PROCESS DESIGN AND OPERATING PHILOSOPHIES
ON
BLOWDOWN AND SEWER SYSTEM

OISD-STANDARD - 109
Amended Edition, August 1999
Revised Edition, January 2015

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PROCESS DESIGN AND OPERATING PHILOSOPHIES ON BLOWDOWN AND SEWER SYSTEM

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Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate
FOREWORD

Petroleum refinery & Gas processing plants comprise of Crude & vacuum Distillation units along with a number of complex secondary units like Catalytic Reforming, Fluidized catalytic cracking, Delayed Cokers, Vis-Breaker, Hydrotreater, Hydrocracker & Hydrogen Units including process like Sulphur Recovery units and Amine treatment/recovery units and facilities like Flare etc. From the above units, various blowdown streams such as aqueous blowdown, hydrocarbon blowdown and chemical blowdown of liquid streams containing water, oil, chemicals or a combination of two or more of these are required to be drained & routed to safe destination either during the normal operation of the units or during shutdown/emergency situations.

Though these blowdown streams are usually waste products, their handling and disposal is paramount importance in enhancing the safety of the plant and protecting environment. This necessitates the introduction of inbuilt safe and efficient handling and treatment facilities as well as fire protection facilities in the system.

This standard was first released in November 1988 and was subsequently amended in the year 1999. With adoption of new process & technology especially the secondary processing facilities coupled with capacity augmentation of existing facilities and recommendations from recent incident analysis necessitated up-gradation of this standard and subsequently revised was issued in January 2015.

This standard is meant to be used as a supplement and not as a replacement for existing codes & practices. The provision of this standard if implemented objectively will go a long way to improve the safety & reduce accidents in the Oil & Gas Industry. Users are cautioned that no standard can be a substitute for the judgment of responsible & experienced engineer. Suggestions are invited from the users after it is put into practice to improve the standard further. Suggestions for amendments to this standard should be addressed to:

The Coordinator
Committee on “Process Design and Operating Philosophies on Blowdown and Sewer system”

Oil Industry Safety Directorate.
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These documents are intended to supplement rather than replace the prevailing statutory requirements.
# FUNCTIONAL COMMITTEE

*(SECOND EDITION, January 2015)*

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In addition to the above, several other experts from industry contributed in the preparation, review and finalisation of this document.
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# PROCESS DESIGN AND OPERATING PHILOSOPHIES ON BLOWDOWN AND SEWER SYSTEM

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PROCESS DESIGN AND OPERATING PHILOSOPHIES ON BLOWDOWN AND SEWER SYSTEM

1.0 INTRODUCTION

Blowdown is a liquid stream containing water, oil, chemicals or a combination of two or more of these which are required to be drained from various process equipment in the hydrocarbon industry under different operating situations like start up, shutdown, normal operation or emergencies. Since majority of these streams are usually waste products (however in some situations these may be recoverable), their handling and disposal often gets a low profile in the plant design and operation. However, the importance of handling these blowdown streams in enhancing the safety of the plant cannot be underestimated.

2.0 SCOPE

This document covers the design and operating philosophies for safe handling and disposal of liquid blowdown from various process equipment in the Refineries, Gas Processing & Petrochemical Plants and their storage facilities. Pressure relief of vapour/liquid and their disposal is not covered in this document for which OISD - 106 Standard on “Pressure Relief and Disposal System” should be referred to.

3.0 DEFINITIONS

3.1 Blowdown:

Blowdown is a liquid stream containing water, oil, chemicals or a combination of two or more of these which are required to be drained from various process equipment in the oil & gas industry under different operating situations like start up, shutdown, normal operation or emergencies.

3.2 Cryogenic:

Cold substances i.e. Gas, Liquid or Solids having subzero temperature.

3.3 Congealing & Viscous Fluids:

Congealing fluids are those which thicken and resist to flow due to higher viscosity at ambient temperatures. These fluids are normally stored at elevated temperatures to maintain fluidity.

3.4 Effluent:

Effluent is a liquid such as sewage, Hydrocarbon or chemical contaminated water or other liquid, partially or completely treated or in natural state as the case may be flowing out of reservoir, process unit basin or treatment plant.

3.5 Manhole:

Manholes are used in sewer mains as junction points and sediment traps, and to access for maintenance and inspection.

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3.6 Non Volatile:

Substance that does not change from solid/ liquid state to vapour or gas state at normal
temperature and pressure condition is called non volatile substance.

3.7 Seals:

Seals (hydraulic seals) are used to isolate various parts of sewer system, preventing vapour
travel and spread of fire or explosion.

3.8 Sewer:

Sewer is an underground pipe or open channel in the sewage system for carrying water of
sewage to a disposal point.

3.9 Sewerage:

Sewerage is a system of sewers and ancillary sewage from its point of origin to a treatment
facility or other point of disposal.

3.10 Should:

The word ‘shall’ is used to indicate that the provision is mandatory.

3.11 Should:

The word ‘should’ is used to indicate that the provision is recommendatory as per good
engineering practice.

3.12 Storm water:

Storm water is a system for rain water discharge from catchment area.

3.13 Volatile Compounds:

Compounds which can easily become vapour or gas from the solid or liquid state at normal
temperature & pressure conditions are called Volatile Compounds.

