




OGDCL PAKISTAN:
OIL & GAS DEVELOPMENT
COMPANY LIMITED

KPD-TAY COMPRESSION PROJECT

ISSUED FOR TENDER

0	07-JAN-2022	ISSUED FOR TENDER	JAB	ZHW	AIB	MPM	MAS		
REV	DATE	DESCRIPTION	ORIG	CHKD	LE	QA	PM	LPE/TA	
REVISIONS			APPROVAL					OWNER APPROVAL	
<div></div> <div>ENAR Petrotech Services (Pvt.) Limited , 7-B , Sector 7-A , Korangi Industrial Area , Karachi Pakistan</div>			TITLE:						
			SPECIFICATION FOR DIESEL ENGINE DRIVEN GENERATOR						
			DOCUMENT NO:						
			PROJECT NUMBER 14-0258						
			PROJECT CODE	DOC. TYPE	SEQ. NO.	REV			
			0258	ELA	6508	0			



CLIENT : OIL & GAS DEVELOPMENT COMPANY LIMITED

PROJECT : KPD-TAY COMPRESSION PROJECT

**SPECIFICATION FOR
DIESEL ENGINE DRIVEN GENERATOR**



OIL & GAS DEVELOPMENT COMPANY LIMITED
KPD-TAY COMPRESSION PROJECT
SPECIFICATION FOR DIESEL ENGINE DRIVEN GENERATOR

DOC NO: 0258-ELA-6508

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REV: 0

DATE: 07-JAN-2022

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1. PURPOSE

This specification is intended to specify the basic requirements for designing, engineering, selection, procurement, testing, installation, pre-commissioning, commissioning and performance of the Diesel Engine Driven Generating set. The requirements mentioned herein and elsewhere in tender package are the minimum required. However, minimum requirement stipulated in tender document shall remain same. This specification does not relieve the CONTRACTOR from his responsibility of supplying/ furnishing equipment, installing and commissioning, auxiliaries and 2-years spare parts of proper design material and workmanship meeting all the specified rated operating and service conditions of suitable Diesel Engine Driven Generator set complete in all respect. The CONTRACTOR shall develop detailed datasheets, specifications, ITP and installation details based on this specification and submit to the COMPANY/CONSULTANT for approval during detailed engineering stage.

The diesel engine driven generator unit shall be designed, built/manufacturing and tested in accordance with requirement stipulated in stated reference standards and codes herein Section-2. Where the manufacturer's standards differ from other supplementary requirements of this specification details shall be submitted to the COMPANY/CONSULTANT for approval.

In the event of any conflict of data or requirements in any of the above documents, it is the CONTRACTOR's responsibility to resolve these conflicts before proceeding with design, manufacture or purchase. In any case the most stringent requirement shall prevail. However, COMPANY/CONSULTANT interpretation shall be considered as final.

1.1. DEFINITION

Where used in this specification, the following terms shall have the meanings indicated below unless otherwise clearly indicated by context of their use.

COMPANY – Oil & Gas Development Company Limited (OGDCL).

CONCESSION REQUEST - A deviation requested by the CONTRACTOR/VENDOR, usually after receiving the contract package or purchase order. Often, it refers to an authorization to use, repair, recondition, reclaim, or release materials, components or equipment already in progress or completely manufactured but which does not meet or comply with COMPANY/CONSULTANT requirements. A Concession Request is subject to COMPANY/CONSULTANT approval.

CONTRACTOR - The party which carries out all or part of the design engineering, procurement, construction and commissioning or management of the project.

DRAWINGS - Drawings provided by the CONTRACTOR/VENDOR.



SUPPLIER/MANUFACTURER/VENDOR - The party which manufactures and/or supplies the material/ equipment, and provides technical documents/drawings and services to perform the duties specified by the COMPANY /CONTRACTOR.

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1.2. ERRORS & OMISSIONS:

- The review and comment by COMPANY/CONSULTANT of any CONTRACTOR's/VENDOR's drawings, procedures or documents shall only indicate acceptance of general requirements and shall not relieve the CONTRACTOR/VENDOR of its obligations to comply with the requirements of this specification and other related parts of the Contract Documents.
- Any errors or omissions noted by the CONTRACTOR/VENDOR in this Specification shall be immediately brought to the attention of COMPANY/CONSULTANT.

