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**TECHNICAL JOB  
SPECIFICATION**

**332/1**

**REVISION 0**

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# **HIGH PRESSURE (HP) TRANSMISSION SYSTEMS**

## **EMERGENCY DIESEL GENERATORS**

**QUALITY ASSURANCE PAGE**

CHANGES LOG

REVISIONS LOG

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## 1.0 SCOPE

This Specification covers the minimum requirements for the selection, design, fabrication, testing and commissioning of emergency diesel generating sets for emergency power supply in stand-by and safety service.

This Specification applies to the "package" diesel engine and synchronous generator set, including relevant mechanical equipment and the control board for diesel engine and generator, which shall be considered as a package, excluding electrical power equipment and control devices connected to generator load terminals, which shall be specified separately.

## 2.0 GENERAL

### 2.1 CODES AND STANDARDS

Unless otherwise specified, the following reference codes and standards shall be applied:

**Diesel engine and mechanical equipment -  
ISO 3046-1**

- **Synchronous generator and electrical equipment**

**EN Standards and particularly:**

**E LOT EN 60034  
ELOT EN 60085  
ELOT EN 60947  
ELOT EN 60439  
ELOT EN 60529**

Various publications relevant to specific equipment and components (e.g. relays, cables etc.).

#### **CE marking**

Equipment, components as well as the complete assembly shall comply with all applicable Directives of EU and in particular:

<b>2006/42/EC</b>	Machinery Directive
<b>97/23/EC</b>	Pressure Equipment Directive ( <b>PED</b> ) (KYA 16289 / 330 ΦΕΚ 987/27.05.1999
<b>2004/108/EC</b>	Electromagnetic Compatibility (as amended by <b>92/31/EEC</b> and <b>93/68/EEC</b> ) Υπουργ. Απόφ. 60600/93 ΦΕΚ-B' No 280 / 23.04.1993
<b>2006/95/EC</b>	Low Voltage Directive (as modified by <b>93/68/EEC</b> ) Υπουργ. Απόφ. 8881/94 ΦΕΚ-A' No 450 / 03.06.1994
<b>94/9/EC</b>	Explosive Atmospheres ( <b>ATEX</b> )

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Equipment components and the complete unit shall be properly CE marked by the Supplier and /or his sub-suppliers and the relevant certificates or declarations of conformity shall be submitted.

### **Codes and standards issued by national authoritative organization**

In general codes and standards issued by authoritative organizations of the country of origin of machinery and equipment shall be accepted, provided that they are equal or more restrictive than standards listed in this Specification.

## **2.2 UNITS, TERMS AND DEFINITIONS**

Units, terms and definitions used in this Specification shall be in accordance with :

**ELOT HD 60027**  
**IEC 60050 ELOT**  
**EN 60617**

## **2.3 DEFINITIONS**

Throughout this Specification the following definitions shall be applied.

### **2.3.1 DUTY TYPE**

Continuous service: Operation for 24 hours over 24 hours, for a duration of at least 1000 hours of uninterrupted running;

Short time service: Operation for one hour run in any period of 24 hours at rest;

### **2.3.2 SERVICE TYPE**

Base service is the continuous service of the generating set as the normal power supply source of the concerned plant.

Stand-by service is the continuous or short time service of the generating set as the power supply source in case of failure of the normal supply sources for reasons other than safety of persons.

Safety service is the continuous or short time service of the generating set as the power supply source in case of failure of the normal supply sources for reasons concerning safety of persons.

Safety and stand-by service (emergency service) is the service for reasons concerning safety of persons and of property. The term "emergency service" will be used throughout this specification.

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### 2.3.3 POWER OUTPUT

Power output is the net active power at generator's terminals; continuously running. Ancillaries necessary to the operation of the generating set mechanically connected to it are considered as internal losses of the set, whereas ancillaries not mechanically connected to it, but requiring independent power supply shall be stated separately and their absorbed power shall be deducted as a loss from net output.

Radiator fans for water-cooled engines shall be considered separately, as if they were independently driven. Refer to **ISO 3046-1**.

