



Exploration & Production

GENERAL SPECIFICATION

ROTATING MACHINERY

GS MEC 144

Fire Pumps

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1. Scope

1.1 Purpose

The purpose of this specification is to define the minimum requirements for the design, fabrication, inspection, testing and supply of Fire Fighting Pump units used for fire water systems.

A pump unit shall mainly consist of a pump, a driver, a power transmission, auxiliaries and controller.

This document may modify or complement some requirements of **NFPA 20**, when deemed necessary in the light of COMPANY experience.

1.2 Conflicting requirements

In the event of conflict between the requirements of **NFPA 20**, this specification and the other applicable documents specified, document priorities shall be as listed below, in decreasing order:

- Local regulations,
- The job specification, including data sheets,
- This specification,
- The National Fire Protection Association Standard **NFPA 20**,
- **API 610**.

In the event of discrepancies relative to other documents, only the COMPANY shall be empowered to decide when advised by the VENDOR.

1.3 VENDOR experience

The equipment shall be of proven design and reliability and the VENDOR shall provide a reference list of identical equipment in operation for at least 2 years, under equivalent operating conditions.

1.4 Basis of design

Fire water pump units shall be designed for continuous operation, even if the normal operation is intermittent, with immediate start-up and continuous operation for some hours.

Note: Diesel engine design for safe area.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
ISO 3046	Reciprocating internal combustion engines – Performances
SAE J517 & 100R	Hydraulic Hoses

Professional Documents

Reference	Title
API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API 670	Machinery Protection Systems
API 671	Special-Purpose Couplings for Petroleum, Chemical, and gas Industry Services.
ISO 1940	Balance quality requirements of rigid rotors
ANSI / ASME B 16.5	Pipe flanges and flanged fitting
AGMA 6000 B96	Measurement of Linear Vibration on Gear Units
AGMA 6010 & 6110 F97	Standard for Spur, Helical, Herringbone and Bevel Enclose Drives

Regulations

Reference	Title
NFPA 20 – 2003 Edition	Standard for the Installation of Stationary Pumps for Fire Protection
94/9/EC (ATEX 100a ¹ /ATEX 95 ²)	European Directive 94/9/EC (23/03/94) on the approximation of the laws of the Member State concerning equipment and protective systems intended for use in potentially explosive atmosphere
1999/92/EEC (ATEX 118 ¹ /ATEX 137 ²)	European Directive 1999/92/EEC (16/12/99) on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres

Codes

Reference	Title
Not applicable	

¹ Reference to Articles 100/118 of the Treaty of Rome

² Reference to Articles 95/137 of the Treaty of Amsterdam

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS COR 350	External protection of offshore and related structures and equipment by painting.
GS COR 351	External protection of structures and equipment by painting. Floating structures.
GS COR 354	External protection of onshore structures and equipment by painting.
GS ELE 011	Electrical requirements for packaged units.
GS ELE 079	Electrical apparatus for potentially explosive gas atmospheres.
GS STR 103	Design and fabrication of skids and equipment supporting structures.
GS MEC 101	Design and power margin
GS MEC 271	Process centrifugal pumps comments to API 610 (8 th edition)
GS MEC 290	Rotating machines packages
GS INS 110	Instrumentation for package units
GS SAF 222	Safety rules for machinery and equipment handling hydrocarbon in enclosed area.
GS SAF 312	Guidelines for selecting and installing fire and gas detection systems
GS SAF 321	Fire pump station and fire water mains
GS SAF 331	Carbon dioxide fire extinguishing system
GS PVV 111	Piping design specification
GS PVV 112	Piping material classes
GS PVV 175	Internal cleaning of piping and vessels
GS PVV 202	Standard drawings for accessories and equipment of vessels
GS PVV 211	Design and fabrication of pressure vessels according to ASME VIII
GS PVV 614	Welding of duplex and super-duplex stainless steel
GS STR 103	Design and fabrication of skids and equipment supporting structures

3. Definitions and abbreviations

COMPANY	:	TOTAL E&P or any TOTAL E&P subsidiary.
CONTRACTOR	:	Any company TOTAL E&P has signed a contract with for the Engineering, Procurement, Construction and Installation of a part of a project.
SUPPLIER or VENDOR	:	The package Supplier or Vendor.
PACKAGE	:	Prefabricated process or utility self-contained unit, generally able to operate on its own, supplied fully tested and ready for immediate installation.
SPL	:	Spare Parts List

