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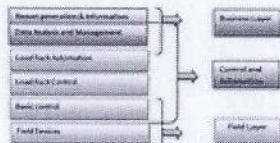
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News Article Instrumentation And Automation For Terminals

Instrumentation And Automation For Terminals

May 28
2015



INTRODUCTION

Terminal Automation system (TAS) is a process in which a Supervisory Software System (Terminal Automation System) automates certain manual processes in a terminal. TAS is used to automate, measure, record and report all transfers and exchanges throughout the product movement in a terminal. TAS provides monitoring, control and management of the entire product handling process from receiving to storage to distribution.

TAS combines automatic control and business management functions. It is generally an integrated, modular, open and scalable solution that helps ensure the safe and stable operation, optimal management and profit

maximization of the terminal, as well as lowering production costs. This paper covers all the aspects of TAS.

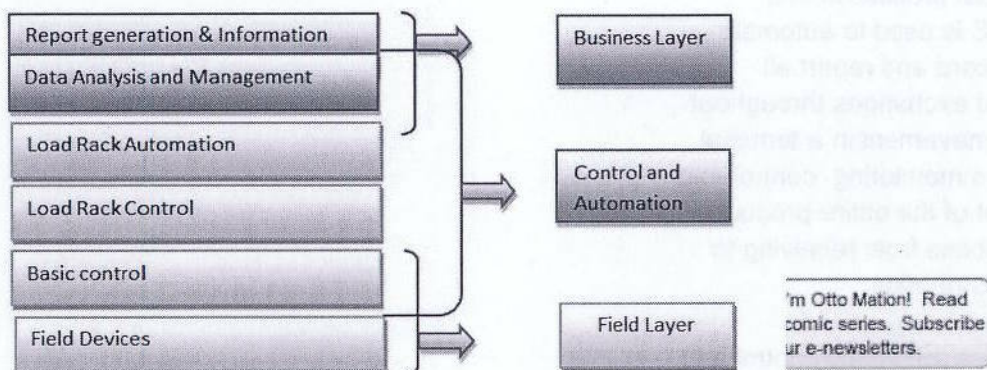
LAYERS OF TAS

A complete TAS has three basic layers:

- Field Layer,
- Control and Automation and
- Business layer.

The Field layer includes Remote operated shutoff valves (ROSOV), flow meters, control valves, Double Block and Bleed valves (DBBV), temperature and pressure measurements, Level measurement and groundings.

The Control and Automation layer includes computers / servers, Operator stations, PLCs, Printers, card readers, and emergency shutdown system. The top Business layer is for data exchange between the Management / Enterprise systems and control & automation. Orders are transferred from the Management / Enterprise systems. When the order is complete, a transaction is uploaded to the Management / Enterprise systems for invoicing.



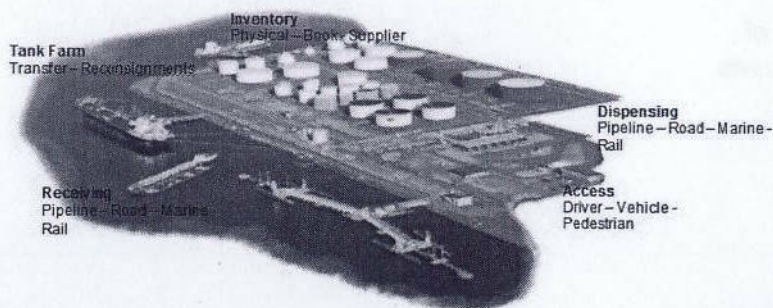
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FUNCTIONS OF TAS

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SUB SYSTEMS OF TAS

TAS encompasses various sub systems for automatic, reliable, efficient and safe operation of entire terminal from receipt to dispatch. The various subsystems of TAS are as mentioned below.

* Required Fields

SUBMIT

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- Ø Process control system
- Ø Emergency Shutdown system
- Ø Tank farm management system
- Ø Fire and gas system
- Ø Custody Metering
- Ø Truck Lorry filling system
- Ø RFID Based Truck Identification System
- Ø Traffic Signaling
- Ø Truck Queue Management System
- Ø Weighbridge
- Ø PA system
- Ø CCTV system
- Ø Fire Detection and Alarm System
- Ø Intrusion detection system

All the above sub systems of TAS are integrated with each other for

efficient and smooth operations of the terminal. Functions and features of these sub systems are briefly described in the subsequent paragraphs.

