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White Paper

Reducing the Cost of Tank Farm and Terminal Operations Safety Compliance while Increasing Business Value

What's Inside:

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1. Abstract

This white paper examines the implications of current tank farm and terminal operations' management procedures as well as safety compliance obligations while offering some best practices currently employed by leading companies. The paper will also look at how one large refinery is employing wireless technology for tank farm monitoring and how the cost savings can then be applied to smart instrumentation, automated off-sites management, motor condition monitoring and other applications to drive additional operational performance while improving safety.

2. Introduction

The unfortunate number of safety and environmental incidents in recent years has prompted regulators and the industry to a "lessons learnt" approach to reassure communities and industry stakeholders that these accidents will not occur again. As model for the approach between regulators and the industry in the UK, after the Buncefield accident (December 2005), representatives from the Control of Major Accident Hazard (COMAH) Competent Authority and industry issued as the Buncefield Standards Task Group (BSTG) a report entitled *"Safety and environmental standards for fuel storage sites."* The BSTG Report states safety recommendations (referred to below as the HSE Recommendations) to turn the safety investments into effective incident prevention.

Many industrial plants with tank farms and terminal operations have already set aside capital expenditure budgets to comply with the HSE Recommendations. While most companies would prefer to invest in other areas of their operations, some are using their tank farm and terminal operations improvement budgets in innovative ways and are finding unexpected value.

This value is tied in with observations from independent industry analysts, ARC Advisory Group, which published a three-part series on Terminal Automation System (TAS) strategies in which ARC indicates, *"The industry is on the cusp of a major transformation enabled by a combination of new and existing technologies from both the industrial and information technology worlds, that, when brought to bear in a unified manner, will significantly improve the performance of tomorrow's terminal."* ARC's report specifically mentions Wireless-Enabled Inventory, Process, and Condition Monitoring as one of the new technologies supporting the Terminal Automation System of the future.

Just as the standard of best practices in tank farm and terminal operations has evolved, so have the technologies employed at these sites. Wireless infrastructures are increasingly used to enable a more mobile workforce, improve communications and increase safety while technologies to automate processes drive greater efficiencies and provide more accurate and timely information to operators. However, many industrial operations have continued to rely on traditional procedures – that is, until now, as the HSE recommendations are setting a new standard for tank farm and terminal operation management.

3. Challenges with the Traditional Approach

When funds are being allocated for efficiency increases or improved operations management, tank farms and terminal operations are traditionally considered last, with most major investments going into the process area. As a result, many tank farm and terminal operations management systems rely on manual field operations supported by tools and systems that are not very sophisticated and are often either home grown or no longer supported by the original application provider.

When using Excel spreadsheets and data from the historian to generate reports or relying on the tools that come with tank level gauges to visualize tank data, there tends to be a lot of isolated information that is difficult to put into context and which therefore provides limited value to operations. As many monitoring tasks are performed manually, the risk of error increases, as does the time to realize that something has gone wrong; both can have a major impact on safety and the environment as well as quality performance.

The manual procedures found in many of today's operations require a high level of operational instructions to execute a simple lineup – an approach that is both time-consuming and prone to error. For non-standard movements, the execution often relies on staff experience and tends to be inconsistent from shift to shift due to the complex topology of many tank farms. Pockets of knowledge exist for specific areas of the tank farm where shifts may know certain areas well while other shifts are more familiar with other areas, so that most operations do not have a single source of expertise across the complete site.

The sharing of best practices tends to be limited as many find security in the knowledge they possess; a problem that is compounded with the high rate at which experienced workers are retiring. The strong linkage between tank farms/terminal operations and the planning and scheduling teams involves a high degree of teamwork and knowledge sharing to effectively schedule movements. Current practices and manual procedures make it difficult for scheduling personnel to fully understand the current status of the tank farm and forecast future activities, which reduces the chance of capitalizing on market opportunities.

The issue of limited information extends to other areas of the operation as well and is often linked to the high costs of cabling. Control room operators seldom have sufficient visibility to the pipeline network or the status of valves if this data is not brought into the control system. Additionally, gas detection and CCTV investments, which can have a huge impact on the safety of the operation, tend to be minimized due to the costs of getting the signal back to the control room.

While plant and operations management understand the risks posed by information gaps, manual procedures and ad-hoc tools, ongoing cost reductions make it difficult to justify the investments needed to improve tank farm monitoring and terminal operations. However, these industrial plants are now faced with having to find the funds in order to comply with HSE recommendations so the challenge now becomes investing in the right areas to maximize the business value of the operational improvements.