4. Scope of Supply

4.1 Extend of supply

The scope of supply shall be as defined by the fire pump unit requisition and should include as a minimum:

4.1.1 Equipment

4.1.1.1 Fire water pump Unit

- Driver with auxiliaries,
- Power transmission(s),
- Pump,
- Base-plate,
- Pump Unit enclosure, (When required) and associated accessories,
- Unit Control Panel (UCP),
- Gauge board(s),
- Suction strainer,
- Air release valve
- Spare parts,
- Special tools.
- Circulation Relief Valve.

4.1.1.2 Services

- Inspection and testing,
- Painting, packing and preparation for shipment,
- Documentation,
- Field assistance.

5. Package Unit design

Package unit design shall conform to the requirements of **GS MEC 290**.

Unless otherwise specified, the package design shall be of single lift type i.e. all package components shall form a completely and self contained skid mounted package ready for bolting down on the foundations and hook-up.

For fire pumps and drivers, maximum operating speed shall be as follows:

- Horizontal pumps: 1800 RPM
- Vertical pumps driven by:
 - Electric motors: 1800 RPM
 - Diesel engines: 1500 RPM.

For vertical pumps, pump columns and pump hydraulics will be delivered loose for field reassembly by others under the responsibility of the pump unit vendor.

Skid design shall be according to **GS STR 103**. Unless otherwise specified, base-plates shall be designed to rest on several points equally spaced.

Drip pan underneath the diesel engine shall be provided to protect any accessories from oil spillage.

Platform gangways with access ladders shall be provided at each side of the diesel engine to have access to top of the diesel engine for operation and maintenance purpose (manual speed control lever arm, injectors, valve rockers, cooling expansion tank).

Ladders shall be provided to access to the top of the diesel tank and to the level transmitter.

Base-plates shall be installed as per appendix 2 which defines the scope of supply.

Torsional analysis of the complete shaft line shall be performed and submitted to the COMPANY for approval.

Shafts, gears and couplings shall be capable of withstanding 120% of the maximum possible torque that can be generated by driver at start up without exceeding allowable yield stress of any component.

Heat exchangers when applicable shall be made of 90-10 copper nickel Fe alloy.

6. Comments and/or additions to NFPA 20 – 2003 Edition

Following are the comments and / or additions to the corresponding paragraph numbers of **NFPA 20**:

5 General Requirements

5.8 Centrifugal Fire Pump Capacities

In case of diesel engine driven pump, the rated pump capacity shall include the required flow for site fire fighting network and flow required for diesel engine and gear cooling.

5.11 Circulation Relief Valve

The circulation Relief Valve shall comply with **GS SAF 321** paragraph 4.2.3.3 and made of material selected for sea water service in case of off-shore application.

5.12 Equipment Protection

Enclosure (When required)

The enclosure, when required, shall comply with **GS SAF 321**, **GS MEC 290** and **GS SAF 222** requirements to meet the noise and the installation area classification requirements.

Air ventilation system

The enclosure air ventilation system shall comply with **GS MEC 290** and **GS SAF 222** requirements.

Ventilation of the enclosure shall be achieved by a fan powered from an engine power take off through either a mechanical or hydraulic or electrical transmission.

Enclosure ventilation system shall be designed to limit the enclosure outlet air temperature to the rated site temperature plus 15°C at the rated engine power.

Chapter 6 Centrifugal pumps

When a Horizontal centrifugal pump is specified, it shall be **API 610** compliant.

Chapter 7 Vertical Shaft Turbine - Type Pumps

Section: 7.3 Pump

This type of pump shall comply with **API 610**.

In particular, section **8.3 of API 610**, Vertically Suspended pumps shall apply with the following comments:

8.3.3 Impellers and column shaft couplings must be G 2.5 balanced and balance certificates must be provided.

8.3.5 For 400 m³/h flow pumps and above, the SUPPLIER shall carry out a dynamic study of the whole discharge column, pump and shaft to determine the natural frequencies and associated modes under the following conditions: Fixed on top (stiffness 10⁻⁷ m/N), free at bottom, pump and column filled with water, both at design bearing clearances and at twice design bearing clearances.