Rated power output

- a. Nominal (rated) power output is the net power output at standard (reference) ambient and operating conditions stated by applicable standard for the engine and the generator.
- b. Effective (rated) power output is the effective net power output at standard (reference) ambient and operating conditions stated by applicable standards for the engine and the generator considering the loss of power absorbed by all continuously running ancillaries necessary to the operation of the generating set, mechanically connected to it or electrically driven, including shaft driven radiator fan for water cooled engines.

Site power output (effective) is the effective net power output at ambient and operating conditions differing from standard (reference) conditions (e.g. altitude, temperature and humidity, type of fuel etc).

Power output at continuous service is the power output in continuous service, including an overload of 10% for one hour in any period of 12 hours consecutive running.

Power output at short time service is the power output at short time service

Derating factor ( $\leq 1,0$ ) - uprating factor ( $\geq 1,0$ ) is the factor to which the rated power output must be multiplied to obtain the power output corresponding to ambient and operating conditions different from standard ones.

Site derating factor - site uprating factor is the factor to which the rated power output must be multiplied to obtain the power output corresponding to "site" ambient and operating conditions.

### 2.3.4 MODE OF INTERVENTION

Automatic starting

A starting system which does not depend on the intervention of an operator, but on a start-up impulse given through a supervisory device of the normal supply system.

Non automatic starting

A starting system which is caused by the intervention of an operator.

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#### With break

A generating set with automatic starting, the availability of which is assumed:

Up to and within 0.15 s - very short break.  
Up to and within 0.5 s - short break. Up to  
and within 10 s - medium break. Beyond 15  
s - long break.

#### No break

A generating set with automatic starting, which can assure a continuous supply within specified conditions during the period of transition, e.g. for variations in voltage and frequency.

### 3.0 OPERATING CONDITIONS

#### 3.1 GENERAL

Two different categories of operating conditions shall be considered throughout this Specification.

Standard (reference) conditions, which correspond to the reference ambient and operating conditions stated by applicable standards.

Site conditions, which are the specific ambient and operating conditions at installation site.

Standard conditions are used to be valid only for guarantee reference and for information by Vendor (usually as listed in catalogues). Site conditions are valid for the sizing of the complete generating set with respect to actual conditions in which the plant shall operate.

#### 3.2 STANDARD (REFERENCE) OPERATING CONDITIONS

Standard operating conditions stated by reference codes and standards are as follows.

- a. Standard (reference) conditions for the diesel engine and mechanical equipment are specified in **ISO 3046-1**, para B.
- b. Standard (reference) conditions for the synchronous generator and electrical equipment. (Refer to **ELOT EN 60034-1**).

##### Ambient conditions

Design ambient temperature: 40°C.  
Minimum ambient temperature: -5°C.  
Site elevation : less than 1000 m above sea level.

### Operating conditions

Rated power output of the synchronous generator shall be referred to synchronous speed, rated voltage and rated power factor equal to 0,8 lagging, (nominal rated power output).

## **3.3 SITE OPERATING CONDITIONS**

The following site conditions shall be considered.

### **3.3.1 AMBIENT CONDITIONS; Refer**

to inquiry documentation.

### **3.3.2 INSTALLATION CONDITIONS**

The set shall be installed outdoor in a closed, weatherproof canopy.

### **3.3.3 NOISE LEVEL**

The noise level of the set shall be limited within the values of the human physiological and psychological withstand capability within a closed room where personnel shall be present without individual ear protection. The noise level shall not exceed 85 dBA at a distance of 1 m from any point of the canopy. (Inside the canopy operators will use individual ear protection).

### **3.3.4 TYPE OF SERVICE AND MODE OF PROTECTION**

Unless otherwise specified, the diesel generating set shall be for emergency, continuous service and for short break (medium break).

## **4.0 GENERAL DESIGN CRITERIA**

The design and construction of the diesel generating set and relevant equipment shall be such to ensure:

Safety to personnel under all operating and expected conditions.

Suitability to general plant conditions.

Reliability and quality of operation correspondent to the best standard for machinery and equipment for public utility and industry applications.

Ease and simplicity of operation.

Inspection and intervention during operation under safety, conditions for attendant personnel.

Ease of erection.

Ease of maintenance.



