MATERIAL AND EQUIPMENT STANDARD

FOR

RECIPROCATING INTERNAL COMBUSTION ENGINES

SECOND EDITION

JUNE 2015

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS:

Throughout this Standard the following definitions shall apply.

COMPANY:

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER:

Means the “Company” where this standard is a part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR:

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR:

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

This Standard Specification covers the minimum requirements for reciprocating internal combustion engines for mechanical drives and electric power generator drives for use in oil refineries, chemical, gas and petrochemical plants and where applicable in production, exploration and new ventures.

1. SCOPE

1.1 This Standard specification covers the minimum requirements for reciprocating internal combustion engines for mechanical drives and electric power generator drives.

It is intended for use in oil refineries, chemical, gas and petrochemical plants and where applicable in production, exploration and new ventures.

1.2 Compliance by the engine Vendor with the, provisions of this Standard specification does not relieve him of the responsibility of furnishing properly designed equipment, mechanically and electrically suited to meet operating conditions.

1.3 The engine shall be the product of a manufacturer regularly engaged in manufacturing of engines and shall have been in regular production by the manufacturer for at least three years.

1.4 No exceptions or deviations from this Standard are permitted without prior written approval of Company.

The intended deviations or exceptions shall be listed separately along with the reasons thereof for Company's consideration.

1.5 This standard applies only to Non-hazardous area (according to standard of IPS-E-EL-110).

For use in potentially explosive atmospheres, British Standard of BS.EN -1834-1: 2000, "Reciprocating internal combustion engines – Safety requirements for design and construction of engine for use in potentially explosive atmospheres" shall be considered.

Note 1:

This is a revised version of this standard, which is issued as revision (1)-2005. Revision (0)-1996 of the said standard specification is withdrawn.

Note 2:

This is a revised version of this standard, which is issued as revision (2)-2015. Revision (1)-2005 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards / codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date, shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

API (AMERICAN PETROLEUM INSTITUTE)

614	"Lubrication Shaft-Sealing & Control-Oil Systems and Auxiliaries"

ASTM (AMERICAN SOCIETY for TESTING and MATERIALS)

B111/B111M	"Standard Specification for Copper and Copper- Alloy Seamless Condenser Tubes and Ferrule Stock "
B169/B169M	"Standard Specification for Aluminum Bronze sheet, Strip and Rolled Bars"

B171/ B171M "Standard Specification for Copper Alloy Plate and Sheet for Pressure Vessel Condenser and Heat Exchanger"

B 584 "Standard Specification for Copper Alloy Sand Castings for General Applications"

BS (BRITISH STANDARD)

EN-1834-1:2000 "Reciprocating Internal Combustion Engines – Safety Requirements for Design and Construction of Engine for Use in Potentially Explosive Atmospheres ,Group II Engines for Use in Flammable Gas and Vapour Atmospheres "

DEMA (DIESEL ENGINE MANUFACTURERS ASSOCIATION)

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-EL-110 "Engineering Standard for Hazardous Area"

IPS-E-GN-100 "Engineering Standard for Units "

IPS-G-PM-120 "General Standard for Accessibility and Safety of Machineries"

IPS-E-SF-860 "Engineering Standard for Air Polllution Control"

IPS-M-PM-320 "Material and Equipment Standard for Lubrication, Shaft Sealing And Control Oil System for Special Purpose Application"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

3046 PART 1&2 "Reciprocating Internal Combustion Engines: Performance"

2710-1: 2000 "Reciprocating Internal Combustion Engines-Vocabulary Part 1: Terms for engine design and operation"

NEMA (NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION)

SM-23 "Steam Turbines for Mechanical Drive Service"

SM-24 "Land Based Steam Turbine Generator Sets 0 to 33000 kW"

REQUIREMENTS OF ENVIRONMENT DEPARTMENT OF ISLAMIC REPUBLIC OF IRAN

TEMA (TUBULAR EXCHANGE MANUFACTURERS ASSOCIATION)

3. CONFLICTING REQUIREMENTS

In case of conflict between documents relating to the enquiry or order, the following priority of documents shall apply:

- First Priority: Purchase order and variation thereto
- Second Priority: Data sheets and drawings
- Third Priority: This Standard specification

All conflicting requirements shall be referred to the Purchaser in writing. The Purchaser will issue conforming documentation if needed for clarification.

4. UNITS

This standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. DEFINITIONS AND TERMS

For Definitions and Terms refer to ISO 2710-1: 2000**.**

6. DESIGN

6.1 General

6.1.1 Unless otherwise specified, the equipment shall be suitable for the service specified on the engine data sheet. Site data and cooling parameters will be specified by purchaser.

