MANUAL

DIESEL OIL SYSTEMS IN OIL AND GAS PRODUCTION FACILITIES

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

This new DEP specifies requirements and gives recommendations for the design of diesel oil systems as installed in oil and gas production facilities and gas plants. It covers manned and unmanned, onshore and offshore, drilling, producing and gas conditioning installations. It does not cover LPG plants, and/or refineries and chemical plants; these are covered in DEP 20.05.60.10-Gen.

The scope of this DEP is the complete diesel oil system as required for the reception, storage and treatment of the diesel oil and its distribution to the various end users, within the following boundaries:

- Diesel supply to facility - hose coupling at loading station;
- Diesel to users: block valve either downstream of day tanks or at equipment interface;
- Drains: open drain tundishes.

Other utilities which interface with the diesel system are outside the scope of this DEP.

The figures in this DEP are intended to illustrate process design concepts only. Details such as safety relief valves, heat tracing and insulation are not included.

As there can be significant variations in diesel oil system requirements from one location to another where operational and environmental priorities may differ, this DEP cannot cover every system specifically. Nevertheless, the design principles described in this DEP shall be considered in all designs and applied as relevant to the particular circumstances.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIEP, the distribution of this DEP is confined to companies forming part of or managed by the Royal Dutch/Shell Group and to Contractors nominated by them (i.e. the distribution code “C” as defined in DEP 00.00.05.05-Gen.).

This DEP is intended for use in oil and gas production facilities and gas plants.

If national and/or local regulations exist in which some of the requirements may be more stringent than this DEP, the Contractor shall determine by careful scrutiny which of the requirements are more stringent and which combination of requirements will be acceptable as regards safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned with the object of obtaining agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project, or operation or maintenance of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer**/ **Supplier** is the party which manufactures equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Cetane Number	an index of ignition quality determined by comparison of the test fuel with fuels used as standards for high and low cetane numbers.
Cloud Point	the temperature, expressed as a multiple of 1 °C, at which a cloud or haze of wax crystals appears at the bottom of the test jar when the oil is cooled under prescribed conditions.
Cold Filter Plugging Point (CFPP)	an experimental measurement determining the flowing properties of diesel. It has replaced the Pour Point as more accurately predicting diesel's flow characteristics in engine fuel systems.
Pour Point	the lowest temperature, expressed as a multiple of 3 °C, at which the oil is observed to flow when cooled and examined under prescribed conditions.
Not Normally Manned Installation (NNMI)	an unmanned platform designed with minimum equipment for high reliability and minimum maintenance. NNMIs are operated remotely with small multi-skill teams visiting six to nine times per year.

1.4 ABBREVIATIONS

BS&W	Base Sediment and Water
DCS	Distributed Control System
ESD	Emergency Shutdown
HAZOP	Hazard and Operability
NNMI	Not Normally Manned Installation
PEFS	Process Engineering Flow Scheme

1.5 CROSS-REFERENCES

Where cross-references to other parts of this document are made, the referenced number is shown in brackets. Other documents referenced in this DEP are listed in (5).

2. GENERAL CONSIDERATIONS

2.1 THE ROLE OF DIESEL OIL IN OIL AND GAS PRODUCTION FACILITIES

Diesel oil (2.2) may be used for various purposes on oil and gas production facilities. Its primary use, however, is that of a (motive) fuel, i.e. a substance that can provide self-sustaining combustion in air and provide a source of useful heat.

The term fuel applies to both liquid fuels and gaseous fuels. Fuel systems on EP production installations can be divided into four different categories:

- fuel gas systems;
- crude oil and residual fuel oil systems;
- distillate liquid fuel systems;
- aviation fuel systems.

This DEP covers distillate liquid fuel systems, specifically those systems handling diesel oil, but it should be realised that there may be interaction with other types of fuel, e.g. where diesel oil is used as a back-up fuel for another type of fuel.

In this context, diesel oil is a refined fuel imported and stored to run emergency services and to provide power during start-up and maintenance turnarounds when produced gas/oil or imported electricity is not available. Typical users of diesel oil as a motive fuel are (3.3.2):

- dual fuel (gas and diesel) turbine generator sets;
- diesel engine generator sets for emergency services, black start and/or basic services;
- diesel engine generator sets for drilling services;
- dual fuel (gas and diesel) mechanical drive turbine sets;
- diesel engine driven fire pump sets;
- water heaters.

Finally, there are a number of non-fuel uses of diesel. These include its use as a solvent for corrosion inhibitor in the main production facilities, back-filling of pipelines prior to commissioning, a solvent for well-stimulation chemicals, wellhead equalisation and as a light hydrocarbon to displace well completion fluid before production starts.

As can be appreciated from the foregoing, the number and type of diesel users will vary significantly from facility to facility. Appendix 2 lists typical users for each type of facility.

2.2 DIESEL OIL PROPERTIES

Diesel oil is the generic term used for the distillate fuel oil supplied to production facilities. In refineries, the particular distillate produced for industrial engines is known as gas oil, which in the UK is marketed to BS 2869: Part 2 as Classes A2 and D (for the purpose of this DEP, the name diesel oil will be retained). Class A2 differs from Class D only by the addition of a cetane specification required by diesel combustion engines. Refiners generally make all their gas oil to Class A2, refer to (Appendix 3) for details.

Special constraints apply for liquid-fuelled gas turbines, where physical and chemical properties of the fuel affect combustibility and contaminants can cause damage to the unit such as hot section corrosion, erosion (on blades etc.) and fouling. Removal of solid contaminants, such as sand, rust, and micro-organisms, can often be effected by filtering and/or biocide treatment. Water-soluble salts, such as sodium, potassium, calcium and magnesium, can often be removed by washing and drying the fuel oil. Removal of corrosive contaminants that are chemically bound to the hydrocarbon fuel (or which are oil-soluble), such as vanadium and lead, is not viable.

With respect to contaminants, only solids are addressed in the diesel standards. The soluble metal contaminants which can cause blade damage, particularly in high temperature aero-derivative gas turbines, are not mentioned.

Vanadium contamination can occur if diesel is transported in containers previously used for crude oil or residue, while lead contamination can be picked up from previous gasoline cargoes.

Sodium is a more common diesel oil contaminant. Some sodium is picked up in the refinery through the addition of diesel blending streams neutralised with caustic. More sodium contamination can occur during transportation, particularly to offshore locations due to salt water ingress.

As a guide, maximum fuel contamination for gas turbines should not exceed the accepted limits for standard liquid fuel (for which LHV = 42 680 kJ/kg):

Sulphur (S)	10 g/kg	x	(LHV) / 42 680 kJ/kg
Vanadium (V)	0.5 mg/kg	x	(LHV) / 42 680 kJ/kg
Sodium plus Potassium (Na + K)	1.0 mg/kg	x	(LHV) / 42 680 kJ/kg
Lead (Pb)	1.0 mg/kg	x	(LHV) / 42 680 kJ/kg
Calcium (Ca)	2.0 mg/kg	x	(LHV) / 42 680 kJ/kg

NOTES:

1. Since contaminants can also come from air and injected water, the total level of contaminants passing through the compressor shall be considered.

2. For the purposes of diesel oil system design, the maximum acceptable level of sodium in the fuel is taken as 0.3 mg/kg (assuming an equivalent 0.3 mg/kg is ingested with the combustion air). This means that seawater contamination in diesel shall be reduced to approximately 25 mg/kg for gas turbine fuel. Water and sediment levels of diesel oil for diesel engines should not exceed 0.1%.

3. For diesel engines, fuel sulphur content should be limited to 0.4% wt (BS 2869 maximum sulphur content 0.2% wt). Higher sulphur contents will require the use of high total base number (TBN) oils or shorter oil change intervals.

Fuels specified to BS 2869 Class A2 and D will also meet the other requirements. Care must be taken, however, to avoid contamination during transportation. The equivalent US specification for diesel fuels oils is ASTM D 975.

In general, fuel characteristics shall comply with the equipment manufacturer's fuel specification, and any noted departure from specification requirements shall be submitted for review.

2.3 HAZARDOUS AREA CLASSIFICATION

Diesel oil to BS 2869 will have a flashpoint of 56 °C minimum. For the purposes of area classification, diesel oil may be considered as **not** giving rise to a hazardous area, so that hazard zoning is not necessary for the surrounding plant provided that the following two conditions are met:

- the diesel oil will be handled below flashpoint;
- the release of diesel oil will not be in the form of a flammable mist, spray or foam.

Where elevated temperatures or pressures may arise, e.g. due to the type of surrounding plant, or where the surrounding plant itself gives rise to a hazardous area, the diesel oil system components shall be designed as applicable to the hazardous area classification requirements (DEP 80.00.10.10-Gen). The requirements for the diesel oil system to be operational under the facility's emergency conditions shall also be considered (2.4).

2.4 SAFETY CONSIDERATIONS

In general, the design of diesel oil systems, in particular pressurised systems, shall be reviewed as part of the HAZOP studies for the facility. Actions on gas detection and/or fire detection should be as set out below.

2.4.1 Action on gas detection

Status of hazard alert resulting from gas detection in hazardous areas shall cause automatic shutdown of electrical equipment not suited for hazardous atmosphere.

Where a supply of diesel has to be maintained during emergency situations, e.g. to the emergency generator, the electrical equipment shall comply with the hazardous area classification effective during such emergencies.

2.4.2 Action on fire detection

Status of hazard alert resulting from fire detection shall cause automatic shut-off of diesel supplies.

This shall be accomplished by automatic shutdown of the diesel forwarding pumps and automatic shut-off of the diesel outlet from bulk storage tanks. Supplies to and from day tanks shall be fitted with shut-off valves that can be operated from a safe position, i.e. outside the area where the tank is located.

Since fire pumps, emergency generator(s) and most other equipment will be fitted with day tanks, there will be no immediate shut-off of diesel users in unaffected areas. Following isolation of supplies to affected areas, the forwarding pumps can be restarted after inhibiting the pump shutdown signal.

2.5 INSTRUMENTATION AND CONTROL

Specific instrumentation requirements will vary from project to project, with the individual project requirements covering overall aspects such as central control room monitoring (DCS) and control requirements, use of local control panels, selection of pneumatic or electronic instrumentation, etc.

Instruments should be as shown on the figures included in this DEP. Instrument selection and design shall comply with DEP 32.31.00.32-Gen; instruments shall be suitable for the applicable hazardous area classification (2.3).

3. SYSTEM DESIGN

3.1 SYSTEM DEFINITION

Within the context of this DEP, a diesel oil system is defined as the system which receives the diesel oil, stores it as required, conditions it so that it is suitable for use in the user's combustion system(s) or for other end uses (2.1), and distributes it to the user's at the required conditions.

3.2 DESIGN CRITERIA

3.2.1 Availability and sparing

Fuel systems are designed to supply fuel to the user's combustion system at conditions which allow safe, reliable and uninterrupted combustion as required by the process or utility unit. Unless specified otherwise, the diesel oil system shall be designed for continuous operation and an appropriate philosophy of component sparing shall be applied to achieve the required availability. Particular consideration shall be given to the need to keep vital utility services in operation during major plant emergencies. In some cases, this may result in diesel oil being used as a second independent fuel backing up the normally used type of fuel, which can influence the equipment sparing for each of the fuel systems.

The provision of a diesel oil system as a second independent fuel system may also be considered necessary for other reasons, such as the need for a production facility black start or the need to provide a lighter fuel oil to the user during start-up before switching to a much heavier fuel oil. Such a second system can also serve as a source of a suitable flushing medium for the primary heavy fuel oil system.

3.2.2 Storage requirements

On-site storage requirements (4.2) will greatly depend on the frequency and reliability of supply, and on whether a plant, or parts thereof, has to operate in 'boxed-in' mode.

Utility systems, particularly power generators, are often required to operate in 'boxed-in' mode when the rest of the facility is shut down and there is no fuel supply from outside the battery limits. In such cases, the on-site storage of fuel shall be sufficient to maintain the supply to these priority units over this period, taking into account such factors as duration of shutdown, fuel bunkering frequency, etc. If a diesel oil system is used as a back-up fuel system to maintain continuity of operation during an emergency when the main fuel supply is lost, the diesel oil system shall be on continuous standby.

The required storage capacity of the fuel system shall take account of all these factors.

3.2.3 Diesel oil quality requirements

The diesel oil system shall not only satisfy the user's rate of demand but also deliver the diesel at the correct pressure, temperature and composition.

3.2.3.1 Pressure

Frequently the diesel oil end user has its own fuel oil pump to feed the diesel into the burners/nozzles at the correct pressure to ensure satisfactory fuel atomisation. Generally these pumps will be fed from a buffer storage system (e.g. day tank) to protect them from diesel distribution system pressure variations as other system users draw off supplies, e.g. when storage tanks are filled up, etc.

