overfill prevention systems in new facilities according to API 2350

Still using old mechanical point-level gauges for overfill prevention? Technology has changed and there are safer, more efficient options available today. The new API 2350 overfill prevention standard combined with IEC 61508 (SIL)-certified continuous level measurement also for the HiHi-alarm, is the way forward to meet current and future safety requirements

Nowadays petroleum tank spills are major news that can easily escalate from local media to regional and global publicity. The Buncefield overfill accident, which caused Europe's largest vapour cloud since the Second World War, is by far the most famous example. But new incidents are continuously occurring and there are several examples of terminals that have gone bankrupt due to oil spills.

Safety is becoming increasingly important and the underlying driver is clear: a gradual reduction in acceptable societal risk throughout the entire world. The same trend also applies to tank farms and bulk liquid storage facilities where it is driving development of new technologies, standards and best practices towards safer options.

Overfill prevention is important due to numerous reasons. Human safety, environmental protection, public relations, clean-up costs and indirect effects such as down-time are pretty obvious. Maybe less obvious is, by better knowing what is in the tank, the insurance cost can be reduced, while simultaneously improving the operational efficiency due to increased tank utilisation and higher transfer rates, for example. Often petroleum products with high volatility and flammability are stored. Mix an ignition source with the right amount of air and the combination can cause a vapour cloud explosion, which is exactly what happened at Buncefield. Besides causing considerable damage to surrounding tanks and nearby assets, vapour cloud explosions are also a realistic and serious safety concern for the on site employees.

Overfill prevention technology is currently undergoing the same transformation as tank gauging technology once did. The establishment of API 2350, which is becoming the globally recognised overfill prevention standard, is a major step in this development (compare with API 3.1 for tank gauging).

New reasonably priced products have emerged that allow for replacement of mechanical and electro-mechanical point-level switches to new and modern electronic level gauges. Traditional and well-proven tank gauging concepts, such as continuous level measurement, is rapidly becoming the preferred industry choice and the new 'best practice' also for overfill prevention sensors. This transformation is on-going and inevitable. Although traditional switches are well-known, inexpensive and easy to understand, the inherent problem with these will always be it is difficult to know whether they are working or not.

To prevent and mitigate overfills from occurring, a multitude of independent protection layers should be used.

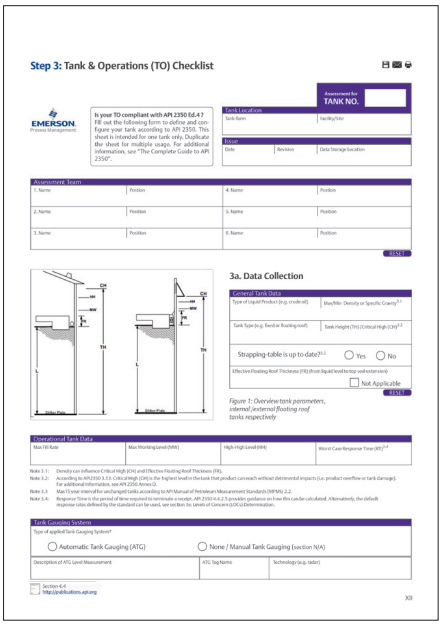
Secondary containments and dikes are commonly used passive protection layers, but these are only for mitigation. Commonly used for prevention is a combination of a basic process control system (BPCS) and an independent safety layer. Often the BPCS is referred to as the 'tank gauging system', and the safety layer is referred to as the 'HiHi level alarm' or 'overfill prevention system'.

A common misperception, inevitably caused by the nomenclature, is that the safety layer is the most critical component. This should not be the case in a properly designed system; the tank gauging system is continuously in operation 24/7 and is the operators' primary tool to prevent overfills from occurring. The overfill system is only to be used in exceptional circumstances, and the more seldom the better. Exchanging old mechanical tank gauges to a modern tank gauging system is therefore one of the most important activities to reduce the risk for overfills.

Another benefit with most modern tank gauging systems is built-in temperature compensated leak-detection, which can be used as a critical tool for early detection of small and gradual spills due to e.g. corrosion.