Process Control System

Process control system is PLC based system which interfaces with various other sub systems. It can be called as heart of TAS. The main functions of process control system are

- Improves Productivity
- Reduces Loss
- Prevents Accidents and & Improves Safety
- Protects the Environment
- Reduces Paperwork
- Expedites Billing Process
- Enhances Product Security

The process control system is PLC based system with PC based operator stations. It mainly control and monitor the following areas / equipment

- a) Pumping plant: The complete automatic start and stop of pumps based on the process requirements are controlled by process control PLC system
- b) Motorized valves: Motorized valves are either hardwired or multidropped using communication bus and connected to process control PLC. All the motorized valves are operated and monitored by process control PLC as per process requirement. As per OISD guidelines motor operated valve (MOV) on inlet, outlet and recirculation lines should be located outside the dyke.

c) Double Block and Bleed Valves:

The purpose of DBBV is to have positive isolation of lines / tanks.

Remote operation and monitoring of DBBV is carried out through process control PLC.

d) Dyke valve position monitoring:

As per OISD guidelines Dyke drain Valves shall be provided with position indication and alarm system in the event of opening the valve.

e) Truck Queue Management

System: The trucks arriving at terminals shall register at the entry gate. After registration vehicle is parked in parking area and driver goes and rest in driver rest room. A LED monitor is located in Driver rest room provided in parking area. According to the process requirement and first cum first basis the vehicle number will be displayed on the monitor for driver to report at the entry gate. This system will be part of process control system PLC.

f) The process control system PLC shall be Interfaced with the following systems for efficient operation of the terminal.

- Tank Farm Management System
- Truck Lorry Filling System
- Weighbridge
- RFID Based Truck Identification System
- Traffic Signaling
- RIM seal protection
- Upstream and Downstream control system

Emergency Shutdown System

The emergency shutdown system for terminal consists of the following:

- SIL certified PLC system
- Interfacing with Terminal control system
- ESD Push buttons at critical locations in terminal
- ROSOVs
- Flame detectors
- Gas detectors (Point Type and Open path)
- Audio Visual alarms
- Manual call points in field
- Vibrating foot type level switch

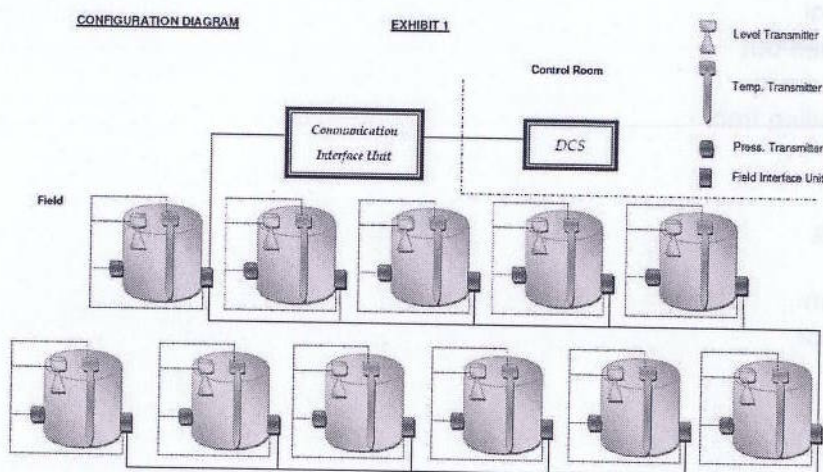
As per OISD guidelines the SIL classification study shall be carried out to determine the required SIL level. SIL of the safety instrumented function for the tank including overfill protection shall be meeting the requirement of Part 1 of EN 61511. ESD system shall be only through push buttons with wired connection.