4.0 CLASSIFICATION OF BLOWDOWN STREAMS

The blows down streams are classified based on the nature, frequency and other characteristics,
these streams can be classified as below:

4.1 CLASSIFICATION BASED ON COMPOSITION

Depending on the composition of blowdown streams, these may be classified as:

4.1.1 Aqueous Blowdown:
These streams contain water as the major constituent with small amounts of hydrocarbons. Such streams are usually encountered during the normal running of the units. These streams may be continuous or intermittent in nature. Some typical examples are:

i) Water draw-off from reflux drums
ii) Water-caustic (or other solvents) draw-off from treating units
iii) Brine water draw-off from desalters and heater treaters.
iv) Water draw-off from oil separators.
v) Stripped water draw-off from sour water strippers
vi) Water draw-off from crude oil tanks and other products tanks.

4.1.2 Hydrocarbon Blowdown

These streams contain mainly the hydrocarbon fractions and may be encountered during normal operation, start-up, normal shutdown and emergency shutdown. These streams are usually intermittent in nature. Some typical examples are:

i) Intermittent draining of process equipment during normal operation.
ii) Drains and vents/bleeders on pumps, pipelines, and manifolds
iii) Sampling of products from equipment and piping
iv) Emptying of an equipment during planned shutdown
v) Emergency draining of process equipment like furnace, tower or vessel etc,
vi) Coker plant blowdown
vii) Oily condensate
viii) Water coming from all hydrocarbon pollutable paved areas mainly including process units, non volatile product loading gantries, pumps stations etc.

4.1.3 Chemical Blowdown

These streams contain aqueous solutions of chemicals and may have small quantities of hydrocarbons. Such streams may be continuous or intermittent in nature. Some typical examples are:

i) Caustic drains from treating plants
ii) Reactor washes
iii) Effluents from water treatment plants
iv) Water draw-off from sour water sources which may contain sulphides, H2S, ammonia & phenol etc.
v) Cooling Tower blowdown
vi) Amine Blowdown
vii)

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4.2 CLASSIFICATION BASED ON TEMPERATURE

Blowdown streams as classified above can further be grouped depending on the temperature. These streams can be hot or at ambient temperature or be under cryogenic conditions. The hazards involved in handling different blow down streams and the technique of handling and disposal of each one of such streams will be different. Some typical examples of such streams are:

4.2.1 Hot Blowdown

i) Coker plant blowdown
ii) Fractionating tower blowdown
iii) Hot heat exchanger/reboiler blowdown
iv) Samples of hot products
v) Vents/drains from hot equipment
vi) Boiler blowdown-continuous and intermittent
vii) Decoking drum blow down

4.2.2 Cryogenic Blowdown

i) Drains, vents, and bleeders on equipment operating at sub-zero temperatures like cold boxes, refrigeration systems, etc.
ii) Drains, vents and bleeders on flashing liquids.
iii) Drains, vents and bleeders on high pressure gas transmission lines.

4.3 CLASSIFICATION BASED ON VOLATILITY AND VISCOSITY

Based on relative volatility, the blowdown streams may be classified as volatile or non-volatile. Similarly these may be viscous and congealing type or the free flowing type blowdown streams. Some typical examples are:

4.3.1 Volatile

i) Gas condensates
ii) LPG
iii) Gasoline and lighter naphtha
iv) Hot-heavy hydrocarbons above their flash points.

4.3.2 Non-Volatile

i) Kerosene
ii) Heavier hydrocarbons below their flash points.

4.3.3 Viscous/Congealing

i) High pour point Crude Oil

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ii) Vacuum Gas Oil
iii) Vacuum Residue
iv) Reduced Crude Oil
v) Fuel Oil
vi) Bitumen
vii) Wax

5.0 SAFE HANDLING

The facilities and procedures of safe handling of various blowdown streams will vary with the type and general grouping of these streams as listed in clause 4.0. While designing it must be ensured that the facilities shall be designed for maximum reuse of blow down water after proper treatment. Depending upon the type of blowdown, some typical handling facilities are recommended as under:

5.1 Aqueous Blowdown:

Generally aqueous blowdown streams consist of water with small amounts of hydrocarbons. Depending upon whether these streams are continuous or intermittent and the nature of hydrocarbons associated with them, the handling arrangements will vary as described in some typical examples below:

5.1.1 Continuous aqueous Blow Down- Non Volatile:

Water draining from barometric condenser drums/ hot well vessels of vacuum units, water seal vessel in flare area is typical examples of continuous aqueous blowdown with some non volatile HC.

This blowdown stream shall be routed to sour water stripping unit with a level indicator and controller. In case of tripping of sour water pump, the arrangement shall be available to route it to oily water sewer by means of a U seal (if operating under atmospheric pressure). A low level alarm should be provided to ensure that all liquid is not drained out allowing escape of HC gases. See fig 1.

5.1.2 Aqueous blowdown – Volatile

In equipments like light end reflux drums, desalters etc. where process water/ steam is continuously withdrawn as liquid water, medium to large quantity of lighter volatile hydrocarbons can also get carried away along with the water.

These blowdown streams shall not be routed to OWS directly to avoid any hazardous situation. Such streams from pressure vessels which have provision to separate water and HC shall be routed through a closed system to CBD with the following instrumentation to enhance safety.

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1. Automatic level indicator & controller to maintain water/Hydrocarbon inter-phase level.

2. High and low inter-phase level alarm independent of level indicator/controller from a separate tapping to ensure that Hydrocarbon is not carried along with water or water is not carried along with Hydrocarbon (as part of reflux, crude etc).

The blowdown stream shall be routed to effluent treatment plant (ETP) / Sour water stripper (SWS) or to some other equipment as the process demands. A typical scheme for handling such streams is depicted in fig 2a.

