



GS 124-3

ELECTRIC MOTOR DRIVEN FIREWATER PUMPS FOR OFFSHORE USE

August 1993

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SCOPE AND PURPOSE This document specifies the general requirements for the design and testing of Firewater Pumps. Its purpose is for the specification of fit-for-purpose Firewater Pumps at minimum cost.											
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FOREWORD

Introduction to BP Group Recommended Practices and Specifications for Engineering

The Introductory Volume contains a series of documents that provide an introduction to the BP Group Recommended Practices and Specifications for Engineering (RPSEs). In particular, the 'General Foreword' sets out the philosophy of the RPSEs. Other documents in the Introductory Volume provide general guidance on using the RPSEs and background information to Engineering Standards in BP. There are also recommendations for specific definitions and requirements.

Value of this Guidance for Specification

This Guidance for Specification was developed under the BP Exploration XEU Simple Specifications Initiative. This initiative is intended to simplify the purchasing requirements through a minimum conditions of satisfaction approach in regions where there is a mature supplier resource.

Application

This Guidance for Specification is intended to guide the purchaser in the use or creation of a fit-for-purpose specification for enquiry or purchasing activity.

Text in italics is Commentary. Commentary provides background information which supports the requirements of the Specification, and may discuss alternative options. It also gives guidance on the implementation of any 'Specification' or 'Approval' actions; specific actions are indicated by an asterisk (*) preceding a paragraph number.

This document may refer to certain local, national or international regulations but the responsibility to ensure compliance with legislation and any other statutory requirements lies with the user. The user should adapt or supplement this document to ensure compliance for the specific application.

Specification Ready for Application

A Specification (BP Group GS 124-3) is available which may be suitable for enquiry or purchasing without modification. It is derived from this BP Group Guidance for Specification by retaining the technical body unaltered but omitting all commentary, omitting the data page and inserting a modified Foreword.

Principal Changes from Previous Edition

BP Engineering Standard 217 is being withdrawn and will be replaced by BP Group [GS 124-1](#) for Onshore Firewater Pumps and by BP Group [GS 124-2](#), [GS 124-3](#) and [GS 124-4](#) for Offshore Firewater Pumps.



Feedback and Further Information

Users are invited to feed back any comments and to detail experiences in the application of BP RPSE's, to assist in the process of their continuous improvement.

For feedback and further information, please contact Standards Group, BP International or the Custodian. See Quarterly Status List for contacts.



1. INTRODUCTION

1.1 Scope

This document specifies the minimum requirements for diesel engine driver firewater pumps, with the pump driven electrically via a generator, cables and electric motor. It should be noted that this configuration can be used with any type of electric motor, be it conventional squirrel cage or submersible.

It is intended, primarily, for use on hydro-carbon production, processing and export facilities offshore.

This document is intended for use in conjunction with a functional specification and associated data sheets and drawings which give specific project requirements.

For offshore fire pumps a number of configurations are acceptable depending upon the platform type, e.g. floating or fixed, and the method of power transmission from the diesel engine driver to the pump itself. Separate specifications have been developed for three basic configurations which are:-

- (i) Diesel engine driver with pump driven via a gearbox, BP Group [GS 124-2](#).
- (ii) Diesel engine driver with pump driven electrically via a generator, cables and electric motor (this document).
- (iii) Diesel engine driver with two pumping stages using a combination of direct drive and hydraulic motor drive, BP Group [GS 124-4](#).

*

The requirements detailed within this document are applicable irrespective of the final location. Details which are site specified, e.g. pump capacity, environmental data, are specified by the Purchaser.

1.2 Quality Assurance

Verification of the vendor's quality system is normally part of the pre-qualification procedure, and is therefore not specified in the core text of this specification. If this is not the case, clauses should be inserted to require the vendor to operate and be prepared to demonstrate the quality system to the purchaser. The quality system should ensure that the technical and QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free issue materials.

Further suggestions may be found in the BP Group RPSEs Introductory Volume

2. GENERAL REQUIREMENTS

- 2.1 The overall design should recognise that the fire pump package will be required to operate on an intermittent basis and be able to start and



operate independently of external supplies. As all offshore installations will have at least two fire pumps, the package will be required to operate in parallel with other fire pumps. The driver will be located in a non-hazardous area, within a fully walled and roofed room or enclosure; the enclosure, if included as part of this package may be located in an exposed location as indicated in the data sheets.

- 2.2 In case of conflict between this document and inquiry or requisition, the order of precedence shall be:-
- (a) Local Authority or Statutory Regulations
 - (b) The Equipment Requisition and Data Sheets
 - (c) This Document
 - (d) Other Industry and National Standards and Specifications.
- 2.3 The vendor shall co-ordinate the design, and ensure the satisfactory functioning of the complete package i.e. pump, driver, transmission, controls and other ancillaries. In cases where the vendor supplies equipment that he has not manufactured, the vendor shall ensure that the designs of these are compatible with each other and his own equipment. The satisfactory functioning of the complete package shall form part of the vendor's guarantee.
- 2.4 High priority shall be given to the design, package construction and installation to ensure simple and reliable starting of the diesel engine driver unit and ease of access and maintenance.
- * 2.5 For floating installations, equipment shall be capable of operating at a sustained maximum inclination as stated in the data sheets.
- 2.6 When indicated in the data sheets the vendor shall include, within his scope of supply, all necessary spreader beams, slings, shackles and lifting gear etc., to enable the package to be handled at the job site and all necessary specified tools to enable maintenance to be carried out.
- 2.7 Due to varying operating scenarios the design should be based on the most severe option. The options include the discharge valve being open, partially open or closed and the fire main being pressurised, anywhere within the range of atmospheric pressure to the discharge pressure of an already operating fire pump. In all cases there will be a check valve between the pump discharge and pump isolation valve.
- 2.8 The generator/motor may be arranged for either of the following configurations:-
- (a) The generator permanently connected directly to the motor(s), with no interposing switchgear, such that when the diesel



engine is started and run up to speed, the motor and pump will follow with no operator intervention on the electrical system.