1.3. DEVIATIONS:

- All deviations to this Specification, other related specifications or attachments shall be brought to the knowledge of COMPANY/CONSULTANT as a section in the bid. All deviations made during the procurement, design, manufacturing, testing and inspection shall be with written approval of COMPANY/CONSULTANT prior to execution of Work. Such deviations shall be shown in the documentation prepared by the CONTRACTOR/VENDOR.

1.4. CONFLICTING REQUIREMENT:

- In the event of any conflict, inconsistency or ambiguity between the CONTRACTOR's/VENDOR's scope of work, this Specification, National Codes and Standards, and referenced in the Project Specification or any other documents, the CONTRACTOR/VENDOR shall refer to COMPANY/CONSULTANT whose decision shall prevail.

1.5. REPORTING PROCEDURE:

- A reporting and documentation system shall be agreed between the CONTRACTOR/VENDOR and COMPANY/ CONSULTANT for the status of procurement, design, manufacturing, inspection, testing and shipment of the equipment/material to be supplied under this specification. The CONTRACTOR/VENDOR shall provide reports and summaries for production performance and testing operations in conformance with a manufacturing schedule approved by COMPANY/CONSULTANT.
- Daily, weekly, monthly and run summaries of all major aspects of the production process shall be provided as reports to COMPANY/CONSULTANT.

1.6. THIRD PARTY INSPECTION:

- In addition to the inspection and witnessing of tests by the inspectors to be appointed by the COMPANY/CONSULTANT during the manufacturing and shipment of the equipment/material,
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COMPANY/CONSULTANT may appoint a third party or its own inspector for witnessing of the inspection and tests to be carried out at VENDOR's facility under this specification.

Information w.r.t inspection and testing purposes as per applied reference Standards and Codes shall be submitted to COMPANY/CONSULTANT.

1.7. UNIT RESPONSIBILITY

- The CONTRACTOR/VENDOR shall be responsible for the complete design, manufacture, supply, inspection, testing and performance of Diesel Engine Driven Generator set including full compliance with all applicable design codes and standards, including those listed in Section-2 of this document and the requirements of the certifying authority. The CONTRACTOR/VENDOR shall handle and expedite drawings and data, and supervise and coordinate all inspection and testing.
- The CONTRACTOR/VENDOR shall guarantee that all material and parts included in construction of the specified Diesel Engine Driven Generator set shall be new, unused and of the required/ specified grade.

1.8. DOCUMENTATION

- Documents, calculation/data sheets, technical details, etc., to be submitted to the COMPANY/CONSULTANT shall be in English Language.
 - Unless otherwise specified, the metric units shall be used in documents and drawings by the CONTRACTOR/VENDOR.
 - The form of drawings and documents may be as per the CONTRACTOR/VENDOR's Standards. However, the format of the data sheet will be submitted to COMPANY/CONSULTANT for approval.
 - Variations from or additions to this specification shall be called to the attention of the COMPANY/CONSULTANT and approved in writing by the COMPANY/CONSULTANT prior to starting manufacturing.
 - Comments made by COMPANY/CONSULTANT on drawing/technical details submittal shall not relieve the CONTRACTOR/VENDOR of any responsibility in meeting the requirements of the specifications.
 - Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.
 - The CONTRACTOR/VENDOR shall notify the COMPANY/CONSULTANT of any apparent conflict between this specification, the Standards & Codes and any other specification noted herein.
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Resolution and or interpretation precedence shall be obtained from the COMPANY/CONSULTANT in writing before proceeding with the design manufacture.

1.9. ABBREVIATIONS

AC	-	Alternating Current
AMSL	-	Above Mean Sea Level
AVR	-	Automatic Voltage Regulator
CT	-	Current Transformer
C	-	Centigrade
DC	-	Direct Current
DG	-	Diesel Engine Driven Generator
ICSS	-	Integrated Control and Safety System
VT	-	Voltage transformer

2. REFERENCE STANDARDS & CODES

The equipment and material selection, design, manufacturing and test and inspection shall confirm to the relevant standards and codes for Diesel Engine Driven Generator set.

It shall be manufacturer responsibility to be or to become knowledgeable of the requirements of these reference Standards and Codes. The supply shall also include the requirements of local standards and regulations following the principles and practices detailed in this philosophy. Any changes, alteration and necessary re-certification of the equipment for compliance with the applicable Standards and Codes shall be at the expense of the Manufacturer.