The diesel oil distribution system needs to be able to supply these users at the correct pressure with allowance being made for system pipework pressure drops, static head effects, treatment system supply pressures and pressure drops across treatment plant etc. In order to ensure satisfactory performance the calculations shall take into account the system geometry and size of the piping runs, maximum expected flowrates and draw-off points, ambient conditions (a effecting diesel viscosity) if the lines are uninsulated/or not trace-heated, and location/elevations of day tanks/end users.

3.2.3.2 Temperature

Low temperatures cause the viscosity of the diesel oil to increase or the diesel oil to solidify when the temperature falls below its cloud point. If the diesel oil pour point is less than 10 °C below the minimum ambient temperature, provision of diesel tank heaters and the insulation and heat tracing of exposed lines shall be considered. Such measures shall also be taken if the fuel supply temperature could approach the diesel cold filter plugging point.

3.2.3.3 Quality

Adequate diesel oil treatment systems shall be specified to ensure that the diesel oil quality meets the requirements specified by the equipment Manufacturer (2.2).

Gas turbines typically have relatively high diesel fuel quality requirements, and so the main features of the diesel oil system designs will depend on whether gas turbine quality or diesel engine quality diesel oil is required (3.4).

NOTE: Contamination commonly arises during transportation and off-loading, particularly offshore. Contracts and procedures shall be formulated so as to minimise this risk.

3.2.4 Diesel oil quantity requirements

The total demand for diesel oil will depend on the type and number of diesel oil users, as well as the operational phase of the facility (3.3).

3.3 SYSTEM DEMANDS

Diesel oil users shall be inventoried and the total system demand determined. As the diesel number of oil users, and their average demand might vary during the different operational phases of a production facility, the total diesel oil demand shall be calculated for the various operational phases to determine the governing case.

3.3.1 Operational phases

A production facility is characterised by various operational phases throughout its design life, each of them with its specific diesel oil demands.

3.3.1.1 Life support phase

The facility is not drilling, producing or exporting. No fuel gas is available. Typical users would be fire pumps, cranes, water heaters, and either the main turbine generator or the basic services generator depending on the required load. The emergency generator may also be in operation during this phase.

3.3.1.2 Drilling phase

The facility is drilling, but not producing or exporting. No fuel gas is available, unless commissioned from a nearby pipeline. Typical users would be fire pumps, cranes, water heaters, the main turbine generator and drilling services users. Note that this phase may be minimised by using early well production to supply fuel gas to the main generators, thereby reducing diesel fuel consumption.

3.3.1.3 Production phase

The facility is producing and/or exporting but fuel gas is temporarily unavailable. Typical users would be fire pumps, cranes, water heaters, main generators and possibly dual fuelled gas turbines in mechanical drive applications.

NOTE: While this will be a high demand period, it should only last for a short time until gas is reinstalled. If gas production were to be halted for a long period, production power demands would be reduced so that they could be supported by the basic services generator.

3.3.1.4 Annual shutdown

Drilling may be continuing, while production is shut down for a major maintenance turnaround. Cranes and main generators will be operating with no fuel gas available.

NOTE: With Tender Assisted Drilling (TAD), platform power and diesel for drilling during the drilling phase and annual shutdowns may be supplied from the tender.

3.3.2 Diesel users

3.3.2.1 Emergency generator

Each manned platform and onshore facility will be fitted with a diesel generator for standby emergency use. Diesel consumption will be about 0.1 m^3/h for a typical 300 kW generator, which can be assumed to operate only 1 hr/week. In the hook-up and commissioning phase, the emergency generator may be used continuously for more extended periods, particularly during hook-up, if there is insufficient temporary construction power and the facility does not have a basic services generator.

3.3.2.2 Main generators

The type, number, size and mode of operation of a facility's main generators will depend on the specific power generation scheme.

In general, however, where power is generated on the facility and the total power requirements are low (< 800 kW) the main generator will usually be driven by a gas engine or diesel engine. For diesel-driven generators, a fuel consumption of approximately 0.25-0.30 litre/kWh can be assumed for initial sizing purposes.

For high-demand installations, with typical power demands from 15 - 50 MW, gas turbines generators are the norm. Two approaches are common, viz. all dual-fuelled, so that any one can run up on diesel and provide all the power necessary to produce a stable gas supply in the fuel gas separator, or sub-main generators dual-fuelled (typically 2.5 - 7.5 MW) and large main generators gas fuelled only.

Refer to (Appendix 4) for the approximate diesel consumptions of a range of gas turbine generators.

NOTE: Some high-demand installations have a basic services generator which provides power for a black start of the turbine generators. In some facilities, the basic services generator, instead of a separate emergency generator, also covers emergency loads. A typical duty would be around 900 kW.

3.3.2.3 Mechanical drive gas turbine drivers

Some installations may have crude export pumps, pipeline booster pumps, gas compressors or water injection pumps, which are driven by dual-fuelled gas turbines. The decision to opt for dual fuel depends on whether the pump or compressor is critical to the operation of the field.

3.3.2.4 Fire water pumps

Normally, at least one diesel engine driven fire pump is installed in each facility. The exception offshore is on installations with High Integrity Generation Systems, where fire water and sea water lift duties can be supplied by common electro-submersible pumps. Diesel consumption for fire pumps can be expected to be 0.2-0.5 m^3/h and, for system design purposes, each can be assumed to operate for 1 hr/week.

3.3.2.5 Water heaters

Fired water heaters use either gas or diesel for fuel. Diesel consumption can be expected to be 0.2 - 0.7 m^3/hr per unit, and for system design purposes at least one unit can be assumed to operate continuously on manned installations.

3.3.2.6 Cranes on offshore platforms

Cranes are diesel users throughout the operational life of the platform. Consumption can be estimated at 0.04 - 0.4 m^3/hr per unit. For system design, each crane should be considered to run continuously during hook-up.

3.3.2.7 Drilling services

During drilling and drilling/production phases, a diesel supply may be required for drilling service users such as the cementing and well logging units. Their rates of consumption can be expected to be 2.1 and 0.1 m^3/hr respectively and for system design purposes each unit can be expected to run for 2 hours in any one week.

Diesel may also be used for well test and clean-up operations. If so, temporary storage should be included in the drilling package to meet the higher flow rates required during these operations.

3.3.2.8 Life boats and mobile equipment

These are small users, supplied directly through a flexible hose from the diesel supply main.

3.3.2.9 Non-fuel diesel demand

Common non-fuel diesel users are listed in (2.1). Their frequency of operation is generally low. Therefore while they need to be considered during design, they should not become the governing case for sizing of equipment in the diesel system. It is always possible to bring in temporary bulk storage and pumps on land or to provide these facilities offshore from a specially adapted supply boat.

3.4 DIESEL OIL SYSTEM COMPONENTS

As indicated in (3.2.3), the single piece of equipment which distinguishes complex from simple diesel oil systems is a diesel-fired gas turbine.

Nevertheless, each diesel oil system is characterised by the presence of the following individual components, or building blocks:

- Loading system;
- Bulk storage;
- Forwarding system;
- Treatment;
- Distribution.

Typical Utility Flow Diagrams for gas turbine quality diesel systems and diesel engine quality diesel systems are shown in (Figures 1 to 5).

3.4.1 Loading system

3.4.1.1 Boat loading station

Diesel is loaded onto an offshore facility from a supply boat at a boat loading station (Figure 6). The loading station will usually be equipped to also load other commodities, such as fresh water, bulk cement, bulk barytes etc., in addition to diesel oil. There may be more than one boat loading station per facility to accommodate different wind directions and currents.

The diesel shall be discharged from the supply boat to the platform by means of a flexible hose stored on the platform (typically lowered by crane to the boat). Delivery rates from supply boats vary, but as a guide 80 - 200 m^3/hr should be used for high-demand platforms, 50 - 100 m^3/hr for low-demand platforms.

NOTE: Delivery of diesel to the platform is on demand, the supply boat being requested to deliver a stated volume to the platform. On unmanned platforms, delivery of diesel to the platform will generally be timed to coincide with maintenance visits. Some NNMIs have had automatic loading arms, controlled from remote or onshore facilities, installed so that diesel can be off-loaded without operators being on the platform. However, operational experience has proved that this relatively complex equipment is maintenance-intensive and has limited reliability. Thus the current trend is to refrain from installing such devices.

A totalising flowmeter shall be installed in the common loading line. A sampling point shall be installed at a convenient location to allow water content checks to be carried out on the off-loaded diesel in accordance with Operating Procedures. The installing of a coarse duplex filter, typically 750 µm to 1 000 µm, in the common loading line should be considered.

3.4.1.2 Road tanker loading station

Onshore, there will be different stand-alone diesel installations, but almost all will be simple day tanks feeding a dedicated driver. Supply is from a road tanker positioned alongside the diesel storage.

At a relatively large and/or complex onshore facility, there may be one central loading facility from which all diesel is distributed to bulk storage and/or individual day tanks. This type of loading facility will usually be located in the utilities area, easily accessible by road. The loading station will often be equipped to load other commodities.

Delivery rates from road tankers are typically 36 m^3/hr. A totalising flowmeter shall be installed in the loading line. A sampling point shall be installed at a convenient location to allow water content checks to be carried out in accordance with Operating Procedures. The installing of a coarse duplex filter, typically 750 µm to 1 000 µm, in the common loading line should be considered.

3.4.1.3 Diesel fuel pods

For small offshore facilities, the use of fuel pods (transportable containers) for diesel import may be considered.

3.4.1.4 Umbilical hose

For small offshore facilities, diesel supply from a nearby facility may also be considered. This option may be attractive where a multi-core umbilical is shared with other utility services.

3.4.2 Bulk storage

The bulk storage shall have sufficient capacity to allow continuous operation of the facility during the phase of maximum diesel use for the maximum period during which supplies may not be available. Additionally, bulk storage allows entrained water to settle out (first level of diesel treatment). The minimum settling time allowed should be 1 day. Settled water should be drained regularly.

NOTE: The supply frequency depends on the location and type of installation. For example, on manned North Sea platforms, storage equivalent to 10 days of normal diesel consumption is normally used, while on unmanned platforms longer intervals between re-fuelling are the norm (typically coinciding with maintenance visits).

3.4.2.1 Offshore storage systems

Bulk diesel storage systems vary according to the topsides support structures. In most cases deck storage is fed from the bulk storage as and when required. Bulk storage is essentially divided into three types:

- **Seawater displacement systems**, where the diesel is effectively ‘floated’ on seawater within a storage cell. The driving head to feed the diesel to transfer pumps is usually the static head provided by a column of seawater, or
- **Pressurised air/gas displacement systems**, where the diesel has a gas blanket over it within the storage cell. The driving head to the transfer pumps is provided by an increase in the storage cell gas blanket pressure.
- **Atmospheric storage systems**, where diesel is stored at atmospheric pressure, and the transfer pump suction head is provided by the static head of the diesel fuel itself.

In Gravity Based Structures (GBS), one of the base concrete cells, operating as a seawater displacement system, is usually reserved for raw diesel storage. GBS storage systems work as either ‘closed’ or ‘open’ storage systems. In a closed storage cell system, seawater is pumped into the cell when diesel fuel is drawn off. The pressure from the seawater pumps, and the static head due to the difference in specific gravities enables the diesel to be transferred to deck storage by pumps installed in the utility shaft. In an open storage cell system the seawater naturally migrates out of and into the cell via pipes/passages as the diesel fuel volume increases/decreases. The diesel is thus pressurised by the seawater static head into the top of the storage cell, from where it is drawn off by transfer pumps.

Frequently, after the initial hook-up and drilling phase has been completed and diesel demand drops, the cell storage is decommissioned and the deck storage suffices for the raw diesel.

On steel jacket platforms, all three bulk storage system types can be considered. Using the legs of the structure for storage avoids the weight penalties associated with using structural members in the module support frame or deck storage tanks.

Pressurised leg storage tanks are often used on steel jacket platforms, rather than atmospheric leg tanks, as this eliminates the significant cost penalty of having a submersible diesel pump in an external caisson. Also pump maintenance accessibility is improved when the pump and instrumentation are at deck level, as is the case with a pressurised gas storage system. Atmospheric leg storage may, however, be considered if the pumps can be accommodated inside the structural leg member. This may be feasible flexible if rising mains are used to overcome limitations in space and headroom for pump withdrawal and replacement.

It is also possible to employ a closed cell seawater displacement storage system in the jacket legs and install the forwarding pumps in the cellar deck.

Despite the weight advantages of leg storage, it is very common, even in high-demand facilities, for raw diesel to be stored exclusively in either bulkhead tanks, crane pedestals or specially fabricated tanks on deck. Diesel storage in bulkheads under the cellar deck has been chosen recently by some other operators.

Bulk storage on manned low-demand platforms and on Not Normally Manned Installations (NNMIs) will usually be in fabricated tanks on deck. The installing of a partition to create separate duty/spare tank volumes should be considered in order to facilitate inspection, cleaning and maintenance.