4. Removing the Cost Barrier and Extracting More Value from the Operation

For those operations that are currently or soon will be budgeting and planning for solutions to comply with tank farm and terminal operations management recommendations, wireless technology should be considered in the evaluation. Advances in wireless technology are proving to be a preferential alternative to conventional cabling with significantly lower installed costs as well as higher reliability and security levels. The following offers a brief overview of the advantages of wireless technology that one large refinery in the UK is experiencing and how the money saved can be invested in other technologies to automate processes to provide more accurate and timely information while further improving safety.

In their effort to comply with the HSE Recommendations, this UK-based refinery estimated it would cost at least $1 million to implement a cabling infrastructure alone. Another terminal operations unit recently learned it would cost £100,000 for every 200 meters to lay new fiber. The project scope for a traditional wired solution not only requires extensive costs for cabling but also soil tests for underground deployment, and investments in scaffolding for overhead cable trays, for which this refinery found a three-month waiting list, as well as additional expenditures for the premium that would have to be paid for operators who work at height. Wireless technology removes these costs.

By implementing a secure, wireless infrastructure, the UK refinery estimated they would save half the cost of implementing a wired solution. However, the benefits extend far beyond costs. A secure wireless infrastructure adds an additional level of security protection and opens up more options for improving tank farm operational performance. The refinery can now put many of their current devices on the wireless network and use the original cables for the new smart devices required to meet compliance. Low cost devices can also be added to monitor rotating equipment.

The savings realized by using wireless can be applied to automating their terminal operations management system to remove the risks and inefficiencies associated with manual procedures. Furthermore, the wireless infrastructure can also be used to improve the workflow between the control room and the field operator. It improves the efficiency of handheld devices which allow identification of isolation valves through Radio Frequency Identification (RFID) tags. These handheld devices can now download operational orders from the control system. Once the related equipment, such as isolation valves, have been correctly identified by RFID, the field operator can now enter the position of the isolation valve into the handheld device and automatically upload that data immediately to the DCS so that the control room operator can monitor the tank farm alignment. This allows rapid operation of a movement process while reducing the risk of cross-contamination.

Upon further evaluation of the wired versus wireless approach, the path forward was clear for this refinery. A wireless approach would significantly reduce the cost of complying with the HSE recommendations while opening additional possibilities for ongoing operational performance improvements.

5. Best Practices and the HSE Recommendations for Tank Farm and Terminal Operations management

Monitoring the levels in offsite storage tanks of flammable materials in particular can significantly reduce the likelihood of initiating events that could have a potential impact not only on operation but also on safety and the environment. Tank level deviations can result in hazardous events such as a tank overfilling, liquefied gas flashing through a pressure safety valve header, a floating roof mechanical damage, or an extraction pump running dry. The high severity of consequences for safety and the environment are exacerbated by the large inventories of hazardous materials involved.

As more operations are pressed to make improvements in their tank farm and terminal operations management systems, the following offers an overview of best practices for complying with the HSE Recommendations while reducing costs and driving more value from the operation.

It is not the intent of this paper to go into detail, but the following provides the key elements:

1. Process Safety Review
2. Process Hazard & Risk Analysis
3. Systematic assessment of Safety Integrity Levels (SILs) by Layers of protection Analysis (LOPA)
4. Safety Requirements Specification
5. Engineering against loss of secondary and tertiary containment
6. Implementing procedural automation for critical product receipt, movements, and dispatch operations

For each of these topics the HSE Recommendations are focused on improving safety in the design and operation of fuel storage sites. The current minimum good safe design and operation practices will be met by complying with these HSE Recommendations.

It is highly recommended before initiating the above activities to execute a complete process safety study on the facility to identify any potential lack not only on safeguards, but, specifically for fuel storage sites and terminals, the potential human error typically linked to loading and unloading operations, as well as to shift handover.

Safety procedures, on-site and off-site emergency plans, firefighting planning and preparation, evaluation of F&GD system effectiveness will also be part of the process safety review. Minimization of human errors will eventually determine an appreciable risk reduction to safety and environment. To minimize human errors, a Functional Safety Competency Assessment (FSCA) activity should be preferably planned as soon as the FSM system is set up.

Last but not least in the frame of high reliability organizations a process safety performance indicators study should be executed to implement effective process safety management.

Reduce Costs with Wireless Technology

To realize the cost benefits of utilizing a wireless approach, there are a number of considerations when evaluating a wireless solution and no two implementations are alike. The first step is to conduct an onsite assessment that involves representatives from all departments to determine the right bandwidth that will meet short- and long-term needs. Next, an RF survey is needed to measure the radio frequency and electromagnetic fields across the plant in order to design the wireless infrastructure around the current environment and avoid any interference. Other variables such as European and local government compliance as well as environmental and climate factors must also be considered prior to designing a solution. These are critical steps in the process and should involve key plant personnel such as an ATEX or Intrinsic Safety Officer to ensure all requirements are identified and the design is done right the first time. The goal is to build one infrastructure that is easily expandable so additional applications can be easily added over time in a plug-and-play fashion.