6.1.2 The engine noise shall be not more than 90 dB at 1 meter from the equipment surface.

6.2 Mechanical Design

6.2.1 The rated output for the engine shall meet the requirements of ISO 3046-Part 1.

6.2.2 Unless otherwise specified, a speed governing system shall be provided per NEMA SM-23 and SM-24.

The following governing classes shall be provided:

For mechanical drive NEMA class C or D for electric power generator drive NEMA class D, isochronous.

When hydraulic governor is furnished, an independent hydraulic oil system from engine lubricating oil system shall be provided for governor.

6.2.3 The torsional natural frequencies of the engine and driver equipment system, including couplings and gear units, shall not be within 10% of any normal operating shaft speed range.

6.2.4 When emergency duty is specified the engine shall be designed to reach operating speed and full load capability within 10 seconds after receiving a short signal.

6.2.5 A tachometer shall be supplied and mounted on the engine. Speed range shall be 0 to 115 percent of rated speed.

6.2.6 All gears, belts, couplings, pulleys, or similar shall be adequately guarded for personnel protection in accordance with IPS-E-PM-120.

6.3 Construction

6.3.1 The cylinder block and crankcase shall be made of one piece high quality casting of high quality cast iron having a minimum tensile strength of approximately 241000 kPa, with thick top deck and heavy structural webbing between cylinders and bearing journal bridging.

6.3.2 The crankshaft shall be made of a multi-plane forging of high alloy steel statically and dynamically balanced with one crank for each cylinder and each crank supported between two main bearings.

When approved by the Purchaser forged carbon steel may be considered. The crankshaft shall be carefully designed to avoid torsional vibration within the operating speed ranges.

The crankshaft shall be hardened to a depth so that the depth of hardness allows the shaft to be reground up to minimum three times for under size bearing.

6.3.3 The connecting rod shall be strong heat treated alloy steel without excessive weight with bearing at each end to transmit the piston thrust to the crankshaft and vice versa.

For high speed or emergency cases connecting rods with excessive weight may be considered.

The big end of the connecting rod shall be split horizontally or angularly with serrated surfaces.

A two-piece-precision, Babbitt-lined, or tri-metal type bearings shall connect the rod to the crankshaft at big end. If purchaser approved, the tongue and-groove joint can be employed.

6.3.4 Cylinders shall be provided with sleeves. Unless otherwise specified, cylinder sleeves shall be replaceable wet sleeve design, made of centrifugally high strength alloy cast iron.

6.3.5 Unless otherwise specified the piston shall be made of machined, heavy-duty aluminum alloy castings with a cast-in-NI resist steel insert.

The piston shall be cooled by a pressure jet of oil from the connecting-rod impinging upon the under side of the piston crown and upper ring belt region.

The wrist ring set consisting of a barrel faced, chromium carbide-molybdenum coated top compression ring and conformable hooker type oil rings is preferred.

6.3.6 The camshaft shall be made of a carburized forged steel providing hard surface case and precision ground to a super finish.

6.3.7 Principle engine accessories including camshaft, magneto drive and lubricating oil pump shall be gear derived from the crankshaft.

All gears shall be high strength alloy steel forgings. The gear shall be helical tooth design with tooth engagement overlap considering quiet operation and strength.

The teeth shall be crowned shaved for ideal tooth contact and loading.

6.3.8 Individual deep section cylinder heads shall be made from high quality alloy cast iron with an internal baffling arrangement to direct coolant flow at high velocity across the high temperature surfaces insuring good heat transfer and low thermal stresses.

The valves shall be made of high quality material and puppet type with hardened stem tips and stellite facing.

6.4 Lubrication System

6.4.1 The engine shall be equipped with pressure lubrication system supplying oil to all surfaces requiring pressure lubrication. Circulation shall be by means of positive displacement engine-driven pump equipped with adjustable pressure regulator.

The lubrication system shall include a full-flow oil filter and a series connected oil cooler of sufficient size to properly cool all lubricating oil circulated.

Unless otherwise specified for babbited bearings 25 µm or finer mesh filter and for aluminum and micro babbited bearings 10 µm or finer shall be supplied. Filter cartridge materials shall be corrosion resistant.

For replaceable cartridge filter, the clean pressure drop shall not exceed 35 kPa (5 psi) at design temperature and flow. The cartridge collapse pressure shall not be less than 350 kPa (50 psi). The filter shall be equipped with vent and drain connections.

All lubricating components shall be installed and mounted on the engine or engine baseplate complete with piping and including automatic lube oil temperature control.

6.4.2 The engine shall be equipped with a hand-operated, pre-lube pump of adequate size to provide oil to all force-fed location. For engines 200 hp and higher DC Pre-lube pumps shall be provided.

6.4.3 All components of the oil system shall be made of steel construction, 18 chrome -8 Nickel stainless steel piping shall be provided downstream of the lube oil filter to the engine and drive train bearings.

6.4.4 Carbon steel lube oil piping shall be pickled. Stainless steel tubing and piping shall be cleaned with suitable solvent.