International standards

From a global perspective there are two key standards for overfill prevention: API 2350 and IEC 61511. These standards establish best practices which are accepted by most judicial systems. In the past it was relatively common with country-specific requirements and deviations (e.g. TÜV/ DIBt WHG in Germany), but also these are slowly being influenced and replaced with their global counterparts.



Emerson and the API committee chairman have developed a guide and checklist to API 2350

2xATG for level and overfill prevention. An increasingly common view when old mechanical level switches are replaced with modern solutions

API 2350 Ed. 4 is an application specific standard for 'Overfill Protection for Storage Tanks in Petroleum Facilities' covering a range of topics associated to this subject. IEC 61511 on the other hand is a generic functional safety standard targeted specifically towards 'Safety instrumented systems for the process industry sector'. Therefore compliance with IEC 61511 is usually an excellent way, and sometimes even required, to comply with API 2350. However, this is not a sufficient requirement because the two standards complement each other perfectly.

The new API 2350 Ed. 4 standard is an indirect consequence of Buncefield. As a response, a large portion of the industry gathered under the API framework to develop a better overfill prevention standard.

Although the API name indicates otherwise, the committee had a global representation covering tank owners and operators, safety experts and vendors. UK government officials also participated in the committee to ensure that the result from the Buncefieldinvestigation was leveraged to the fullest. It is however important to understand this is a consensus standard covering the bare minimum requirements; alternative solutions that provide equal or better safety are acceptable if they can be technically justified.

Another necessity to get the standard through the consensus process was to limit the scope. API 2350 is intended for atmospheric storage tanks above 5,000 litres containing petroleum products. It is not intended for underground tanks, LPG/LNG tanks or pressure vessels. The principles however are generic and may, with proper precautions, be applied also outside the standard's designated scope.

API 2350 has been inspired by IEC 61511's life cycle approach. The entire journey from requirement specification to commissioning, and from operations to decommissioning is covered.

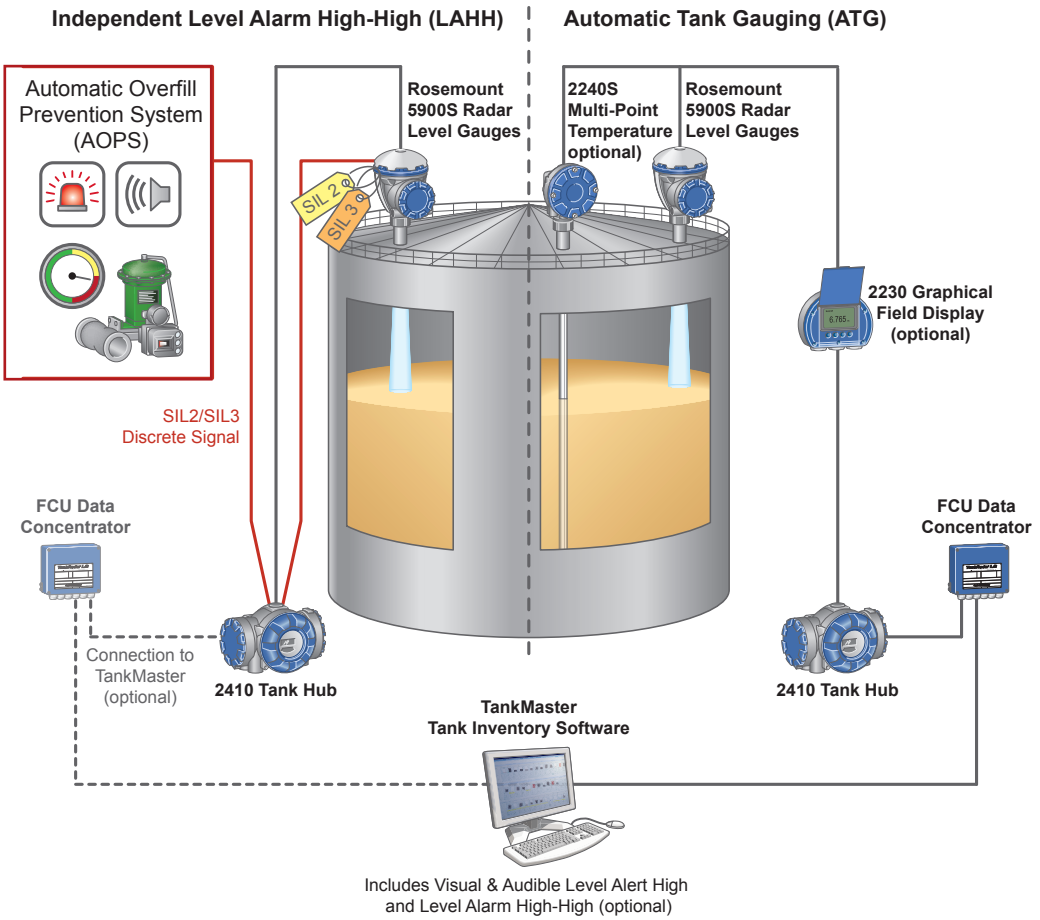
An essential part of this is the risk assessment and