NOTE: If diesel fuel pods are used for bulk loading, they can also be used for bulk storage.

3.4.2.2 Onshore storage systems

Onshore facilities requiring large storage capacity would typically require a BNC or BND standard vertical tank, selected in accordance with DEP 34.51.01.31-Gen.

For onshore facilities requiring smaller storage capacity a non-standard rectangular tank may be considered, subject to approval by the Principal.

3.4.3 Forwarding system

The type of forwarding system greatly depends on the type of storage system (pressurised or non-pressurised, elevated or non-elevated) and the treatment system. Forwarding pumps are normally required if treatment of the diesel beyond settling out and draining out of entrained water is necessary.

For pressurised gas bulk diesel storage, the forwarding (transfer) pump shall be mounted at the lowest deck level with the suction being supplied from the base of the storage tank. With atmospheric leg storage, the pump shall be located at the bottom of the leg tank. In closed seawater displacement systems, the pump suction will be near the top of the leg tank.

Normally, the forwarding pump will operate continuously, discharging to the treatment package (Figure 1). Excess flow will be returned to storage via a pressure control valve and recirculation line located downstream of the treatment package. If a filter coalescer is fitted, the pressure control valve may be replaced by a restriction orifice. The pump(s) shall be sized so that each pump can supply the maximum design throughput of the treatment unit on duty and shall include minimum flow recirculation if a restriction orifice is installed.

If treatment of the diesel stocks is not necessary (beyond settling out and periodic draining of water from the bulk storage tank), forwarding pumps should only be installed if the layout cannot be arranged to support gravity feed. In this case (Figure 4), the simplest scheme is to install a common day tank for the main generators, with the pump automatically starting and stopping on low and high levels in the day tank.

NOTE: If intermittent users require a higher head and often a higher throughput than most other users, the installing of a second forwarding pump (Figure 1) would be considered.

3.4.4 Treatment

Treatment is generally only required for gas turbine quality diesel oil systems. For systems not requiring such high quality diesel supplies, treatment is not normally required other than settling out, periodic draining of water from the tanks and filtering (100 µm).

For gas turbine quality diesel oil systems, the diesel will be treated by either a centrifuge or a filter coalescer supplied as a package by a specialist supplier. Throughput shall be at least one-third greater than the maximum continuous demand to allow for recirculation back to storage. This ensures continuous improvement in diesel quality and, in the case of the centrifuge, allows it to run constantly at its design rate.

It can be assumed that the water and sediment level of diesel oil entering the treatment plant will not exceed 2% at any time. Normally, after one day of settling in the raw diesel tank, the water and sediment level of the diesel oil, even close to the bottom of the tank, should be less than 100 mg/kg if the tank is designed to minimise mixing and water is drained off.

NOTE: It is also relevant to remember that after gas turnbines have been commissioned on gas, their firing on diesel is very infrequent. Therefore, for the majority of a platform’s life, periods when continuous diesel treatment is necessary should also be short and infrequent.

3.4.4.1 Centrifuge package

A centrifuge separates water and solids from diesel with an efficiency that depends on the density difference between the fluids/solids being treated, particle size and continuous phase viscosity. It is important to specify these parameters carefully to ensure optimum performance of the centrifuge.

Treated oil and dirty water are continuously discharged, while solids collect in a sludge space around the outside of the centrifuge bowl. An automatic self-cleaning centrifuge package shall be specified, thereby providing for solids discharge without stopping the centrifuge.

To ensure a consistent quality of clean diesel, the centrifuge operates continuously at constant throughput. Because demand varies between 0 and 100%, excess diesel is recycled back to the raw diesel storage tank.

Diesel oil quality at the outlet from the centrifuge package shall be continuously monitored (BS&W or equal) to ensure that the water contamination level is maintained below the limit specified by the turbine manufacturer. Sample points shall be provided to allow performance checking (Figure 9).

NOTES:

1. Centrifuges can be provided with a continuous potable water wash facility (injection of approximately 3% of potable water), which improves the removal of sodium from the diesel. This would not normally be required for diesel oil treatment.

2. Tuning of the cleaning cycle, i.e. the frequency of the solids discharge, might have to be changed over time. While the initial set-up will be for a clean system, rust, scale and bacterial growth may increase with time, necessitating shortening the cleaning cycle to maintain efficient solids removal.

3. The centrifuge is mechanically more complex than a filter coalescer. It requires power, about 8 kW to 9 kW for 12 m^3/hr capacity. Its initial cost will be greater, its weight and footprint will be larger and it will require a higher standard of maintenance than the filter coalescer. Spares will also be more expensive. To offset this, if it is set-up correctly and re-tuned when necessary, a centrifuge should give trouble-free service and a reliable quality of treated diesel.

3.4.4.2 Filter coalescer

A filter coalescer is a two-stage separation device consisting of a first-stage coalescer and a second-stage mesh coated with a hydrophobic film, which collects any water which is carried over from the coalescer. Both elements are installed inside a single coalescer vessel. The complete diesel coalescer package will also contain a pre-filter in a separate vessel.

The filter/coalescer package shall normally be installed downstream of the storage tank, and forwarding pumps if fitted.

The pre-filters and filter/coalescers shall be of the replaceable element type. Consideration should be given to dual facilities, two 100% pre-filters and coalescers, to avoid interruption to diesel flow during element change-out.

NOTES:

1. Paraffin waxes within the diesel cause more problems with filter coalescers than with centrifuges as they clog up the coalescing fibres rendering them impermeable. If ambient temperature conditions are likely to cause the diesel stocks to approach the diesel Cold Filter Plugging Point, then coalescers are likely to be problematic. Consideration should then be given to heat conservation methods (insulation, tracing, heating etc.).

2. Bacteria developing in both the diesel and water phase have also caused problems for coalescer systems. Provision for biocide treatment/tank cleaning should thus be made during design activities.

3. The main advantages of a filter coalescer over a centrifuge are: it is smaller and lighter, has no moving parts, requires minimum maintenance skills, needs no power and costs less. To offset this, solids contamination necessitates periodic replacement of the filter elements, which must be stocked on the facility. A batch of contaminated fuel will cause rapid increase in differential pressure requiring an frequent change-out of the elements.

3.4.5 Distribution system

Diesel is supplied to all users via the distribution system, which shall be a conventional steel pipework system. Supply and return pipework should be routed through non-hazardous areas wherever possible.

Particularly for multi-jacket (bridge-linked) installations, the use of a pressurised supply and return header shall be considered. It will enable:

- simplified piping system design for tying back various loading system locations to central bulk storage;
- continuous cleaning of stored diesel;
- automatic cut-in of dual fuelled machines when changing over from gas to diesel.

A totalising flowmeter complete with bypass should be installed in the diesel supply line to drilling. Meters on other main user supply lines are optional.

Users shall be connected to the distribution system via day tanks or via flexible hose and pistol filler, refer to Table 1.

Table 1 Distribution system outlets

User	Connection to Distribution System
Basic services generator Emergency generator Main generator	fitted with day tanks (NOTE 1, NOTE 2, NOTE 4)
Water heaters	‘package’ supplied from distribution system (NOTE 3)
Cranes	flexible hose with filler pistol to fill day tank within crane package
Fire water pumps	fitted with day tanks (NOTE 1)
Mechanical drive gas turbines	‘package’ supplied from the distribution system (NOTE 3)
Life boats	flexible hose with filler pistol located near lifeboat
Drilling services users	day tanks provided within cementing unit and well logging packages.
Mobile equipment	flexible hose on reel with filler pistol

NOTES:

1. Day tanks are provided adjacent to user equipment packages, and may be supplied as part of those packages. Day tanks on emergency generators and fire water pumps are required to enable self-sustained operation of the packages in emergencies. Their sizing is governed by local regulations, or the applicable DEP, whichever is the most stringent (4.5).

2. For High Integrity Power Generation, the turbines shall have diesel day tanks as they are the sole source of emergency power. Day tank capacity shall ensure fire pump operation in accordance with the conditions above. Additionally, the day tank shall have 30 minutes' capacity at generator full load if the drilling rig does not have its own emergency power.

3. Continuous users, such as dual-fuel gas turbines and water heaters, are normally supplied directly from the distribution system to the Manufacturer’s package. In some circumstances, within the package a booster forwarding pump may be installed to meet the Manufacturer’s burner/injector head requirements. In this case, there will be an additional pressure control within the package, and spill back to either the package day tank or to the main raw diesel tank. In the latter case provision shall be made for the return of excess diesel back into the distribution system.

4. If the drilling rig has its own diesel generator, then this should have a day tank with a minimum of 30 minutes' supply enabling the drill bit to be pulled in an emergency and the well made safe. If the drilling rig relies on the platform's basic services generator for back-up, then this should have a with a minimum of 30 minutes' supply.

4. MECHANICAL DESIGN

This section considers the mechanical design of all equipment required by Gas Turbine Quality Diesel Systems.

4.1 LOADING SYSTEM

Refer to (Figure 6).

Loading stations shall be designed and installed in accordance with local regulations and practice. Loading stations for offshore installations shall comply with DEP 37.05.10.12-Gen.

The design shall take into account the following:

- Safe and protected stowage of hoses without disconnection from the hose station.
- Hoses shall be designed so that spillages on breaking connection with the supply vessel are minimised. Tight shut-off valves and quick-release self-sealing couplings shall be fitted to the supply boat end of the hose. End caps shall be provided for sealing the end of the hose when not in use.
- Hoses shall be designed for emergency decoupling situations.
- The hose shall have mechanical protection to prevent overloads being exerted on the loading station by an over-extended hose.
- Diesel hoses shall have anti-static wires incorporated in the hose which are electrically connected to all couplings and are connected to earth.

High-level alarms shall be installed at the loading stations to prevent overfilling of the bulk storage tanks. On completion of filling, the platform piping shall be drained back to the bulk storage tank and the hose shall be drained back to the supply boat.

Coarse duplex filters, typically 750 µm to 1 000 µm, should be installed in the common loading line to operate at the shut-in pressure of the supply boat's pumps (9 bar (ga) to 10 bar (ga)) and at flow rates of up to 200 m^3/hr.

The sampling point and a totalising flow meter shall be installed downstream of the duplex filter.

4.2 BULK STORAGE

4.2.1 Sizing criteria

The total volume of the bulk diesel storage shall be based on the expected diesel consumption and diesel supply frequency, taking into account the different operational phases of a facility (3.3.1). Minimum demand is taken to be the continuous operation of one main power generator to provide basic services. Normal demand will take into account other users, with allowance being made for their intermittent/continuous use.

Supply frequency will vary with location. As a guide, for manned offshore facilities a diesel re-supply interval of 10 days can be assumed. For NNMIs, planned visits for maintenance, inspection and consumable re-supply may be limited to six to nine times per year. Bulk diesel storage should be sized for the re-supply volume plus a contingency margin.

4.2.2 Design

Guidance in this section will be restricted to the most common types of storage tanks in recent platform designs, namely pressurised leg storage, bulkhead deck tanks and fabricated deck tanks.

4.2.2.1 Pressurised leg storage (Figure 7)

The number of pressurised leg storage tanks shall depend on the total volume of storage required and the available tank capacity in each platform leg. During normal operation, one tank will be pressurised and in service, while the other is depressurised ready to receive new diesel supplies.

Pressurised leg storage tanks shall be an integral part of the jacket structure and as such will not be the subject of an equipment requisition. Selected legs should be under a safe area of the platform, typically the living quarters area (4.7).

Instrument air is used to pressurise the tanks, each of which has its own split-range pressure controller. Pressure in the duty tank is varied automatically by the controller to maintain a constant pressure of 0.5 bar(g) at the suction to the forwarding pump. The minimum internal design pressure of the leg tanks shall be the design pressure of the instrument air system.

The level reading in the duty tank is derived from measuring the differential pressure between the air space of the tank and the pressure in the line to the forwarding pump suction. High and low level alarms shall be generated at a point which is normally manned during loading operations. Facilities shall be provided to prevent overfilling of the tanks, taking into account the maximum supply boat pumping rate.

NOTE: If the tank is filled at atmospheric conditions, the differential pressure measurement to indicate tank level will not function correctly. Suitable means of indicating the tank level under atmospheric filling conditions shall be provided to prevent overfilling of the leg; maximum fill level shall take into account sea level changes due to tidal movement etc.

Tank outlets from pressurised storage shall be fitted with remotely operable shut-off valves. To prevent air from entering the diesel system when the tank level is low, two independent switches are typically installed on the diesel outlet line from the storage tank. Both switches shall close the remotely operated shut-off valve on the tank outlet, close the shut-off valve on the air supply line, and trip the forwarding pump through the ESD logic.