6.4.5 **a)** Oil cooler shall be provided to maintain lube oil supply temperature at or below 65°C.

b) The cooler shall be a water cooled, shell and tube-type per TEMA C with removable bundle and channel cover design, or it shall be a suitable air cooled type, as specified.

c) Tubes shall not be smaller than 16 mm OD (5/8") and the minimum tube wall thickness shall be 1.24 mm (0.044"). U-bends are not permitted.

d) Materials shall be per the manufacturers' standard, except that materials for salt or brackish water service shall be according to the following table.

SHELL	CHANNELS AND COVERS		TUBE SHEETS		TUBES	
	Materials	Specification	Mat.	Spec.	Mat.	Spec.
Carbon Steel	Acid resisting Bronze or Aluminum Bronze	ASTM B584 ALLOY C92200 ASTM B169 ALLOY C61400	Naval brass	ASTM B171 ALLOY C46400	Inhibited Admiralty	ASTM B111 ALLOY C44300 C44400 or C44500

e) The Vendor shall insure that the lubricating oil pressure at the cooler outlet is greater than the cooling water pressure specified to prevent contamination of the lubricating oil in case of cooler failure.

f) Coolers shall be equipped with vent and drain connections on oil and water sides.

6.4.6 A removable steam heating element or thermostatically controlled electrical immersion heater shall be provided for heating the charge capacity of oil prior to start up in cold weather. The heating device shall have sufficient capacity to heat the oil in the reservoir from the specified minimum site ambient temperature to the manufacturer's required temperature within 12 hours. If an electrical immersion heater is used, it shall have a maximum watt density of 2.3 watts/cm².

6.4.7 Oil lubrication system shall be provided with replaceable dual oil filters.

6.5 Cooling Water System

6.5.1 The engine shall have an engine jacket water heater with adjustable thermostat control in a water bypass line of ample (wide range) capacity to maintain water temperature in engine between 38 to 50°C. Heater voltage will be specified on the engine data sheets.

6.5.2 The engine shall be cooled by means of a closed loop jacket water radiator with pusher type fan. The radiator shall have provisions for attachment of purchaser's discharge ducting. The cooling

system shall be thermostatically controlled and capable of maintaining engine outlet water temperatures between 74-80°C at continuous full-load operation.

6.5.3 Engine cooling other than by means of a pusher type fan and radiator will be specified on the individual engine data sheets.

6.5.4 Unless otherwise specified the engine shall operate completely independent of any external cooling water supply and require make-up water only.

6.5.5 Service connections and valves for draining and filling shall be easily accessible.

6.5.6 The Vendor shall provide a diagram of the cooling water systems showing all connected equipment, the water flow rate, heat pickup and volume of air required.

6.5.7 The deaeration line shall be provided to pick up air and separate it from the water in the header tank for desiel engine with power of 150 kW and more.

6.6 Inlet and Exhaust System

6.6.1 The Vendor shall provide an industrial type intake air filter with replaceable dry elements.

6.6.2 A residential type spark arrestor/silencer with flexible exhaust connection shall be furnished with engine. Silencer shall be properly sized for the engine and be completed with companion flanges and rain cap. Exhaust silencer will be connected to the exhaust system and mounted over the engine. The mounting plate shall be provided with lifting lugs for a four-point lift, which the package can be lifted without permanently distorting or otherwise damaging either the base plate or any component mounted on it.

6.6.3 Flexible exhaust expansion joints shall be furnished for exhaust outlet.

6.6.4 For the exhaust system, a suitable safety protection and coating shall be considered.

6.6.5 Unless otherwise specified, vendor shall include elbow, flanges, straight pipes, rain traps, drain plugs and rain cover to provide a complete system, stated in data sheet.

6.6.6 Vendor shall advise the exhaust gas temperature in his proposal.

6.6.7 Air intake and exhaust systems shall be supplied complete with supporting stands for outdoor installation and interconnecting pipe work from engine with necessary support plates, unless otherwise specified.

6.7 Mounting plate

6.7.1 Unless otherwise specified, the engine driven equipment and local control panel and jacketed water radiator shall be mounted on same steel mounting-plate of adequate size and strength to properly support and align all rotating equipment. The Mounting plate shall be provided with lifting lugs for a four-point lift, which the package can be lifted without permanently distorting or otherwise damaging either the base plate or any component mounted on it.

6.7.2 Grout holes shall be arranged so that the base plate with driven equipment and all auxiliaries mounted in place, can be grouted without removing any components or piping. Adequate vent holes shall be provided to insure a complete distribution of grout.

6.8 Instrumentation and Controls

6.8.1 The engine shall be equipped with a tachometer, a governor and automatic speed control complete with a bump-less transfer station sensing from electrical signal.