In case the aqueous blowdown contains entrapped gases, the stream shall be routed to a disengaging drum. The vapours released from the top of the drum shall be routed to closed flare header and the free water shall be drained to OWS as shown in fig 2b.

5.1.3 Boiler Blowdown

Blowdown from a boiler/waste heat steam generator is done usually at high temperature and high pressure to maintain the water quality for steam generation. Such streams should be handled carefully to avoid personnel hazards. A typical scheme of handling boiler blowdown is depicted in Fig.3. Boiler or steam generator generally operate at high pressure and their blowdown streams are generally flashed into lower pressure steam system or heat energy is recovered in heat exchangers before final safe disposal. A stream of cold ambient water is mixed with the hot effluent water to cool it before discharging into oily sewer or storm water drain.

5.1.4 Water Draw-off from Crude Oil Tanks

This is an important routine operation intermittent in nature and can lead to lot of problems if not done properly. Though, it is satisfactory to drain free water from the crude oil tanks into oily water sewer leading to waste water treatment plant, draining of emulsion and wax etc. into the oily sewer can lead to unsafe conditions in addition to increasing the load on the waste water treatment plant. It is recommended that the emulsion etc. from the crude tanks be received in a slop tank located in the crude tank farm area. The capacity of the slop tank should be adequate to handle the wax and BS & W likely to be present in a single largest crude tank. The slop tank should be provided with steam coils or alternative heating facilities to help break the emulsion. A typical scheme for handling such streams is depicted in Fig. 4. More than one crude tank can be served with a single slop tank located inside the crude tank(s) dyke area. However, if there are many large size crude oil tanks, more than one slop tank may be required.

After draining the free water from the crude tanks to oily water sewer, if oil water emulsion is observed, the draining should be lined up to the slop tank where the contents should be heated to the desired temperature to break the emulsion and allowed to settle for separating oil water phases. The water phase from the slop tank should be drained to oily water sewer and the oil content should be pumped back to the crude tanks by two slop oil pumps (1 operating + 1 standby) located outside the tank dyke. The slop tanks(s)
should be provided with temperature gauge at different elevations of the tank. A level indicator and a high level alarm should be provided at the slop tank as shown in Fig.4. These indications and alarms should be taken to the control room and / or the local instrument panel as the case may be.

It is essential that draining operations from the main crude tanks and the slop tank shall be properly supervised by the operator to avoid large quantities of crude getting carried over into the sewer.

5.1.5 Other Aqueous Blowdown - Intermittent in Nature

Such blowdown streams are not continuous, but required to be handled during frequent draining or venting operations while the plant or facility is under normal operation. Typical examples of such systems are - water draining from boot leg of reflux drum, compressor suction knockout drum etc. Usually, these streams consist of water, but may carry some traces of hydrocarbons. However, if not handled properly, large quantities of hydrocarbons can be drained along with water which can pose serious hazards.

The blowdown shall be provided with manually operated double valves to enhance the integrity of isolation. It is essential that intermittent draining of water from storage tanks shall always be done under supervision. A typical arrangement of draining water from product storage, LPG storage vessels is depicted in Fig.5.

For LPG, Propylene, Propane etc storage vessels, the draining connection shall be given at downstream of ROV at bottom line and water shall be drained through a Dead man’s valve as depicted in Fig.5

5.2 HYDROCARBON BLOWDOWN STREAMS

i) Hydrocarbon blowdown streams contain mainly hydro-carbons. Most of these streams such as compressor suction knock out drums, are intermittent in nature and are required to be handled during frequent draining or venting operations while the plant or facility is under operation. Such streams are also required to be handled during a planned or emergency shutdown or start up of the plant/facilities. It is essential that such operations shall always be done under supervision. The blowdown drain or vent lines shall be provided with double valves to enhance the integrity of isolation and routed to CBD/flare.

Draining from the process equipment can also be done with on/ off control valve. For this system should have suitable instrumentation/ shutdown logics to ensure safety of system.

ii) Sour Water Disengaging Drum

Sour water from different process units is collected in sour water disengaging drum before sending to sour water stripper. The hydrocarbon oil gets separated from the sour water and floats oil on top of water, which subsequently overflows to other side of chamber in the disengaging drum. The drum is floating with acid gas flare system. The hydrocarbons are drained out time to time from the oil chamber.

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Draining should be done through a drain line provided with i). Alarm for the minimum level of the oil chamber ii). Remote operated shutdown valve to isolate the drain to stop any emergency escape of H2S vapour into atmosphere. H2S gas detector/monitor should be provided near the drain point for early detection. A typical arrangement of such a blowdown drum is depicted in Fig. 14. The excess stripped water from the sour water stripper, if any, should be routed to ETP through a separate header and not to be drained in to OWS system.

5.2.1 Draining and venting from LPG/Cryogenic Product Pumps:

Draining and venting of pumps handling LPG and other cryogenic products should be done very carefully. The products coming out of these pumps would flash immediately giving large quantities of vapours and also create low temperature in the vent and drain piping.

Such pumps shall be drained/ vented to flare/ closed system. The drain connection to oily sewer/ CBD shall be provided with isolation to facilitate draining of water or liquid hydrocarbons. A typical scheme for handling such streams is depicted in Fig.7. Double valves shall be provided on the vent and drain header line

While handling cryogenic liquids, the temperature in the vent/drain lines may drop down due to flashing of liquid form higher pressure to lower pressure. This phenomenon should be considered while selecting the materials for such piping. Also due to this phenomenon ice formation can take place around isolation valve and hence second isolation valve in such draining system shall be anti-freezing type.