NOTE: The diesel outlet piping up to and including the ESD valve shall be rated for the maximum air supply pressure. Air can be prevented from entering the diesel system when the level is low by linking the shut-down switches to the level indicator (differential pressure cell), or alternatively high-pressure switches on the pump suction line can be used (responding to air breakthrough when the level falls below suction offtake).

Relief valves shall be installed on the tank in the event of a fire. A blowdown facility operated from the ESD system to allow remote depressurisation shall also be provided in this instance.

A DN 600 manway shall be provided for internal access and for inspection by remote-operated vehicle.

The filling line shall extend to the lowest working level of the tank to avoid the risk of explosion due to static from diesel droplets, when the level is low.

Zinc anodes shall be fitted in the tank bottom, where water can settle out. This should be designed as part of the protection for the complete structure.

4.2.2.2 Deck storage (Figure 8)

Diesel storage on deck will be either part of the structure in the form of bulkhead tanks or crane pedestal tanks, or stand-alone fabricated tanks. Provision of a duty/spare storage capacity should be considered to facilitate tank cleaning, inspection and maintenance.

Deck-mounted diesel tanks are normally of welded carbon steel construction. Cylindrical vertical steel tanks should be designed, fabricated and tested according to DEP 34.51.01.31-Gen. Bulkhead tanks and crane pedestal tanks are specified as part of the structure. Most fabricated diesel tanks are rectangular tanks for which there is no specific code, but common structural standards such as AISC and AWS shall apply. Free vented tanks shall be designed to withstand overpressure and underpressure conditions of 7.5 and 2.5 mbar(g) respectively without deformation or overstress.

NOTES: 1. Where only a small quantity of diesel storage is required, Glass Reinforced Plastic (GRP) tanks may be considered, provided that a resin suitable for oil is specified. GRP tanks should be designed and supplied in accordance with DEP 31.22.30.14-Gen. and are available up to 25 m^3.

2. For rectangular tanks, the tank top, bottom and sides shall be adequately stiffened by rolled steel sections, which shall be arranged so as not to restrict drainage or access to internals for inspection.

Tanks shall be provided with:

- A spillage/drip tray, with a maximum depth of 200 mm at its low point, beneath the tank for containment and detection of small leaks. Liquids collected will be manually drained through a normally closed valve connection at the bottom of the drip tray to the open non-hazardous drain. To capture major tank leaks, the drip tray shall also be provided with an overflow outlet having an upstand of 100 mm and routed to the non-hazardous drains.
- Adequate access for visual inspection of their internal surfaces.
- The tank bottom sloping towards the drain nozzle or sump. Water draining from the tanks should be a regular operating task. The supply to the forwarding pumps or users shall be at least 150 mm above the tank or sump bottom.
- Inlet dip pipe and siphon break hole, to minimise swirl and build-up of static electricity during filling.
- Vents routed to a safe location and configured to prevent the ingress of debris, water and other foreign matter (e.g. insects). They shall be sized for handling vapour generated under fire conditions.
- An overflow outlet, capable of handling the maximum rate from a supply boat and routed directly to the non-hazardous drains. The option of combining the overflow and vent nozzles should be considered.

Wherever possible, the tank level should be indicated by means of externally mounted displacer tubes supplemented by gauge glasses. Level instrument outputs should be repeated at a point which is normally manned during loading operations. Where practical, a separate gauge glass should be provided at the bottom of the tank to identify the presence of an oil water interface.

NOTE: An alternative is to use a dipstick with water-seeking paste.

High and low liquid level alarms should be installed. Low level trips shall operate on the forwarding pumps. The tank outlets shall be fitted with remotely operable shut-off (ESD) valves to isolate the bulk of the stored diesel in the event of an emergency.

4.2.2.3 Paint system for tank internals

Carbon steel diesel storage tanks, including jacket leg tanks, bulkhead tanks, crane pedestal tanks and fabricated tanks, should be coated in accordance with DEP 30.48.00.31-Gen.

4.3 FORWARDING SYSTEM

4.3.1 General

If forwarding pumps are not installed in utility shafts, or submersed inside a jacket leg or caisson, they should be located on the lowest deck.

Minimum-facilities platforms generally have a gravity-feed diesel supply system. If a pump is necessary, plant availability requirements shall determine the number of pumps required. However, if more than one atmospheric leg tank is used, each tank or caisson shall have its own pump.

Power supply to the pump motors shall be from the emergency board, manually started and stopped from the Control Room. On High Integrity Power Generation installations, power supplies are taken from the main board.

4.3.2 Design

Pump design and installation shall be in accordance with DEP 31.29.02.11-Gen and DEP 31.29.00.10-Gen.

Centrifugal pumps, rather than positive displacement types, are preferred as being less susceptible to wear and damage when pumping dirt, rust particles or slugs of water. However, if oil/water emulsions are likely to formed or high heads are required, then positive displacement pumps of the screw or gear types in accordance with API Std 676 may be considered.

Submersible pumps for atmospheric storage shall be multi-stage centrifugal type and provided with a rising main of the flexible hose type. Submersible pumps may also be used in bulkhead storage tanks. Submersible pumps shall be mounted with the suction inlet sufficiently below the low diesel level to ensure the required minimum suction head.

Pumps shall be sized so that each pump can supply the largest coincident user demand, including any recycling. If a centrifuge package is used for diesel oil treatment, the pump(s) shall be sized to supply the maximum design throughput of the centrifuge package. A minimum of 5 m^3/hr should be used to avoid excessive tank filling times. The head requirement shall be carefully established, taking into account any pressure requirements imposed by the treatment package, frictional losses and directly connected diesel users. The pump and motor shall be capable of operating on water with a density of 1 060 kg/m^3.

A permanent strainer should be provided at the pump suction, sized in accordance with the pump Manufacturer’s requirements.

NOTES:

1. With atmospheric storage, consideration should be given to the pump operating envelope in order to to prevent possible overload when the suction static head is high. Flow control of the pump discharge might have to provided in this case.

2. If the operating pressure in the distribution system is set by a restriction orifice, this shall normally be sized to provide a 1 bar pressure drop across the highest level control valve in the distribution system.

3. Depending on the application, the forwarding pump(s) shall be capable of start-up against the static system head or against an open discharge valve. The applicable start-up scenario should be clearly stated on the data sheets.

4.4 TREATMENT

4.4.1 Centrifuge

Any centrifuge package should be supplied by the Supplier on a common baseframe on which the centrifuge and all associated equipment, including a fresh water tank and sludge tank are mounted (Figure 9). Normally, the centrifuge will not be spared but will have a locked-shut bypass, depending on the required availability of the diesel oil system.

For designs incorporating connections to the facility's potable water system, it shall be ensured that there can be no back flow of diesel into the potable water system.

The package should comprise but not be limited to the items described below:

Centrifuge

Self-cleaning type centrifuge with drive motor.

Water tank

An operating water tank with anti-frost heater, ball float valve and contents sight glass. This item may be supplied loose for mounting by others.

Sludge tank

A drip tray/sludge tank fabricated in mild steel shall be incorporated into the baseframe to retain the sludge removed during the cleaning cycle.

Baseframe and skid terminations

The baseframe shall be of welded construction, designed and fabricated to provide sufficient stiffness for transportation, installation and operation.

All skid piping, including drains, shall terminate at the skid edge, with ANSI flanges.

Instrumentation and control equipment

The centrifuge package shall be designed to operate with minimum operator intervention. It shall normally operate continuously under the control of a local panel which shall also govern the frequency and operation of the self-cleaning cycle. The package shall be fully instrumented, the minimum requirements being indicated on (Figure 9). Instrumentation should include an oil-in-water indicator and high alarm on the water outlet for loss of water seal.

As a minimum, the Supplier shall provide terminals to allow a common alarm to be sounded/ displayed in the main control room, in the event of a fault in the package. On DCS-controlled platforms consideration shall be given to wiring all signals back to the DCS so that the data received at the control panel is sufficient to allow operators to take the necessary action without first visiting the equipment. This is particularly applicable to unmanned facilities.

Selection of instruments and electrical equipment, particularly the required explosion protection rating, shall comply with DEP 32.31.00.32-Gen. and DEP 33.64.10.10-Gen. Consideration shall be given to the requirement for some of the equipment to operate in an emergency and to the implications this has for the required explosion protection rating.

All on-skid wiring and cabling shall terminate where appropriate at skid edge terminal boxes.

Power supply

Where the package is required to operate under emergency conditions, the power supply shall be taken from the emergency board, except on High Integrity Generator supply installations where power shall be taken from the main board.

4.4.2 Filter coalescer

A filter coalescer package will typically comprise, as a minimum, one pre-filter and one filter coalescer supplied with inter-linking piping and instrumentation on a base unit by a single Supplier (Figure 10). Pre-filters and filter coalescers should be of the replaceable element type.

If the design incorporates two 100% filter/coalescer units to avoid interrupting the diesel flow when a unit is serviced, the change-over valve design shall allow transfer from duty unit to the other unit without a break in flow of diesel from the package.

Instrumentation requirements are indicated on (Figure 10). The Supplier shall provide terminals to allow a common alarm to be sounded/displayed in the main control room in the event of a fault in the package. On DCS-controlled platforms consideration shall be given to wiring all signals back to the DCS so that the data received at the control panel is sufficient to allow operators to take the necessary action without first visiting the equipment. This is particularly applicable to unmanned facilities.

Water draining from the filter coalescer shall be under automatic level control and routed to the open drain. A high-water level shall also sound or display an alarm in the control room. Level instruments shall be externally mounted.

4.5 DAY TANKS

Refer to (Figure 11) for a typical PEFS.

Emergency equipment such as emergency generators and fire water pumps, which shall have day tanks, is listed in Table 1, Section 3.4.5. Day tanks for other equipment are optional. Day tanks should be located adjacent to their respective users.

NOTES:
1. Day tanks should be located so that they do not create excessive head at the equipment they supply, causing diesel fuel to be conveyed when the equipment is not operating (particularly fuel injectors).
2. Where possible, overflow from day tanks shall be routed back to bulk storage.

Day tank sizing shall be in accordance with the requirements of the type of equipment supplied from the day tank. Design of day tanks should follow the guidance for rectangular carbon steel or GRP atmospheric tanks in (4.2.2.2).

External and internal coating of carbon steel day tanks shall be in accordance with

DEP 30.48.00.31-Gen.

4.6 PIPING

Diesel piping shall conform to DEP 31.38.01.15-Gen.

Piping design shall be in accordance with DEP 31.38.01.11-Gen.

Exposure of diesel piping to cold weather shall be avoided. If this is not possible, and if ambient conditions frequently fall below the diesel cloud point, lines should be insulated and possibly heat-traced to avoid deposition of wax. See also (3.2.3).

4.7 LAYOUT

Wherever possible, all diesel equipment and pipework shall be located in non-hazardous areas.

The location of the diesel oil storage on the facility shall be reviewed as part of the overall facility lay-out review to ensure that all possible incidents, including the escalation of incipient incidents, are adequately prevented. This typically results in the diesel oil storage being located in the utilities, close the main diesel oil users. Offshore storage in jacket legs is typically under the safest part of the platform, normally under the living quarters.

Where diesel oil tanks are located in an enclosure or module wall, they should be located so that outlet valves can be operated from outside the enclosure or module via extended spindles or similar means. For day tanks used with emergency generator sets and fire pumps, this is often a legal requirement.

5. REFERENCES

In this DEP, reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments, supplements or revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Fuel systems	DEP 20.05.60.10-Gen.
Painting and coating of new equipment	DEP 30.48.00.31-Gen.
Glass-fibre reinforced epoxy and polyester vessels - Design and installation	DEP 31.22.30.14-Gen.
Installation of rotating equipment	DEP 31.29.00.10-Gen.
Pumps - selection	DEP 31.29.02.11-Gen.
Piping - general requirements	DEP 31.38.01.11-Gen.
EP piping classes	DEP 31.38.01.15-Gen.
Instruments for measurement and control	DEP 32.31.00.32-Gen.
Electrical engineering guidelines	DEP 33.64.10.10-Gen.
Standard vertical tanks - Selection, design and fabrication	DEP 34.51.01.31-Gen.
Design of hose bulk transfer facilities offshore installations	DEP 37.05.10.12-Gen.
Area classification (amendments/supplements to IP15)	DEP 80.00.10.10-Gen.