6.8.2 Unless otherwise specified, controls shall be provided to protect the engine against the followings:

a) Low lubricating oil pressure

b) High temperature cooling water leaving the engine jackets

c) Low flow or low pressure occurred in each cooling water circulation pump

d) Low level in each cooling water surge tank

e) Over-speed

f) Excessive vibration

g) High lubricating oil temperature

h) Temperature monitoring of each cylinder

6.8.3 Provision shall be made for a manual speed control in addition to the automatic speed control.

6.8.4 A vibration free instrument local panel having the following instrumentation shall be provided (all gages in SI units):

a) Mechanical Tachometer

b) Oil Pressure Gage

c) Water Temperature Gage (water out of engine)

d) Engine Manifold Vacuum Gage (for gas engines)

e) Fuel Pressure Gage (for diesel engines)

f) Fuel Reservoir Level (for diesel engines)

g) Running Time Meter, (5 digits minimum)

h) Battery Charging Ammeter

i) Start/Stop Control

j) Low Battery Voltage Indicator and Battery Voltmeter

k) Exhaust Gas Temperature

l) Cooling Water Pressure

6.8.5 Particular attention shall be focused on emission Nitrogen Oxide (NO_x) and Engine NO_x emission level reduction control in accordance with IPS-E-SF-860 and/or the Requirements.of Environment Department of Islamic Republic of Iran.

6.9 Nameplates

A stainless steel nameplate must be provided for each equipment as shown below.

Manufacturers may add the data required to their standard plates provided that they are made from the above mentioned material. The data called for must be legibly stamped or preferably engraved on the plate which shall be fixed to an accessible part of the equipment.

The nameplate shall be securely fixed to the equipment, but the method of fixing shall not involve drilling into the wall of a pressure part. The name plate shall include as a minimum the following information:

Equipment Identification No. ……....

Order No. .....Order Placed by .....

Manufacturer's Name .....……

Manufacturing Date…….

Type and Size .....Serial No. .....

Bore and Stroke, mm .....……..

Rated, kW .....@ R.P.M.....

Firing Order .....

Weights-Total Net Wt. Equipment ……...kg

Mounting Plate ..…….....kg

Heaviest Removable Component for Overhaul .....…….....kg

6.10 Special Tools

6.10.1 When special tools and fixtures are required to disassemble, assemble, or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the machine. For multiple-unit installations, the requirements for quantities of special tools and fixtures shall be mutually agreed upon by the Purchaser and the Vendor.

These or similar special tools shall be used during shop assembly and post-test disassembly of the equipment.

6.10.2 When special tools are provided, they shall be packaged in separate, rugged boxes and marked "special tools for (tag/item number)." Each tools shall be stamped or tagged to indicated its intended use.

6.11 Specific Requirements for Diesel Engines

6.11.1 Mechanical

The rated power of the engine at rated speed, with all accessories driven, shall be at least that required to produce the power specified on the diesel engine data sheets for adverse conditions.

6.11.2 Fuel system

6.11.2.1 Unless otherwise specified, a day tank with a minimum 8 hours operating capacity shall be supplied with the unit. An engine-driven fuel pump shall draw fuel from this tank for operation. The day tank shall be made of heavy duty welded construction type and shall have individual vent and drain points.

A level control facility shall be provided on the day tank to prevent overfilling, and also to give alarm on high and low levels of fuel oil.

Day tank shall also be provided with a guarded sight gage glass.

6.11.2.2 If the fuel pressurized system will not be available the following sub-clauses shall be complied.

a) An electric motor-driven fuel transfer pump shall be provided by the engine Vendor to transfer fuel from main storage tank to the day tank. Pump shall be designed for the horizontal run and suction lift as required or sustained normal and overload operation of the engine. Pump shall be controlled by the level control facility in the tank.

b) A hand operated fuel pump with handle length min. 25 cm shall be provided with connections to bypass the electric fuel pump and discharge into the day tank.

c) The main storage diesel fuel tank shall be quoted as separate item by the engine Vendor. It shall have a 36 hours minimum capacity and be preferably suitable for underground installation.

Exterior of this tank shall be properly coated for direct burial. No galvanizing shall be used. Suction and return line connections, filter and breather lines, water draw-off and gagging connection as well as any other necessary lines or connections shall be furnished by the engine Vendor.

6.11.2.3 Fuel oil filter shall be provided by the engine Vendor and shall be made of dual full-flow replaceable cartridge type.

6.11.3 Starting system

6.11.3.1 Unless otherwise specified an electric engine starting is required. The engine Vendor shall provide two (2) heavy duty starting batteries of the Nickel-Cadmium alkaline type, not less than 200 ampere hour capacity, complete with battery cables and vibration-proof rack. Battery voltage requirements will be specified on the diesel engine data sheets.

6.11.3.2 A battery charger with a high and low rate, shall be provided, and shall have manual switch to select and adjustable trickle charge rate. The charger shall operate from normal mains supply, to maintain the battery fully charged for engine starting.

6.11.3.3 An automatic change-over switch shall be provided to change from mains to engine driven charging when the set is running.