- (b) The generator used to drive designated existing water pump(s) for fire duty in the event of mains failure. On this occasion the logic of the switchgear will directly connect the generator to the designated motor(s) so that the start up sequence is as (a) above.

The actual configuration is identified in the data sheets.

The design of these systems should be based on starting the motor from rest. Consideration should also be given to preventing reverse rotation.

- 2.9 The run up time of the combined unit shall be kept to a minimum (approx. 10 sec).
- 2.10 The vendor shall provide an analysis of axial loads, static and hydraulic, during starting and stopping and while operating with flow between minimum continuous stable flow and 150% rated flow. The analysis shall include minimum and maximum speeds and internal pump clearance at both design values and twice design values.
- 2.11 Thrust bearings shall be rated for at least twice the maximum thrust (up and down) which may be developed under the condition detailed in 2.10.

3. DIESEL ENGINES

3.1 Performance

- 3.1.1 The engine continuous nett brake power, fuel and consumption and lubricating oil consumption, and overload power shall be declared at the standard reference conditions in accordance with [BS 5514](#) Part 1 (ISO 3046/1-1981).
- 3.1.2 The engines shall have a continuous site rating which exceeds the total absorber power of the pump package, transmission system and any auxiliaries under all operating conditions by a minimum of 5%. This continuous rating shall have a minimum of 10% overload capacity.

3.2 Starting System

- 3.2.1 General



Each engine shall be provided with two starting systems. The preferred primary system shall be electric, based on the use of batteries; the secondary system may be either hydraulic or compressed air. Any Project preference for the type of secondary system will be identified in the data sheets.

Initiation of the secondary start system shall be by the manual operation of a single control button or equivalent.

3.2.2 Electric Starting Systems

Power for successive cranking cycles shall alternate between two battery systems. In the event of a battery failing during the cranking period, the healthy battery shall be brought in automatically to provide power for all the remaining cranking cycles.

Each battery unit shall have sufficient capacity at the site minimum temperature to maintain the cranking speed recommended by the engine manufacturer through a 6 minute cycle (15 seconds cranking and 15 seconds rest in 12 consecutive cycles).

All batteries shall be of the sealed for life type.

On offshore installations the starting batteries shall be capable of being isolated by a remotely controlled contactor contained within a Ex'd' enclosure. The contactor shall be used for isolation purposes only. Control of this contactor will be from the installation's Fire and Gas Detection system supplied by others.

A means of recharging the storage batteries shall be provided. It shall be based on automatically controlled chargers taking power from a separate alternating current power source.

Each battery system shall have its own independent dedicated charger. Each charger shall comply with the following:-

- (a) Have a rate of charge consistent with:-
 - (i) recharging the respective battery in the minimum time
 - (ii) not causing damage to the battery
 - (iii) not reducing battery design life
 - (iv) restoring full charge of the battery within 24 hours following any style of discharge.
- (b) The charger shall be marked with the ampere-hour rating of the largest capacity battery that it can recharge in compliance with (a) above.
- (c) An ammeter with an accuracy of $\pm 5\%$ of the normal charging rate shall be furnished to indicate the operation of the charger.

3.2.3 Hydraulic Starting Systems



When hydraulic starting is used the accumulators and other accessories shall be located on the same skid base as the diesel engine.

The hydraulic starting facility shall comply with the following conditions:-

- (a) The hydraulic cranking device shall operate independently of external power supplies.
- (b) The overall hydraulic system shall contain at least two accumulators each capable of being isolated from the system and removed from maintenance without depressurising the system. The removal arrangements shall also facilitate in-situ checking of the accumulator pre-charger pressure.
- (c) For recharging the accumulators the hydraulic systems should contain one engine driven pump and one manually operated pump.
- (d) The capacity of the hydraulic cranking system shall provide not less than six cranking cycles at the site minimum ambient temperature.
- (e) Pipework shall be stainless steel.

3.2.4 Air Starting Systems

The air start facility shall normally be by use of an air driver starting motor using compressed air from a storage reservoir. Direct air injection systems may only be considered for larger engines when available as a standard engine feature.

The air storage reservoir shall be sized for 180 seconds continuous cranking without recharging.

The air starting system, including the reservoir, shall either be recharged from high pressure storage bottles or via an intensifier from a separate air supply, provided by the purchaser, independent of the fire pump package. In both cases a hand started diesel engine driven compressor shall be provided as back-up. A by-pass with manual valve or switch shall be provided for supplying compressed air to the engine starter in the event of control circuit failure.

3.3 Cooling System

3.3.1 General

Either direct air cooling or water cooling of the engine is acceptable providing they are of the manufacturer's standard design. The vendor



shall identify the method within the data sheets to be completed as part of the proposal.



3.3.2 Water Based Cooling

The cooling system shall be sized for the engine continuous nett brake power as defined in 3.1.2 at the maximum ambient and cooling water temperatures. If specified on the data sheets the system shall also include capacity for cooling the air within the engine enclosure or room and for cooling the engine exhaust: as an alternative the Vendor may propose separate systems for each duty.

