Design & Use of Ground Based Pumps Guidance Document

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The information and recommendations in this guidance are given in good faith and belief in their accuracy at the time of publication, but do not imply any legal liability or responsibility by the Refined Bitumen Association (RBA) and Mineral Products Association (MPA).

The Health and Safety at Work Act 1974 and The Management of Health and Safety Regulations 1999 require employers to provide safe systems of work to ensure the safety of their employees and the public. Health and Safety Law imposes duties on both the supplier and the customer to provide safe systems of work. This guidance is intended to help both parties comply with their respective responsibilities during the transfer of hot bitumen from a delivery vehicle into a storage tank, and is not intended to vary the legal responsibility of either party.

PURPOSE

This guidance paper is to provide information to assist companies when specifying, designing, installing and operating new and existing ground based pump systems used for the off loading and transfer of bitumen.

Since the introduction of ground based pumps in the UK there have been a number of incidents where delivery drivers and plant operators have been exposed to significant spills of bitumen. These have been due to poor planning, design and maintenance of ground based pump delivery systems and, in some cases, the potential consequences of these incidents are very serious.

The intent of this document is to provide the operating companies with best practice as well as guidance for the minimum requirement when designing ground based pump delivery systems.

This document has been written jointly by representatives of the MPA – H & S Working Group 7 and the RBA Health Safety and Environmental Committee.

ACKNOWLEDGEMENTS

The following contributed to the development of this best practice guide:

Malcolm Apperley	MPA
Matt Avery	MPA H&S Committee – Working Group 7
Gary Rorke	RBA H&S Committee
Andrew Williams	RBA / MPA Safety Committee Groups

SCOPE

This guidance is applicable to ground base pump delivery systems associated with atmospheric-pressure bitumen storage tanks that have a maximum design temperature of 260°C (500°F). Other forms of tanker discharge and transfer are not covered in this document.

Due to the potential hazards and the complexities involved with designing and constructing hot bitumen storage systems, operating companies are advised to consult a competent engineering company when initiating a new ground based pump delivery system project. The competent engineering company will be knowledgeable in the design/construction process of hot bitumen storage tanks and associated equipment, including all applicable specifications, codes, and regulatory requirements, thereby minimising the potential risks.

It does not cover other areas which should also be considered, such as the type of instrumentation, traffic light system, CCTV systems, communication links and tank engineering designs.

REFERENCES

Guide to Safe Delivery of Bitumen, UK Edition, Refined Bitumen Association

Guidance for Safe Bitumen Tank Management, Refined Bitumen Association/ Mineral Products Association

Model code of safe practice, Part 11, Bitumen safety code, (4th edition), Energy Institute

BS EN 61511, Functional safety. Safety instrumented systems for the process industry sector

New hot bitumen storage tank construction guidelines, Refined Bitumen Association

Dangerous Substances and Explosive Atmospheres (DSEAR) Regulations 2002

DEFINITIONS

Hazard Identification Study (HAZID): A systematic approach to identify potential hazards that exist in the plant and to document it for later usage in assessments such as hazards and operability (HAZOP) studies.

Hazard and Operability Study (HAZOP): The HAZOP study is a formal method of assessment, performed by a committee which consists of fully experienced plant engineers, technical, laboratory and safety personnel, to identify hazards in the process plant by using specific procedures.

Functional Safety: Functional Safety is part of the overall safety of a plant that depends on a system or equipment operating correctly in response to its inputs.

Functional Safety Assessment (FSA): The purpose of a functional safety assessment is to identify the functional safety and safety integrity that has been achieved, and as such must as a minimum be carried out after installation and before the use of the system.

Independent Protection Layer: Independent mechanism that will prevent an unsafe scenario from progressing (prevention or mitigation) regardless of the initiating event or the performance of another layer of protection.

Safety Instrumented Function (SIF): Specific single set of actions and the corresponding equipment needed to identify a single hazard and act to bring the system to a safe state, e.g. detect high product level in a tank and prevent an overfill by shutting a valve.

Safety Instrumented System (SIS): The instrumented system used to implement one or more SIFs. Comprises a means of:

1) Detecting the hazardous condition.
2) Determining what needs to be done.
3) Taking effective action to control the hazard.

Below is an example of a SIS.

Safety Integrity Level (SIL): Level of performance required for a system to perform a required Safety Instrumented Function (SIF).