STANDARDS AND CODES

STANDRD/CODE	DESCRIPTION
AMERICAN STANDARDS	
ANSI/ASME B16.5	Pipe flanges and flanged fittings
ANSI/ASME B31.3	Chemical plant and petroleum refinery piping
ANSI/API 671	Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services
ASHRAE 52	Method of testing air- cleaning devices used in general ventilation for removing particulate matter AWS American Welding Association
AWS D1.1	Structural Welding Code - Steel
INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)	
IEC 60034-1	Rotating Electrical Machines
IEC 60038	IEC Standard Voltages
IEC 61869	Instrument Transformers
IEC 60050	International Electro-technical Vocabulary



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IEC 60051	Direct Acting Indicating Analogue Electrical Measuring Instruments and their Accessories
IEC 60072	Dimensions and Output Ratings for Rotating Electrical Machines
IEC 60073	Basic and Safety Principles for Man-Machine Interface, Marking and Identification
IEC 60079	Electrical Apparatus for Explosive Gas Areas
IEC 60085	Thermal Evaluation and Classification of Electrical Insulation
IEC 60255	Electrical relays
IEC 60269	Low Voltage Fuses
IEC 60317	Specifications for Particular Type of Winding Wires (formerly IEC 60182)
IEC 60417	Graphical Symbols for Use on Equipment
IEC 60445	Identification of Equipment Terminals
IEC 60529	Classification of Degrees of Protection Provided by Enclosures
IEC 60617	Graphical Symbols for Diagrams
IEC 60898	Electrical Accessories - Circuit Breakers for Over-current Protection
IEC 60947	Low Voltage Switchgear and Control gear
IEC 60950	Information Technology Equipment-safety general requirement
IEC 61000	Electromagnetic Compatibility (EMC)
IEC 61150	Sealed Nickel Cadmium Rechargeable Batteries
IEC 61158	Digital data communications for measurement and control
INTERNATIONAL ORGANIZATION FOR STANDARDS (ISO)	
ISO 1813	Belt Drives-V-ribbed belts, Joined V-Belts and V-Belts standard
ISO 3046	Reciprocating Internal Combustion Engines: ISO 8528 Reciprocating Internal Combustion Engine Driven Alternating Current Generating sets - Transient Loading Response
ISO 9000	Quality management and quality assurance standards
ISO 9001	Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation and Servicing
ISO 9003	Quality Systems - Model for Quality Assurance in Final Inspection and Test
ISO 9004	Quality Management and Quality System Elements - Guidelines
ISO 10441	Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services - Fourth edition (Ref. Standard ANSI / API 671)
ISO 14001	Environmental Management Systems
ISO 18001	Occupational Health and Safety Management Systems
NEQS	National Environmental Quality Standards (revised) –Pakistan



It shall be manufacturer responsibility to be or to become knowledgeable of this requirement of these standards and codes. All standards, regulations and codes of practices used shall be of latest current issues at the date of contract award.

3. SITE CONDITIONS

3.1. SITE CONDITIONS

As a minimum requirement the electrical equipment selection shall take into account the following extreme climate conditions.

SITE AND ENVIRONMENT DATA

PARAMETERS	VALUE/UNIT
MAXIMUM AMBIENT TEMPERATURE	118 °F
MINIMUM AMBIENT TEMPERATURE	36 °F
WET BULB TEMPERATURE (DESIGN)	88 °F
MAXIMUM RELATIVE HUMIDITY	77%
MINIMUM RELATIVE HUMIDITY	20%
WIND VELOCITY	101 (Miles/Hour)
ELEVATION ABOVE MEAN SEA LEVEL (GPF)	250 ft.
SEISMIC ZONE	Zone 2A of Uniform Building Code- UBC-1997.

The atmosphere shall be regarded as dusty, sulphurous, salty and corrosive, as commonly encountered in Petroleum product storage & transportation terminal stations.

The Diesel Engine Driven Generating set package and all individual items forming part of the generator shall be suitable for use in indoor location.

If not otherwise specified in the purchase requisition, the following service conditions shall apply:

3.2. SUPPLY SYSTEM CHARACTERISTICS:

The Diesel Engine Driven Generator set covered by this specification shall be suitable for the following operating conditions and shall be designed and constructed accordingly.