The supplier must specify:

- The design assumptions and method,
- Field experience references in this range,
- The tolerance on these calculated frequencies.

8.3.6.1 Bearings bush shall be non metallic suitable to start in dry conditions. Distances between column bearings shall comply with figure **32** of **API 610**. This requirement is applicable for all pumps size, regardless of flow.

8.3.8.4 Antifouling system

The SUPPLIER shall provide anti-fouling dosing facilities complete with piping, diffuser ring, etc to be connected with the site hypochlorite distribution network.

Use of different material for water wetted material parts shall be avoided to prevent galvanic corrosion.

Unless otherwise specified, guidance for the selection of the pump materials shall be as follow:

- For seawater application, pump materials shall be selected according to API 610 Table H1, material class D2. Super Duplex material grades with a Pitting Resistance Equivalency (PRE) greater than 40, where PRE is based on actual chemical analysis.

Discharge columns for vertical pumps shall be of Super Duplex Stainless steel as above.

- For fresh water application, pump materials shall be selected according to API 610 Table H1, material class S3 or S6

In his proposal, VENDOR shall clearly identify selected materials for all parts of the pump unit including suction strainer, with reference to COMPANY approved standards including the material grade. When no such identification is available, the material specification shall give chemical composition, mechanical properties and test requirements.

Section: 7.3.2 Column

SUPPLIER shall ensure that the pump will be installed in the riser with sufficient clearance to avoid stress in the column. In addition the riser shall be considered to have a vertical offset of 5/1000.

The shaft seal on pump head shall be a stuffing box seal. The packing material shall be compatible with sea water. The shaft shall be sleeved. The permanent leak shall be drained to the riser.

7.3.2.2 The Supplier shall provide parallelism and concentricity control reports for all column flange faces and bearings supports.

Section: 7.3.4 Suction Strainer

Suction strainer material shall be selected in line with pump materials to avoid galvanic corrosion.

Section: 7.5.1.6 Gear Drives

Right angle gears shall have a hunting tooth ratio.

Unless otherwise specified, the right angle gears shall be of hollow shaft type.

Right angle gears shall be designed, manufactured and tested in accordance with the applicable AGMA standard.

Right angle gears shall be manufactured and assembled to meet the AGMA quality number of 12 minimum.

Right angle gears shall be designed with an AGMA Service Factor of 2 based on the rated power of the driver.

The right angle gears oil shall be cooled with a pumped water/oil exchanger of exactly the same design as that of the engine. It shall be independent of the right angle gears to permit its changeover, if necessary.

Pressurized oil system achieved by a mechanical shaft driven oil gear pump shall be provided.

Right angle gears bearing housing shall be designed with 3/8" NPT stud mounting flat surface for vibration monitoring purpose in accordance with the API 670 Appendix C guidelines.

These flat surfaces shall be an integral part of the right angle gears casing and shall be located to measure the vibrations in the 3 directions on both shafts.

Gear and pinion teeth shall be finished by grinding.

Gear Drive Accessories

Unless otherwise specified, the right angle gears shall be provided with:

- Lifting eyes or lugs,
- An anti reverse rotation ratchet wheel,
- Casing oil level glass,
- Oil pressure gauges,
- Oil temperature gauges
- Casing valved drain with plug,
- Water oil cooler.

Section: 7.5.1.7 Flexible Connecting Shafts

Flexible coupling shall be provided in accordance with **API 671**.

Universal joint transmissions are acceptable for operating speed below 1500 RPM.

Power transmissions shall be balanced to G 2.5 according to **ISO 1940**.

7. Diesel Engine Drive

Engine rating shall be as per **NFPA 20**, section 11.2.2 requirements, in accordance with **ISO 3046-1**, amended by **GS MEC 101**.

The **VENDOR** shall provide details of engine rating calculation.

7.1 Engine heater

VENDOR shall provide electric heating of the diesel engine (for the cooling water and/or lubricating oil) so that, on start-up, the diesel engine can immediately run safely under full load.

The electric heater must be shut off while the diesel engine is running.

7.2 Starting Systems

Diesel oil engines shall be provided with two distinct starting systems completely independent of the plant support facilities:

A) A Main starting system as described in the **NFPA 20** paragraphs 11.2.5.2 (Electric Starting) or 11.2.5.4 (Air starting).