The most effective wireless infrastructure designs use sophisticated mathematical models that identify the optimal frequency, power, antenna type and location to produce various options from which the operation can choose. It is important that the operation has the flexibility to choose the best-in-class components on the market that will exactly meet their unique criteria. Designs that utilize a redundant true Ethernet-over-wireless backhaul system with triple redundancy offer the highest levels of security and reliability. To maximize security, the wireless network should be kept separate from the corporate LAN. A full cyber security audit is highly recommended.

Many companies implement the design using in-house staff with support by certified RF engineers who will oversee the installation and provide training. Onsite training is critical for managing the installed infrastructure and all related peripherals. After the installation it is important to tune the network to ensure it operates at optimum performance. The evolution of wireless technology is moving at a rapid rate, so ongoing management services are also recommended that offer a technology refresh, allowing the operation to benefit from the latest advances at minimal costs.

Increase Business Value by Automating the Process

In this context, automation applies to the business processes as well as the physical equipment and processes. By replacing a manual or non-optimal tank farm monitoring process with an automated one that runs closer to constraints, an optimized system can generate high returns in typically six months. Automated systems better control product movements to increase product availability while removing inefficiencies, reducing contamination and minimizing reprocessing or quality giveaways.

The key objective for automating tank farm and terminal operations processes is to close the gap between planned and actual schedules. Deviations between the availability of product and the export schedule not only impact the tank farm process but can also have huge cost implications on downstream operations such as blending and shipment.

In order to achieve this alignment, it is necessary to manage the workflow of the scheduling and operations teams and provide a structured approach for transferring information between the functions while providing visibility to the panel operator. Automated processes are better able to monitor what's going on in the field to help improve the management of all activities. This includes having more visible and accurate information on the tank farm status, which can be done through mobile operations and RFID tagging on instruments that send data back to the control room. Wireless allows a low cost option to increase availability of information about the status of the tank farm so the panel operator avoids a situation where he or she is flying blind.

Status information for pumps must also be made available to the operator in a timely manner. Cabling costs tend to limit the visibility of this data in the control room, despite the threat of delays in export movements should a pump fail. Pumps such as those used for gasoline export can encounter problems like vibration that often leads to failure and can result in major safety issues. Most critical pumps already have vibration monitoring, but this can be augmented by low cost techniques that monitor the acoustic or electrical signals from the pump to determine incipient failure months in advance of vibration signals. Improved monitoring of this equipment along with mobilizing the workforce helps ensure un-instrumented devices are visited by the field operators and the information is sent back to the control room. Additionally, smart instrumentation 'head units' can be added to many primary sensors to give improved data about the health and calibration accuracy of the instrument.

Movement automation systems are useful for ensuring that lineups are correct by calculating the optimal movement path based on the current status of the tank farm. These systems can also automatically monitor an active movement to verify that volumes at source and destination match, and provide the operator with timely instructions that indicate when a movement has to stop or where an operator may have to manually monitor the level.

Finally, in addition to improving workflow and optimizing processes, automating tank farm and terminal operations management increases the accuracy of shift logs to help management ensure procedures are being properly followed and reported.

6. Getting started

Perform a Gap Analysis
Understanding the gaps between the current and desired states of operation is a critical first step. Once these have been identified and prioritized based on the impact on the operation, the path forward can be determined. Invensys has the experience and expertise to conduct in-depth functional safety audits as well as wireless assessments in order to recommend, design and implement an optimal solution.

Choose the Right Technologies

i. *Wireless Infrastructure:* Wireless technologies include communications hardware and software such as wireless access points, transmitters, receivers, antennas, protocols, powering options, servers, and security technology ranging from intrusion detection devices to data encryption. Making the most effective use of any of these technologies in tank farm and terminal operations as well as other applications requires resource planning, performance management and a common wireless systems management platform.

   Since there is great heterogeneity to the applications and no "one size fits all" solution with regard to the technology, it is important that the necessary monitoring, management and security span the entire wireless enterprise to ensure the most efficient use of the limited resource while, at the same time, allowing disparate applications to share the spectrum within the context of their importance, time sensitivity and mission criticality.