PARAMETERS	VALUE/UNIT
VOLTAGE LEVEL	400 V ac \pm 10%, 3-PHASE 4WIRE SYSTEM 230 V ac 1-PHASE
PHASE	3
FREQUENCY	50 Hz. \pm 2Hz
GENERATOR NEUTRAL	SOLIDLY GROUNDING SYSTEM IF UNLESS OTHERWISE SPECIFIED



4. SCOPE OF EQUIPMENT SUPPLY

The Generating set and other auxiliary equipment shall be complete in all respects and as defined in this specification and material requisition and shall include as a minimum the following:

- Diesel Engine complete with all necessary auxiliaries;
- Synchronous AC generator complete with excitation equipment;
- Combined chassis / base plate;
- Engine and generator control and protection philosophy
- Engine control panel
- All necessary noise and vibration suppression equipment;
- Engine starting system;
- Engine and generator cooling systems;
- Lubrication system;
- Combustion air intake system;
- Exhaust system;
- Engine fuel system;
- Fuel day tank suitable for 12 hours fuel consumption;
- Couplings and guards;
- Battery System;
- All necessary interconnecting pipe work and valves, including drain connections terminating at the DG of the base plate;
- Local gauge panel and instrumentations;
- All CT's, VT's, ATS & AMF.
- Power supply distribution board for all the auxiliaries on the package;
- Fire & Gas System including fire extinguisher.
- IP-54 protected sound proof canopy

With the exception of the remote control and generator protection panel, the generating set shall be furnished as a skid mounted unit, consisting of generator, diesel engine driver and auxiliary systems, IP-55 terminal box & control panel.

4.1. DOCUMENTATION

VENDOR shall submit the type and quantity of drawings and documentation for CONTRACTOR'S authorization or information as listed in the individual Material Requisitions and Purchase Orders.



Provide CD ROMs for any software loaded into the Diesel Generator set operating control system for OWNER future use. Contractor/ Vendor to train COMPANY/CONSULTANT personnel (minimum of three) on using such software.

Drawings and data shall be provided as detailed below and shall be in English language and metric unit.

- Completed data sheets;
- General arrangement drawing of all equipment also showing dry and operating masses, arrangement of components, cable entry details, minimum space required for erection, testing and maintenance;
- Schedule and drawing of electrical, instrument and mechanical termination points, electrical single line;
- Complete exhaust system assembly drawings;
- Foundation design data;
- Base plate construction data;
- Dynamic performance calculations;
- Torsional and lateral vibration data;
- Structural dynamic calculations for generator set vibration, taking account of anti-vibration mounts;
- Schematic and connection diagrams of main, control, status indication, alarm, metering, protection, trip, shutdown and auxiliary circuits, relay sections, AVR schematics;
- Alarm and trip setting schedules;
- Starter / Cubicle wiring diagrams;
- Material specifications;
- Equipment lists/parts lists;
- Recommended spare parts lists;
- Preservation for shipment procedures;
- Operating manuals incorporating unpacking, depreservation, installation, commissioning, operating and maintenance instructions and fault finding procedures;
- MANUFACTURER'S proposed service and repair support after warranty;
- Test and inspection procedures;
- Testing program;
- Certificates of conformity and declarations of compliance for equipment used in hazardous areas;
- Reports and certificates of all tests performed (QA/QC & HSE).

Descriptive literature for all items together with a full system description shall be provided as part of the bid documentation.



After placement of order, the VENDOR shall submit for approval, all listed drawings and documents, strictly in accordance with the agreed schedule and program.

- Sectional drawings, part lists;
- Lifting and handling devices, drawings and calculations;
- Auxiliary materials drawings and descriptions/characteristics;
- List of instruments, panels, auxiliary devices with main characteristics;
- Other documents as applicable.

In addition to the instructions in standard forms, the VENDOR/MANUFACTURER shall comply with the following additional requirements for installations, operating and maintenance manuals.