- Electric starting: This shall be in accordance with **NFPA 20** section 11.2.5.2, and the following additional requirements:
 - Nickel Cadmium batteries shall be provided instead of lead acid batteries,
 - Battery banks shall be installed in movable trays made of glass reinforced plastic,
 - Two battery chargers shall be provided even if the diesel engine is supplied with a driven generator or alternator as a manufacturer standard,
 - Manual start-up facility by-passing the driver controller.

- Air starting: This shall be in accordance with **NFPA 20** section 11.2.5.4, and the following additional requirements:

The starter shall be made by INGERSOLL RAND" or "GALI".

The air start device shall include:

- Compressed air vessel(s) located in the mainframe, sized for 6 times 5 seconds cranking. These vessel(s) shall be easily accessible and removable, designed and built in accordance with the ASME Section VIII,
- Non return valve(s) on the air vessel,
- A low pressure switch on the air vessel,
- A vessel pressure gauge,
- A compressed air amplifier, fed by the instrument air system at 7 bar g,
- A manual start lever,
- An air pressure reducing valve designed to feed the starter with the correct pressure and flow, if necessary.

- B) A Back-up hydraulic starting system as per **NFPA 20** paragraph 11.2.5.3 requirements consisting of:**

- Hydraulic starting:
 - An hydraulic motor starter,
 - Hydraulic storage bottle(s) sized to permit six time 5 seconds consecutive cranking. These bottles shall be easily accessible and removable, designed and built in accordance with the ASME Section VIII,
 - Electric motor or pneumatic driven pump to permanently pressurize the storage bottle(s) with the powering fluid (diesel engine driven pump is not allowed),
 - A manual pump to pressurize the storage bottle(s),
 - Safety devices and associated instrumentation to safely operate and monitor the system.
 - Manual starting facility by-passing the driver controller.

Both systems shall be installed on the pump unit base plate.

When required by VENDOR to ensure safe and reliable start-up, the diesel engine shall be provided with starting aids such as pre-lube system and water jackets heaters or other devices as recommended by the VENDOR.

However, the lack of such systems shall not prevent the start-up of the pump unit in any case.

7.3 Cooling System

Diesel engine cooling system shall be based on closed treated water cooling system and either an air cooler or a water to water heat exchanger.

When the pump unit is installed offshore, treated water to sea water heat exchanger shall be provided and the sea water shall:

- Be fed from the pump discharge,
- Be delivered to the various users through a Y type strainer as per attached APPENDIX 1 arrangement,
- Return to the pump caisson.

Each user branch shall be provided with restrictive orifice for field flow and pressure adjustment purpose and a flow glass downstream the users.

Cooling piping system shall be complete within the limits of the pump units, designed and erected in accordance with the applicable specifications. Piping shall be rigid, flexible parts shall be limited to join static and moving equipment and be as short as possible. Piping layout shall avoid any air pockets. High points shall be provided with valved vents. Low points shall be provided with valved drains connected to the customer common drain connection.

Piping between pump and engine exchanger shall be made of stainless steel type 316L.

Expansion cooling tank shall be provided with low alarm level, relief valves, valved drain and filling connections.

7.4 Diesel fuel system

The diesel fuel shall be gravity fed from a day tank. Unless otherwise specified, this day tank shall be mounted on the pump unit base-plate, the elevation being such that the maximum permissible static pressure head at the diesel engine is not exceeded.

A manual isolation valve shall be installed between the day tank and the diesel engine, accessible for safety purpose.

The day tank shall be sized for 12 hours based on the driver consumption at its rated power and shall be provided with a low alarm level when the useful capacity is less than 10 hours based on the same driver consumption.

The tank shall be made of carbon steel internally epoxy coated fitted with an automatic top up, an overflow and a flow glass, a sludge trap, a valved drain point, a level gauge over the whole tank height, a flanged vent connection provided with a flanged flame arrestor.

The diesel fuel system shall include diesel filter and water coalescer separator.

A differential pressure gauge will indicate the condition of the fuel filter.

All piping shall be metallic. When required, flexible connections shall be reduced to the minimum and special care shall be taken to ensure adequate support at the rigid end pipes.