5.2.2 Draining/Venting from other Hydrocarbon Pumps:

During start up operation, it is required to drain or vent/bleed hydrocarbon pumps occasionally. Drain connection to oily sewer/ CBD with valve shall be provided to facilitate draining of water or liquid hydrocarbons. Double valves shall be provided on the vent and drain header lines as shown in the Fig 6.

Venting and draining of pumps handling hot products can lead to hazardous conditions due to auto ignition. This risk is higher especially for hot and heavy products like fuel oil etc. whose auto-ignition temperatures are usually lower (250 Deg - 300 Deg. C range). A typical scheme for handling such streams is depicted in Fig.6. A suitable arrangement for cooling of such hot material being drained and vented from the pump shall be provided to cool the liquid before draining to closed system.

The pumps handling Class-A hydrocarbons shall be drained to CBD only.

5.2.3 Draining of Equipment for Shutdown:

Various equipment are required to be drained free of hydrocarbons and other hazardous materials during shutdown for maintenance or inspection. For infrequently used connections normally associated with equipment maintenance, the drain lines shall be

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provided with double block valves and the connection shall be plugged/ capped/ blinded for integrity of isolation. Drain lines carrying such streams from process equipment having significant inventories shall be piped to the unit closed blowdown drum(s) or a pump out header for the safe recovery of the hydrocarbon product. Fig.10 depicts a typical arrangement of the draining system.

5.2.4 Sample Points:

Closed sampling system should be provided for all sample points with an objective to avoid/minimize Hydrocarbon draining / venting to atmosphere. Sampling lines should be small in size (preferably ½” dia.) and the dead portion of the sample line shall be minimised (preferably limited to less than 2 feet). Each sampling line shall be provided with two valves, one isolating valve and the other regulating valve. Process related sample points should be located at one convenient location in the unit and a collection tray shall be provided below the sample points. Open draining of the hydrocarbon streams shall not be allowed within the unit area. The drain from the sample point shall be routed to OWS. Hot products should be provided with suitable sample coolers. See Fig.8 for a typical sample point’s installation.

LPG sampling shall be done as detailed in OISD-STD-144 and gas sampling shall be done in closed loop system.

5.2.5 Gas-Condensate Blowdown:

When the blowdown stream consists of condensate drawn-off from gas-liquids separators inter/after condensers/coolers or compressors etc. the blowdown line should be provided with automatic shutdown valve actuated on low level in the separator to avoid gas blow-by in the downstream liquid system which usually operates at lower pressure. A typical scheme for handling such streams is depicted in Fig.9

5.3 EMERGENCY BLOWDOWN FOR LPG AND CRYOGENIC VESSELS

During a fire emergency, above ground vessels containing LPG and other such products pose additional hazards because of BLEVE (Boiling Liquid Expanding Vapour Explosion) effect. The fire increases the internal pressure and weakens the vessel until the vessel can no longer contain the pressure. The vessel ruptures violently, with its parts propelled to great distances. The released liquid flashes often resulting in a large fireball. The fireball can cause very widespread damage due to flame contact. Although the fire ball lasts only a few seconds, its effects can be devastating. Pressure vessels containing LPG or other such liquids located in the process areas have higher risks to BLEVE as compared to storage vessels in the offsite area.

In a fire situation, therefore, it is desirable to empty out the liquid inventory of the process vessels containing LPG etc. to a safer location. Such vessels therefore should be connected to fuel gas system/ flare/ unit blowdown drum through adequately sized line so that the liquid content of the vessels can be quickly emptied in the shortest possible time (say 5-10 minutes). The blowdown line from the vessel should be provided with a tight shut

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off shutdown valve remotely operated from the control room. The blowdown drum can be the common light oil blowdown drum located at one corner of the unit and connected to the flare header. The liquid contents from the blowdown drum can be pumped for reprocessing or recycle etc. The capacity of the drum should be adequate to receive the total contents of a single process vessel containing LPG or similar materials. This drum should not be combined with hot blowdown drum which receives heavy and fouling type products (e.g. CBD). A typical arrangement of such a blowdown drum is depicted in Fig.11. Refer OISD-STD-106, Standard on “Pressure Relief and Disposal System” for more details on blowdown drums.

Similar blowdown for large size offsite storage vessels is usually not practicable. However, facilities for transferring inventory of LPG etc from one storage vessels to other should be considered.

5.4 CHEMICAL BLOWDOWN

Like aqueous blowdown streams, chemical blowdown streams and drains may be continuous or intermittent. These should be handled with care to avoid accidents. The design and operating philosophies for handling continuous and intermittent aqueous blowdown streams shall be as discussed earlier under “Aqueous Blowdown”. The continuous chemical blowdown streams shall be controlled automatically through the vessel level control and where there is a possibility of hydrocarbon phase coming out with the chemical, disengaging drums should be provided. The integrity of isolation of intermittent blowdown streams by double valves, blinds or caps shall be ensured and routed to OWS/Chemical sewers as applicable. Refer section 6.2.3 for disposal of chemical blowdown streams. Examples are amine blow down, solvent blow down, caustic drains, drains from chemical additive storage and pumping area etc.