6.11.3.4 Provision shall be made for automatic test start of the engine.

6.12 Specific Requirements for Gas Engines

6.12.1 Mechanical

6.12.1.1 Unless otherwise specified the engine shall be turbocharged four cycles .and fitted with after cooler.

6.12.1.2 The available engine power, when de-rated as per DEMA for continuous duty, (at site condition including altitude, temperature and other), service conditions, shall be sufficient to drive the unit coupled with, at speeds ranging from 60% to 100% of design speed with the unit operating at its design conditions.

6.12.1.3 A clutch is not required unless it is specifically called for by the Purchaser.

6.12.2 Fuel system

6.12.2.1 The engine shall be designed to operate on fuel gas of the approximate composition specified by the Purchaser.

6.12.2.2 The fuel gas system shall include all items required to accept the fuel gas specified by the Purchaser and utilize it in the engine.

This system shall include as a minimum, a pressure gage, temperature gage, relief valve, drain valve, pressure reducing valve(s), fail-safe emergency shutdown valve and a fuel gas control valve.

All valves provided shall be steel.

6.12.2.3 A fuel gas demister shall be provided where the fuel gas available is not processed plant residue gas.

6.12.3 Starting system

6.12.3.1 The starter shall be an air, electric, or gas operated cranking motor. It shall be sized with adequate capacity to rotate the engine and any unloaded unit which may be coupled with the driver.

6.12.3.2 The starter motor piping shall be supplied complete with a block valve, liquid trap, fog lubricator, strainer, control valve and regulator with a relief valve. When fuel gas pressure is adequate for use as starting gas the starter supply shall be connected to the engine fuel gas line. Adequate exhaust piping shall be supplied.

6.12.3.3 When electric engine starting is specified, the engine Vendor shall provide two (2) heavy duty starting batteries of the Nickel cadmium alkaline type, not less than 200 ampere hour capacity, complete with battery cables and vibration proof rack. Battery voltage requirements will be specified on the gas engine data sheets.

6.12.3.4 A battery charger with a high and low rate, shall be provided, and shall have a manual switch, to select and adjust trickle charge rate. The charger shall operate from normal mains supply, as specified in data sheet, to maintain the battery fully charged for engine starting.

6.12.3.5 An automatic change-over switch shall be provided to change from mains to engine driven charging when the set is running.

6.12.3.6 All mechanical electric switching and other electric devices shall conform to Class I, Division I, Group D service and to purchase order for other specific requirements.

6.12.3.7 Provision shall be made for automatic test start of the engine. The engine shall also be automatically stopped after a preset period of unloaded running.

6.12.4 Control

An automatic fuel gas shut-off and vent valve shall be provided to shut-off the fuel gas to the engine in the event of its stopping.

This type of shut-off mechanism shall be used in conjunction with grounding the magneto to automatically shutdown the engine in case of any abnormalities listed in 6.8.2 occur.

7. INSPECTION AND TESTING

7.1 General

The Vendor shall provide the Purchaser with advance notification of certain shop inspection and tests as outlined in the purchase order or other agreements.

The Purchaser's representative shall have entry after prior notification by the Purchaser to all vendor and sub-vendor plants where work upon or testing of the equipment is in progress.

The Purchaser or his representative shall have the right to reject any parts of equipment which do not conform to the purchase order. It shall be the responsibility of the Vendor to notify sub-vendors of the Purchaser's inspection requirements.

7.2 Inspection

7.2.1 Information specified in the following paragraphs shall be provided to the inspector upon request, as specified in the purchase order.

7.2.1.1 Evidence, such as purchase specification or bills of material to establish that major parts are of specified materials.

7.2.1.2 Copies of shop test data for the purchased equipment as required in the purchase order.

7.2.2 When specified the oil system furnished shall meet the cleanliness required by API Standard 614 as amended supplemented by IPS-M-PM-320.

7.3 Testing

7.3.1 General

All engine testing will be non-witnessed unless otherwise noted on the individual engine data sheets.

7.3.2 Hydrostatic test

a) Engine cylinders or liners shall be hydrostatically tested with water at ambient temperature. The minimum test pressure shall be 1- ½ times the maximum allowable casing pressure.

b) Cooling water jackets shall be hydrostatically tested at 790 kPa (G).

c) All hydrostatic tests shall be maintained for a minimum period of 30 minutes. Certification of the test results is required.

7.3.3 Mechanical running test

a) The engine shall be operated at 100% load for a period of 4 hours. When steady-state conditions have been reached and held for 15 minutes, test data shall be recorded.

Final readings shall be recorded at completion of 4 hours tests, following which, and overload test of 110% full load shall be run for 30 minutes. Overload test data shall also be recorded.