- The front cover, spine and inside page shall state the purchase order number and MANUFACTURER'S reference number;
- The inside front page shall carry an index listing the contents of each section of the manual;
- Individual sections shall be complete and shall refer to equipment actually supplied;
- Published data shall also be included, including published data for bought-out items;
- Full details of any special equipment shall be clearly set out in separate sections;
- A punch list of "do's" and "don'ts" shall be included;
- Full details for installation and setting up shall be included;
- Recommended test data shall be stated, covering initial and also regular testing; i.e., values for high voltage, AC. or DC, etc. shall be given;
- Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated;
- Important items shall be cross referenced to other parts of the manual as necessary
- Quality control, inspection and testing documents;
- Type test certificates and test reports;
- Visual examinations;
- Other documents as applicable or all package information provided for handling.

Comments made by CONTRACTOR on drawing submittal shall not relieve VENDOR or SUB-VENDOR'S of any responsibility in meeting the requirements of the specifications. Such comments shall not be construed as permission to deviate from requirements of the Purchase Order unless specific and mutual agreement is reached and confirmed in writing.

Each drawing shall be provided with a title block in the bottom right-hand corner incorporating the following information:



- Official trade name of the VENDOR;
- VENDOR'S drawing number;
- Drawing title giving the description of contents whereby the drawing can be identified;
- A symbol or letter indicating the latest issue or revision;
- PO number and item tag numbers.

Revisions to drawing shall be identified with symbols adjacent to the alterations, a brief description in tabular form of each revision shall be given, and if applicable, the authority and date of the revision shall be listed. The term "Latest Revision" shall not be used.

5. MATERIAL HANDLING

Preparation for shipment shall be in accordance with the VENDOR'S standards and as noted herein. VENDOR shall be solely responsible for the adequacy of the preparation for shipment provisions with respect to materials and application, and to provide equipment at the destination in ex-works condition when handled by commercial carriers.

Adequate protection shall be provided to prevent mechanical damage and atmospheric corrosion in transit and at the job site.

Preparation for shipment and packing will be subject to inspection and rejection by COMPANY/CONSULTANT's / CONTRACTOR's inspectors. All costs occasioned by such rejection shall be to the account of the VENDOR.

After inspection and test, equipment shall be completely free of water and dry before start of preparation for shipment.

Equipment shall be packed, securely anchored, and skid mounted when required. Bracing, supports, and rigging connections shall be provided to prevent damage during transit, lifting, or unloading. All temporary bracing/supports shall be marked "REMOVE BEFORE EQUIPMENT COMMISSIONING AND STARTUP".

Open ends of tubes and pipe shall be capped for protection. Female threaded connections shall be plugged with solid metal pipe plugs, and male threaded connections shall be protected with full metal pipe caps.

Separate, loose, and spare parts shall be completely boxed. Pieces of equipment and spare parts shall be identified by item number and service and marked with CONTRACTOR'S order number, tag number, and weight, both inside and outside of each individual package or container. A bill of material shall be enclosed in each package or container of parts.



Exposed finished and machined surfaces, including bolting, shall be given a coating of rust inhibiting compound. Internal metal surfaces shall be sprayed or coated with a suitable rust preventative prior to shipment. Openings shall be suitably tagged to indicate the rust preventative applied.

Mechanical seal assemblies shall be fully protected from rusting and entry of moisture and dirt.

One complete set of the installation, operation, and maintenance instructions shall be packed in the boxes or crates with equipment. This is in addition to the number called for in the Purchase Order.

Equipment and materials shall be protected to withstand ocean transit and extended period of storage at the job site for a minimum period of 18 months.

6. GENERATOR REQUIREMENTS

Gen-set shall be capable of supplying continuous power at variable load & allow 10% overload for 1 hour following 100% load 12 hour operation.

The stated output rating of mentioned in *Section-6.1* shall be based on ambient conditions defined in *Section-3*.

The current rating of the equipment must be guaranteed at the specified design temperature. Equipment shall be fully rated and constructed to withstand the specified short circuit duty.

The generator and all individual items which are a part of the generator package shall be designed in accordance with sound engineering practice to provide a minimum service life of 30 years.

The generator set shall be suitable for continuous full load service, duty type S1 according to IEC 60034-1, at the rated power and specified ambient conditions.

Safe working space shall be provided for maintenance of instrument (gauges, vibration switches, valves, pressure switches) inside the enclosure.

The rating of the machine offered by the manufacturer shall be based on Class H insulation & temperature rise B for all parts of the generator, e.g., stator, rotor and exciter windings, at ambient temperature.

The generator shall be skid mounted and shall be placed inside generator room/shed suitable for an unclassified area (non-hazardous/safe area).



