



SAFEGUARDS

FOR STORAGE

Suresh K Ravindran, Honeywell Process Solutions, India, explores a design and implementation philosophy for tank storage overfill prevention.

Hindustan Petroleum Corporation Limited (HPCL), a Government of India enterprise with Navratna status, markets a wide range of petroleum products, such as fuels and specialties to the tune of 31 million tpy, with product sourced from its own and joint venture (JV) refineries.

HPCL's infrastructure is at par with that of the best global corporations in the hydrocarbons sector. Over the last four decades, the company has consistently been breaking new ground in production and marketing.

HPCL's consistently good performance has been made possible by a highly motivated workforce of over 11 000 employees working all over India at its various refining and marketing locations.

Challenge

It is a given that refineries and chemical plants have large volumes of hazardous chemicals. Even small accidents can have major repercussions, with property and production loss piling in comparison with the loss of human life.



Figure 1. Major operational areas identified by HPCL for automation, safety and operations.



Figure 2. Honeywell's SmartRadar FlexLine.

Over the last 40 years, there have been more than 240 recorded storage tank accidents, with the most frequent cause being attributed to operational error cite overfilling. Overfilling a tank with flammable liquid creates the conditions for an unavoidable fire or explosion and, over the last decade, there have been increases in fires at hydrocarbon storage terminals globally.

Recommendations from a team of experts who investigate these incidents have drawn great attention to the safety aspects of receipt, storage and distribution of hydrocarbons. Trade organisations have published guidelines and standards for the construction, material selection, design and safe management of storage tanks and their accessories.

The final report of the major incident investigation board on the Buncefield UK incident, a major fire caused by a series of explosions at the Hertfordshire Oil Storage terminal in December 2005, emphasised the importance of enhanced safety in end to end operations of sites handling hydrocarbons. Following this, OISD STD 244, a comprehensive standard on storage and handling of

petroleum products in depots and terminals, was developed by India's Oil Industry Safety Directorate (OISD) and revised to incorporate new guidelines.

HPCL envisioned a model of excellence that met social commitment, environment and health and safety norms, so it decided to implement the recommendations of the M B Lal Committee. The M B Lal Committee's recommendations were based on the Jaipur incident, an explosion fire at Indian Oil Corporation's oil depot tank in October 2009, which killed 12 and caused the evacuation of 500 000 people.

This massive exercise involved enhancements of safety in existing terminals and depots across India and also covered new facilities under construction or planning.

The major challenge was to implement the standards in existing facilities with minimum disruption of operations. HPCL formed a task force to plan the project for safety enhancement, under close monitoring of cross-functional executives.

HPCL's core project and engineering team engaged in an intense discussion and consultation with safety experts, and developed a plan to roll out this project in 63 locations across India. The operations being carried out at these locations, which involve receipt, storage and distribution of petroleum products, were identified by HPCL as areas for improved automation, safety and operations.

Project scope

In defining the scope of this project, HPCL included an enhanced emergency shutdown (ESD) system capable of handling all the operations related to entire terminal safety, utilising a modular architecture to permit a wide range of system configurations and facilitating system flexibility and expandability. It included real time control at the field instrumentation level, supervisory control, and monitoring of all safety-related alarms.

The SIL 2 certified radar type automatic tank gauge (ATG) was considered to be critical within the instrumentation scope of the project. HPCL's marketing storage locations have provision for storing various grades of products, including motor spirit, superior kerosene oil, high speed diesel and aviation turbine fuel.

Products are stored in cone roof tanks, floating roof tanks, underground and above ground horizontal tanks, based on storage requirements regarding vapourisation and other conditions.

These locations have efficient terminal operation systems in place as part of earlier automation projects. A tank gauging system for inventory measurements and reconciliation of the products in storage tanks was also part of an earlier automation system project.

The safety enhancement project included provision of safety integrity level (SIL) certified radar type ATGs, separate and independent from the existing tank level gauges on class 'A' and class 'B' products tanks. The project team encountered several challenges in deploying level measuring and overfill protection radar on the tanks, including:

- Limited availability of suitable mounting nozzles/stilling wells on the tank top.
- Minimising cabling requirements.

- Minimising operation shutdowns during implementation.
- Design and implementation of SIL 2 certified safety interlock loop of overfill protection system standards.

The loop design consisted of sensors (radar level gauge and level switch), a logic solver (ESD) and the final control element remote operated shut-off valves (ROSOVs). The design of a SIL 2 rated loop required critical analysis of sensor and logic solver safety-related data.