High High Level Alarm (HHLA): Alarm to prevent a potential overspill condition.

High Level Alarm (HLA): Alarm to warn of abnormal operating conditions for the tank level in relation to the safe working capacity of the tank.

Independent Layer of Protection: A layer of protection that will prevent an unsafe scenario from progressing, regardless of the initiating event or the performance of another layer of protection.

GENERAL GUIDELINES

1. RISK ASSESSMENT

During the design stage of any new plant Hazard and Operability (HAZOP) and Hazard Identification (HAZID) studies should be carried out. The HAZOP & HAZID techniques are used universally across high hazard industries as a method of identifying hazards and operability problems in new and existing plant.

Before a HAZOP/HAZID study is started, detailed information on the process must be available including:

- Up-to-date process flow diagram (PFD).
- Process and instrumentation diagram (P&ID).
- Detailed equipment specifications.
- Construction Materials.

A Functional Safety Assessment (FSA) must be carried in accordance with BS EN 61511.

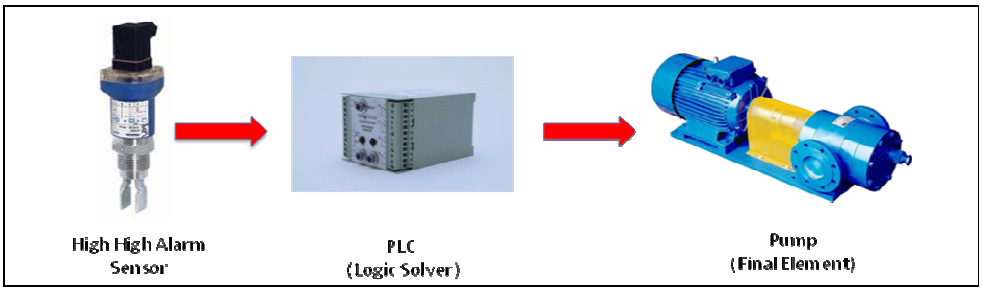
The process ensures a systematic and well documented evaluation of potential problems or hazards and will assist in the identification of any:

- Potential safety instrumented functions that are required by BS EN 61511.
- Any potential requirements under the Dangerous Substances and Explosive Atmosphere Regulations 2002.

2. SYSTEM DESIGN

The ground based pump system should comprise of a storage vessel with associated pipework, a pump, in-line valves, a tank gauging system with a High Level Alarm (HLA) and an independent High High Level Alarm (HHLA).

The system must be designed to fail safe. Upon activation of either alarm or any system failure the system will simultaneously and automatically stop the pump, close any in-line valves and stop any ancillary equipment. If any of these components fail the system must stop, e.g. if an in-line valve closes, the pump, additional valves and any ancillary equipment will stop.



3. CONSIDERATIONS

When designing a ground based pump delivery system the following should be considered and implemented.

a. High High Level Alarm

The storage tank must have an independent HHLA. When the HHLA is activated the stopping of the ground based pump must be sequenced to simultaneously shut off both the pump and any in-line valves, and initiate an audible & visible alarm, as determined by the HAZOP/FSA. This Safety Integrated System must be independent of all other control systems, refer to the "Guidance for Safe Bitumen Tank Management".

b. High Level Alarm

The storage tank must also have a HLA. As with the HHLA, when the HLA is activated the stopping of the ground based pump must be sequenced to simultaneously shut off both the pump and any in-line valves, and initiate an audible & visible alarm, as determined by the HAZOP/FSA. The HLA system must operate independently from the HHLA system.

The activation of the HHLA and HLA must be set to trigger at the available capacity as defined in the "Guidance for Safe Bitumen Tank Management".

c. Pump

The ground based pump is an integral part of the bitumen storage plant and, as such, the characteristics of the pump must be considered in conjunction with the characteristics of the whole system to ensure compatibility and safe operation. This must only be undertaken by a competent person.

Consideration must be given to the rating of the installed pump, i.e. how many litres per minute. This needs to be measured against the vent line capacity of the bitumen delivery vehicle to prevent under pressure, and of the bitumen storage system to prevent overpressure, see Annex 1.

The ground based pump should be situated as close as is reasonably possible to the delivery flange, to minimise the amount of bitumen in the pipework.

The design should allow for the suction of the pump to be below the outlet flange of the bitumen delivery vehicle, to allow total clearance of the delivery line before the pump loses suction.