Flexible hoses shall be of oil resistant rubber of two-ply reinforced construction and external metal braid protection, compliant with SAE J517 and 100R standards requirements. Each flexible hose shall terminate in an approved screwed union connection with shrouded ferrules. Mating screwed connectors shall be provided at each rigid pipe end. Union connectors shall be arranged so that no bending or torsion is applied to either the hose, ferrule ends or rigid pipe ends.

7.5 Air inlet system

A complete air inlet system shall be provided and shall consist of:

- Air inlet filter designed to meet diesel engine manufacturer requirements,
- Associated instrumentation (differential pressure gauge and alarm),
- Expansion bellow,
- Flaps with fully closed and open limit switches and manual reset facilities.

The air inlet system, downstream the flaps, shall be designed to withstand complete vacuum.

7.6 Exhaust System

Unless otherwise specified, a complete exhaust system supported from the pump unit base-plate shall be provided and shall consist of:

- Expansion below,
- Exhaust spark arrestor and silencer fitted with ash drain plugs. The silencer shall be designed to meet the project noise specification,
- Supporting.

Driver manufacturer shall advise the maximum allowable back pressure at the exhaust customer connection at the rated power exhaust gas flow.

All parts of exhaust system must comply with **GS SAF 222** requirement.

Exhaust shall be suitably cooled or lagged to obtain surface temperature less than 70°C for personnel protection, whenever necessary.

7.7 Driver installation

Diesel engine shall be installed with flexible isolator mountings.

Base-plate supporting structure in front of the flexible isolator mountings shall be locally reinforced.

7.8 Unit Control Panel

Unit Control Panel shall be designed built and wired in accordance with the applicable specifications.

UCP shall be in accordance with the **NFPA 20**, enclosed to IP 65 standard as per IEC regulations fitted with an anti-condensation heater, installed on the driver unit base plate with anti-vibration mountings.

Unit Control Panel shall be:

- Designed to execute the operating philosophy described in section 8 of this specification.

Provided with the following devices as a minimum:

- Mode selector switch,
- Control of the start and shutdown sequences,
- Manual start,
- Control of both starting systems,
- Control of the diesel engine and auxiliaries,
- Diesel engine over-speed reset,

Provided with the following metering devices as a minimum:

- Diesel engine tachometer,
- Hours run meter,
- Diesel engine oil pressure and water temperature,
- Diesel engine exhaust temperature,
- Battery voltage and ammeter,

Provided with the following status, alarms, shutdown as a minimum:

- Status
 - Diesel engine available,
 - Diesel engine on demand,
 - Diesel engine running,
 - Diesel engine failed to start,
 - Diesel engine start inhibited,
 - Diesel engine air flaps status, fully open and fully close,
- Alarms
 - Low cooling water level,
 - Low fuel level,
 - Low oil pressure (diesel engine and right gear box),
 - High oil temperature (diesel engine and right gear box),
 - High cooling water temperature,
 - Diesel engine high exhaust temperature
 - Starting systems (low pressure, low Voltage),
 - Weekly start due,
- Shutdown
 - Diesel engine over-speed.

The controller circuitry shall be arranged to provide volt free contacts to give remote annunciation as follows:

- "Pump unit on demand": upon reception of the starting signal and during the starting sequence.
- "Pump unit started": when the driver has reached 90 % of the rated speed.
- "Fail to start": when all start attempts have failed.
- "Pump unit available": when the pump unit is ready for a remote start,
- "Pump unit fault": when any of the alarms, shutdowns and abnormal status as here above listed have been annunciated at the controller,
- "Pump unit start inhibited acknowledgement": upon reception of the "inhibit automatic start" remote signal.

The controller shall accept the following remote signals:

- "Start": upon reception of any of the start signals, the pump unit automatic start sequence must be initiated,
- "Inhibit automatic start": upon reception of this signal, the pump unit automatic start sequence is inhibited.

8. Operation

8.1 Starting conditions

Fire pumps are always started with the pump discharge valve fully open.

8.2 Parallel operation

Pumps shall be suitable for parallel operation even if normal operation is planned with a single pump.

8.2.1 Operating modes

4 modes will be made available by means of a mode selector switch:

- Auto,
- Manu,
- Test,
- Off.