- As per OISD guidelines Remote operated shut off valve (ROSOV) is not a regularly operated valve and is kept normally open; the second motor operated valve (MOV) is a regular operating valve. ROSOV shall be fail safe and fire safe (shall close in case of signal failure). The actuator shall be fail-safe. The cables leading to the control room shall be fire retardant. ROSOV shall have only close operation from control room or at a strategic remote location. The Open/Close push buttons of ROSOV shall be provided in field i.e. just outside the dyle. These push buttons shall have distinctive feature so that opening is different than action required for closing (e.g. pull type and push type).

Tank farm management system

The various components of the Tank farm management system are as follows:

- Radar gauge level measurement
- Multipoint temperature measurement
- Side mounted liquid head measurement
- Field control unit
- Central control unit
- Water level measurement
- PC based monitoring station with following features
 - Individual temp. and temp. Profile for tank
 - Product density
 - Volume calculation as per ASTM / API table
- Interfacing with Terminal control system



Fire and gas system

The various components of the Fire & Gas system are as follows:

- SIL certified PLC system
- Flame detector
- Point type gas detectors
- Beam type gas detectors
- Sounders
- Beacons
- Sounder cum beacon
- Manual call points
- Interfacing with ESD PLC

Custody Metering

For custody metering of the despatched product from the terminal there are there are two methods

- Mass flow meter / Positive displacement flow meter
- Weigh bridge

The custody metering of product despatched from terminal can be carried out using either flow meter or weigh bridge. Generally in most of the terminals the metering of despatched product is carried out using Weigh Bridge and same is cross verified using the reading from flow meter

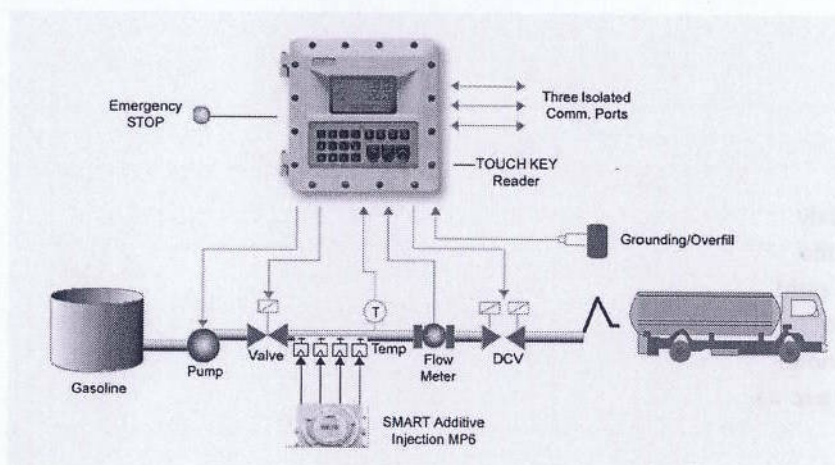
Truck Lorry filling system

The truck lorry filling system comprises of following major components.

- Batch controller
- Flow meter
- DCV (Digital Control Valve)
- Truck tank overfill switch

- Earthing system
- Interfacing with Terminal control system

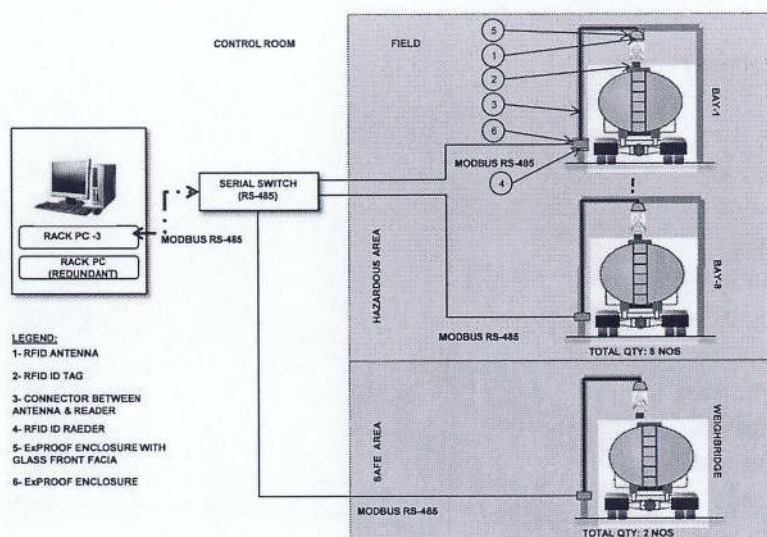
As OISD recommendations loading pumps shall be provided with additional explosion proof switch located at the strategic location in the gantry to switch off the pump in case of emergency such as over flow, fire or any other abnormal situation. Also automated locations should provide suitable overfill protection system to prevent any overflow and hazards arising out of that