The circulating water shall be cooled in either an air cooled radiator or in a water/water heat exchanger using sea water from the pump discharge. Any project preference for type of cooling method and/or location of the air cooled radiator (if needed) is given in the data sheets.

If provided, the radiator fan shall be driven from the engine either directly or by the use of hydraulic transmission. It shall not be independently powered.

The engine shall be provided with thermostatically controlled jacket water heaters and, if necessary, circulating pump to ensure optimum engine starting temperature at the minimum specified ambient temperature.

If necessary, provision shall be made for the prevention of over heating of the coolant due to local high temperature after shut down.

3.4 Fuel System

3.4.1 Each diesel engine shall have a dedicated fuel storage tank designed to [BS 799](#) Part 5 type J or equivalent. It shall be sized to provide a nett capacity of fuel in accordance with statutory regulations (e.g. for offshore use in UK, 12 hours based on fuel consumption at engine continuous nett rated power).

3.4.2 The fuel tank location will be specified in the scope of supply data sheets. Under no circumstances shall the tank be located above the hot exhaust ducting or the engine itself. Within the diesel engine data sheets the vendor shall state the maximum allowable height of the tank bottom above the underside of the diesel engine skid/package frame.

In all cases a locally operated manual valve shall be installed in the fuel line to the engine at the tank outlet. If the tank is located within the diesel engine room/enclosure this valve shall also be operable from outside the room/enclosure.

3.4.3 A thermostatically controlled tank heating system shall be provided if ambient conditions could result in the viscosity of the fuel exceeding the maximum recommended by the engine vendor.



- 3.4.4 The fuel suction filters shall be of the duplex type with replaceable elements and a changeover facility to permit removal and replacement of either element without need for engine shut-down. Filter mesh size shall be specified by the engine supplier.
- 3.4.5 Provision shall be made for priming and bleeding the fuel injection system.
- 3.4.6 For unmanned installations high pressure fuel lines between the fuel pumps and injectors shall be double-skinned, seamless tubing with fuel leak monitoring and alarm. On manned installations the fuel lines may be as above or heavy seamless tubing.
- 3.4.7 Flame resistant flexible hoses shall be provided within the fuel supply and return piping systems between the engine and off skid pipework at the edge of the engine. There shall be no shut-off valve in the return line to the tank.

3.5 Exhaust System

- 3.5.1 The exhaust system shall include silencers, bellows and spark arrestors. If two or more fire pump packages are provided each engine shall have its own exhaust system.
- * 3.5.2 The discharge location from the exhaust system will be specified by the purchaser. The extent of the vendor's supply will be identified within the data sheets.
- 3.5.3 Hot exhaust system piping within the confines of the package and constituting a danger to personnel shall be insulated or protected to limit surface temperature to 65°C.
- * 3.5.4 Where exhaust systems can be exposed to hazardous area conditions, they shall be water cooled to limit surface temperature. The temperature and the length of the system requiring cooling will be specified by the purchaser within the data sheets.
- 3.5.5 The vendor shall propose the materials of construction and submit reasons for his selection.

3.6 Air Intake System

- 3.6.1 Dry replaceable filters shall be provided for the combustion air intake. Filter condition gauges shall be provided.
- 3.6.2 An automatic shut-off valve actuated by engine overspeed shall be fitted in the air intake manifold. Operation of the valve shall be



independent of external power sources and shall be capable of manual operation.

3.7 Lubrication System

3.7.1 Lube oil filters shall be of the replaceable element type and shall be equipped with relief valves and, if no other lube oil pressure indication is provided, a differential pressure gauge. Filters shall be of duplex type with manual changeover facility.

3.7.2 Engines shall be suitable for starting under all conditions without the need for engine prelube.

3.7.3 Electric sump heaters, if provided, shall have a power density not exceeding 2.3W/cm².

3.8 Couplings

3.8.1 It shall be possible to remove couplings without the need to move the engine or driven equipment.

3.8.2 All flexible couplings incorporating a spacer piece shall be of a design in which the spacer piece is positively constrained from flying out in the event of failure of the flexible elements.

3.8.3 The maximum coupling torque shall be limited to a maximum of 80% of the coupling rating.

3.9 Torsional Vibration and Critical Speed

3.9.1 The engine vendor shall carry out a 'torsional vibration analysis' of each complete equipment string and shall submit to the Purchaser for review.

3.9.2 Each engine, coupling, driven unit system shall be so designed to ensure that the complete installation starts, operates and stops free from torsional vibration and oscillation. The first lateral and torsional critical speeds for the complete train shall be at least 10% above the maximum operating speed. No lateral or torsional critical speed shall lie within the operating speed range of the system.

3.9.3 Diesel engine RMS velocity of vibration shall not exceed 11.2Êmm/s at any operating condition.



4. GENERATOR

4.1 General

- 4.1.1 Rotating machines shall comply with [IEC 34](#), Parts 1 to 11 inclusive. All machines shall be of continuous running duty S1 and continuous maximum rating. All machines shall have Class F insulation with a design temperature rise limited to Class B.
- 4.1.2 The degree of protection of the machines shall be IP 54.
- 4.1.3 Rotating machines shall comply with [IEC 72 and IEC 72A](#).
- 4.1.4 AC generators driven by reciprocating internal combustion engines shall comply with [BS 5000](#) Part 3.

4.2 Special Design Requirements for Electrical Rotating Machines

4.2.1 Cooling

- (a) Air cooling is the preferred cooling method. If water cooling is used the water system shall be included as part of the package; cooling water supplies shall not be derived from outside the package except in the case of off skid located radiator.
- (b) When the generator employs a closed circuit cooling system using heat exchangers, then the latter are to include temperature detectors in the air flow ducting to and from the generator with contact for alarm annunciators.