management system, which now both have become mandatory parts of the standard. A clear indication of the importance of these systems is the Buncefield accident, where the electro-mechanical servo gauge had stuck 14 times in the three months prior to the accident. With a proper management system, this problem could have been solved.

All tank farms are different and the risks vary based on things like location, products stored, tank integrity and operational procedures. API 2350 categorises tanks based on attendance level and degree of complexity. Basically any modern tank farm will be classified as a category 3 facility, which shall be equipped with (at a minimum):

- 1x automatic tank gauge (ATG) and
- 1x independent overfill prevention system (OPS).

Automatic overfill prevention systems in new facilities shall be compliant with IEC 61511 according to API 2350. For existing facilities, an alternative approach (loop-hole) where the automatic overfill prevention system complies with Annex A in API 2350 is also available. However, as it has turned out, this Annex A approach usually requires more or equal amount of work than the IEC 61511 approach, but without being future-proof.



Most bulk liquid storage tanks will be characterised as category 3 according to API 2350. Category 3 tanks are required to have an automatic tank gauge and an independent overfill prevention system

Technology breakthroughs

The ongoing safety trend has also spurred equipment manufacturers to develop new products. An evident advancement in this direction is that there are now 2-wire radar level gauges certified according to IEC 61508 for up to SIL 3 overfill prevention applications.

This finally allows for the usage of well-proven tank gauging technology also in overfill prevention systems. A requirement for device verification emerges with safety applications and overfill prevention systems. API 2350 requires point-level gauges to be proof-tested every six months, and other equipment at least annually (unless a technical justification says otherwise).

For point level gauges, the proof test has traditionally been performed on the tank roof, using labour intensive procedures like water tests, pushing buttons or pulling levers. But, as one tank operator explains: 'I don't know if my level switch works right now even if I proof-tested it according to schedule.'

Fortunately proof-testing is one of the fields where new continuous level measurement technology can change the entire industry's behaviour. The most obvious advantage is the operators obtain two independent measurements that can be compared with each other. Often a fairly generous deviation alarm (e.g. 5cm) is sufficient to help the operators early detect any problems while at the same time avoiding false alarms.

Some users refer to this testing technique as online or 24/7 proof-testing. Nevertheless, plenty of research is on-going in this field and it would be no surprise if there soon exist devices with the capability to perform proof-test remotely.

API 2350 Ed. 4 is a milestone in overfill prevention that will contribute to safer and more efficient tank farms throughout the world

Requirements are continuously changing, and overfill prevention is no longer synonymous with mechanical level switches. The completely revised API 2350 standard for overfill prevention is a major milestone that will streamline and drive the industry forward together with IEC 61511.

Equipment that traditionally has been used only for tank gauging can also be used for overfill prevention and will thereby play a major role in this transformation. Although traditional level switches can still be used, the most efficient and future proof solution today appears to be an IEC 61508 (SIL)-certified overfill prevention sensor that measures the level continuously and independently of the automatic tank gauge.

For more information:
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