AMERICAN STANDARDS

Positive displacement pumps - rotary — API Std 676

Issued by:
American Petroleum Institute
Publications and Distribution Section
1220 L Street Northwest
Washington DC. 20005
USA

Standard classification of diesel fuel oils — ASTM D 975

Issued by:
American Society for Testing and Materials
1916 Race Street,
Philadelphia Pa 19103
USA

BRITISH STANDARDS

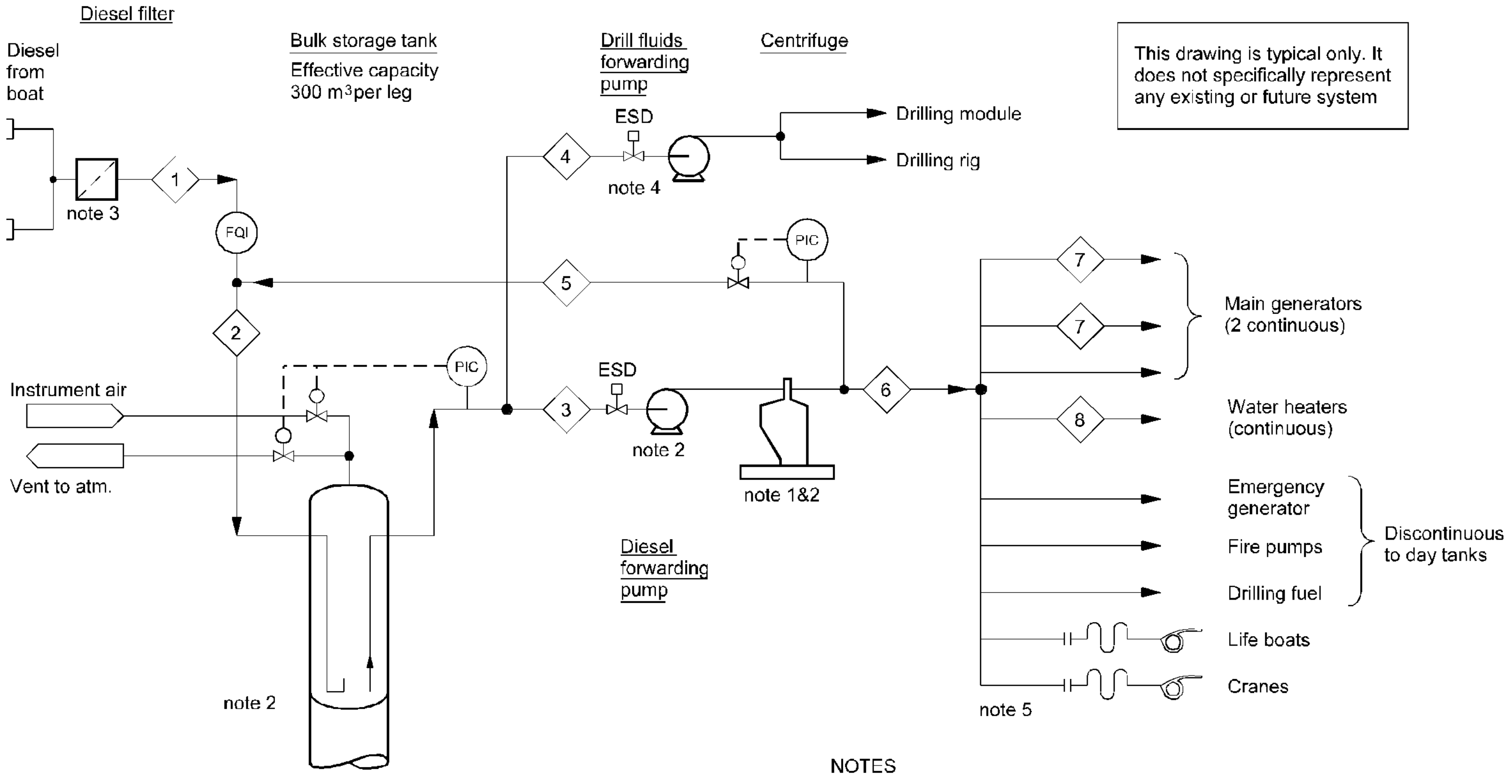
Fuel oils for non-marine use
Part 2: Specification for fuel oil for agricultural and industrial engines and burners (classes A2, C1, C2, D, E, F, G and H) — BS 2869-2

Issued by:
British Standards Institution
389 Chiswick High Road
London W4 4AL
UK

APPENDIX 1 FIGURES

Figure Number	Type	Title
1	UFD	TYPICAL UTILITY FLOW DIAGRAM FOR GAS TURBINE QUALITY DIESEL
2	UFD	TYPICAL UTILITY FLOW DIAGRAM FOR DIESEL ENGINE QUALITY FUEL - MANNED PLATFORM WITH FORWARDING PUMP
3	UFD	TYPICAL UTILITY FLOW DIAGRAM FOR DIESEL ENGINE QUALITY FUEL - MANNED PLATFORM WITHOUT FORWARDING PUMP
4	UFD	TYPICAL UTILITY FLOW DIAGRAM FOR DIESEL ENGINE QUALITY FUEL - UNMANNED PLATFORM WITH FORWARDING PUMP
5	UFD	TYPICAL UTILITY FLOW DIAGRAM FOR DIESEL ENGINE QUALITY FUEL - UNMANNED PLATFORM WITHOUT FORWARDING PUMP
6	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - LOADING SYSTEM
7	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - PRESSURISED LEG STORAGE
8	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - DECK STORAGE
9	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - CENTRIFUGE TREATMENT
10	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - FILTER COALESCER TREATMENT
11	PEFS	TYPICAL PROCESS ENGINEERING FLOW SCHEME - DAY TANK

Figure 1 Typical utility flow diagram for gas turbine quality diesel

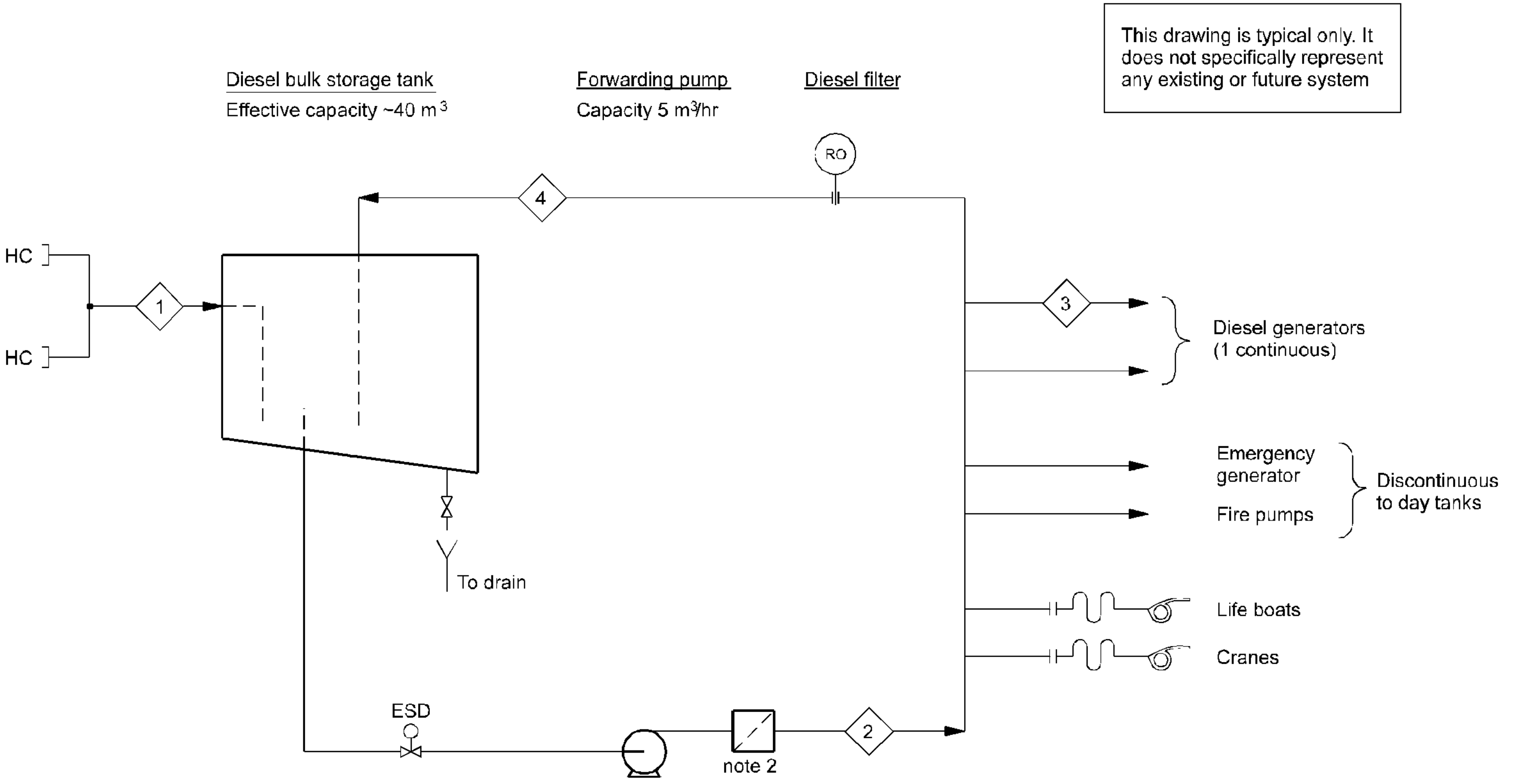


Streams		1	2	3	4	5	6	7	8
Pressure	bar (abs)	10	4	1.5	1.5	1.5	4	3	3
Normal flow	m³/hr	NNF	3	12	NNF	7	5	4	1
Max. flow	m³/hr	120	132	12	25	12	12	5	1

NOTES

1. Treatment package could be a filter coalescer instead of a centrifuge.
2. Second bulk storage tank, forwarding pump and treatment package optional.
3. Dependent on cleanliness of diesel supply.
4. Second forwarding pump for intermittent users requiring higher head and often higher throughput (optional).
5. Restriction orifices in individual supply lines may be required to limit filling rate and maintain header pressure.

Figure 2 Typical utility flow diagram for diesel engine quality fuel - manned platform with forwarding pump

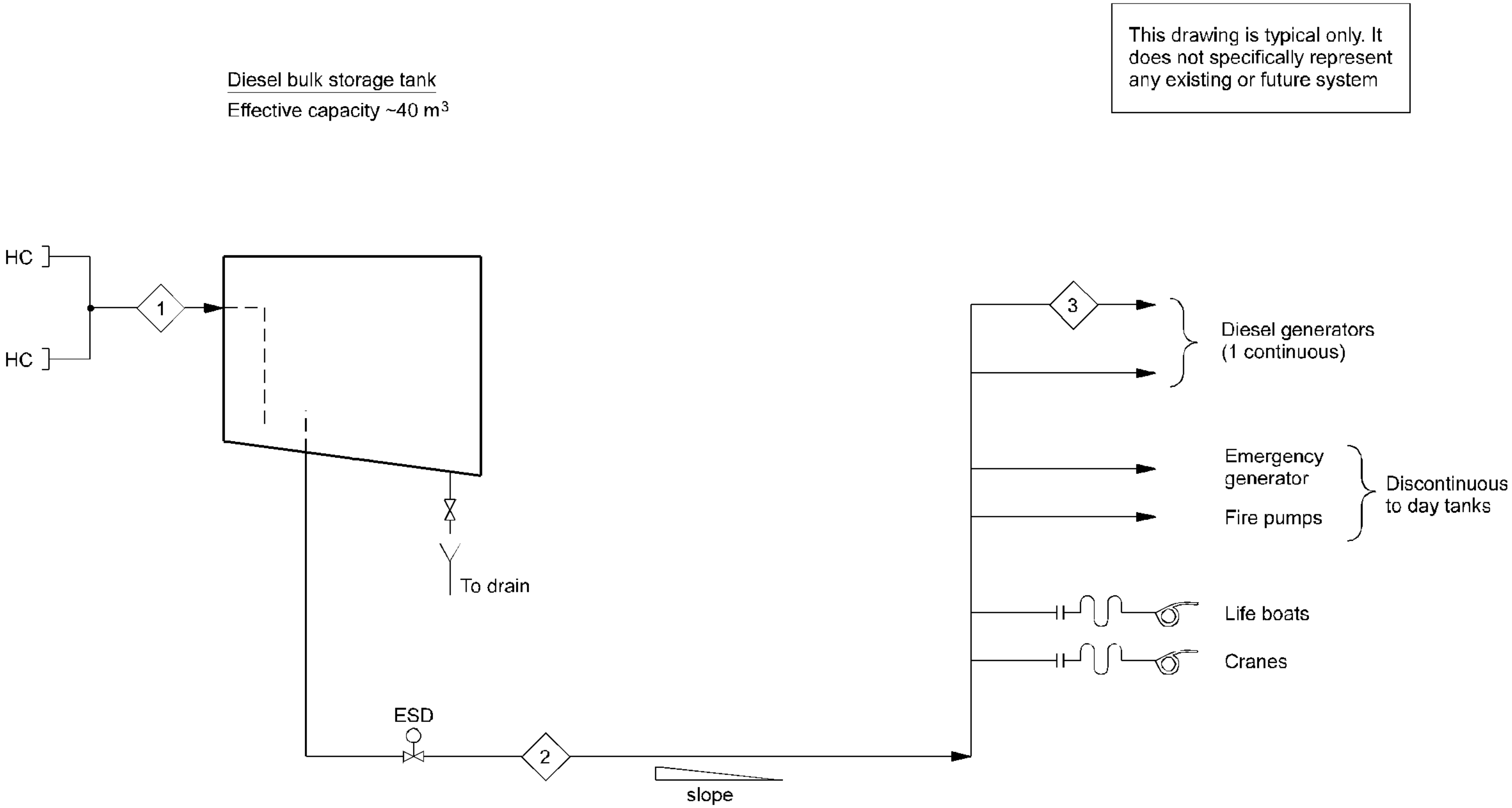


Streams		1	2	3	4	
Pressure	barg (abs)	10	3.5	3.0	1.0	
Normal flow	m³/hr	NNF	0.6	0.1	0.5	note 1
Max. flow	m³/hr	80	5	0.1	0.5	

NOTE

1. Flow rate for pump.
   Minimum flow recirculation to be confirmed by pump vendor.
2. Diesel filter may be located upstream as pump suction strainer, provided pump NPSH not adversely affected.