4.2.2 Built-in Temperature Detection

Machines shall include built-in thermal protection in accordance with [IEC 34-11](#). Two level detection, alarm and trip, shall be included.

The alarm and trip setting differential should be such that adequate time is available for the plant operator to shed load in the event of slow overload. Trip settings, slow and rapid, should be as high as is practicable under all operating conditions.

4.2.3 Main Terminals

- (a) Terminal boxes shall be of the air insulated pattern in which the protection of phase conductors against electrical failure is by adequately spaced bare conductors with appropriate insulated supports in accordance with the requirements of [BS 4999](#) Part 145.



- (b) Generators including the terminal box, windings, and cable terminations shall be suitable for operation at the fault level given in the Data Sheet.
- (c) Means shall be provided for electrically isolating individual windings from each other and from the main incoming cables without involving major dismantling of the machine or risking damage to the windings or cables.

4.2.4 Bearings and Lubrication

- (a) On both oil and grease lubricated bearings it shall be possible to relubricate in safety without stopping the machine. A minimum relubrication interval for grease lubricated bearings of 4,000 hours is required irrespective of actual running hours. Where oil lubricated bearings are used level indications or a device for indicating oil flow to each bearing shall be provided.
- (b) When hydrodynamic radial bearings are fitted they shall be provided as a minimum with local dial type thermometers to read oil bath temperatures.
- (c) Machines without thrust or location bearings shall be stated as such in the initial proposal and on the manufacturer's drawing. The machine shall be coupled to the driver by a limited end float coupling. The machine rating plate shall be marked 'limited end float' (LEF). The correct running position of the rotor shall be permanently marked together with the limits of permissible movement. It shall be possible to observe the rotor position at all times relative to the above marks.
- (d) All bearings shall be fully insulated from the machine carcass and/or bedplate to prevent a flow of shaft current unless type tests demonstrate that the shaft voltage measured at any load across the ends of the shaft is less than 150 mV rms. The insulation method shall be permanent and non-deteriorating. This shall include any connections to the bearing housing.
- (e) Machines shall be tested with their service bearings fitted. If transit bearing or other devices are employed for transport purposes, clear labels stating this shall be affixed to the machine.

4.2.5 The critical speeds of the rotor shall not be within 20% of any speed in the operating range nor within 20% of two times operating speed range.



5. AUTOMATIC VOLTAGE REGULATOR (AVR)

The AVR shall include the following features:-

- 5.1 In addition to the provision of main solid state automatic voltage regulation, manual facilities shall be included. The manual facility shall incorporate an automatic follower so that stepless changeover can be effected.
- 5.2 Means of adjusting the set point of the main generator output voltage over a range of $\pm 10\%$ of nominal voltage rating.
- 5.3 The generator AVR should have a characteristic to suit the requirements of the drive during start-up and throughout the operating range (e.g. constant volts/cycle). The supplier shall provide calculations to demonstrate the system performance.

The automatic voltage regulator shall be of electronic design accommodating protection against over voltage.

The temperature stability of the voltage regulation shall be better than 0.5% for temperature between the maximum and minimum ambient.

The steady state voltage regulation shall be within plus or minus 2.5% of the set point between no-load and full load.

6. ELECTRIC MOTORS

6.1 General

- 6.1.1 Motors shall have a continuous site rating that exceeds the power absorbed by the pump (and transmission if applicable) under any operating condition by a minimum of 5%.
- 6.1.2 The torque characteristics during run-up shall be adequate for starting the pump under the most arduous conditions. The difference between the motor torque and load torque at any speed and at 80% rated voltage shall be not less than 10% of the rated motor full load torque.
- 6.1.3 Motors shall be capable of three starts from cold in quick succession against loads corresponding to the most arduous pumping conditions and at 80% rated voltage. Winding temperatures shall not reach levels that would result in significant degradation of insulation.
- 6.1.4 Motors for dedicated diesel-electric drives must be suitable for this soft start application.



The generator must be matched to the motor characteristics to ensure that the pump/motor combination can be accelerated from standstill.

- 6.1.5 Electric drive controllers and accessories shall comply with [NFPA 20](#).

6.2 Conventional Motors

- 6.2.1 Motors operating at above 1000 V shall comply with BP Group [GS 112-4](#) with the exception that anti condensation heaters shall be provided and water cooling is not preferred.

- 6.2.2 Motors operating at below 1000 V shall comply with BP Group [GS 112-3](#) with the exception that two winding temperature detectors per phase shall be provided and water cooling is not preferred.

6.3 Submersible Electric Motors and Cables

- 6.3.1 Submersible motors shall be of the 'wet' type where the stator is flooded by a coolant suitable for the environmental and service conditions. Water triethylene glycol mixture shall normally be used as coolant. Motor stator, rotor and winding materials shall be compatible with the coolant used.

- 6.3.2 The motor shaft shall be sealed with, as a minimum, an unbalanced mechanical seal to prevent the ingress of pump fluid. Mercury seals shall not be permitted.

- 6.3.3 The motor shall incorporate a pressure compensation system to cater for pressure fluctuations during installation, operation and shutdown. Designs that do not require a header tank are preferred. However, if fitted, the pressurising and vent piping shall be continuous flexible hose of reinforced construction and clearly identified.

- 6.3.4 The motor assembly shall incorporate a product lubricator hydrodynamic thrust bearing and rated in accordance with sub section 6.3.5.

- 6.3.5 The motor should be supplied complete with power cable(s) extending where possible in one piece from the motor to an above deck junction box. IP 65 junction box(es) suitable for Zone 1 classified hazardous areas shall be provided at the caisson mounting flange.