RFID Based Truck Identification System

This system is very useful in reducing errors in terminals. It also reduces processing time of the various operations in dispatch. Various components of the RFID based truck identification system are as mentioned below.

- RFID tag fitted on vehicle body.
- RFID antenna fitted at the entry point to capture information from RFID tag
- RFID reader to receive data from RFID antenna and transmit all the data to TAS

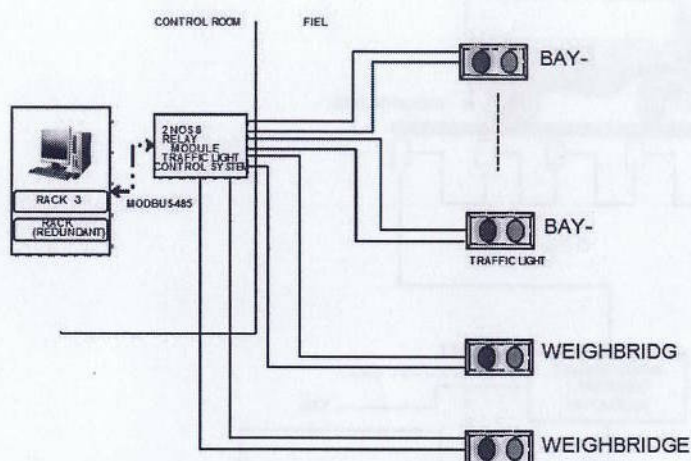


Traffic Signalling System

This is very useful for properly guiding the vehicles inside the terminal and to ensure that right designated vehicle enters to allocated locations. The various components of this system are as mentioned below.

- Red and Green signalling lights
- Software to program the functions
- Cable and connectors

This system is interface with the terminal automation system so that it can work in co-ordination with the RFID system for controlling the movement of vehicles.



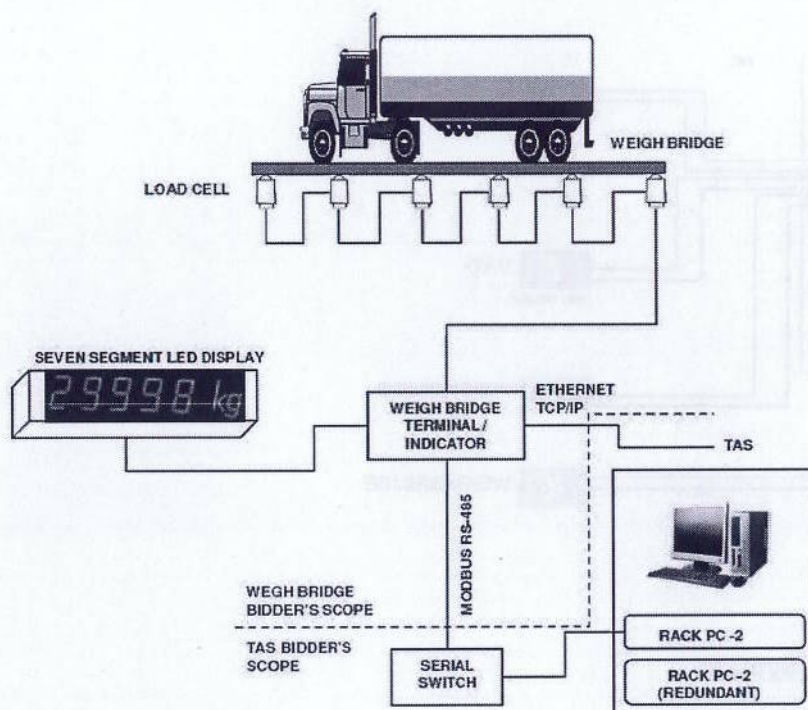
Truck Queue Management System

This system is very helpful in avoiding congestion inside the terminal. The truck queue management system mainly comprises of following items.