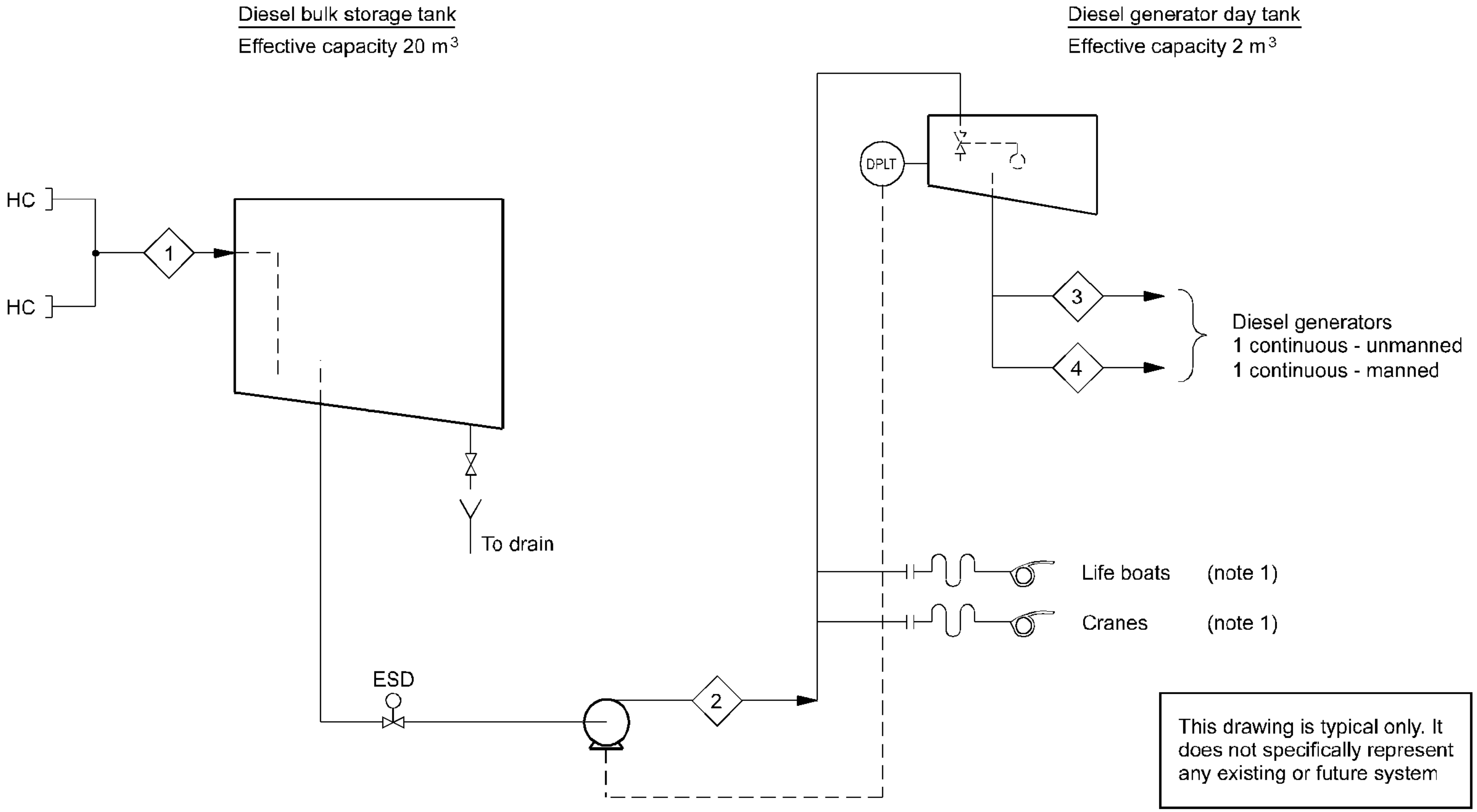
Figure 3 Typical utility flow diagram for diesel engine quality fuel - manned platform without forwarding pump



Streams		1	2	3	
Pressure	bar (abs)	10	1.5	1.5	note 1
Normal flow	m³/hr	NNF	0.1	0.1	
Max. flow	m³/hr	80	1.0	0.1	

NOTES
1. Distribution system pressures dependent on relative elevations and user pressure requirements.

Figure 4 Typical utility flow diagram for diesel engine quality fuel - unmanned platform with forwarding pump



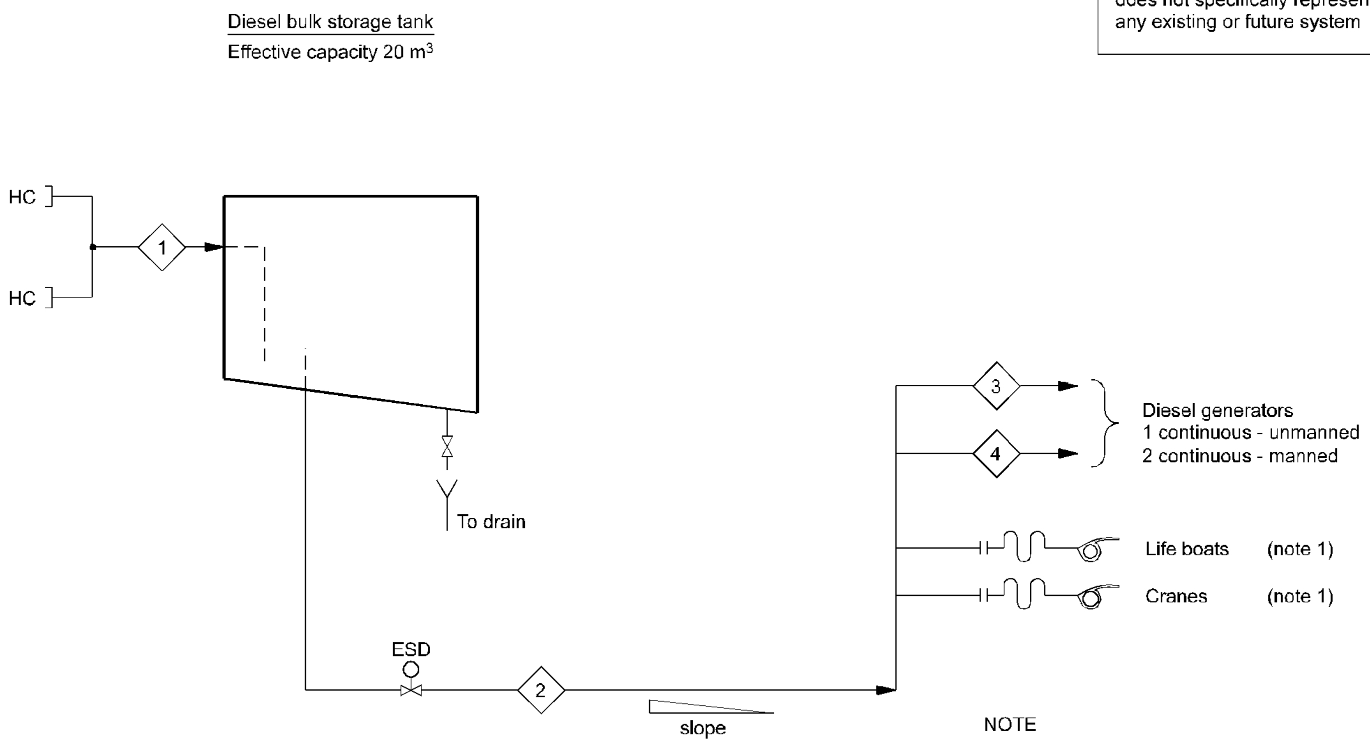
Streams		1	2	3	4
Pressure	bar (abs)	10	3.5	1.0	1.0
Normal flow	m^3/hr	NNF	NNF	0.01	NNF
Max. flow	m^3/hr	80	5	0.02	0.02

NOTE

1. Manual start of pump may be necessary to fill life boat and crane diesel tanks.

Figure 5 Typical utility flow diagram for diesel engine quality fuel - unmanned platform without forwarding pump

This drawing is typical only. It does not specifically represent any existing or future system



Streams		1	2	3	4
Pressure	bar (abs)	10	1.5	1.0	1.0
Normal flow	m^3/hr	NNF	0.01	0.01	NNF
Max. flow	m^3/hr	80	1.0	0.02	0.02

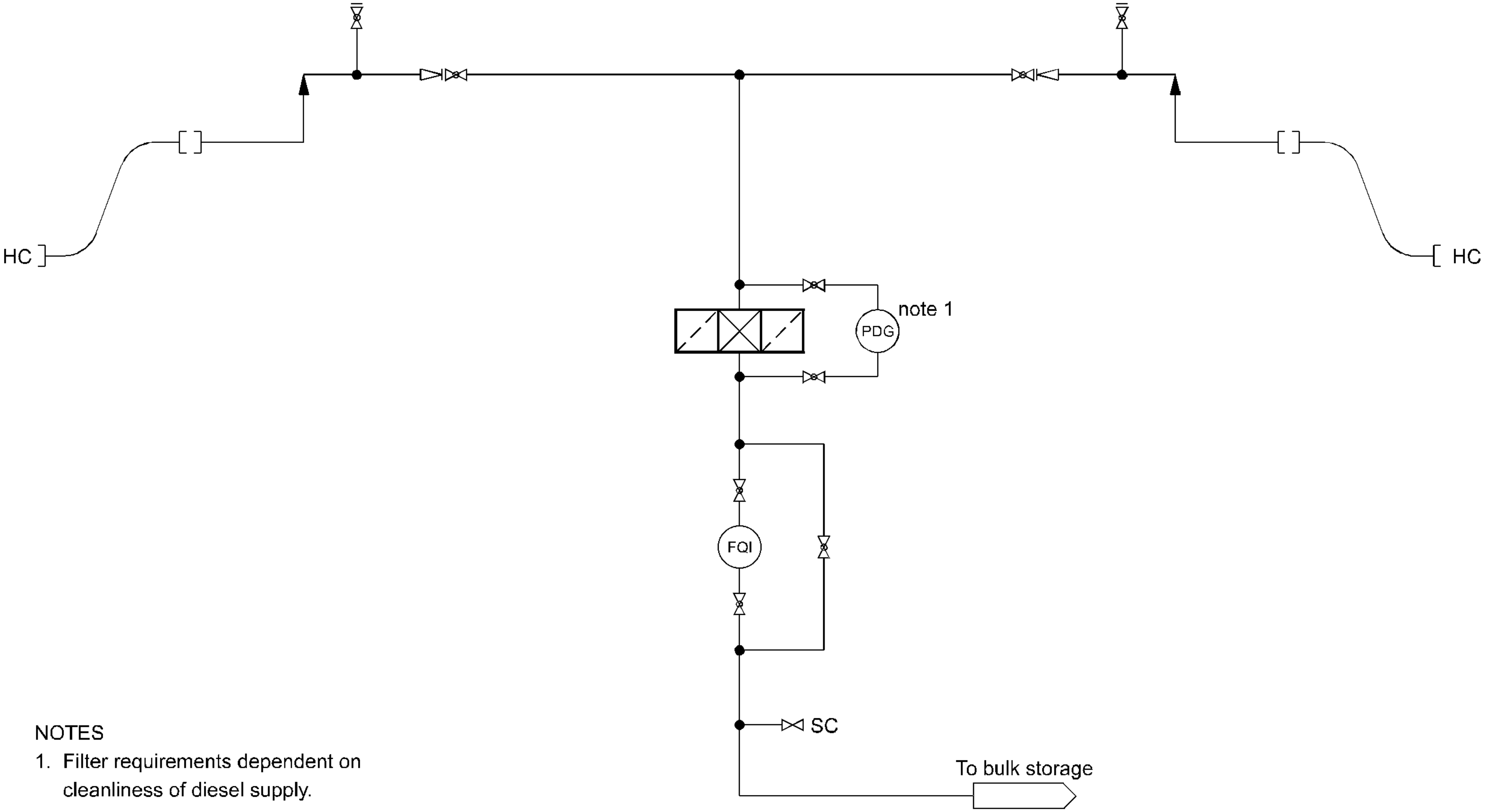
note 3 (Pressure)

note 2 (Max. flow, stream 2)

NOTE

1. A hand pump may be necessary to fill life boat and crane diesel tanks.
2. Max. flow is for filling life boat and crane diesel tanks.
3. Distribution system pressures dependent on relative elevations and user pressure requirements.