- 6.3.6 The rising main shall be suitable for motor earthing. Two earth connections shall be provided, one to the pump head piece and one to the caisson mounting flange.



- 6.3.7 The power cable shall be protected against mechanical damage and fire, and shall be supported to prevent bending below the minimum bending radius. Strain relief shall be provided to prevent damage from tensioning.

The power cable (and motor pressurings/vent lines, if applicable) shall be supported from the rising main by clamps.

7. PUMP

7.1 General

- 7.1.1 Dependent upon the platform type, the lift pump will be either of the vertical suspended type located within a caisson (stilling tube) or of the split casing type located within a flotation chamber below sea level. The platform type and required pump type are given in the Data Sheets.
- 7.1.2 The pump performance characteristics shall fully comply with the requirements of [NFPA 20](#).
- 7.1.3 Where applicable pumps shall comply with the requirements of [API 610](#).
- 7.1.4 The capacity specified on the Data Sheet will be that required from the pump package into the firewater system. The vendor shall make allowance for any cooling water or other requirements of the pumping package when determining the capacity of the pump itself.
- 7.1.5 Suction and discharge pressures specified on the Data Sheet will be those required at the termination points of the pump package. The vendor shall make allowance for internal losses from pipework, strainers, changes in elevation, etc., when determining pump pressures and head.
- 7.1.6 Low flow relief or leak-off valves will be provided by the purchaser downstream of each pump to maintain the minimum continuous stable flow (as defined in [API 610](#)) with no flow into the firewater system.
- The capacity of the relief or leak-off system shall take into account any permanent internal flows such as for cooling and shall be specified by the pump vendor.
- 7.1.7 Provision for measuring pump capacity and differential head will be provided in the firewater pump system by the purchaser.



- 7.1.8 A lateral critical speed analysis shall be carried out on all multi-stage pumps. It shall include both wet and dry criticals and shall be calculated both at design clearances and twice design clearances.
- 7.1.9 Wet critical speeds, both at design clearances and at twice design clearances, shall be at least 20% above maximum continuous speed.
- 7.1.10 A torsional analysis shall be carried out. Acceptance criteria shall be as specified in [API 610](#) clauses 2.8.3.2 and 2.8.3.3.
- 7.1.11 Strainers in the lift pump's suction shall have a minimum free area of four times the pump's first stage suction cross sectional area and a maximum slot dimension of 12 mm.
- 7.1.12 The material of construction shall be appropriate for the type of water in the system: this water will normally be sea water and any deviation is given in the data sheets. Any project preferences for the materials to be used are given in the data sheets but the vendor shall be free to offer alternatives providing he can demonstrate within his bid that the alternatives will give an equal or superior performance. When selecting the materials of construction the vendor should note that the water intake may be dosed for antifouling purposes; dosing details are given in the Data Sheets.

7.2 Line Shaft Driven Vertical Turbine Pumps

- 7.2.1 The stuffing box seal cage shall be drained to the caisson.
- 7.2.2 Lineshaft sections shall be coupled using sleeve type couplings keyed and locked to the shaft. Sleeve coupling design shall be detailed in the quotation.
- 7.2.3 Unless otherwise specified by the purchaser, lineshaft pumps shall have a separate thrust bearing situated between stuffing box and drive coupling. Where a hollow shaft gearbox is specified and a pump thrust bearing is not supplied, the gearbox thrust bearing shall be rated for at least twice the maximum thrusts (up and down) which may be developed under the operating conditions identified in 2.10 above.
- 7.2.4 The vendor shall provide an analysis of lineshaft elongation to demonstrate adequate pump internal axial clearances under all conditions detailed in 2.10 and taking into account assembly tolerances.
- 7.2.5 Bowl assemblies shall be flanged and bolted.
- 7.2.6 Impellers shall be individually secured against axial movement in either direction along the shaft.



- 7.2.7 Shafts shall be provided with renewable sleeves at all interstage and steady bearing points. Sleeves shall be securely fixed so that they cannot be forced out by either hydraulic pressure or mechanical forces.
- 7.2.8 Pumps shall be designed to be freely suspended from the discharge head with no guide system. A bumper may be provided to protect vulnerable areas.
- 7.2.9 The pump/caisson diametrical clearance shall be 100 mm minimum. This shall be maintained over any bumper. The proposed caisson size is given in the data sheets: the Vendor shall also identify the minimum caisson size acceptable whilst maintaining the required diametrical clearance.
- 7.2.10 The column pipe shall be in flanged sections. The section length shall be consistent with ease of handling and overall shaft rigidity. The maximum acceptable length, as dictated by overall platform design, is given in the data sheets.
- 7.2.11 By means of a small bore pipe 'strapped' to the main column pipe, facilities shall be provided for the injection of chemical dosing into the water adjacent to the pump suction strainer. This small bore pipe shall terminate in a flange at the column pipe head piece.

8. CONTROL AND INSTRUMENTATION

8.1 General

- 8.1.1 The control and instrumentation equipment provided as part of this package shall comply within the requirements of BP Group [GS 130-2](#), Electrical and Instrumentation Requirements for Rotating Machinery.
- 8.1.2 The package shall be provided with its own unit control equipment logic system and alarm annunciation necessary for the protection and operation of the complete set as an integral part of the package.
- 8.1.3 Facilities shall be provided to repeat information and alarms to a remote control room, signals shall be wired to output terminals in the unit control panel for connection by others.
- 8.1.4 The unit control panel and equipment shall be installed in a front access cubicle. The control panel shall have an IP 55 enclosure and be suitably protected against a saline atmosphere.