- Vehicle registration
- Q-management software
- Monitor in Driver's rest room

Weighbridge

Weighbridge plays a very important role in functioning of the terminal. It is used for custody metering. All the billing for the material dispatched from terminal is based on the reading from weighbridge. Hence weighbridge in the terminal has to be periodically calibrated through national accredited authorities. All load cell of weighing system shall be OILM R 60 (International Organisation of Legal Metrology) Certified for custody transfer measurement



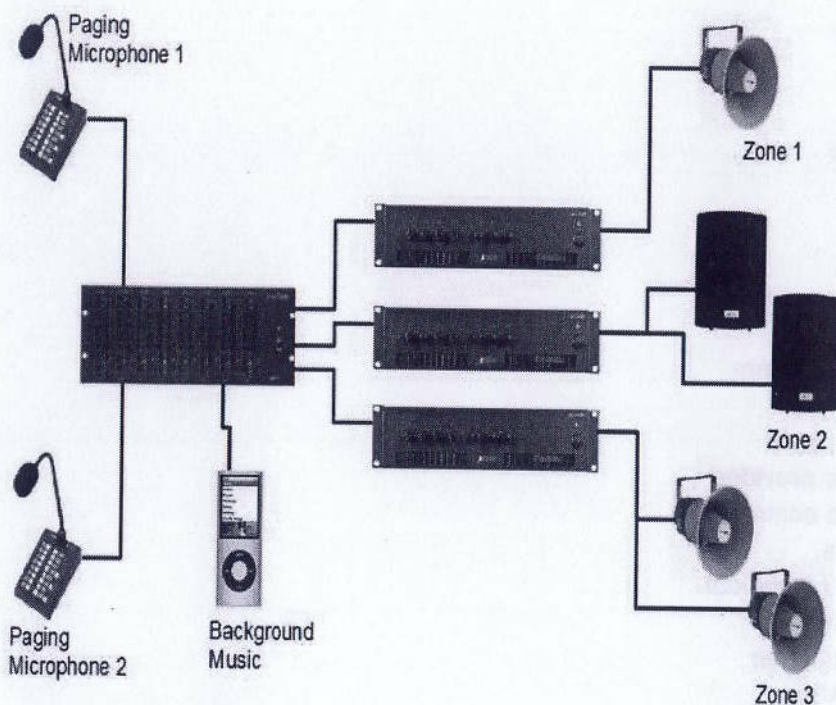
Public Address System (PAS)

The public address system is very important for the smooth operation and terminal and also for safe evacuation of people from terminal during emergency situations. PAS is interfaced with F&G and FDAS system so that pre-recorded message can be initiated during emergency situations. The major components of PAS are

- Speakers
- Desktop call station
- Field call stations
- Amplifier and controller
- Interfacing with F&G and FDAS system

As per OISD guidelines loading gantry shall be provided with at least one suitable explosion-proof telephone / paging device for communication with pump house in normal & emergency operations. In addition, operating personnel shall be provided with intrinsically safe walky-

talky suitable for use in oil installations.



Closed Circuit Television system (CCTV)

It is mandatory to provide CCTV system in the terminal for surveillance and safety of terminal. Generally the CCTV system LED monitors are located in control room and security cabins for continuous monitoring the healthiness of terminal. The cameras located in the field shall be exproof suitable for hazardous area classification. The major components of CCTV system are

- Cameras
- Ethernet switches
- Network video recorder (NVR)
- Cable and connectors
- LED monitors at control room and security

As per OISD recommendation the areas to be covered by CCTV system are

- Tank farm
- Entry / exit gate
- Periphery
- Critical operating areas

Fire Detection and Alarm system (FDAS)

The FDAS is required to be provided for all indoor areas such as control room, electrical substations, workshops, administrative / technical buildings etc. FDAS system is mandatory in control room as per OISD guidelines. The FDAS is designed as per the guidelines stated in NFPA 72 and IS 2189. The major components of FDAS are