5.5 TTL / TW gantry Blow down system:

i) In rail/road gantry there are chances of oil spillage from loading arms drippings after removal of loading arm from tanker. To avoid this oil spillage and loss of material an open funnel shall be provided to collect the hydrocarbon dripping from loading arms which shall be routed to slop header. Through slop header shall be routed to an underground vessel similar to CBD drum in the gantry area. The material from this sump shall be pumped to slop tank. A typical sketch -12 is attached

ii) Open channel fully covered with grating shall be provided around the Tank wagon/ tank truck gantry to collect any oil spillage during the loading. Oil and water collected from loading areas shall be routed to ETP. Where ETP facility does not exist, as in the case of terminals/bulk plant/depots, local oil collection and separation system shall be provided. Depending on size, this could be a catch basin or trap, API separator or similar facility. A slop tank should be earmarked for storing separated oil.

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6.0 DISPOSAL OF BLOWDOWN

The various blowdown streams should be disposed off safely to their respective destinations. Selection of disposal system will depend on the type of blowdown stream. Disposal system shall be closed pressurised system or gravity sewers.

6.1 CLOSED BLOW DOWN SYSTEM

All hydrocarbon blowdown streams free of water and chemicals etc. which are drained from various vessels and equipment are received in a Closed Blowdown Drum (CBD) at one corner of the unit.

The closed Blowdown (CBD) system eliminates atmospheric venting and useful in case of toxic and hazardous gases. It eliminates the risk of liquid back up into other module at different levels.

The vessel/ equipment shall be depressurised before draining to CBD. Liquid levels in equipment shall be lowered to minimum practically possible level using normal process connections before it is fully depressurized through draining via CBD system.

Depressurization can lead to cooling of vessel contents. The vessel should be allowed to regain ambient temperature before admitting to the CBD system. Care must be taken to minimise the risk of back pressure due to line blockage and draining of vessel under full pressure.

i) All drains from equipments shall be connected to CBD header.

ii) All CBD lines in the unit shall be isolated from equipment by double block valves and intervening spade or spectacle blind.

iii) CBD header shall be buried pipeline with suitable external protective coating to prevent it from corrosion.

iv) CBD header shall be sloped towards the CBD Drum (buried / placed in a pit) to prevent any vapour reaching / flashing in the drum.

v) At the dead end of the CBD header steam and/ or inert gas connections shall be provided for proper purging and cleaning of the header.

vi) The blowdown drum can be a common drum for more than one process units and shall be located underground at a leeward side of the unit with its vent routed to flare. CBD can be buried or placed in open pit.

vii) In case CBD is buried, the drum shall have suitable external protective coating to prevent it from corrosion. The providing cathodic protection to buried drums for corrosion protection can also be considered. A Brief Write up on design and requirement of CP System for buried CBD is given in Annexure-I.

viii) In case CBD is kept in pit, a system shall be installed to evacuate the liquid/ HC accumulated in the pit.

ix) Vapours from CBD vent shall be directed to flare system. The CBD vent can be opened to atmosphere with the provision of snuffing steam only if flare system is not available in the installation.

x) Liquid collected in CBD shall be pumped to slop tank / suitable destination. Vertical submersible pump is used for pumping out the contents of CBD and it

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shall have automatic starting and stopping facility on high and low liquid levels in the drum.

At least two pumps with independent power supply as specified in OISD-STD-106 for flare KOD pump shall be provided in case unit flare KOD contents are routed to CBD.

The CBD shall have level indication in the control room inline with OISD-STD-152. CBD shall be provided with suitable heating/cooling coils as per the material being handled.

The blowdown streams shall be routed to feed system, slop tank or downgraded to other products, by suitably designed closed piping system. These streams shall not be put into sewers from safety and loss considerations. A typical scheme of such system is depicted in Fig. 10.

6.2 SEWER DRAIN SYSTEM

Gravity sewer drains are extensively used in the petroleum industry for the routing of various waste and blowdown streams containing oily, chemical and other wastes etc. Generally such items of plant or facility get low profile, but the importance of their good design and operating practices cannot be under-estimated from the safety and loss prevention point of view. Important guidelines for the design and operation of sewer system are provided in this section. These waste water streams should be segregated and treated suitably for recycle/reuse to minimise water consumption.

Depending upon the nature of waste streams, the sewers should be segregated as below:-

6.2.1 Oily Water Sewers:

Oily water sewer shall collect oily waste/drain from pump, equipments through funnel points and shall run with separate headers and manholes. The regular oil contamination areas shall also be segregated and discharge from these areas shall be collected in a catch basin to be joined in oily water sewer.

The following aqueous streams generally have some oil content carried by them. These streams should be routed to effluent treatment plant through oily water sewer system. The recovered oil should be reprocessed and treated effluent water shall be reused to conserve water:

i) Oily water from process unit - Reflux drums, separators, disengaging drums, etc.
ii) Gland and seal cooling/quenching water from pumps/compressors etc.
iii) Brine water/sour water.
iv) Process wash water.
v) Oily water from hot wells.
vi) Floor and paving drains including contaminated rain water.
vii) Oil + water overflow from quench drums.