The generating set shall maintain an electrical output in accordance with the parameters specified on the Data Sheet (to be developed by the CONTRACTOR during detailed engineering) attached with material requisition.

The rating of the generator shall be selected by the diesel engine manufacturer, in line with the specified requirements, such that the generator does not limit the output of the diesel engine over specified operating temperature range.

The generator neutral shall be solidly earthed.

The generator shall be capable of the following operation:

The emergency generator is required to start and take load automatically on the loss of regular normal load supply (from gas gen-sets). The automatic starting sequence must be completed within 5 seconds or less. The cumulative load takeover time shall be more than 15 seconds.

The Gas Gen-set supply and the diesel generator supply shall not operate in parallel in normal operation, but provision of parallel operation shall be provided.

ON FAILURE OF GAS GEN-SET SUPPLY MAINS:

- Switchboard Gas Gen-set Supply breaker opens and locks,
- Automatic start of engine and acceleration to governor control,
- Automatic control of generator voltage and frequency,
- Automatic closure of Emergency Switchboard generator supply circuit breaker,
- Energization of Emergency Switchboard.

ON RESTORATION OF UTILITY SUPPLY:-

- Switchboard generator supply circuit breaker opens and locks,
- Automatic closing of Switchboard Utility Supply circuit breaker,
- Energization of Switchboard from Gas Gen-set Supply,
- Time delay and automatic generator shutdown.

When the generator Auto-Manual-Test-Off selector switch is in “Manual” position, the set can be started and stopped by hand and the hand control shall initiate the auto sequence described above.

When the selector switch is in “Test” position, the test shall always be possible to be performed without load or changeover.

With the selector switch in “OFF” position, manual and automatic starting of the unit shall not be possible.



Refer single line diagrams for further details regarding operation philosophy.

The generator shall be designed to have an acceptable wave form and distortion and shall not exceed more or less 2% at rated frequency under no load condition.

An appropriate temperature monitoring system shall be provided to give a remote alarm if the temperature of the equipment/components exceeds the design limits. The external surfaces of motors, generators and other rotating machinery shall have an operating temperature not more than 80% of the ignition temperature of diesel vapor-air mixture.

The VENDOR's packaged unit shall have provision for cable glanding and termination of cables specified.

Cable termination materials, e.g., cable lugs and other terminating components are included in the VENDOR's scope.

A remote control, protection and monitoring panel shall be supplied separately. This panel shall be equipped with all necessary devices and components to ensure proper operation of the power generation package and perfect integration with the overall network design.

Unless otherwise agreed in writing, all electrical equipment required for operation of packaged unit shall be supplied, manufactured, assembled, wired and installed by the VENDOR/MANUFACTURER. Only external wiring between the VENDOR's packaged units standing apart will be carried out by others.

Nameplates attached to equipment and warning notices shall be in English.

6.1. MAIN ELECTRICAL SUPPLY SYSTEM

PARAMETERS	VALUE/UNIT
RATING	Refer Single Line Diagrams Dwg. No. 0258-ELB-6600, and 0258-ELB-6602
VOLTAGE LEVEL	400 V ac \pm 10%, 3-PHASE 4WIRE SYSTEM 230 V ac 1-PHASE
NO. OF PHASE	3 PHASE, 4 WIRE, NEUTRAL SOLIDLY EARTHED. TN SYSTEM
FREQUENCY	50 Hz. \pm 2Hz

6.2. DEGREE OF PROTECTION

The degree of protection of the equipment assembly shall be:

PARAMETERS	VALUE/UNIT
GENERATOR AND EXCITER	IP23
TERMINAL BOX & MOUNTED CONTROL PANEL	IP 55



7. BASIC ENGINE REQUIREMENTS

It is intended that engines shall be designed and supplied generally in accordance with ISO 3046. This specification provides specific requirements amplifying the requirements of the International Standard.

The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 30 years (excluding the normal wear and tear parts) and at least 4 years of uninterrupted operation.

The fuel specification will be given in the requisition. Alternatively the VENDOR shall provide specification of fuel for the engine.

7.1. POWER OUTPUT, FUEL AND LUBRICANT CONSUMPTIONS:

The service power of the engine in accordance with ISO 3046-IV and ISO-8528 shall be the continuous power available at the drive coupling of the engine after deduction of all engine driven auxiliaries. The MANUFACTURER shall state the auxiliaries driven by the engine and their power absorbed in computing the rated power.