## 5.0 RATING AND PERFORMANCE

### 5.1 MINIMUM MECHANICAL AND ELECTRICAL RATING

The diesel generating set shall be electrically and mechanically sized to comply with the following operating conditions:

Furnish continuous power output correspondent to effective continuous power output at site conditions.

Short time operation starting from rest conditions (1 hour stand-by operation), with the effective power output specified, with reference to specified site conditions.

Comply with transient operation conditions stated for emergency loading.

It is Vendor's responsibility to size properly the diesel engine and the generator, in order to meet the continuous, short time and transient performance requirements. With respect to transient performance (instantaneous assumption of loads), alternatively to oversizing the diesel engine and/or the generator, Vendor shall study the possibility of enlarging the flywheel effect of the engine and/or of increasing the performance of the excitation system and voltage regulation of the generator. Unless otherwise specified, the power figure refers to effective continuous site power output, as defined in **para 2.3.1 and 2.3.3**.

### 5.2 PERFORMANCE REQUIREMENTS

Unless otherwise specified, performance requirements specified in the following subparagraphs shall be complied with.

#### 5.2.1 CONTINUOUS AND SHORT TIME OPERATION

Automatic speed control shall be with accuracy within 1% of rated speed, from no load to full load.

Automatic voltage regulation shall be with accuracy of  $\pm 1\%$  of rated voltage, from no load to full load, with power factor 0,8 lagging to 1,0.

#### 5.2.2 TRANSIENT OPERATION

When starting an induction motor sized up to 20% of generator rated output or the largest motor specified, (assuming that the motor locked rotor current shall be 600% of rated current and starting power factor equal to 0,4) the variations shall not exceed the following figures:

Voltage dip at generator's terminals: 20% of rated voltage.

Speed reduction: 5% of rated synchronous speed.

### 5.2.3 EMERGENCY OPERATION (SAFETY AND STAND-BY SERVICE)

The set shall be suitable for quick starting and quick loading (medium break). Provisions shall be incorporated to keep the set preheated and prelubricated (if required by the type of engine) when at rest, to permit quick starting at any time and in any specified ambient condition.

Automatic starting signal shall be given by others.

### 5.3 **QUICK AUTOMATIC STARTING**

#### 5.3.1 STARTING SIGNAL

Starting sequence shall be initiated via a "start signal", given by the monitoring system of the normal supplies.

#### 5.3.2 STARTING SEQUENCE

The starting time shall not exceed the specified break time, counted from "start signal", until the set is ready to take load ("set ready").

The operation sequence of the automatic starting device shall permit 6 (six) automatic attempts to start and additional 4 (four) manual attempts by intervention of the operator.

### 5.4 **SHUT-OFF**

Shut-off of the set after restoring of normal supply conditions or to take out-of service shall be via a shut-off device, operating by a make contact (by other).

After receiving the stop signal, and removing of loads, the set shall run at no load for at least 5 min, before automatic stop (after cooling run). If a starting signal is given during the after cooling run, it must take load instantaneously.

## 6.0 **DESCRIPTION OF THE SET AND LIMITS OF SUPPLY**

### 6.1 **EXTENT OF THE SUPPLY**

The whole diesel generating set shall be supplied as "SKID MOUNTED PACKAGE UNIT", complete with accessories, interconnecting wiring and piping. The set shall mainly be composed of:

One diesel engine with auxiliary mechanical equipment for fuel injection, cooling, lubricating, starting and operation.

One three phase synchronous generator with auxiliary electrical equipment for starting and operation.

One rigid skid baseplate suitable for supporting all the components.

Couplings and guard.

Electrical and mechanical control board.

All necessary special tools and wrenches for maintenance, as hereinafter specified in detail.

The type of the engine, generator and equipment, the material of the various components, the structure of the frame etc. shall be those pertaining to Vendor's standard production for which he can demonstrate his previous experience for the specified service, operating and ambient conditions.

The set shall be furnished completely fabricated, assembled, piped and wired at the factory, skid mounted, tested and dismantled only to the extent required for shipping, if necessary.

The limits of supply shall be such that the generating set shall be supplied complete and ready for operation, except for foundation requirements, utility and power connections down-stream generator's terminals. Detailed limits shall be as described for individual components.