8.2.2 Auto mode

- The fire pump unit shall start automatically and immediately upon reception of anyone of the following signals:
 - A remote signal from the fire and gas detection system,
 - A remote signal from the plant control room,
 - A signal indicating a low pressure in the fire water ring pressure switch on the panel provided by the pump unit manufacturer.
- Upon disappearance of all the above starting signals, the fire pump unit can only be manually shutdown by pressing the stop push button installed on the UCP.
- The fire pump unit shall automatically and instantaneously shutdown only on activation of the driver over-speed device.

8.2.3 Manu mode

- The fire pump unit shall start only by pressing the manual start push button located on the UCP.
- The fire pump unit shall automatically and instantaneously shutdown on activation of the driver over-speed device and may be manually stopped by pressing the stop push button located on the UCP.

8.2.4 Test mode

- The fire pump unit shall start only by pressing the manual start push button located on the UCP.
- The fire pump unit shall automatically and instantaneously shutdown on activation of the driver over-speed device and signals like low cooling water level, low oil pressure, high oil temperature, high cooling water temperature... and shall be manually stopped by pressing the stop push button located on the UCP.

8.2.5 Off mode

- Automatic start up and manual start up initiated from the UCP are inoperative.

However, in all modes, the fire pump unit shall be started by energizing manually and locally anyone of the two starting systems.

8.2.6 Operation in case of gas detection

In case of gas detection:

- When the pump unit is at rest, automatic start-up and manual start-up from the UCP shall be inhibited, but the pump unit shall still be capable of being started using the manual local non electrical starting facility.
- When the pump unit is running, it shall stay on in Auto and Manu modes only.

8.2.7 Over-speed shutdown/diesel engine air flaps.

The over-speed shutdown is operational under all operating conditions.

The diesel engine air flaps shall be triggered closed during an over-speed shutdown by the UCP.

Before restarting, the air flaps must be manually reset as well as the diesel engine over-speed switch.

9. Final Inspection and acceptance tests

9.1 Shop inspection and tests

Shop inspection and tests shall be carried on each component in accordance with the applicable COMPANY specifications.

Unless otherwise specified, each fire pump unit fully assembled and wired including the UCP shall undergo a complete unit test at rated speed, power and pressure.

9.2 Factory Full Load Test

The purpose of this test is to check the package, as close as possible to site configuration.

For vertical centrifugal pump unit, the only difference will be that, because of test bench space limitation, the length of the discharge column may be reduced, but the number of column elements should not be less than three, with at least one shaft bearing inserted.

a) During this test following points shall be checked :

- The control system,
- The safety system,
- The prime starting sequence,
- The prime starting system capacity,
- The back-up starting sequence,
- The back-up starting system capacity,
- The pump performances,
- The noise and vibration level,
- The conformity of the package to the job specification.

b) Test duration

- Four hours at the pump normal operating point.
- One hour at minimum continuous flow,
- One hour at 150 % of rated flow,
- From 30 min to one hour to check or establish the pump curve from zero to maximum flow, and engine consumption.

All of above tests shall be performed at minimum pump submergence.

During the test, the following parameters at least shall be recorded at each operating point:

- Pump flow,
- Suction and discharge pressure,
- Speed,
- Vibrations (bearings, base plates) and noise,
- Cooling flows (using test bench temporary flow meters),
- Temperatures: Ambient,
Engine exhaust
Engine oil
Right angle gear oil
Inlet and outlet raw water,
Engine fresh water,
Internal enclosure (doors closed),
- Pressure: Engine oil
Right angle gear
Exchanger inlet
Emergency starting pressure accumulator, after each cranking test

9.3 Field inspection and tests

Final acceptance of the unit will be pronounced only after the satisfactory completion of the field acceptance tests.