- 8.1.5 The unit control panel shall be mounted either on or off the engine/generator skid as indicated on the data sheets. If the panel is mounted on the skid it shall be protected from vibration by means of suitable anti-vibration mountings and connections between it and the remainder of the package shall be by the vendor. If the panel is mounted remotely from the skid all cables, etc. shall be routed to a junction base located on the skid and the panel shall have a matching junction box: connections between the junction boxes will be undertaken by the purchaser.
- 8.1.6 All shutdown except overspeed shall be via fuel cut-off. Overspeed shutdown shall be by both fuel shut-off and air intake closure.
- * 8.1.7 Electrical power for battery charging etc. shall be derived from a single supply to the package provided by the purchaser.

8.2 Controls

The following controls shall be provided on the unit Control panel:-

- (a) Start/stop push buttons
- (b) Selection of starting method
- (c) Jacket water heater, generator heater and motor heater switches
- (d) Local/Remote Control Switch
- (e) Start selector - manual/auto-standby/off
- (f) Emergency Stop
- (g) Normal/Test Change-over switch

8.3 Indication and Alarms

- 8.3.1 As a minimum the instrumentation within the control panel shall include those items listed in Table 1. As part of his bid the vendor shall identify all additional recommended local indicators, control panel indications, control panel alarms and automatic shutdowns that he considers necessary to monitor the performance of the package and to provide adequate protection of the equipment.
- 8.3.2 Instruments shall comply with [IEC 51](#).
- 8.3.3 All faults which will ultimately lead to a shutdown shall have a pre-alarm which shall be set to give reasonable warning of an imminent shutdown. When the operating mode selector switch is in the normal position all trips other than the overspeed and generator short circuit trips shall be inhibited; when in the test mode all trips shall be operational. Resetting of trips shall only be possible locally.



- 8.3.4 In the event of an equipment trip a 'first out' facility shall be provided to identify the original fault.
- 8.3.5 Repeat 'volt free' contacts shall be provided for remote indication of each alarm and shutdown condition, wired to panel outgoing terminals. Facilities shall be provided to permit remote acceptance of alarms.
- 8.3.6 A facility shall also be provided to permit remote repeat indication of essential indicators.

9. NOISE

9.1 Limits

- 9.1.1 In the absence of any stated noise limits the maximum noise level, irrespective of pump output, at or beyond 1m from the engine/generator package shall not exceed 110 dB(A). Any requirements for a lower maximum noise level will be given by the Purchaser.

9.2 Measurements and Testing Procedures

- 9.2.1 The manufacturer shall provide details of the noise emission from his equipment in octave bands. He shall also provide details of any narrow band noise emitted by his equipment that is noticeable to the ear, together with the octave band or bands in which it occurs.
- 9.2.2 Noise levels shall be measured and calculated in accordance with the procedures stated in [EEMUA Publications No 140 and 141](#).

Alternatively, by prior agreement of the purchaser, such measurements and calculations may be carried out by other standard noise test procedures, such as in [BS 4999](#), part 109. The manufacturer shall provide full details of the test procedure for approval.

9.3 Noise Reduction

- 9.3.1 Where the noise-limiting requirements of the Specification cannot be met without the provision of noise-reducing features, the levels with and without these features shall be stated in any proposal. Such features shall not compromise, in any way, the correct operation of the machine, or any other requirements of this Specification and will only be accepted when there is no alternative for noise control.



- * 9.3.2 Noise-reducing features if provided shall be subject to approval by the purchaser.

10. PAINTING

The Painting system shall be either in accordance with BP Group [GS 106-5](#), or the vendor's standard, providing it gives the same or better degree of protection. The vendor shall include within his bid details of the painting system he proposes to use.

11. TESTING AND INSPECTION

- * As part of his bid, the vendor shall include details of the inspection and testing he proposes to undertake in order to ensure that the equipment meets the functional requirements. These details will be reviewed as part of the bid review process and may be extended by the purchaser.

As a minimum the testing should include:-

11.1 Diesel Engine

- 11.1.1 The diesel engine shall be tested against a water brake, to demonstrate full load power and 10% overload capability.
- * 11.1.2 The diesel engine shall be tested in accordance with [BS 5514](#) Part 2. The test measurements to be carried out shall be in accordance with Table 1 and 2 of [BS 5514](#), Part 2, unless otherwise agreed in writing by the Purchaser.
- 11.1.3 The functional checks to be carried out shall, as a minimum, meet the requirements of [BS 5514](#) Part 2 C1 to C5, C7 to C9.
- 11.1.4 The operation of the overspeed protection system shall be demonstrated mechanically or hydraulically without the use of electrical power (See also 3.6.2).
- 11.1.5 All testing shall be carried out using the contract heat exchangers, filters, governor and overspeed device. Oil having identical characteristics to the contract oil shall be used.
- * 11.1.6 All testing shall be carried out in accordance with written procedures approved by the Purchaser. The test procedures shall detail, as a minimum, the scope, duration and acceptance criteria of all tests, measurements to be taken, and shall include the following data:-



- (a) declaration of power, fuel consumption, lubricating oil consumption and 'Information to be supplied by the engine manufacturer' as detailed in BS 5514 Part 1, Item 13.
- (b) outline technical documentation concerning the engine and type.
- (c) the vendor's standard data sheets compiled for BS 5514 purposes are the preferred format for the above data.
- (d) a clear statement of engine group number as detailed in Table 1 of BS 5514 Part 2.