## 6.2 LAYOUT

All components shall be mounted on the common skid-base plate.

## 6.3 FOUNDATION

The foundation shall be consisted of a concrete block or building structure of rigid nature. Vendor shall provide adequate elastic supports to prevent excessive vibrations to the supporting structure. Vendor shall furnish foundation drawings.

## 7.0 DIESEL ENGINE AND MECHANICAL EQUIPMENT

The mechanical equipment of the generating set shall include, but not be limited to, the following components.

### 7.1 DIESEL ENGINE

It shall consist of a complete base frame with cylinder heads, liners, pistons, connecting rods, crankshaft, bearings, flywheel, oil sump, foundation bolts etc.

The engine shall be of the compression-ignition diesel type, four strokes, minimum four cylinders, with nominal speed not higher than that corresponding to a four pole synchronous generator.

### 7.2 LUBE OIL SYSTEM

The frame lubrication system shall be suitable for fast automatic starting of the generating set.

The forced type lube oil system shall cover the following items, as a minimum:

- a. Main oil pump (shaft driven), with suction strainer, pressure regulating valve and separate relief valve.
- b. Oil cooler.
- c. Double oil filter, edge type, cleanable while in service. Degree of filtration 40 micron or finer (10 micron for aluminium bearings).
- d. Auxiliary lubricating oil pump, with timer and starting equipment for pre-lubrication of the diesel engine when in stand-by service, in order to assure initial lubrication during quick starting. This pump shall be equipped with two coaxial motors: one A.C. and one D.C., supplied from the control panel of the set.  
D.C. source shall be the diesel set battery; controls shall be at control board of the set.

### 7.3 FUEL SYSTEM

A complete fuel system shall be supplied including, but not limited to:

Fuel tank sufficient for 24 hours continuous operation unless otherwise specified in the Data Sheet at full load, complete with level gauge, level switch for automatic filling from fuel header, manual feed line, drain and vent valves, dial thermometer, fittings, overflow connection and low level alarm switch.

Fuel filters, single-full flow with sludge sump, if of the edge type, or dual-full flow, if of the cartridge type.

Fuel feed pump driven by engine shaft.

Auxiliary fuel pump, gear type, driven by an A.C. motor, for filling the fuel tank. The motor shall be fed from the diesel set control board.

Fuel storage system shall be in accordance with NFPA, which concerns fire safety.

### 7.4 COOLING WATER SYSTEM

Diesel engines shall be water cooled by forced circulation.

Air cooling system shall be permitted for low power sets, if manufacturer's standard.

The diesel engine shall be fitted with a complete water system of the closed circuit type, with shaft-driven water pump (by means of a gear), heavy duty radiator and fan.

The coolant shall be a glycol-water solution, suitable for the minimum specified ambient temperature.

The system shall be sized to maintain safe operating temperatures of the engine through all the specified ambient temperatures and the full power range of the engine.

The following instrumentation shall be included as a minimum in the supply:

- a. Automatic control devices for engine inlet water temperature.
- b. thermometers, complete with thermowells, at all engine and cooler outlets.
- c. A cooling water maximum temperature shut-down device in the cylinder outlet manifold with alarm light on the control board.

- d. A cooling water high temperature alarm in the cylinder outlet manifold with alarm light on the control board.

This alarm shall sound prior to the maximum temperature, which shall actuate the shut-down device.

- e. A heavy duty level glass and a low level alarm shall be provided on the surge tank, with alarm light on the control board.

The surge tank shall be completely piped to the system and shall be equipped with drain valve and service fittings.

The cooling system shall be fitted with an automatically controlled pre-heating system, suitable to permit fast starting and loading of the engine with the coldest ambient temperature.

Heaters shall be thermostatically controlled and supplied from the control board. Water circulation during pre-heating shall be natural (convection).

#### **7.5 AIR INTAKE SYSTEM**

Filters shall be suitable for the specified ambient conditions.

Louvres shall be provided, when specified, and they shall be automatically servo-operated by starting and shut-down sequence of the generating set.

#### **7.6 EXHAUST SYSTEM**

Vendor shall provide the exhaust system, complete with the, expansion joints, spring hangers, heat insulation, ducting etc.