The SIL certified radar gauges are independent and separate from the existing tank gauging system. Major design considerations for selection of the radar gauges included:

- SIL 2 (or better) certification of radar gauges and its safety function, by an accredited third party safety certification agency, as per the latest IEC 61508 safety standard.
- Capability of hard wiring of safety function (relay output) to ESD system.
- Transmission of level measurement data over wireless protocol to minimise signal cabling, and availability of the level data as additional inputs in terminal automation system.
- Performance of radar level gauges to provide an accurate and precise level measurement and to perform as overfill protection device through its safety function.
- Proven performance record of radar level gauges in class 'A' and class 'B' products.
- Assured performance of radar level gauges in existing or new stilling wells in floating roof tanks and man holes on top of cone roof tanks.
- Design and deployment of low accuracy radar level gauges for new fire water tanks, with wireless level data transmission capability to the control room.

Solution

HPCL chose Honeywell's SmartRadar FlexLine for implementing the requirements of this critical project. SmartRadar FlexLine combines new software algorithms with Honeywell Enraf's planar antennae technology to provide precision levels demanded for custody transfer accuracy.

Honeywell's gauging solution features a modular design and flexible architecture that would allow the radar level gauge to synchronise with multiple third party applications and environments, and also address the specific requirements of the safety enhancement project. It offers high flexibility that can be used for dedicated tank applications such as independent overfill protection, floating roof monitoring, rim fire detection, roof immersion compensation, etc. The FlexLine wireless option reduces the cost for wiring infrastructure and increases flexibility, as various instruments can be added to the network without adding cables. The radar tank gauge is also certified for use in custody transfer applications.

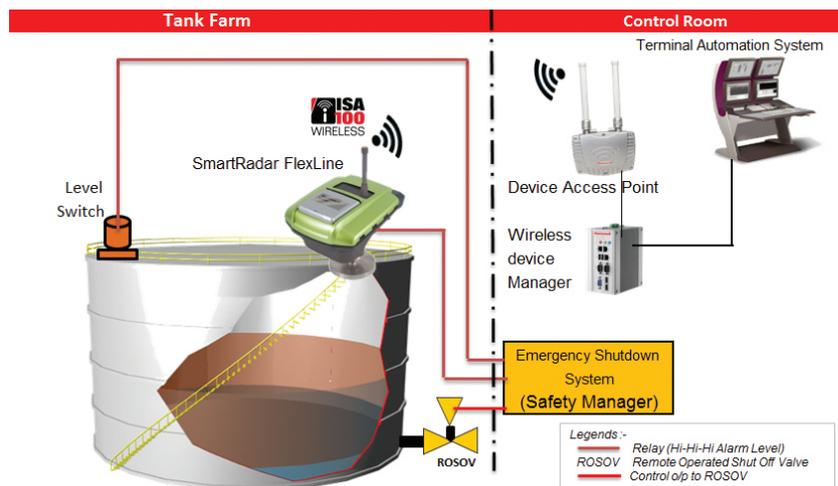


Figure 3. Design of overfill prevention safety rated loop.

The enhanced performance signal processing enables the radar tank gauge to provide an accurate level reading, even in difficult applications (close to the tank shell), and prevents the need for a costly stilling well. The FlexLine radar tank gauge can be used in overfill protection applications, while additional diagnostics have been added to detect hardware failures, and a 2004D voting algorithm detects, reports and isolates failures on the boards without interrupting the loading or unloading of a tank.

HPCL's chosen solution is SIL certified by TÜV. The safety instrumented function design for overfill protection included the following main criteria:

- Loop average probability of failure on demand (PFDavg): the PFD value contributes to achieving the target loop PFD as defined in IEC 61511, bringing down safety loop budgeting.
- Architectural constraints: meeting the requirements of minimum SIL 2 per IEC 61511.
- Proof testing requirement of primary sensor (radar) and loop (SIF): meet or exceed loop proof test requirement of once in 10 years.

The overall design of the ESD system, considering other safety loops within each location, was thoroughly and carefully scrutinised by HPCL. The entire process resulted in a sophisticated safety system with end to end consideration of all safety features.

Close to 600 product storage tanks, distributed in 63 project locations, are covered in HPCL's safety implementation project. Honeywell's SmartRadar FlexLine is being delivered to all locations through HPCL's integrators, including 23 locations on a turnkey basis.

Conclusion

The enhanced safety project has enabled HPCL to reduce financial and environmental risks. The safety certified gauge enhances safety by actively guarding and alarming. HPCL has increased terminal efficiency with their implementation, assuring onsite accuracy, which helps optimise available storage capacity and product movement guidance, and improves resource planning.