11.2 Generator

11.2.1 The generator shall be tested in accordance with BS 4999 (Part 143). In addition to those tests specified in BS 4999, the following shall also be carried out:-

- (a) generator over-speed test as required by IEC 34-1
- (b) insulation testing of bearing pedestal/housing
- (c) response testing of the AVR to sudden shedding of the load specified by the chosen grade in Table E1 of BS 4999 Part 140.

11.3 Engine/Generator Combination Test

*

Tests shall be carried out on the assembled generator package unit using all contract equipment. Vendor is to submit a procedure for review and approval by the Purchaser.

Load tests shall be carried out against resistive and reactive load banks as follows:

11.3.1 Eight-hour run at full load current at 0.8 power factor recording:-

- (a) engine parameters as identified above
- (b) vibration of engine, fan and generator
- (a) alternator voltage, current and power factor
- (d) exciter field volts and current
- (e) noise levels

11.3.2 Rejection of full load current at 0.8 power factor. Recording voltage, frequency and load current on pen recorder or other form of trace.

Generator control tests shall be carried out on an unloaded generator as follows:



- (a) demonstration of all generator trips and alarms
- (b) demonstration of electric start capability.

11.4 Motors

- 11.4.1 Conventional Motors shall be tested in accordance with the requirement of the relative BP Specification.
- 11.4.2 Submersible motors shall, as a minimum, be tested in accordance with [BS 4999](#) part 143. In addition the vendor shall include within his bid details of additional tests he proposes to undertake to demonstrate the acceptability of his product.

11.5 Pump

- 11.5.1 All pressure containing parts shall be hydrostatically tested in accordance with [API 610](#).
- 11.5.2 Performance and NPSH tests shall be carried out in accordance with [ISO 2548 \(BS 5316: Part 1\)](#), and shall be within the limits specified under Class C. The tests shall be extended as required to demonstrate the characteristics defined in [NFPA 20](#).
- 11.5.3 As a consequence of the length of the columns employed offshore and the limitations of test facilities, vertical column pumps and submersible pumps may have to be tested with shortened columns. Prior to such tests, agreement with the purchaser shall be reached on the head losses in the test and final configurations, and the corrections to be applied to the test measurements.
- 11.5.4 NPSH tests on horizontal pumps shall be carried out on the first pump of each type when the NPSH required at 150% rated capacity exceeds 80% of the NPSH available as specified on the data sheet for the same capacity. Submergence tests should, however, be performed on vertical well-type pumps.
- 11.5.5 Vibration levels shall be agreed between supplier and purchaser.

11.6 Control Panel

The control panel shall be subjected to simulated function and insulation testing at the manufacturer's work.

In addition the panel should be subjected to a full heat soak test where required.



11.7 Enclosure

Where the fire pump package has an integral enclosure, tests shall be carried out to verify the functioning of all equipment and cabling within the package enclosure.

11.8 String Test

When practicable, a test of the complete unit including pump, driver, transmission, control panel and all ancillaries including those supplied by the Purchaser, shall be carried out by the supplier. When this is not possible, a 12 hour proving test shall be carried out after installation. The purpose of these tests is to prove the correct functioning of all equipment. They shall include but not be limited to the following.

11.8.1 Cold start capability shall be verified as follows:

The engine shall be stationary for at least 12 hours prior to testing (preferably overnight) without jacket water heating.

The starting system shall be tested as per crank sequence to ensure the full automatic and subsequent manual start capability is achieved.

Secondary starting systems shall be tested to verify their capability for starting the engine and if sized for more than one start attempt, their total storage capacity shall be verified.

11.8.2 All alarms and control functions shall be tested by reproducing the relevant condition or by simulation and observing the system response.

11.8.3 Vibration measurements shall be made on all relevant accessible equipment. Measurement points and operating conditions shall be the same as for the individual component tests. Vibration levels shall be no more than 110% of those recorded during the component tests and shall be within the limits specified for the individual items of equipment.

11.8.4 Noise level readings, where specified by the purchaser, shall be conducted in accordance with [EEMUA publications 140 and 141](#), where applicable to factory test conditions.

11.8.5 Surface temperatures shall comply with the requirements of this specification.

11.8.6 The ventilation system of any enclosure shall be shown to operate in compliance with the purchaser's requirements.

11.8.7 Demonstration of compliance with the expected pump delivery characteristics including the requirements of [NFPA 20](#).



12. PACKAGING

12.1 Enclosures

- * 12.1.1 The need for a firewater pump enclosure shall be specified by the Purchaser. If required the enclosure shall be designed as an integral part of the package.
- 12.1.2 For offshore installation the enclosure walls shall have a minimum fire rating of A60, shall comply with local regulations regarding protection and separation of fire pumps and any specific requirements identified in the data sheets.
- 12.1.3 The enclosure shall be designed to allow adequate access for routine maintenance and operation and shall be equipped with as a minimum lighting, lighting points, overhead lifting beams and drainage. Any other requirements shall be as detailed on the data sheets.

13. VENTILATION

- 13.1 Where the firewater pump packages have an integral enclosure, a ventilation system shall be provided to maintain the temperature of the enclosure at an acceptable level during operation. The ventilation fan may be driven off the engine (either directly or by the use of hydraulic transmission) or by an electric motor deriving power directly from the generator or via a local starter.
- 13.2 Where 'unenclosed' diesel engine powered firewater pump(s) are installed in dedicated rooms any requirement for connection (e.g. power and control) to ventilation systems will be specified by the purchaser in the Data Sheets.

14 .DOCUMENTATION

- * 14.1 The Purchaser will provide a list of documentation required.