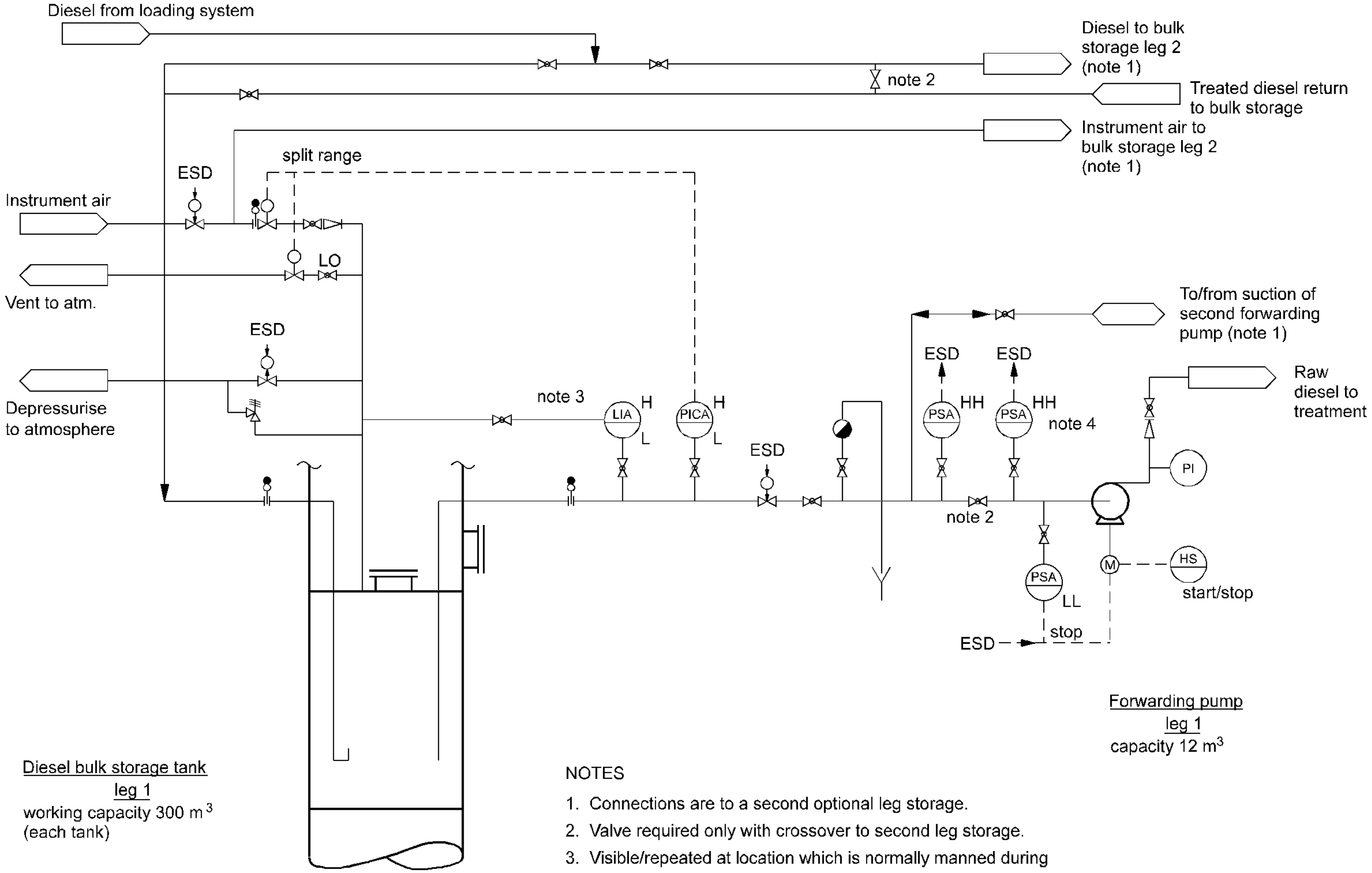
Figure 6 Typical PEFS for loading system



NOTES

1. Filter requirements dependent on cleanliness of diesel supply.

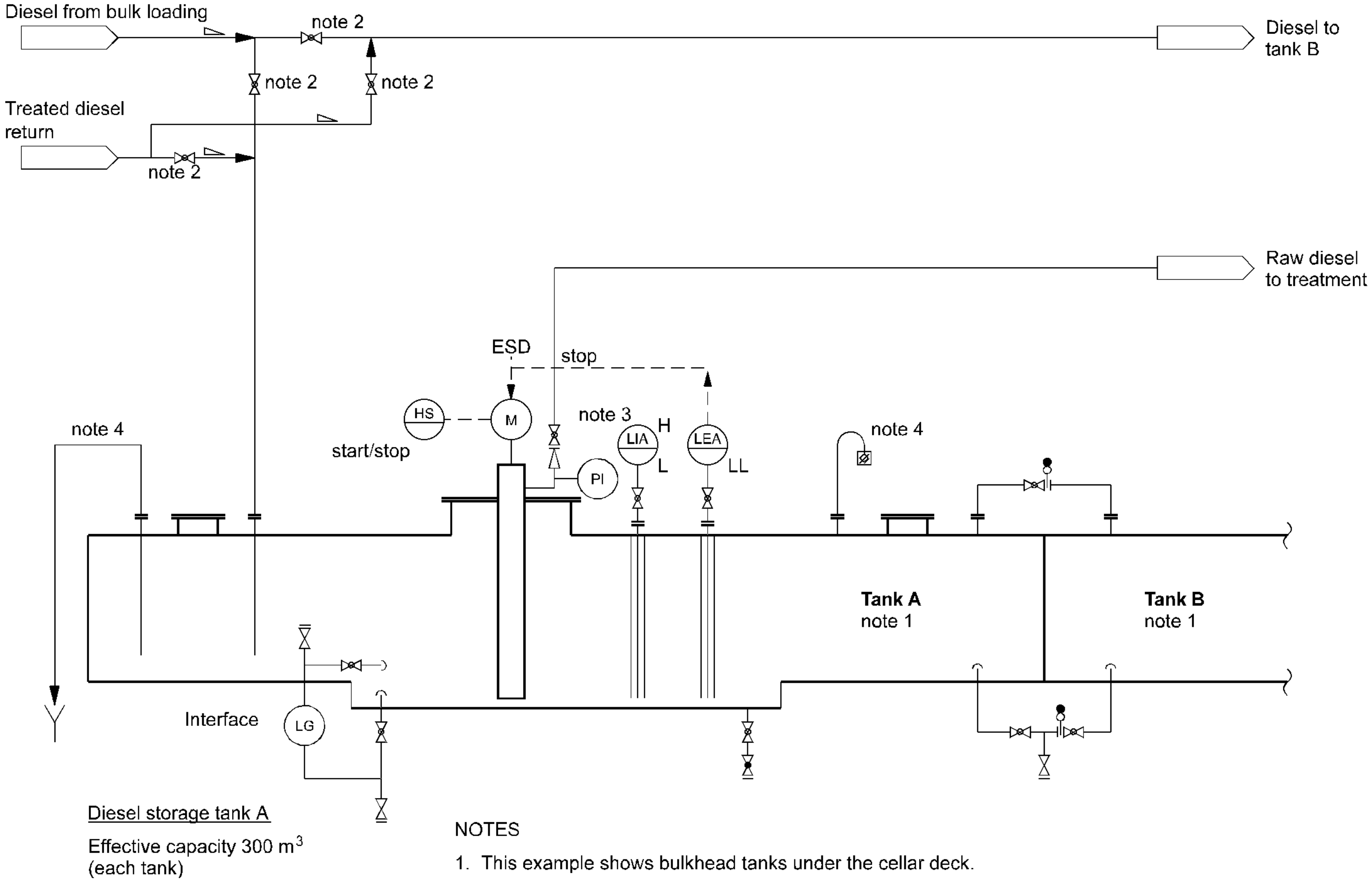
Figure 7 Typical PEFS for pressurised leg storage



NOTES

1. Connections are to a second optional leg storage.
2. Valve required only with crossover to second leg storage.
3. Visible/repeated at location which is normally manned during loading operations.
4. May take form of level shutdown (4.2.2.1).

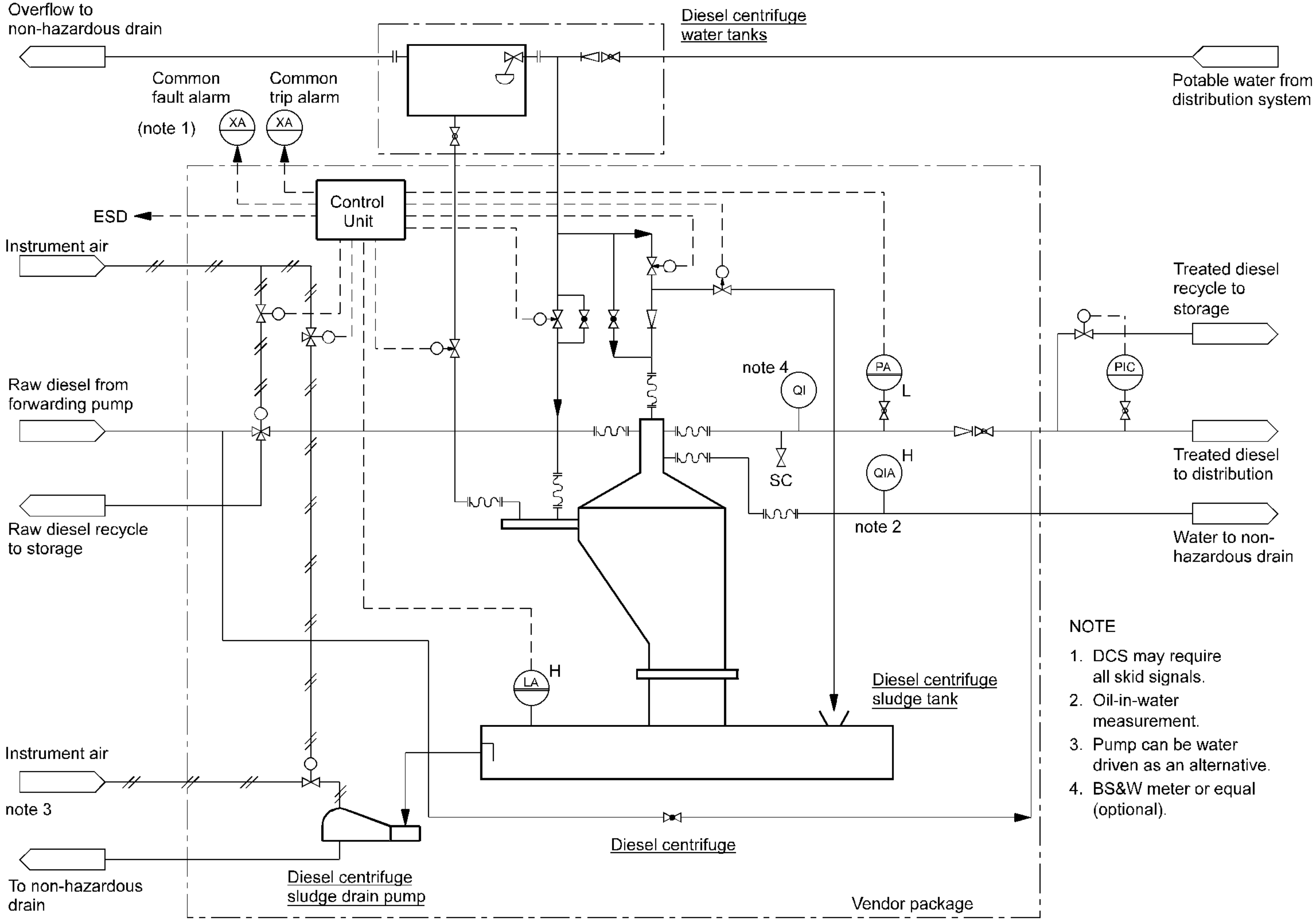
Figure 8 Typical PEFS for deck storage



NOTES

1. This example shows bulkhead tanks under the cellar deck.
2. Diesel routing valves to be accessible and mounted adjacent to each other.
3. Level alarm (high) repeated at point which is normally manned during loading operations.
4. Shall not discharge directly overboard.