#### **7.7 SILENCING SYSTEMS**

Vendor shall provide inlet and exhaust silencing systems in order to comply with noise level.

#### **7.8 STARTING SYSTEM**

The set shall be furnished together with a complete manual and automatic starting system, electrically operated, according to Manufacturer's Standard.

The system shall include:

- One D.C. starting motor, supplied from the stationary battery of the set.
- Control device for starting motor, installed in the control board.

The battery shall be sized for the required automatic and manual consecutive starts.

#### **7.9 SPEED GOVERNOR**

Speed governor shall be of hydraulic type, for general purpose fine governing, designed according to **ISO 3046-4**.

The steady load speed band shall not exceed 1% of the rated speed. In addition, **para 5.2.1** shall be complied with.

7.10 **COUPLING AND ASSEMBLING DEVICES**

The set shall be furnished complete with:

- Coupling between the engine and generator.
- Any required transmission for ancillaries.
- Protective covers for flywheel, coupling and any rotating part
- Electrically interlocked hand barring gear (automatic starting shall be prevented if the barring gear is not in due position).

7.11 **SKID BASEPLATE**

One common rigid skid baseplate shall support all components of the set. Damper elements between the skid and the concrete basement shall be furnished, to eliminate the need of special foundation, in accordance with **para 6.3**. Lifting lugs shall be furnished.

Two diagonally oriented earthing connections shall be provided.

7.12 **INSTRUMENTS AND CONTROLS - ON BOARD MOUNTED CONTROL PANEL**

As a minimum, the following instrumentation shall be provided for the diesel engine, as applicable and practical in relation to the size. (The control board for diesel engine and generator is specified under **para 9.0**).

7.12.1 **PRESSURE GAUGES**

- a) Lube oil engine header.
- b) Lube oil filter differential.
- c) Inlet air engine manifold.
- d) Water pump discharge.
- e) Fuel header on engine.
- f) Fuel filter differential.

7.12.2 **TEMPERATURE GAUGES**

Controlled quantity	Indicator on board	Indicator on control board
a) Lube oil inlet/outlet of coolers	X	
b) Water temperature inlet/outlet radiator	X	
c) Water temperature outlet each cylinder		X(*)
d) Exhaust gas temperature each cylinder		X
e) Fuel tank		X

(^Thermocouples and indicating dial with selector switch.

7.12.3 **LEVEL GAUGES**

- a) Oil pump.
- b) Fuel tank(s).
- c) Water surge tank.

#### 7.12.4 CONTROL SWITCHES AND FUNCTIONS

- a) The EDG set shall be suitable for remote operation from the control room.
- b) The following quantities shall be monitored by suitable control switches, to actuate the functions specified below.

Inscription	Alarm or Prealarm	Function Shut-down
a) low lube oil pressure	X	X
b) low oil sump level	X	X
c) low, fuel oil tank level	X	
d) low surge water tank level	X	
e) high oil filter differential	X	
f) high fuel filter differential	X	
g) low starting air pressure	X	
h) high outlet water manifold temp.	X	
k) high lube oil temp, out of coolers	X	
i) auxiliary prelubric. oil pump "on"	X(°)	
j) shaft barring device "on"	X	
l) cooling water temp, too low	X	
m) overspeed	X	X

(°) Permissive contact for starting, when barring device "out".

- c) All alarms and a cumulative shutdown alarm shall be repeated to a remote alarm panel.

#### 7.12.5 MISCELLANEOUS CONTROLS

Any other instrument or control device necessary for the safe and correct starting and operation of the set, shall also be supplied by Vendor.

#### 7.13 INTERCONNECTING MATERIALS

Any interconnecting piping, tubing, valves, wiring and conduit, fittings, complete with supports between set battery limits, shall be included.

Tubing and wiring between diesel engine, ancillary equipment and control board shall be supplied.

#### 7.14 PLATFORMS AND LADDERS

Platforms, ladders and hand rails to facilitate operation and maintenance of the complete set, including generator, shall be supplied.

#### 7.15 MISCELLANEOUS

Any other auxiliary or ancillary system, equipment or device necessary for correct and safe starting, operation and shut-down of the set, shall be supplied.