All alarm circuits must be tested under actual running conditions, (e.g. engine must be overheated, over-speed tested, lube oil pressure alarms and shutdowns checked, etc.)

b) Operation of the engine over-speed governor shall be checked at 110% normal speed following the final load testing, followings which, the engine shall be re-started and temporarily loaded to 100% full load.

c) Certified test data shall be provided by vendor from data obtained during the performance test of the purchased engine.

7.3.4 Performance test

The engine performance shall be tested in accordance with ISO Standard 3046, parts 1 and 2, to verify that engine rated power, fuel consumption and lubricating oil consumption comply the appropriate declared values.

8. PREPARATION FOR SHIPMENT

8.1 General

Preparation for shipment shall be in accordance with Vendor's standard and as noted in the following clauses.

a) The Vendor shall be solely responsible for the adequacy of the preparation for shipment provisions employed with respect to materials and application, and to provide equipment to their destination in ex-works condition when handled by commercial carriers.

b) All parts shall be shipped with the equipment; separate shipment is not permitted.

8.2 Painted Surfaces

Vendor standard cleaning and painting procedures for the operating temperature and climatic condition of the equipment is acceptable.

8.3 Non-painted Surfaces

Non-exposed finished and machined surfaces including coolers, filters and piping shall be thoroughly cleaned internally from metal particles, dirt and debris, and coated with a suitable rust preventive compound, easily removable by standard solvent, prior to shipment.

Exposed finished and machined surfaces, including bolting, shall be given a coating of rust inhibiting compound.

8.4 Marking and Tagging

8.4.1 Each equipment shall be identified with its Purchase Order Number, and equipment Tag Number. Tags shall be corrosion resistance metal and impression stamped:

P.O. No.....……..
P.O. ITEM No. .....……
EQUIPMENT No. .....……

8.4.2 Tags shall be attached to each component with stainless steel wire. This tagging is in addition to the equipment nameplate. Equipment shipped in fully enclosed containers shall also include the above information marked on the external side of the container.

8.4.3 Miscellaneous parts shall be tagged or marked with the equipment tag number for which they are intended.

9. VENDOR DATA REQUIREMENTS

9.1 General

9.1.1 All drawings and data shall be furnished in English and in accordance with the schedule established at time of Purchase Order Placement.

9.1.2 Approval of drawings shall not relieve Vendor of any responsibility in meeting the requirements of specifications nor shall such approval be considered as permitting deviations from specifications or Purchase Order requirements, unless specifically agreed to in writing.

9.2 Drawings and Data

9.2.1 The Vendor shall provide the Purchaser with the 5 sets hardcopies and one set electronic copy of the following drawings and data in English with Quotation:

- Complete technical vendor's products catalogues and sources of origin..

- Comprehensive catalogues, technical data, dimensional outline drawings, proposed test procedure, service facilities etc. of the equipment offered and its various components.

- Preliminary connection and wiring diagrams, dimensional and cross sectional drawings, control system diagram.

- Declaration of confirmation with this standard and clear indication of deviations there to.

- Completed purchaser data sheets.

- Vendor's design calculations, necessary documents and/or data for engine output power in respect to the site and climatic conditions detailed in data sheets.

- Performance curves showing torque, fuel consumption, engine speed and power output.

- Performance data.

- Reference lists showing the engines of the same frame size or model previously manufactured and operating under similar conditions of service, speed and power and location of such installation.

- Reference list showing the successful continuous operation for at least two years and the location of the equipment

- Recommended commissioning and 2 years running consumables and spare parts separately listed, numbered, referenced, duly priced and approximate normal delivery time and stocking points given.

- Rates and condition for technical assistance and training.

- Shipping dimensions (length, width and height) and weight with shipping schedules.

- Tabulation of all connections to which purchaser connections, giving size, rating, facing etc.

- Schemes of fuel, lube oil circuits, and starting system.

- Assembly drawing of unit electrical and control panels with size and weight (as applicable)

- Location and rates (such as flow, pressure, voltage etc.) of various connection to the outside equipment and recommended installation details.

9.2.2 Upon the placing of order (not later than 60 days) The Vendor shall provide the Purchaser 5 sets of hardcopies and one set electronic copy of the listed below:

- Piping, wiring, control system diagrams, dimensional outline drawings, dimensional outlines of all accessories of various connection details, for purchaser's approval.

- Foundation plan/anchor bolts location, weight of all components shown on drawings, weight of the heaviest piece for maintenance, unbalance forces and moments, start-up forces etc.; foundation and support drawings of intake and exhaust system.

- Instrument specifications with the name of manufacturer, model and technical characteristic and schematic diagrams.

- Local panel dimensions and cutouts.

- Area classification and certificates for electrical equipments installed in hazardous areas.

- Single line and wiring diagram of control and electrical panels (as applicable) with indication of characteristic of control alarms and shut down devices.

- Detailed manufacturing and testing program for the equipment and its components.