   Invensys offers both a wireless infrastructure management platform as well as a technology lifecycle program to provide a roadmap and best practices for an iterative expansion of wireless technology throughout a plant, facility or department. Through its unique set of engineering and managed services offerings, Invensys allows users to focus on outcomes and objectives, while providing a cost-effective method for acquiring and integrating the vast array of wireless-enabled products and devices that are increasingly coming to market.

ii. *Instrumentation:* A wide range of devices for measuring and monitoring tank farm and terminal operations units is available on the market today. The technologies available from Invensys and our ecosystem partners offer a comprehensive set of instrumentation for a variety of applications. After more than 100 years of providing measurements and instrumentation to industrial manufacturers, Invensys has the experience and knowledge to source the measurements and instrumentation that best fit the operations' requirements.

   There are numerous primary measurement devices for measuring tank level/inventory, including differential pressure, displacement or radar type gauges and most tank farm operators already have a system that suits their needs. However, in addition to smart instrumentation, using protocols such as Foundation Fieldbus can provide early notifications to a maintenance department of instrument failure or calibration problems. This can substantially improve the integrity of the Tank Farm Management system.

   Wireless HART technologies enable tank farms with existing cabling pairs to easily migrate their analog 4-20 mA signals to digital HART instrumentation or digital Foundation Fieldbus advanced information signals. Not only does this bring additional asset management information from the field to the control room, but the advanced diagnostics allow for more predictive maintenance to lower costs and contribute to improved safety.

iii. *Off-Sites Solutions:* Invensys' Off-Sites Management solution set offers a series of application modules designed to automate and optimize inventory management and oil movement. The modules include tank inventory calculations and information management, order management and movement monitoring as well as a movement automation system for movement line-up automation. Whether implemented independently, incrementally, or collectively, these applications share a common relational database and communication subsystem that allows OPC or database query integration to any underlying DCS or PLC, and any refinery information or business systems.

iv. *Condition Monitoring:* Low cost devices for monitoring rotating equipment are becoming increasingly popular for predicting incipient equipment failures, particularly in areas that are difficult to access such as the offsite areas frequently used for

tank farms. Invensys has supplied a large number of Motor Condition Monitoring (MCM) solutions. One of the most recent applications is to monitor LNG terminal pumps that otherwise could not be accessed due to their location in remote areas.

Motor Condition Monitoring not only significantly prevents equipment failures and dramatically reduces the MTTR (Mean Time to Restoration), but also reduces the risk of potential loss of containment typically related to the failure of mechanical seals on rotating machinery.

v. *Mobile Workforce:* Invensys offers a range of software solutions that enable the mobile operator to view and respond to alarms and view process variables anywhere in the plant whilst carrying out safety or maintenance rounds via an intrinsically safe hand-held device. IntelaTrac closes the collaboration gap between the field & control room operators, ensuring that policies and procedures are consistently executed and they use IntelaTrac for what it is good for- putting intelligent information into the hands of operators when they are examining the equipment that operates in the plant (manually operated valves, tank condition including floating roofs). They can collect data such as tank level & pass it to the historian for review and trending. If users want to actually make their operations personnel more responsive to the situations that they must deal with in the field, then IntelaTrac is the only product that gives focused advice messaging. Dynamic procedures make it work seamlessly with Movement Automation and other applications such as Enterprise Asset Management systems.

vi. *Visualization:* Invensys' Off-Sites Management solution set provides a powerful visual interface to all the applications, allowing users to see the status of the tank farm, and the operations that are ongoing or planned. For sites that do not have a tank management system, Invensys has powerful visualization software that can be integrated with any measurement system to provide detailed and overview information of the tank farm.

Track, Monitor and Improve
Once a wireless infrastructure has been established, KPIs can be set and an ongoing program developed to ensure that industry best practices continue to be achieved, and that everything is done to achieve the highest levels of safety.

7. Conclusion

The safety recommendations issued after the Buncefield, UK tank farm accident in December 2005 are resulting in benefits to tank farm and terminal operators that extend beyond safety. In particular, wireless-enabled inventory, process and condition monitoring – implemented to comply with the HSE Recommendations – are leading to significant cost savings and added value. A UK refinery estimated it would cost at least $1 million to implement a cabling infrastructure; only half of which would be necessary for a secure wireless infrastructure. In addition, the wireless infrastructure adds increased security protection and enables ongoing operational performance improvements.

To achieve such added value, a partner should be chosen with the experience and expertise to conduct in-depth functional safety audits as well as site assessments in order to recommend, design and implement an optimal solution. This involves performing a Gap Analysis; sourcing the right technologies; and tracking, monitoring and improving the solution. From smart instrumentation to off-sites management solutions to consulting services, Invensys offers a wide range of proven technologies and services to automate and optimize tank farm and terminal operations management systems.

By using such a hybrid of technologies, Invensys solutions offer tank farms and terminal operations improved levels of safety for employees, the local community and the environment, plus many additional benefits. These include a greater return on investment, an increased level of overall compliancy, real-time visibility of plant operations, and empowered personnel to drive ongoing performance improvements.

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