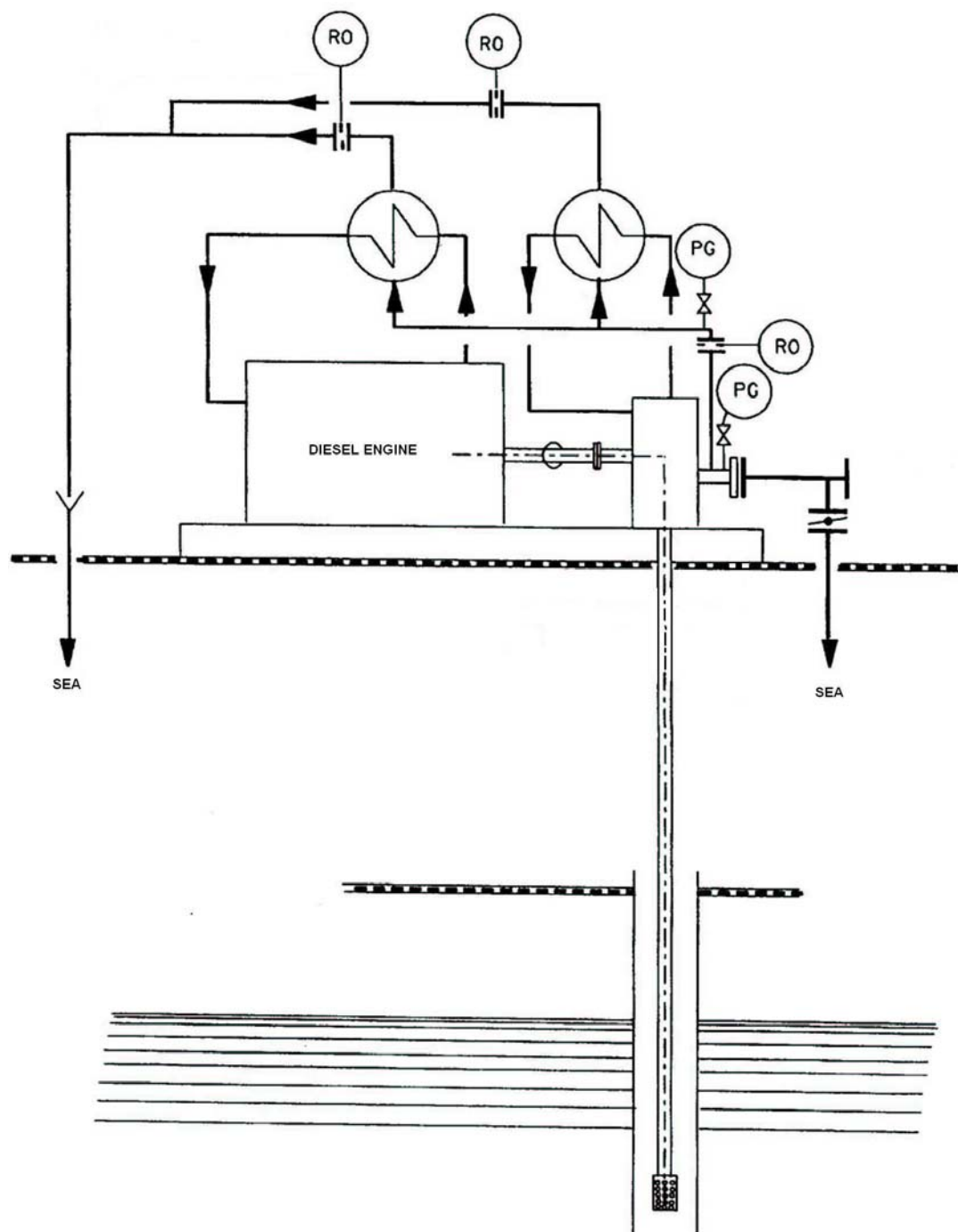
Such tests shall demonstrate that the pump unit meets the mechanical and performance requirements within the specified operating range and conditions.

9.4 Acceptance criteria

These acceptance criteria are valid for both shop and field tests and shall be as follows:

- Performances and tolerances:
 - Pump: as per **NFPA 20**, **API 610**,
 - Diesel driver: as per **ISO 3046-1**.
- Mechanical:
 - Vibration levels over the whole operating range:
 - Pump: as per API 610
 - Driver: as per VDI 2056 - Group G severity "satisfactory"
 - Gear as per AGMA 6000 – B96 - Class B
 - Base-plate and right angle gears or pump supports when applicable 7.5 mm/s RMS
- Noise as specified in Project specification.