**7.16 HOUSING CANOPY**

Vendor shall furnish a steel canopy for weather protection and sound attenuation. Canopy shall be furnished with utilities (ventilating fans, lighting, etc.) depending on dimensions, as well as operational and maintenance requirements.

**8.0 SYNCHRONOUS GENERATOR**

The synchronous generator shall be furnished complete with excitation, automatic voltage regulator and any device necessary for correct and safe operation. The supply shall include, but not limited to the following items.

**8.1 SYNCHRONOUS GENERATOR**

The generator shall be three phase, four (4) pole or more, revolving field type.

Unless otherwise specified, the following shall apply:

Output voltage adjustable plus/minus, 5% of rated value.

Rated output at power factor 0,8 lagging.

Insulation of stator/rotor: not less than H/H.

Stator winding; wye connected with six terminals brought out.

Bearing type: roller, grease lubricated.

**8.2 COOLING SYSTEMS**

The generator shall be air-cooled type.

**8.3 EXCITATION SYSTEM**

Excitation shall be brushless type, with rated current at least 110 of the excitation current at the rated output of the generator (full load at 0,8 pi.), and rated voltage at least 110% of the excitation voltage at rated output of the generator. Excitation and automatic voltage regulation system must be capable supplying the ceiling excitation when a short circuit occurs.

Failure of one diode must be detected to sound the alarm.

Field suppression system shall be designed to reduce terminal voltage to 10% of rated voltage, starting from full load excitation at rated pi. within 1 s. in case of three phase short circuit at terminals.

**8.4 AUTOMATIC VOLTAGE REGULATOR (AVR)**

AVR shall be a static electronic type regulator and shall have high stability, virtually instantaneous response and high inherent reliability. The AVR unit, to be mounted in the control board shall include:



Over excitation limiting device.

Any auxiliary device, such as CT's and PT's etc.

Device for automatic voltage reduction if the load demand exceeds engine capacity, to prevent stalling of engine due to an occasional engine misfire or temporary overload.

Voltage adjuster.

Auto manual switch.

### **TERMINAL BOXES**

Separated terminal boxes shall be provided on generator enclosure for:

Connection of temperature detectors.

Connection of excitation supply (if external).

Connection of space heaters. Main generator terminals.

Star point termination, suitable for mounting of three CT's.

8.6

### **CONNECTION OF NEUTRAL POINT TO EARTH**

The neutral point of low-voltage generators shall be directly earthed (TN system).

8.7

### **TEMPERATURE DETECTORS**

Resistance type temperature detectors shall be used for remote indication of generator stator winding.

The temperature detectors embedded in stator winding shall be at least three, (plus three spare for medium voltage generators).

8.8

### **GENERATOR PERFORMANCE DATA**

The following characteristics shall be considered as a minimum:

Momentary excess current 300% for 10 s, at rated voltage and P.F. 0,8.

Overload capability for 60 minutes: 10% with admissible.

Unbalanced load (negative sequence current of full load current): 12,5%.

9.0

### **DIESEL GENERATING SET CONTROL BOARD**

9.1

### **CONSTRUCTION**

The control board shall be Vendor standard.

**9.2 EQUIPMENT INSIDE THE BOARD**

The following equipment shall be provided:

Automatic starting sequence control device, capable of at least six complete automatic starting operations, consecutively.

Automatic battery charger (A.C. supply, three phase), for boost and floating diesel set battery charge; charger shall have adjustable controlled voltage for recharging, equalizing and floating operations.

Switches, contactors, fuses and auxiliary relays for automatic control of generator space heaters, lubricating oil heater (if any), diesel engine water heater, prelubricating pump, battery charger, etc.

Power and auxiliary terminals.

Monitoring relays for all auxiliary supplies.

Switch for the auxiliary A.C. power incoming line.

Nameplates and fittings.

Electric air cooling blower (if necessary).

**9.3 CONTROL AND ALARM CIRCUITS**

Alarm circuits shall be normally energized; shut-down circuits shall be normally de-energized, when the engine is in operation. Alarm contacts shall open to alarm; shut-down contacts shall close to actuate a shut-down.