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viii) Once through water from barometric condensers
ix) Hydrocarbon tanks’ drains
x) Sample point drains.
xi) Oil contaminated steam Condensate if no condensate recovery and treatment facilities exist.
-xii) Tank Dyked area drains

6.2.2 Storm Water Sewers:

Waste water which has no oil and other objectionable material can be handled by storm water system. This system includes closed conduits and open channels/ditches. Following streams should be routed to storm water sewer system.

i) Rainfall from clean areas (oil/chemical free)
ii) Boiler blowdown
iii) Steam condensate
iv) Tank Dyked area drains (additional routing should also be provided to oily water system in case dyke water is contaminated with oil)
v) Treated water effluent from DM water plants if PH and COD are Okay.
vi) Process cooling tower blowdown,
vii) Captive power plant cooling tower blowdown streams

Unit Storm water Drainage:

To collect the uncontaminated rain water, a peripheral storm water ditch shall be provided all around the unit with suitable grating. The water thus collected shall be routed to OSBL (Outside Battery Limit) storm water drain by providing two way valve arrangements at outlet point at battery limit. The discharge of the drain shall be normally open to OSBL storm water drain. In case of accidental contamination taking place in uncontaminated area, the two way valve shall be operated to route the water to contaminated rain water sewer (CRWS) instead of storm water drain.

Tank farm Storm water Drainage:

Open ditch shall be provided in tank farm along the inside face of dyke/ fire wall. A sand trap shall be provided at outlet point of tank farm. A three way valve arrangement shall be provided just outside the tank farm to route the water discharge of tank farm area either to offsite storm water drain or to OWS depending on whether the water is uncontaminated or contaminated.

Identification of Sewer System and Route Marker:

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Following details shall be distinctly displayed near manhole top slab.

a. Service Name  
b. Size of Sewer  
c. Flow Direction  
d. Manhole number

6.2.3 Chemical Sewers:

Sewers carrying drains/effluent wastes containing chemicals shall be segregated from other sewers since these streams often require different treatment than oily water streams before final disposal. Such streams are also generally corrosive and may require special materials of construction for the sewers. Since the nature of treatment may be chemical specific, it is necessary that the quantities, type and compositions of all such streams likely to be handled in the process areas; chemical storage, handling and dilution etc. should be thoroughly studied to decide their segregation and treatment.

If chemical waste affects only oxygen demand and solid content of the effluent, these can be discharged to the oily water system downstream of primary oil separation but upstream of biological treatment. However, when pH, odour, taste, colour, turbidity etc. are affected, appropriate special treatment should be considered at suitable stage before biological treatment. Since each chemical may require a specific treatment, it is difficult to generalise the treatment facilities here. Detailed guidelines for effluent treatment facilities are therefore not included in the scope of this document. The requirements of chemical effluent streams of amine and spent caustic which are most commonly available in refineries are given below:

i) Amine Blow Down Stream:

Amine drains from equipments handling amine solution (e.g. vessels, columns, lines & pumps, etc.) shall be routed to a dedicated underground Amine blowdown drum floating on acid flare.

Amine drains shall not be routed to any other hydrocarbon CBD system due to following reasons:

a) Draining of amine to hydrocarbon blow down system will lead to contamination of hydrocarbon stream as the mixing of amine and hydrocarbon blow down system will result in amine entering the slop tank (subsequently to crude oil tank) which will result in corrosion of downstream system during reprocessing of slop.

b) Amine mixing with hydrocarbon will form foaming in the amine scrubbers which leads to poor performance of scrubber and high pressure drop in the amine columns.

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c) Amine is very expensive item and can be reused whenever there is planned shutdown of the unit, any residual amine in the system can be collected separately in a blow down system and pumped back to the amine storage from amine blow down vessel for reuse.

ii) Draining condensate from H₂S rich gas from amine & stripper Sour Gas KODs

The liquid condensate from H₂S rich gas of amine KOD & stripper Sour Gas KOD are required to be drained continuously to amine blow down drum and sour water blow down drum respectively to prevent choking of drain lines. Draining should be done with provision of minimum level control of KODs to prevent escape of vapour into blow down system and choking of the drain line.

Amine blowdown drum shall be provided with submerged pump. Liquid from this drum shall be sent to ARU for reprocessing. For design requirement of ABD shall be similar to hydrocarbon CBD as given in Clause 6.1.

iii) Spent Caustic:

Caustic drains should be collected in caustic drum and pumped out through submergible pumps to the wet air oxidation treatment facility for treatment (as described in Annexure II) before routing to Biological/activated sludge treatment or final disposal.

6.2.4 Sanitary Water Sewers:

Sanitary water sewers should collect waste from toilet facilities and route these to a treatment system in the complex, municipal sewer system or to a septic tank depending upon the local condition. The treated sanitary effluent may be discharged to the treated oily water system, to the storm water system or independently to the desired disposal point.

6.3 BASIC DESIGN GUIDELINES FOR OILY-WATER SEWERS

6.3.1 Layout of Oily Sewers:

Oily water sewer (OWS) shall consist of underground carbon steel sewer, funnel points, clean outs, leak proof RCC catch basins and manholes, vent pipes, etc.

A) REQUIREMENT OF SEALED MANHOLES:

The layout of most oily water sewers consists of a trunk sewer with branch connected to process units, dyked areas and other work areas. The main trunk sewer should be isolated from branch sewers by sealed manholes so that the vapours cannot back up into processing areas. Seals play a vital role in maintaining safe operation of a sewer system. Sealed manholes shall be provided on oily sewers at the following locations:

(a) Process Units

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i) At unit battery limit of the unit area a sealed manhole shall be provided to cut off from any fire in offsite areas or vice versa.

ii) Within process units, sealed manholes shall be provided in such locations so that each sub-unit within the unit is isolated from other areas. Where such demarcation is difficult, one sealed manhole for every 30 M length of unit sewer shall be provided.

iii) At change of direction of sewer line.

iv) At entry of branch line to manhole.