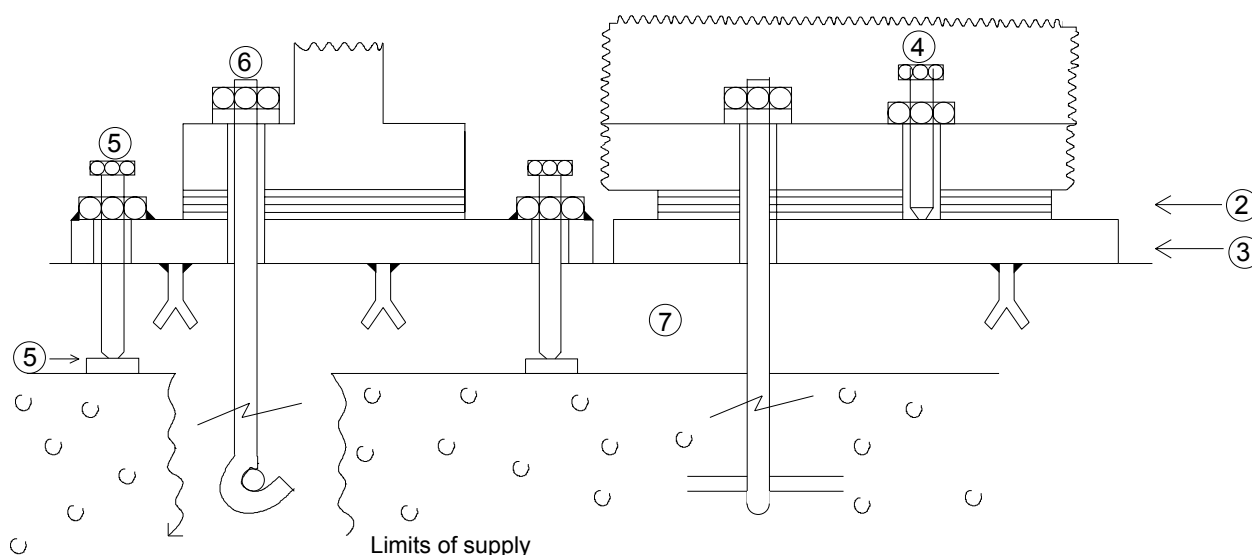
Appendix 1 Cooling circuit arrangement



Appendix 2 Base-plate Installation

DESIGN AND SCOPE OF SUPPLY

CONCRETE FOUNDATION



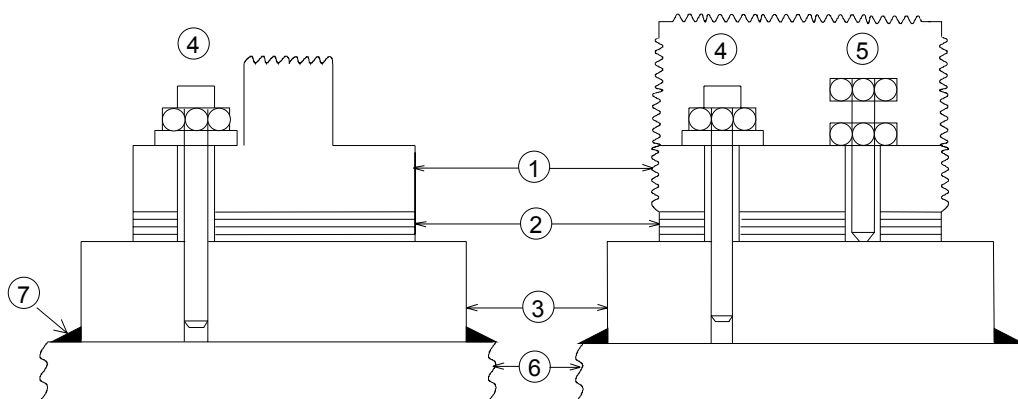
Pump set Vendor

- ① Base plate
- ② Shims (20 mm min)
- ③ Sole plate (30 mm min)
- ④ Base plate levelling screws
- ⑤ Soleplate levelling screws

Others

- ⑥ Anchor bolts
- ⑦ Non shrinking epoxy grout

STEEL STRUCTURE FOUNDATION



Limits of supply

Pump set Vendor

- ① Baseplate
- ② Shims (20 mm min)
- ③ Soleplate (50 mm min)
- ④ Anchor bolts
- ⑤ Levelling bolts

Others

- ⑥ Deck
- ⑦ Welding