**9.4 POWER CIRCUIT**

A main line circuit breaker shall be factory installed. The breaker shall be rated from 100% to 125% of the nameplate. The breaker shall be mounted in the generators junction box or in a free standing link box provided by the manufacturer.

**9.5 AUXILIARY CONTROL DEVICES**

Relays, automatic devices, alarm and signalling relays and lamps, shut-off devices and each auxiliary apparatus shall be suitable for correct operating under any specified operating conditions, particularly with voltage supply variation plus/minus 10% for A.C. circuits and plus 10, minus 15 for D.C. circuits.

Contacts to be connected to external circuits shall be suitable for 110 V D.C. for 400 – 230 VA.C.

Circuit	Control	Alarm
Ampacity	<b>10 A</b>	2 A
Breaking capacity	2 A conductive	0,5 A inductive

**9.6 STATIONARY BATTERY**

Lead acid battery, with a sufficient capacity to allow at least ten (10) consecutive starts in the worst condition (six by automatic control, the others by manual control) and twelve (12) hours of energizing the relays and lamps, during total power failure. Rated voltage:  $V_n + 10\% -15\%$ .

**10.0 EQUIPMENT AND MATERIAL TO BE FURNISHED LOOSE****10.1 EQUIPMENT AND MATERIAL**

Control switch for speed remote control and control switch for voltage remote adjusting, to be mounted on the power center.

**10.2 TOOLS**

Complete set of special tools and wrenches for normal maintenance of the complete generating set. Vendor to furnish tool list.

**11.0 SERVICES BY VENDOR****11.1 BID PREPARATION**

The bid presented by Vendor shall be based on this specification, and on other inquiry technical documents.

**11.1.1 ALTERNATIVE PROPOSALS BY VENDOR**

As an alternative, the Bidder shall quote its own standard machines and/or assemblies.

**11.1.2 EXCEPTIONS TO SPECIFICATION**

Exceptions shall be clearly listed in Vendor's bid. Vendor shall either submit a list of exceptions or clearly state that he is full comply with this Specification. In the latter case, it shall be assumed that the bid includes the cost of the requirements of this Specification.

Vendor is aware that, this bid will not be considered, if it does not comply with the above requests.

**11.1.3 INSTALLATION REFERENCE LIST**

Vendor shall submit together with the bid, his installation reference list for similar units, specifying: Customer, year of installation, site of installation, engine and generator manufacturer, model and size, rated power output, speed, type of service, etc.

**11.2 RESPONSIBILITY BY VENDOR**

Vendor of the "package" emergency diesel generating set shall be responsible for the complete assembly, also if parts are furnished by different Sub-Vendors. Compliance with this specification does not relieve Vendor of the responsibility for furnishing equipment of proper design and construction and fully suitable for all specified operating conditions.

Vendor is responsible that material supplied by his Sub-Vendors comply with the requirements of this Specification.

It shall be Vendor's responsibility to provide engineering coordination of diesel engine, generator, gears, couplings, torsional and lateral speed analysis, accessories, etc. Vendor's responsibility shall extend to all services furnished by Sub-Vendors and considerations in this Specification.

## **12.0 INFORMATION BY VENDOR**

Vendor shall furnish the following information:

### **12.1 GENERAL INFORMATION**

Overall dimensions and weights of the diesel generator set and of main components (reservoirs, control board etc.).

Inertia ( $PD^2$ ) of generator and diesel engine including couplings and fly-wheel.

Characteristics of diesel engine.

Output values at generator terminals, 0,8 power factor lagging, for effective continuous and short time operation at reference and site specified conditions.

Fuel oil specific consumption for continuous service at 4/4, 3/4 and 1/2 of full load and lube oil consumption, specified with reference to rated:

- \* Continuous service
- \* Short time service (1 h every 24 h),

and for continuous service with effective rated power output at site reference conditions,

Derating (uprating) factors, particularly referred to site conditions,

Quantities of air ( $m^3/h$ ) required for cooling radiator,

Type and characteristics of materials used for cylinder block, cylinder heads, cylinder liners, pistons, connecting rods, crankshaft and bearings,

Starting and control battery capacity (**A** h/3 h discharge),

### **12.2 SPARE PART LIST**

Itemized spare part lists with necessary instructions and drawings, indicated separately for start-up, for one year operation and for maintenance.