(b) **Offsite Areas**

i) At connection manholes of branch sewers to main sewers to isolate each facility contributing oily waste from the risk of fire. Such connections may be from tank farms, offsite pump stations, oil loading/unloading areas, railway gantry areas, compressor house, etc.

ii) On main sewer lines at suitable points so as to provide fire barriers for segregation of vital hazardous installations from each other. In general sealed manholes on main sewer lines shall be provided at intervals of not more than 300 meters.

**B) TYPE OF SEALED MANHOLES**

The following fire sealed manholes should be provided:

(a) Single compartment sealed manholes with bent pipes seal type shall be used for CS pipes upto diameter 16”.

(b) Double compartment type sealed manholes shall be provided for CS pipes greater than 16” dia and for all sizes of RCC pipes.

(c) A minimum of 150 mm fire seal shall be provided for both single and double compartment type manholes.

Fig. 13a, 13b & 13c depict Single compartment and double compartment type sealed manholes.

Sewers, in general, should be designed for gravity flow. In a tightly sealed system, a rise in water level would reduce the vapour space causing obstruction to flow. Therefore vents shall be installed on the manhole to maintain atmospheric pressure in the sewer and to release vapours to safe locations. Following shall be ensured during design stage to ensure that accidental release of vapours do not create unsafe condition:

i) At least one vent shall be installed on manhole for every 100 meter in offsite area,

ii) Vents shall not be located near furnaces etc.

iii) The vent of height shall be 3 metre above the nearest tallest structure within 15 metre radius.

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iv) In critical locations, the vent pipes should be provided with steam snuffing connections.

v) Vents should be connected to VOC control system to minimise VOC emissions.

6.3.2 Capacity

The branch sewers from processing areas should be designed for the greater of the following two situations

i) Rainfall plus process waste water with the sewer flowing at 2/3 of full depth.

ii) Process waste water plus expected fire water runoff with sewers running full.

The design capacity of the trunk sewer should depend on the cumulative amount of used cooling water and condensate from various processing areas and the storm drainage from the paved areas and the largest tank dyke area. Trunk sewers generally drain large water shed; therefore, fire water flows are not governing for their sizing. However, this should be checked.

A minimum velocity (at half full or running full) of 0.6 m/sec should be maintained in the branch and trunk sewers to avoid settling of solids. If the water consists of large quantities of sediments, the minimum velocity should be increased to 1m/sec. The maximum velocity should be limited to 2.4 m/sec. The slope of sewers should be decided based on the sewer size.

6.3.3 Material of Construction:

Material of construction for sewers shall be as per IS 1239 ERW.

i) Inside process units, tankage area, offsite pump house and other paved areas CS pipes shall be used.

ii) For offsite main header in unpaved area RCC Hume pipes shall be used.

iii) In case salt water is likely to be used in plant and discharged to drainage system, cement coated piping shall be used.

All underground CS pipes shall be provided with external double wrapping and coating / FRP coating for corrosion protection.

6.4 SPECIAL SEWERS

Because of special nature of some effluent stream-high pour point, wax content, viscosity and other fouling characteristics as is the case with asphalts, waxy lube/intermediates and other similar products, their drains should not be routed to oily water sewers directly as there is danger of the entire sewer system getting choked. Such product drains should be handled separately. Some specific cases are mentioned below:

6.4.1 Asphalt Drains

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All equipment and areas where effluent streams containing asphaltic material is likely to be handled should be segregated from other areas by a 4”-6” high concrete bund wall having a baffle at one end. A small water stream should always be kept flowing in the bund. The water should overflow into a catchpit having two compartments from where the water should overflow into the oily water sewer. Asphaltic material which gets trapped in the catchpit should be occasionally scrapped off manually by isolating one compartment. Provision should also be made for steaming the catchpit in case required.

6.4.2 Waxy Drains

All equipment and areas where effluent streams containing waxy materials are likely to be handled should be likewise segregated from other areas by a 4”-6” high concrete bund wall having a baffle at one end. The water should overflow from the baffle into the oily water sewer. The wax will get deposited within the bund from where it should be scrapped off occasionally.

6.4.3 Drains at Remote Locations

Sometimes because of small capacity of an installation and/or its remote location, it may not be feasible to have elaborated oily water sewer system and treatment facilities. Under such situations, local sumps shall be provided for collection of oily water effluents from such an installation. Oil sumps shall be designed as miniature oil separators with outlet baffles to retain oil. Suitable skimming arrangement shall be provided to withdraw oil to a storage pit, from where it can be pumped out to slop, tank or barrels etc. Oil sumps however are not very efficient for complete removal of oil from waste.

Alternatively, a “Tilted plate” type of oil-water separator can be specified. Oil removal in such separators is very good and the treated wasted water almost oil free. If waxy or fouling type of products are envisaged in the waste water, a grid screen or a filter should be used upstream of these separators.

7.0 REFERENCES:

5. OISD Standard 106 on Pressure Relief and Disposal System.
6. OISD STD 152 Safety instrumentations for process system in hydrocarbon industry
7. OISD STD 144 on Liquefied Petroleum Gas (LPG) Installations
8. IS standard no IS 1239

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Annexure-I

Brief write up on Cathodic Protection (CP) system for CBD drum

Cathodic Protection:

Cathodic protection is an electrochemical technique which is the most effective method for corrosion prevention. It is a least costly method for protecting immersed structures in soil and aqueous medium against corrosion. Sacrificial anode and impressed current are the methods for applying cathodic protection. In sacrificial CP system, electrons are generated from a base metal which is more anodic to the protected structures. Whereas in impressed current CP system, electrons are supplied from a DC source and in electrolyte the current is fed through a non-consumable electrode. A reference electrode is used to check the efficacy of the CP system.