- Smoke detectors
- Heat detectors
- Manual call points
- Fire alarm panel
- Fire alarm repeater panel

Intrusion Detection system

The system is required to the periphery of terminal. There are various types of intrusion detection system available which can be provided for protecting the terminal boundary. There are no statutory guidelines for providing intrusion detection system. However, based on the past experiences and location of terminals it can be decided whether such system is required. Various types of intrusion detection system available are

- Infrared detection system

- Intrusion detection through CCTV.
- Guard touring system
- Break wire type system
- Optic fibre cable
- Optical intrusion detection
- Ultrasonic Intrusion detection
- Electrification of fence

CHALLENGES AND DESIGN ISSUES IN TERMINALS:

Automation of terminals is a must to have safe and efficient operations. Manually planning, executing, and recording movements can greatly impact the profitability of terminal. Mistakes result in contamination, unsafe working conditions, and the loss of materials and energy. Any of these factors can directly contribute to higher operating costs, revenue loss, and, ultimately, lost opportunities.

We have tried to list out some of the common challenges encountered during design of the terminals, the areas which are missed out during engineering and the areas where we are not able conclude during engineering

Operation of valves inside the dyke

In case of emergencies such as oil spillage inside dyke it is not possible to access the valves located inside dyke. Hence it should be ensured that suitable access platforms are provided right from outside the dyke up to the valves so that person need not have to land inside the dyke to approach the ROSOVs.

Cabling inside the tank dyke

It is observed that in most of the cases the inside portion of dyle is required to be made impervious. Due to which providing structural steel support for cable trays on dyle floor is not advisable. The best practice is to avoid puncturing dyle floor and use the access platform provided for valves to support the cable trays.

Cabling for the instruments mounted on the tank

There are many instruments such as Radar level transmitter, multipoint temperature sensor, vibrating fork level switch etc. are located on tank roof. Cable tray routing and supporting for all the cables from these roof top instruments up to junction boxes located outside tank dyle is always a challenge. There are two ways to overcome this situation. First option is to use the tank staircase structure to support all the cable trays from roof top to bottom of tank. Second option is to provide mounting pads all along the body of tank from top to bottom at certain interval to support the cable trays.

Safety Integrity Level (SIL) requirement for field instruments (Radar Relay only SIL certified)

The instrument, valves, relays, control system etc. used in emergency shutdown loops shall be SIL certified. The SIL level for these items shall be ascertained after carrying out SIL identification study. If Radar level transmitters if they are used in ESD loops then the specifications shall be designed considering the following aspects.

- Very few manufacturers provide radar level transmitter with SIL rated 4-20 mA output.
- Some manufacturers provide radar level transmitter with only SIL rated one no. relay output.
- Very few manufacturers provide SIL 3 rated radar level transmitter.

Power supply for periphery security systems.

Generally all the terminals are provided with CCTV cameras, intrusion detection system, guard touring system etc. for security of the plant periphery. All these system components located near periphery boundary wall required power supply. Running long cables to provide power supply to these components from centralized located power source is not advisable from both technical as well as economical aspects. To overcome these problems various options are

- We can locate power sources in various buildings located near plant boundary supply power supply to various nearby cameras.
- Power to the cameras can be fed from the power supply from nearby periphery lighting poles
- In case security watch towers are provided on plant periphery then power source for cameras can be located in watch towers.

Cable sizing for ROSOV(ESD Valves)

The ROSOVs have either pneumatic or electro hydraulic actuators. ROSOVs generally located at quiet long distance from the control room. Proper cable sizing shall be carried out considering the load of solenoid provided for actuation of ROSOVs.

ESD system communication between Jetty and Tank Terminal

The distance between the jetty and tank terminal are large due to which laying of copper cable for interfacing between ESD systems for jetty and tank terminal is not possible. The best alternative is to lay fiber optic cable and provide TUV certified communication between the ESD systems of jetty and tank terminal.

Actuator Selection for ROSOV

The ROSOVs in terminals are part of ESD system and hence are generally provided with pneumatic or electro-hydraulic actuators. In case instrument air is available in terminal then providing pneumatic actuator is most economical. When air is not available the providing electro-hydraulic actuators may be economical. Hence proper techno-economical study shall be carried out in selecting the type of actuator with due considerations to fail safe action, total air requirement, total quantity of valves etc.