9.2.3 At least 90 days before delivery the Vendor shall provide Purchaser 12 sets of hardcopies and one set electronic copy of installation, operation and maintenance manuals consisting of :

- Complete Data Sheets.

- Codes and Standards Compliance Certificate.

- Safety and Control Equipment/Components Calculation Sheets.

- Wiring Diagrams.

- Certificates of Material.

- Panels Layout, Wiring, Connections and interconnections.

- Auxiliary System Schematics.

- Factory Test Certificates, including test data and calculated results (when ready).

- Illustrated and numbered parts list and three years running spare parts list final revision.

- One set of reproducible of all civil, mechanical, control and electrical drawings with "AS BUILT"

9.2.4 Certificate of source of origin shall be furnished to the purchaser for his authorized representative prior to dispatching

10. GUARANTEE AND WARRANTY

10.1 Performance

10.1.1 Operating under load

Engine performance shall be guaranteed for ¼ or ½ and full load operation at the ambient temperatures and atmospheric pressure.

Engines shall be guaranteed to be capable of operation at 110% of full rated load for 2 hours per 24 hours of operation.

10.1.2 Torque and speed

Each engine shall be guaranteed to deliver the rated torque at the rated speed for the type of service and site conditions specified, with no negative tolerances allowed. The actual engine fuel heat rate may not exceed the guaranteed heat rate at full load.

10.2 Mechanical

Unless exception is recorded by the Vendor in his proposal, it shall be understood that the Vendor agrees to the following guarantees and warranties:

During a period of 12 months after the date of commissioning, the Vendor shall, with all possible speed and without cost to the Purchaser, replace or repair the goods or any part thereof found to be defective due to faulty material, workmanship or to any act or omission of the Vendor. In particular the Vendor shall reimburse any transportation and other charges incurred by the Purchaser in effecting such replacement or repair at the point of use.

APPENDIX A

RECIPROCATING INTERNAL COMBUSTION ENGINES, DATA SHEET

JOB NO. …….. ITEM NO. ……..
PAGE .1 …….. OF …… 2 …… ….BY ……..
DATE ……REVISION ……..

NOTE – INFORMATION TO BE COMPLETED BY : O PURCHASER ☐ VENDOR

FOR _____ SITE _____
UNIT _____ SERVICE _____
ENGINE ITEM NO . _____ QUANTITY_____
ENGINE SERIAL NO. ☐ _____ SIZE / TYPE ☐ _____
ENGINE MANUFACTURER ☐ _____

O OPERATION CONDITION

DRIVEN EQUIPMENT _____
DUTY _____
MAX POWER REQUIRED_____ kW
SPEED REQUIRED (RPM) _____
ALTITUDE (m) _____ MAX . AMBIENT TEMP (°C)

TYPE OF ENGINE FUEL :
INSTALL : O INDOOR O OUTDOOR
O SHELTERED O UNSHELTERED
C.P/ CV AT _____˚C _____ kPa
FUEL HHV kJ/ m^3 LHV kJ / m^3
FUEL PRESS , MAX / MIN kPa
FUEL TEMP , MAX / MIN ˚C

☐ PERFORMANCE

ISO CONTINOUS RATING : _____kW AT _____RPM
ISO PEAK RATING : _____ _kW AT_____ RPM
SITE CONTINOUS RATING : _____ kW AT_____ RPM
COMPERATION RATIO : _____
FUEL PRESSURE REQUIRED : MAX / MIN . _____kPa
FUEL GAS HEATER REQUIRED FOR START UP : ☐YES ☐NO
REMARKS :_____

☐ DESIGN AND CONSTRUCTION

NO. CYLINDERS _____ NO. CYCLES _____
ARRANGEMENT _____
BORE (mm) _____ STROKE (mm)____
PISTON SPEED (MAX.) _____ m / sec . _____ SPM
MAX. ALLOW. SHAFT SPEED _____ RPM
SHAFT ROTATION _____ VIEWED FROM COUPLING END
CYLINDERS : ☐ LINED , ☐ UNLINED , ☐ WET ☐ DRY
ENGINE COOLING : ☐ RADIATOR , ☐ AIR FIN , ☐ ____
MAIN BEARINGS : NO. , _____ TYPE , _____ SIZE _____
CRANK BEARINGS : NO. , _____ TYPE , _____ SIZE _____
INTAKE VALVES NO. , _____ SIZE _____
SEATS ☐ INTEGRAL . ☐ RENEWABLE
EXHAUST VALVE : NO. , _____ . SIZE _____
SEATS . ☐ INTEGRAL . ☐ RENEWABLE
LUBRICATION SYSTEM :
☐ FORCED FEED . SPLASH .
OIL PUMP : ☐ INTEGRAL ☐ SEPARATE . ☐ _____
OIL FILTER ☐ SINGLE . ☐ DUPLEX . ☐ _____
LUBE OIL TYPE / GRADE _____
☐ TURBOCHARGED ☐ NATURAL. ☐ ASPIRATED ☐ _____
FUEL INJECTION EQUIPMENT _____
_____
REMARKS :_____