### **12.3 MECHANICAL CATALOGS AND INSTRUCTION MANUALS**

Complete documentation for operation, maintenance and repairing, including:

Drawings. Flow-sheets.

Electrical diagrams.

## 12.4 TECHNICAL REPORT

Vendor shall furnish a technical report concerning the input data, the calculations and the results of critical torsional analysis of the entire generating set to demonstrate that no torsional critical speed will occur within 10 per cent of any operating speed in the rotating system.

When this is impractical, dampers can be used to limit shaft stresses due to torsional vibration.

Vendor shall clearly describe in the bid such devices and equipment, starting the residual forces and peak to peak vibrations, if any.

## 12.5 INFORMATION ABOUT GENERATOR

Efficiency at 4/4, 3/4, 2/4 and 1/4 of rated load at rated power factor (efficiency at 4/4, 3/4 and 2/4 shall be subject to guarantee). Efficiency at 4/4 of site power output.

Voltage regulation at constant excitation from full load to no load at 0,8 p.f. and at 1,0 p.f.

Insulation class: stator/rotor (not less than B), rated current, rated voltage, excitation current and voltage at generator rated load, nominal exciter response in accordance with **ELOT EN 60034**. Type and Manufacturer of AVR.

Accuracy of regulation between no load and full load, 0,8 - 1,0 p.f. load condition, cold to hot variation (static conditions). Range of frequency in which the given accuracy is valid. Rated short circuit ratio (saturated), reactances, time constants. Current decrement curves for three phase short circuit with no load excitation, with rated load excitation, with automatic voltage regulator in service. Current decrement curves for phase to phase and single line to earth faults.

Generator reactances and time constants:  $X''_d$ ,  $X'_d$ ,  $X_d$ ,  $X'_q$ ,  $X_q$ ,  $T''_d$ ,  $T'_d$ ,  $X_o$ ,  $R_o$ ,  $R_g$ ,  $T_a$ .

Documentation shall be supplied by Vendor in accordance with the requirements stated in the inquiry documentation.

## 13.0 INSTALLATION AND ERECTION

Components shall be already workshop preassembled, cleaned, protected and ready for operation.

## 14.0 INSPECTION AND TESTING

### 14.1 GENERAL

Machinery and equipment forming part of the generating set shall be subject to witnessed inspection and testing, as specified hereinafter.

#### 14.2 TESTING OF COMPONENTS AT MANUFACTURER'S WORKSHOP

Machinery and equipment shall be individually tested, at Manufacturer's workshop, in accordance with the applicable standards.

#### 14.3 COMPLETE TEST OF THE GENERATING SET

The complete assembled set and relevant equipment shall be tested at Manufacturer's or at Vendor's workshop.

The same tests shall be performed at site, but reference shall be made to "site conditions".

Test shall include:

- a. Six (6) plus four (4) starts in the worst conditions, with 50% discharged battery or with 50% charged compressed air reservoirs.
- b. Sudden 100% loading and unloading.
- c. Uninterrupted operation at rated full load and determination of fuel and lube oil consumptions.

The duration of test shall be 18 h.

#### 15.0 REFERENCED DOCUMENTS

1. **ELOT HD 60027 Series**  
[Letter Symbols to be used in Electrical Technology]
2. **ELOT EN 60034 Series**  
[Rotating Electrical Machines]
3. **IEC 60050**  
[International Electromechanical Vocabulary]
4. **ELOT EN 60085**  
[Thermal Evaluation and Classification of Electrical Insulation]
5. **ELOT HD 60364 Series**  
[Low-voltage electrical installations]
6. **ELOT EN 60439 Series**  
[Low Voltage Switchgear and Controlgear Assemblies]
7. **ELOT EN 60529 / A1**  
[Degree of Protection Provided by Enclosures]
8. **ELOT EN 60617 Series**  
[Graphical Symbols for Diagrams]
9. **ELOT EN 60947 Series**  
[Low Voltage Switchgear and Controlgear]
10. **ISO 3046**  
[Reciprocating Internal Combustion Engines-Performance]

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**16.0 ATTACHED DOCUMENTS**

None.