Dyke valves position monitoring

For draining of leakage oil from dyke pit valves are provided. It is very important and also mandatory as per OISD to

monitor the open / close positions of these valves and alarms shall be generated on operator stations as per the logic of operation.

Limitations of vibrating fork type level switches for floating roof tank.

The point of high-high level actuation point from tank top shall be properly calculated to decide on probe length for top mounted vibrating fork type level switches. Alternatively the switch can be mounted from side of tank at point of actuation. However, the probe shall not be projected inside the tank as it will get damaged due to movement of floating roof. The switch probe tip shall remain inside the mounting nozzle. Preferably the mounting nozzle shall be tilted upward with 60 degree angle with surface of tank so that no oil gets trapped in the nozzle.

Roof tilt indication for floating roof tank.

It is always advisable to monitor the tilting of roof as may cause hazard. In case roof tilt indication is required same can be achieved by providing 3 nos. of top mounted level transmitters above the tank roof at 120 degree apart. The signals from all these 3 nos. transmitters can be compared in terminal PLC to derive the roof tilt indication.

Location and quantity of Hydrocarbon detectors (HC)

There are no fixed guidelines to locate the HC in a terminal. Practically if HC detectors are to be provided at each leakage point for class A and B products

then the quantity become very high. One has to very selectively place the detectors so that any leakage of class A and B products won't go undetected. If below mentioned guidelines are followed almost all the leakage points will be covered.

- In pump house open path HC gas detectors are most suitable.
- For leakages in tank dyke point type HC gas detector may be located near leakage collecting pit and open path HC gas detector on the leakage path leading to collection pit inside dyke.
- One no. fire detector for detecting fire near the valves inside the dyke.
- In valve terminals open path HC gas detector are most suitable.

Philosophy for Audio visual alarms in field and control room

Providing hooters with single type of tone in field for all conditions does not give clear idea about the cause of alarm. Hence to have clear idea about the cause of alarm conditions the philosophy mentioned below may be followed.

- Red colour beacon with hooter for master ESD condition in terminal
- Amber colour beacon with hooter for detection of gas leakage or fire in the terminal detected by F&G detectors.

- Yellow colour beacon with hooter for rim seal fail (Applicable for only floating roof tanks).

Proof testing for SIL rated instruments

For SIL rated instruments it is mandatory to continuously monitor the healthiness of instrument. This feature shall be always mentioned in the specifications while procuring.

For e.g. In ROSOVs which is the first body valve and part of ESD loop "Partial stroke test" facility shall be specified. Vibration fork type level switch which is provided for overfill protection of tank and is also part of ESD loop. Simulation facility shall be provided to initiate a pulse to check the healthiness of switch periodically without removing the switch from site.

P&ID's (Indicate ESD and Terminal PLC instruments clearly)

It should be ensured that the P&IDs clearly shows the instruments which are in ESD loop and instruments which are part of terminal process operations. So that further engineering is carried out error free.

Size of Nozzle for tank top mounted instruments.

It is always a confusion to finalize the size of process connection for various instruments mounted on tank top. Below mentioned process connections may be followed for mounting of various instruments.

Pressure transmitter: To mount the pressure transmitter on top of tanks, 2" size flange process connection is sufficient. To mount pressure transmitter on bottom side of tank 3" size flange connection may be provided to have desired accuracy level.

Multipoint Temperature transmitter: To mount the multipoint temperature probe 2" size flange process connection may be provided.

Vibration fork type level switch: To mount the Vibrating fork type level switch 2" size flange process connection may be provided.

Radar type level transmitter: Generally for mounting of radar type level transmitter 8" size flange process connection is adequate. However, based on the tank height, type of media to be measured process connection size shall be confirmed with instrument supplier before finalization.

For floating roof tank it is necessary to provide still well for each tank top mounted instruments. Alternatively instead of providing separate still wells for each instrument a common bigger size (around 20 to 24") still well may be provided for mounting of all the top mounted instruments. For radar type level instrument as per manufacturer's requirement a separate 8" still well inside the big size still well may be required.