The ISO 3046 - IV power is to be derated to the service power at the most severe ambient conditions under which the engine will operate.

The fuel and lubricant consumption at the ISO 3046-IV and service powers shall be stated by the MANUFACTURER.

7.2. ENGINE AND AUXILIARIES DESIGN

7.2.1. PROVEN DESIGN

Diesel Engine shall be selected from the MANUFACTURER'S standard range of products and mounted on a heavy duty steel base. Prototype equipment will not be considered. Only equipment which is of a size, type, rating and method of manufacture with which satisfactory experience can be demonstrated, shall be supplied. Details of such equipment in service shall be provided by the MANUFACTURER.

7.2.2. PERIODIC INSPECTION AND OVERHAUL

Gen-set shall have running b/w major overhauls of 35000 hrs minimum or 4 years whichever occurs first for engines in continuous duty. Vendor/Manufacturer shall submit the details of effects of frequent starting and periods of idleness when determining the time between major overhauls of engines in intermittent duty.

The MANUFACTURER shall submit the following information with technical documents to the COMPANY/CONSULTANT for ease of maintenance planning:

- Recommended periods between inspections, minor and major overhauls;
-



- Inspection, minor overhaul and major overhaul activities, including tests Recommended oil and oil filter change frequency;
- Spare parts and special tools required for major and minor overhauls.

7.2.3. AIR INTAKE SYSTEM

The engine air filter shall comprise a minimum of two stages, an inertial stage followed by a replaceable dry media stage for all installations except where specified otherwise in the requisition.

The air filter shall remove 98% of all dust/dirt particles greater than 10 micrometers and abrasives 3 microns or larger from intake air, in SAE fine test dust when tested in accordance with the ASHRAE 52. All air filters shall be sheltered from rain ingress.

The filter shall have means of removing debris arrested in the inertial stage. The filter shall be fitted with a differential pressure indicator to show when the filter requires attention.

Filters shall be sized/ selected for 100 % full load operating condition of the generator set.

All components of the air filter shall be made from non-corroding materials. Stainless steel is preferred. Aluminum alloys shall not contain more than 3% magnesium. Paint or similar coatings shall not be applied to the internal surfaces of combustion air ducting downstream of the air filter.

7.2.4. EXHAUST SYSTEM

The VENDOR shall provide the silencer, mounting for the silencer and all piping and ductwork between the silencer and the engine and all associated parts.

Exhaust ducting or piping shall be properly supported to prevent excessive strains being applied to the exhaust nozzle on the engine. Due account shall be taken of thermal expansion and the expansion bellow provided by the engine Supplier shall be installed in the locations approved by the engine Supplier.

The orientation of the exhaust shall be agreed with the CONTRACTOR, taking account of the location of adjacent equipment and the prevailing wind.

In addition spark arrester shall be provided on the exhaust according to NEQS. The exhaust piping shall be installed and extended outside of the shelter wall taking into account the civil/structural requirement design.



All carbon steel piping, silencers, etc. subjected to exhaust temperatures and exposed to the atmosphere shall be blast cleaned and flame sprayed aluminum coated for corrosion protection. Alternatively, type 316L stainless steel may be used. Any thermal insulation requirement as per VENDOR standard design shall be considered.

The MANUFACTURER shall advise the maximum allowable back pressure on the exhaust of engines to be fitted with exhaust heat recovery systems. A graph of exhaust temperature and mass flow vs. engine power output shall be made available by the MANUFACTURER for engines being considered for this type of duty.

7.2.5. FUEL SYSTEM

If the fuel is not specified, the engine shall be capable of operation on BS 2869 Classes A1 or A2 diesel fuel. The MANUFACTURER shall advise the maximum allowable quantity and size of solids and water in the fuel oil upstream of the engine mounted filters.

The fuel supply and filtration system shall include at least the following:

- Water and sediment trap/pre-filter;
- Engine driven fuel supply pump;
- Fuel filter;
- Manual fuel priming pump;
- Electrically operated fuel pump for the filling of the daily fuel tank (requirement to be evaluated by the CONTRACTOR during detail engineering).
- Fuel line shall be buried or properly laid with self-regulating heating tape and/or heat insulation as per VENDOR standard installation requirement.