General description for CP system for CBD vessel

Impressed current cathodic protection system shall be installed for buried CBD vessel having shallow distributed close anode ground beds. Each vessel shall have independent CP system comprising of one 50V/50A T/R unit, requisite no. of anode beds associated with AJB and CJB, reference cells, test station box, cables etc. Each vessel shall have anode beds, 4 nos. permanent reference cells, 2 drainage cable connections and associated cables, structural and civil works.

Each anode bed shall be of shallow, close and distributed type consisting of continuous wire anode. The power for T/R unit is fed from one Power distribution box. In order to accurately monitor the CP system, 4 nos. of permanent reference electrodes (Cu/CuSO4) with pre-packed chemical backfill are to be placed in 12, 3, 6 & 9 O’clock positions for each vessel. Spacing of wire anode from vessel shall be kept 900mm.

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Spent caustic treatment through wet air oxidation technology

Spent caustic streams are generated from the purification process of Naphtha, Gasoline and LPG streams and contain pollutants like Sulphides, oil, phenol, BOD/COD and spent caustic. It can be treated through the process of Wet Air Oxidation Treatment before routing to Biological/activated sludge treatment wherein Sulphides are converted to soluble sulphates, which is harmless.

The process chemistry is based on the conversion of the obnoxious Sulphides to less objectionable sulfates & Thiosulphates with air at elevated temperature and pressures. The thiosulphates are water soluble & retained in the effluent water and the sulfates are completely harmless and nontoxic.

The principle reactions in oxidation tower are:

\[
2\text{Na}_2\text{S} + 2\text{O}_2 + 2\text{H}_2\text{O} \rightarrow \text{Na}_2\text{S}_2\text{O}_3 + 2\text{NaOH}
\]

\[
\text{Na}_2\text{S} + 2\text{O}_2 \rightarrow \text{Na}_2\text{SO}_4
\]

Some portion of Thiosulfate is further oxidized to sulfate as follows.

\[
\text{Na}_2\text{S}_2\text{O}_3 + 2\text{O}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}
\]

The spent caustic contains the impurities such as Sulphide, COD as high as 10,000 mg/litre & 15,000 mg/litre respectively along with phenol & oil. The conventional Biological process finds it difficult to treat these pollutants. The Typical wet air oxidation process efficiently reduces these impurities.

The spent caustic is stored in settling tanks to equalize fluctuations in caustic flow & to remove floating oil from top of the tanks. The caustic tanks should be blanketed with Nitrogen. The spent caustic is preheated with hot oxidized caustic from the Reactor in a heat exchanger. This hot spent caustic solution after mixing with process air & steam in injector enters the feed reactor. The air flow will be controlled by Flow controller & the steam flow by the temperature controller of the Reactor. Here sulphide gets oxidised to sulphate in the reaction sections and separated by sieve trays in order to ensure a sufficient distribution of caustic and air.

The reaction temperature is approx 120\(^\circ\)C at the beginning and increase to approx 136\(^\circ\)C due to exothermic reaction. The caustic stream goes upward in co-current flow with the oxidation air and leaves the reactor at its head after being separated from the oxidation air. The wet and hot oxidation air usually containing stripped hydrocarbons is vented via high point vent pressure controller to atmosphere. Hot oxidized caustic is cooled down by exchanging heat with the cold incoming spent caustic feed to the reactor. The oxidized caustic is routed to the biological treatment system /
activated sludge treatment system of waste water treatment plant the typical levels of pollutants in spent caustic before and after the treatment is given in the table below:

**Table – 1: Typical levels of pollutants in spent caustic before and after treatment**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>Before treatment</th>
<th>After treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Sulphides</td>
<td>Mg/litre</td>
<td>10,000</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>COD</td>
<td>Mg/litre</td>
<td>15,000</td>
<td>About 2500</td>
</tr>
<tr>
<td>Oil</td>
<td>Mg/litre</td>
<td>200</td>
<td>&lt; 15</td>
</tr>
<tr>
<td>Phenol</td>
<td>Mg/litre</td>
<td>1000</td>
<td>&lt; 800</td>
</tr>
</tbody>
</table>

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Typical scheme of the Wet Air Oxidation process for spent caustic treatment
Use of Single / Double compartment sealed manholes for OWS (Oily Water Sewer) in Hydrocarbon Industry

For all sizes of RCC (Hume) pipes double compartment sealed manholes are only used to avoid use of bends as the sealing of joints in case of RCC (Hume) pipes is not proven as leak proof.

Carbon steel pipes up to 16” diameter are used for construction of single compartment sealed manholes. Perfect sealing of pipe bend is achieved by welding.

Length of the bends of CS pipes larger than 16” dia is very high. For construction of single compartment sealed manholes with these large length of bends leads to increase in the depth of these manholes. Construction of such deep chambers is not advisable from techno economic considerations. Hence double compartment sealed manholes are used for these larger sizes of CS pipes.
FIG-1
CONTINUOUS AQUEOUS BLOW DOWN: NON VOLATILE
FIG. 3
CONTINUOUS BOILER BLOWDOWN

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Note: SDV switch to be placed at a safe distance from the shut-down valve in addition to Control Room switch.