The following is a suggested list of the documentation requirements:-

- (a) *General arrangements drawings showing main dimensions, weights, arrangement of components, package termination points and the minimum space for the erection and future maintenance of the firewater pump, driver and its ancillaries.*



- (b) *Foundation plan showing location and details of foundation bolts and static dynamic foundation loadings.*
- (c) *Electrical schematic, wiring and interconnection diagrams.*
- (d) *Comprehensive data sheets for all major items, including completed data sheets included in the enquiry/purchase order.*
- (e) *Installation, operation and maintenance instructions for all equipment included in the purchase order.*
- (f) *Pump performance curves.*
- (g) *Recommended list of commissioning spares and spares for two year operation. Recommended list of spares for five year operation.*
- (h) *Test reports and test certifications.*
- (i) *Utility usages including fuel consumption at pump rated output*

As part of his bid the vendor shall include the information requested in (a), (b), (d), (f), (g), and (i) above. The information supplied under (b) may be in outline only.

These documents would be requested in the functional specification.



	Function	Ind	Alarm	Trip	Remote
	CONTROLLER				
1.	Auto start switch off	R	X	-	X
2.	Battery No. 1 Healthy	G	-	-	-
3.	Battery No. 2 Healthy	G	-	-	-
4.	Charger No. 1 Healthy	G	-	-	-
5.	Charger No. 2 Healthy	G	-	-	-
6.	Duty pump(s) selected	A	-	-	X
7.	Engine Running	G	-	-	X
8.	Panel on automatic	G	-	-	X
9.	Weekly test start due	A	X	-	X
10	Emergency Manual start selected	R	-	-	-
11	Battery fault/charger fault	R	X	-	C
**12	Pump at pressure	G	-	-	X
	DIESEL				
1.	Failed to start	R	X	-	X
2.	Engine overspeed	R	X	X	C
3.	Oil pressure - Low	R	X	*	C
4.	Cooling water temperature - High	R	X	*	C
5.	Air intake valve - Closed	R	X	*	C
6.	Fuel tank level - Low	R	X	*	C
7.	Secondary start pressure - Low	R	X	-	C
8.	Jacket water temp. - Low	R	X	*	C
	ELECTRIC MOTOR				
***1	Motor winding temperature - High	R	X	*	C
	GENERATOR				
1	Winding Temperature - High	R	X	*	C
2.	Cooler tube leakage	R	X	*	C
3.	Diode failure	R	X	*	C
4.	Overvoltage	R	X	*	C
5.	Short circuit	R	X	X	X
6.	Excitation contactor tripped	R	X	-	C
7.	AVR on manual/off	R	X	-	X
8.	AVR failure	R	X	*	C
9.	Thermal overload	R	X	*	C
	INTERFACE				
1.	Remote start	R	-	-	X
2.	Remote start inhibited (local)	Flag	-	-	X
	AC SUPPLIES				
1.	AC mains on	N			
2.	Engine jacket water heater	N			
3.	Panel heater on	N			
4.	Alternator package supply	N			

* Trip in test mode only

** Signal from pressure switch supplied and mounted in discharge pipework by others

*** Conventional squirrel cage motors only

C=Common package fault N=Neon indicator

A=Amber indicator R=Red indicator

G=Green indicator



TABLE 1
PACKAGE INSTRUMENTATION INDICATOR LAMP/ALARM SUMMARY



DEFINITIONS AND ABBREVIATIONS**Definitions**

Standardised definitions may be found in the BPÊGroup RPSEs Introductory Volume.

Abbreviations

API	American Petroleum Institute
AVR	Automatic Voltage Regulator
BS	British Standard
EEMUA	Engineering Equipment and Materials Users Association
IP	Institute of Petroleum
NFPA	National Fire Protection Association
NPSH	Net Positive Suction Head



LIST OF REFERENCED DOCUMENTS

A reference invokes the latest published issue or amendment unless stated otherwise.

Referenced standards may be replaced by equivalent standards that are internationally or otherwise recognised provided that it can be shown to the satisfaction of the purchaser's professional engineer that they meet or exceed the requirements of the referenced standards.

BS 799 Part 5		Specification for Oil Storage Tanks
BS 4999		General Required for Rotating Electrical Machines.
Part 109		Specification for Noise Levels including Test Methods
Part 140		Specification for Voltage Regulation and Parallel Operation of a.c. Synchronous Generators.
Part 143		Specification for Tests
Part 145		Specification for Winding Terminations.
BS 5000 Part 3		Generators to be Driven by Reciprocating Internal Combustion Engines.
BS 5316 (ISO 2548)		Specification. Acceptance Test for Centrifugal, Mixed Flow and Axial Pumps.
BS 5514 (ISO 3046/1)		Reciprocating Internal Combustion Engines: Performance
Part 1		Specification for Standard Reference Conditions and Declarations of Power, Fuel Consumption and Lubricating Oil Consumption.
Part 2		Test Methods
IEC 34		Rotating Electrical Machines
IEC 51		Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories.
IEC 72 & 72A		Dimensions and Output Ratings for Rotating Electrical Machines.
EEMUA Publications	140	Noise Procedure Specification.
	141	Guide to the use of Noise Procedure Specification.
BP Group GS 106-5		Painting of Offshore Packages



BP Group GS 112-3	Low Voltage Induction Motors (replaces BP Std 221)
BP Group GS 112-4	High Voltage Induction Motors (replaces BP Std 220)
BP Group GS 130-2	Electrical and Instrumentation Requirements for Rotating Machinery (replaces BP Std 128)
API 610	Centrifugal Pumps for General Refinery Service.
NFPA 20	National Fire Protection Association - Fire Pumps, Centrifugal