It is recommended that the pump and delivery lines are heat traced and lagged.

d. Controls

The pump off-loading must be commenced by the delivery driver only after authorisation is given by the plant operator.

The driver must not be able to start the ground based pump until the plant operator specifies which tank the bitumen will flow into.

A panel should be positioned as close as possible to the pump showing the tanker driver the plant status and should include controls to start and stop the pumping procedure.

An Emergency Shut Down Device, i.e. E-stop, must be fitted at the delivery point, readily accessible and clearly identified, so that in the event of an emergency the process can be stopped. This must not be self resetting.

Consideration should be given to a hose detection system, being installed so that the system will not start until it detects a connected delivery hose.

e. System Resets

i. HHLA Reset

Activation of the HHLA must only be reset by a competent designated person, usually a site manager or maintenance personnel.

A thorough investigation to identify the cause of HHLA and fault rectification must be completed before the system is reset.

ii. HLA Reset

Activation of the HLA must only be reset by competent and authorised plant staff.

All HLA activations should be treated as an incident and investigated accordingly.

f. Compressors & Ancillary Equipment

Any compressor or ancillary equipment must be considered during the HAZOP/FSA, to ensure that they are included in any SIS as required.

g. Valves

Any valves must be considered during the HAZOP/FSA, to ensure that they are included in any SIS as required.

An automated fail safe valve must be fitted in the line before the pump. This must be fully integrated into the system and self closing in the event of any system failure or alarm activation.

All automated valves must be self closing in the event of a failure (fail safe).

A non-return valve must be fitted as close to the pump outlet as practicably possible or as an integral part of the pump.

h. Operation & Maintenance

Consideration should be given to incorporating a secondary delivery system. Such a system should be designed to safely integrate with the ground based pump system; the HAZOP/FSA must consider adequate control measures for by-passing the ground based pump SIS.

For each new project and plant modification, the system is deemed to be a Safety Critical Independent Layer of Protection. The operating company must ensure that arrangements are in place for the operation, maintenance, system testing and inspection for the whole SIS and its subcomponents.

Written procedures should be agreed by the site management teams and personnel identified as responsible and competent for the plant's operation and maintenance.

The procedures must cover:

- The procedures, measures and techniques to be used for operations and maintenance.
- Schedule/frequency of proof testing in accordance with the requirements for each SIS.
- Preventative and corrective maintenance activities.
- The persons, departments and organisations responsible for these activities.

i. Procedures

i. Operating Companies

The receiving company must ensure that a safe and effective means of communication local to the discharge point exists between the delivery driver and the plant staff supervising the delivery.

An alarm management plan must be developed by the operating company to instruct all parties of the actions they must carry out in the event of an alarm activation.

The delivery driver must be trained in the unloading and emergency procedures prior to commencement of any delivery.

Procedures and facilities must be in place to allow the driver to clear his hose in the event of a system failure.

ii. Drivers

In the event of an alarm activation, the driver must close his delivery valve and contact the plant personnel and await further instruction.

The driver must not be able to reset the system after an activation of either the HHLA or the HLA.

An Authority to Continue Discharge (ATD) must be raised and a new Bitumen Discharge Permit (BDP) completed if the delivery has been suspended for any reason.

4. Maintenance

To ensure the systems reliability and functionality a robust maintenance regime must be operated.

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Annex 1

Ground Based Pump Bitumen Discharge - Air Inlet Calculations

The table below can be used as guidance on the size of air inlet required to supply the minimum amount of air flow into a road tank during ground based pump discharge, thereby attempting to balance the air pressure within the road tanker and not allowing a vacuum to build.

Pump Capacity litres/minute	Pump Capacity litres/hr	Road Tank Air Inlet Pipe size
750	45000	50mm
800	48000	"
850	51000	"
900	54000	"
950	57000	"
1000	60000	55mm
1050	63000	"
1100	66000	"
1150	69000	"
1200	72000	"
1250	75000	"
1300	78000	60mm
1350	81000	"
1400	84000	"
1450	87000	"
1500	90000	"
1550	93000	"
1600	96000	"
1650	99000	65mm
1700	102000	"
1750	105000	"
1800	108000	"
1850	111000	"
1900	114000	"
1950	117000	"
2000	120000	70mm

NOTE: Companies or individuals are responsible for their own design and method of delivery of the air to the road tank barrel.