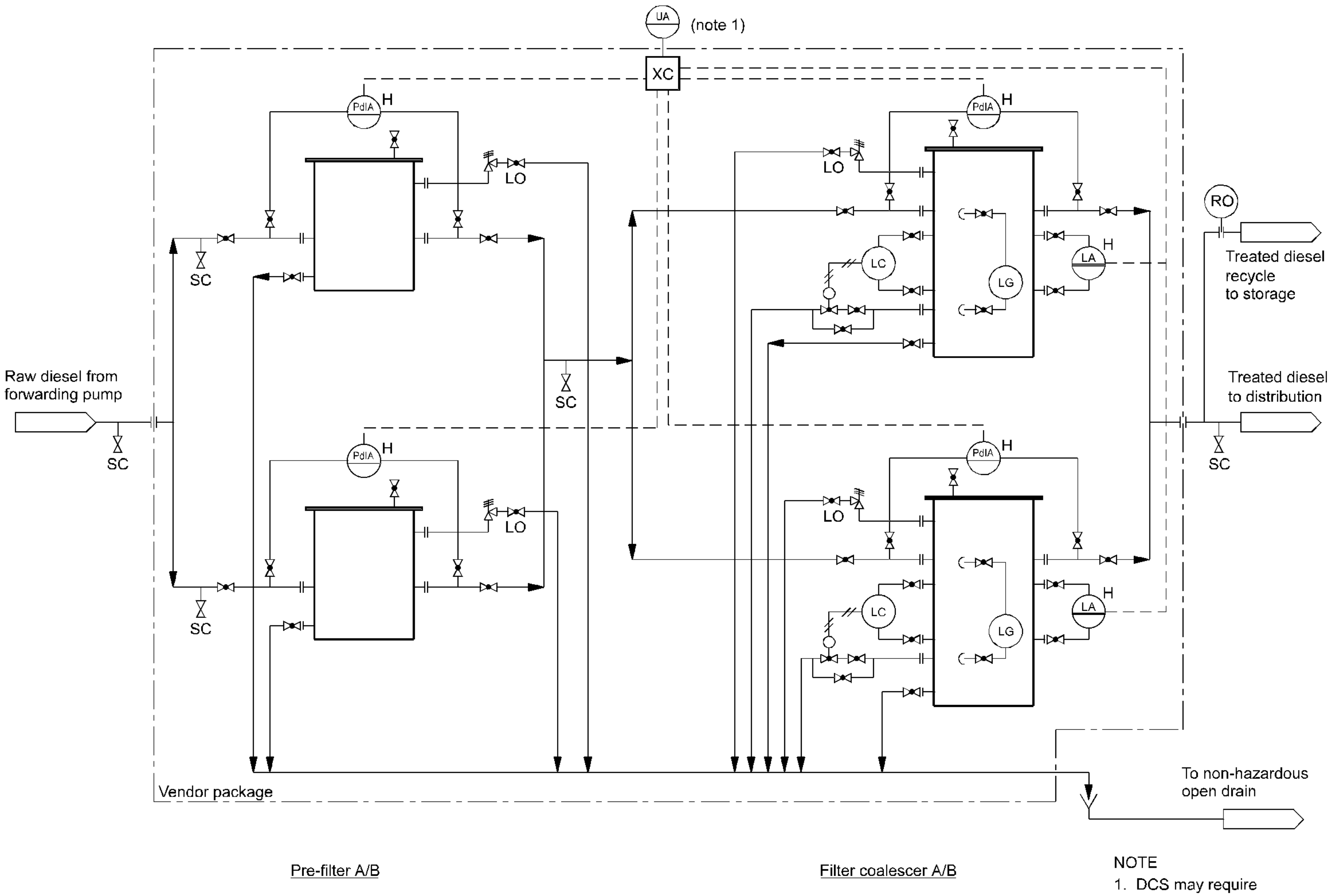
Figure 9 Typical PEFS for centrifuge treatment



NOTE

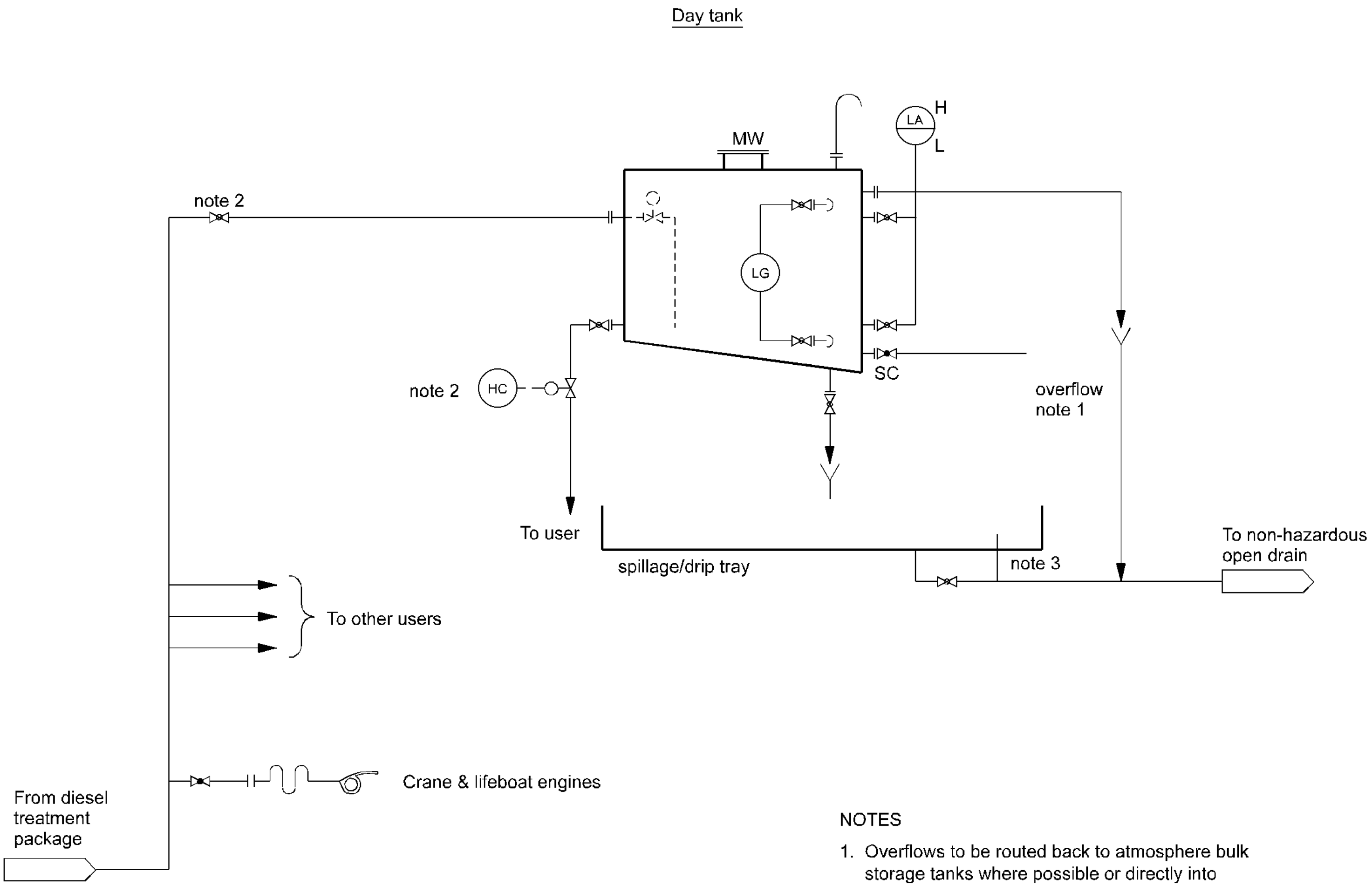
1. DCS may require all skid signals.
2. Oil-in-water measurement.
3. Pump can be water driven as an alternative.
4. BS&W meter or equal (optional).

Figure 10 Typical PEFS for filter coalescer treatment



NOTE
1. DCS may require all skid signals.

Figure 11 Typical PEFS for day tank



NOTES

1. Overflows to be routed back to atmosphere bulk storage tanks where possible or directly into non-hazardous open drains.
2. Operable from outside day tank module.
3. Spillage/drip tray overflow with 100 mm upstand.

APPENDIX 2 DIESEL OIL USERS ON EP FACILITIES

Table 1 Typical diesel oil users on EP facilities

User	Offshore Manned High Demand	Offshore Manned Low Demand	NNMI	Onshore Production or Gas Plant
Emergency Generator	Y (1)	Y		Y
Basic Services Generator	Y	M		M
Main Generator - GT (2)	Y	M		
Sub-Main Generator - GT (2)	M			
Main Generator - diesel engine		M	Y	M
Crude Export Pumps (3)	M	M		M
Pipeline Booster Pumps (3)	M	M		M
Gas Compressor Drivers (3)	M			
Water Injection Drivers (3)	M			M
Fire Water Pumps	Y	Y	M	Y
Water Heaters	Y	M		
Cranes	Y	Y	Y	
Drilling Services	Y	M		
Life Boats	Y	Y	Y	
Mobile Equipment	M	M		Y

Y = usually present

M = may be present

(1) Sometimes combined with Basic Services Generator

(2) Normally run on gas, diesel is back-up fuel.

(3) Normally electric motor or gas turbine driven. Occasionally it may be justifiable to install a dual-fuel turbine with diesel as back-up, such as pipeline oil or gas booster pumps.

NOTE: The onshore case shown is for installations with reliable imported power.

APPENDIX 3 DIESEL OIL PROPERTIES

Typical Properties of Diesel Oil

Shell Gas Oil CI/SH meets BS 2869: Part 2, Classifications A2 and D

Diesel Properties	British Standard	Shell typicals
Viscosity (cSt at 40 °C), kinematic	1.5 min., 5.5 max.	3.5 - 4.5
Density at 15 °C (kg/litre)	-	0.86
Sulphur (% mass)	0.2 max.	0.1 - 0.2
Cetane No. or Calculated Cetane Index	45 min	48
Flash Point (°C)	56 min.	> 62
Ash (% mass)	0.01 max.	< 0.001
Sediment (% mass)	0.01 max.	< 0.001
Water (% volume)	0.05 max.	< 0.01
Cold Filter Plugging Point (CFPP) (°C):		
- Summer (16/3 - 30/9 incl.)	-4 max.	-8
- Winter (1/10 - 15/3 incl.)	-12 max.	-14
Cloud Point (°C):		
- Summer (16/3 - 30/9 incl.)	-	+2
- Winter (1/10 - 15/3 incl.)	-	-2
Carbon Residue (% mass)	0.2 max.	0.1
Ramsbottom on 10% residue:		
- Distillation Recovery at 350 °C (% vol.)	85 min	90
- Carbon (% mass)	-	87
- Hydrogen (% mass)	-	12.75
- Nitrogen (% mass)	-	0.01 - 0.05
- Gross Specific Energy (MJ/kg)	-	45.4
- (MJ/litre)	-	38.8
- Mean Specific Heat Capacity over 0-100 °C (KJ/kg °C)	-	2.05
- Volume Correction Factor (per °C)	-	0.00081
- Copper Corrosion	No.1 max	No.1

APPENDIX 4 GAS TURBINE GENERATOR DIESEL CONSUMPTIONS

Unit	ISO Base Load (kW)	Fuel Consumption (litres/hr)	Specific Fuel Consumption (litres/kW.hr)
SOLAR			
Saturn 20	1210	480	0.40
Centaur 40S	3515	1240	0.35
Centaur 50S	4345	1460	0.34
Taurus 60S	5200	1680	0.32
Taurus 70S	6844	2080	0.30
Mars 90S	9285	2870	0.31
Mars 100S	10695	3230	0.30
General Electric			
LM1600-PA	13750	3800	0.28
LM2500-PE	22800	6080	0.27
LM2500+(PK)	28500	7360	0.26
LM5000-PC	34450	9090	0.26
LM6000-PA	40590	10160	0.25
Nuovo Pignone			
PGT2	2000	790	0.39
PGT5	5220	1910	0.37
PGT10	10220	3210	0.31
PGT16	13750	3860	0.28
PGT25	22450	6060	0.27
EGT			
Hurricane	1662	670	0.40
Typhoon 5.3	5252	1710	0.32
Tornado	6730	2100	0.31
Tempest	7736	2530	0.33
Cyclone	12912	3640	0.28
Rolls Royce			
Avon	14580	5070	0.35
RB211	27210	7450	0.27
Trent	51190	12080	0.24

NOTES:
1. Quoted base load power figures are for operation at ISO conditions (15 °C, 1.013 bar, 60% RH).
2. Diesel consumption based on use of BS 2869 class A2 or D diesel with LHV of 42 680 kJ/kg.