Motorized valve communication

The second valve on the tanks inlet, outlet or recirculation lines

are generally motorized valves. The distance between these valves and the control system located in control room are very large. It is most economical to use multidrop communication cable between the motorized valves and control room for operation and monitoring of valves. This will save huge amount of multicore cables to be laid for each motorized valve. Additionally it will provide all the diagnostic information and save commissioning time of valves.

Waxy Crude special requirement

In case of waxy crude additional instruments are required to be provided as mentioned below same shall be properly considered while designing the system

- Monitoring healthiness of heat tracing system provided for pipelines.
- Control and monitoring of steam for maintaining temperature of crude in tanks.
- Provide temperature sensor located 120 degree apart at suitable level on the tank for monitoring spot heating due to steam leakage inside tank.
- Water level monitoring inside the tank which may rise due to steam leakage inside the tank.

Queue management system

For trucks which come for receipt of material at terminal Q management system is a must. When the truck reaches the

terminal the driver is provided a unique no. and is asked to park the vehicle in parking area and wait in driver's waiting room. In driver's waiting room a LED display is provided. As per the availability of gantry bay and material in terminal the number given to drivers and vehicle no. are displayed on the LED display. Looking at this numbers, sequentially the drivers will proceed toward the terminal. This avoids the congestion near the terminal entry gate.

RFID tracking

In many terminals preregistered trucks are only allowed to enter the terminal. In such cases this system is very useful from operation as well as safety of terminal. In RFID tracking system as preconfigured RFID tag is fixed on truck body which has information about the truck such as vehicle no., driver name, capacity of truck tank etc. The RFID antenna along with reader is provided before weighbridge, entry to gantry bays. As the truck with RFID tag reaches near the RFID antenna the reader captures all the information about the truck automatically. This system can be also used to operate the boom barriers provided at entry of gantry bay so that the truck enters the right designated gantry bay. The fig below shows the typical schematic of RFID system.

Multi spot temperature element(RTD/Thermocouple)

Most of the suppliers of multipoint temperature probe provide RTD as sensing elements in the probe. However, some suppliers

provided combination of RTD and thermocouple as temperature sensing elements in the probe. Looking at the application of i.e. monitoring of temperature profile in tanks, both the option should be acceptable.

Radar Level Transmitter (FMCW/PWM)

There are two technologies (i.e. FMCW: Frequency Modulated Continuous Wave and PWM: Pulse Width Modulation) which are offered by various vendors for radar level measurement. Both the technologies are proven in field. However, when application is for custody metering then FMCW principle of measurement is preferable as accuracy of ± 1 mm is required. Both the principles of measurement are suitable for level measurement in tanks.

Common PLC for ESD and F&G

For both Emergency Shutdown (ESD) and Fire & Gas (F&G) applications SIL rated PLCs are to be provided. As the quantity of I/Os for both F&G and ESD are generally small, it is advisable to provide a common SIL rated PLC for both ESD and F&G applications. This will save cost, intersystem wiring, space in control room etc.

Hardwired console

As per OISD guidelines ESD system shall be only through push buttons with wired connection. The hardwired console in control room is often missed out. For all the devices such as ESD valves, pumps, etc. operated by ESD system stop button along with status

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indicating lamps shall be provided on the Hardwired console in control room. All the signals from this console shall be wired to ESD PLC.

REFERENCES

The information given in this paper is having references from below mentions various codes and standards. These OISD standards are applicable only for the terminals located in India. For designing of terminals located outside India suitable NFPA codes shall be followed.

OISD-117	Fire protection facilities for petroleum depots, terminals and pipeline installations
OISD-118	Layouts for oil and gas installations
OISD-163	Process control room safety
OISD-244	Storage and handling of petroleum products at depots and terminals including standalone crude oil storage facilities.
















About the authors

Sunil P Agarwal is General Manager (Instrumentation and controls) at Tata Consulting Engineers Limited

Mohan R Joshi is Deputy General Manager (Instrumentation and controls) at Tata Consulting Engineers Limited

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