

PETRONAS TECHNICAL STANDARDS

DESIGN AND ENGINEERING PRACTICE

MANUAL

DIESEL OIL SYSTEMS IN OIL & GAS PRODUCTION FACILITIES

PTS 37.05.10.11

DECEMBER 2009



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This revision of PTS 37.05.10.11 – Diesel Oil Systems in Oil & Gas Production Facilities (December, 2009, Revision 1.0) has been updated to incorporate PETRONAS Lessons Learnt, Best Practice and new information issued by relevant industry code and standards. All updates in the document are highlighted in *italic font*.

The previous version of this PTS 37.05.10.11 (December, 1998) will be removed from PTS binder/e-repository from herein onwards.

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1. INTRODUCTION

1.1 SCOPE

This new PTS 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 PTS 20.05.60.10.

The scope of this PTS 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 PTS.

The figures in this PTS 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 PTS cannot cover every system specifically. Nevertheless, the design principles described in this PTS 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 Principle, the distribution of this PTS is confined to companies forming part of or managed by the PETRONAS and to Contractors nominated by them (i.e. the distribution code "C" as defined in PTS 00.00.05.05.).

This PTS 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 PTS, 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 PTS 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 PTS 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. NNMI's 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 PTS are listed in (5).

1.6 SUMMARY OF CHANGES

The previous addition of this PTS is dated December 1998. This PTS was updated accordingly with the latest revision of British Standard (BS 2869:2006). The summaries of changes are tabulated in the table below.

No	Section	Changes
1	Appendix 3	i. Typical properties of diesel were updated based on latest revision of BS 2869. ii. Shell typical diesel properties was removed and changes with PETRONAS Premium Diesel properties.

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 PTS 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 start.

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 2869:2006 Part 2: Fuel oils for agricultural, domestic and industrial engines and boilers.

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:

BS Spec

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 (PTS 80.00.10.10). 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 PTS. Instrument selection and design shall comply with PTS 32.31.00.32, instruments shall be suitable for the applicable hazardous area classification (2.3).

3. SYSTEM DESIGN

3.1 SYSTEM DEFINITION

Within the context of this PTS, 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 (affecting 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 m³/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 m³/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 m³/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 m³/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 m³/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.