O EQUIPMENT & ACCESSORIES

STARTER : O ELECTRIC O HYDRAULIC O PNEUMATIC
START- UP : MANUAL (LOCAL / REMOTE) AUTO BOTH
BATTERIES : TYPE _____ AMPERE HOUR CAPACITY ☐ _____
BATTERY : CHARGER ☐ _____
DRIVE TYPE : O DIRECT , O GEAR , O _____
COUPLING : TYPE / MFR _____
CLUTCH REQUIRED : O NO O YES. TYPE . MFR._____
GEAR REQUIRED : O NO O YES RATIO _____ MFR._____
GOVERNOR : TYPE / MFR . _____ , CLASS _____
PRELUBE PUMP & DRIVE REQUIRED NO YES, TYPE
LUBE OIL COOLER ☐ AIR BLAST . ☐
SHELL & TUBE ☐
LUBE OIL HEATER WITH THERMOSTAT:_____
C.W. HEATER WITH THERMOSTAT : _____
INTAKE " AIR FILTER " . ☐ DRY . ☐ WET . ☐ . _____
EXHAUST SYSTEM COMPLETE WITH :
O SILENCER . O SPARK ARRESTOR . O EXPAN. JOINT
HORTZONTAL PIPE (mm) ☐_____VERTICAL PIPE (mm) ☐ _____
ELBOW (S) ☐ _____LAGGING ☐ _____
DAY FUEL TANK : CAPACITY _____ LITER _____
SKID MOUNTED . O SEPARATE . O_____
FUEL FILTER , O SINGLE , O DUPLEX , O_____
SKID MOUNTING , O SEPARATE , O WITH DRIVEN EQUIPMENT
TACHOMETER : O MECHANICAL . O ELECTRICAL . O _____
COMPLETE ENGINE , ENCLOSURE REQUIRED : O NO O YES
DIMENSIONS (mm) : LENGTH ☐ _____ WIDTH ☐ _____
HEIGHT ☐ _____
WEIGHTS (kg) : TOTAL ☐ _____
HEAVIEST PART FOR OVERHAUL. ☐ _____
_

☐MATERIAL OF CONSTRUCTION

FRAME _____
CRANK SHAFT_____
CONNECTING RODS _____
CYLINDERS _____
LINERS _____
PISTONS
CYLINDER HEADS _____
MAIN BEARINGS _____
CRANK BEARINGS _____
WRIST PINS _____
VALVES _____
INTAKE _____ , SEAT _____
EXHAUST _____ , SEAT _____
REMARKS : _____

INSTRUMENATION

SHUTDOWN DEVICES :
O LOW OIL PRESS. O HIGH COOLING WATER TANK
O HIGH OIL TYPE . O OVER - SPEED
ENGINE INST. PANEL : O ON SKID O OFF SKID
ANNUNCIATOR PANEL : O ON SKID O OFF SKID
REMARKS :_____
_____
_____
_____
_____
_____
_____
_____

APPENDIX A

RECIPROCATING INTERNAL COMBUSTION ENGINES, DATA SHEET

JOB NO . ……. ITEM NO . ……..
PAGE .. 2…… OF ……2… BY ……
DATE …… REVISION ……

☐ TOTAL UTILITY CONSUMPTION :	☐ MAINTENANCE :
COOLING WATER _____ m^3 / h ELECTRICAL . POWER _____ kW . AC _____ kW . DC STEAM NORMAL . _____ kg / s MAX . _____ kg / s FUEL . NORMAL. _____ m^3 / h Max . _____ m^3 / h INSTRUMENT AIR _____ m^3 / h	MAINTENANCE REQUIREMENTS (HOURS) _____ _____ TIME BETWEEN MAJOR OVERHAULS _____ _____ _____ _____
ATMOSPHERIC ENISSIONS	
INFORMATION BY PURCHASER	**INFORMATION BY VENDOR**
NO_X. REQUIREMENTS _____ NO_X. REDUCTION METHOD (IF REQUIRED) O WATER INJECTION OSTEAM O OTHER SO_2 REQUIREMENTS _____ SULFUR CONTENT OF FUEL . _____ % WT. CO REQUIREMENTS _____ PARTICULATE REQUIREMENTS _____ _____ APPLICABLE EMISSION CODES OR REGULATION O EPA – TITLE 40 – CFR O OTHERS _____ O _____	GUARANTEED NO_X . _____ NO_X . REDUCTION METHOD ☐ WATER INJENCTION ☐ STEAM ☐ OTHER SO_2 (BASED ON STATED SULFUR CONTENT) _____ CO EMISSIONS _____ PARTICULATE EMISSIONS _____ _____ _____ _____ _____ _____

COMMENTS : _____
_____
_____
_____
_____
_____
_____