Duplex fuel filters with a changeover valve shall be supplied. The filters shall be of the replaceable element type and readily accessible for maintenance. The elements shall be capable of removal with the engine running without breaking any fuel connections or disturbing the fuel pumps or other engine parts.

Fuel filters shall be equipped with a differential pressure indicator. Fuel filters and pre-filters shall be fitted with sediment drain valves and vent valves for purging any air trapped in the filter.

The injector fuel spill shall be routed to the fuel day tank. This requirement does not apply if the MANUFACTURER has a standard system which returns the spillback to the suction of the fuel injection pump.



The MANUFACTURER shall provide a manually operated quick-acting fuel isolation valve for installation in the fuel supply line to the engine. This valve shall be additional to any automatic cutoff valves specified in any certifying authority rules.

The fuel system components shall be mounted either on the engine or supplied loose to the packager for mounting on the base-plate.

A fuel oil day tank shall be supplied by the MANUFACTURER. The tank shall be manufactured from type 316L stainless steel. The tank shall be arranged to supply the engine by gravity via the pre-filter and the fuel supply pump.

The tank capacity shall be sufficient for not less than twelve (12) hours continuous operation at full load or other capacity or operating period that may be specified in the requisition.

The day tank shall be fitted with level gauge(s) and high and low level alarm switches. The low level alarm shall be set for half the running time design capacity of the tank, or as otherwise specified in the requisition. The inlet shall be fitted with a level control float valve if specified in the requisition; otherwise it shall be fitted with a snap-opening cap for manual filling.

The following connections are required on the tank: inlet, outlet, injector spillback (if required), drain (with self-closing valve), overflow, vent line (with flame-trap), manhole and nozzles for instrumentation. The nozzles welded to the tank shall be 2 NPS minimum, concentrically reduced to the required flange size where necessary. The fuel outlet to the engine shall be not less than 50 mm above the bottom of the tank.

If the site ambient temperature given in this specification is below the cloud point of the specified fuel, the day tank shall be fitted with an electric heater. The heater shall maintain the fuel at a temperature 20 °C above the fuel cloud point and a thermostat control shall be installed.

The MANUFACTURER'S standard selection of fuel injection pumps, fuel injectors and spill back arrangements will be acceptable.

7.2.6. COOLING SYSTEM

The engine shall be cooled by water with added scale and corrosion inhibitors. The MANUFACTURER shall advise the method of coolant temperature control, which will be acceptable unless otherwise specified.

The cooling system shall be provided with an expansion tank, level indicators, pressure relief valve and filling connections. The expansion tank shall have sufficient volume to allow for the



thermal expansion of the water. The expansion tank may be either separate from or integral with the radiator according to the MANUFACTURER'S standard design.

All low and high points in the coolant circuit shall be fitted with drain or vent cocks.

The coolant shall be cooled in an air-cooled radiator supplied by the MANUFACTURER, unless otherwise specified in the requisition. The radiator will be attached to the engine, free-standing for separate installation or included in associated package process equipment, as stated in the requisition. The radiator shall be designed for 110% of the engine heat rejection at the engine service power at site conditions with the absolute maximum ambient temperature given in the requisition.

The air flow through the radiator shall be away from the engine or towards the outside of the enclosure or vertically upwards as appropriate for the location of the radiator.

Engine cooling by separate water circulation systems shall be used if specified. The jacket coolant pressure shall at all times be greater than the circulating water pressure.

7.2.7. LUBRICATION SYSTEM

The MANUFACTURER'S standard system of lubrication of on-engine moving parts will be acceptable unless otherwise specified in the requisition.

Full flow oil filters should be fitted as standard. Duplex filters with changeover valves will not be required provided that the maintenance schedule specifies a filter change no more frequently than with each lubricating oil change. Duplex full flow filters with manual changeover valves shall be fitted to engines in continuous vital service. In this case, the lubricating oil filters shall be fitted with DP indicators to show when the filters require changing. Provide valves for pressure relief or regulation as required.

Separate free-standing lubricating oil filters shall have a manual drain valve and a manual vent returning to the oil sump with a sight glass for removal of trapped air during filter changes.

The lubricating oil cooler may be either included in the engine coolant circuit or separately cooled in an air cooled radiator. All lubricating oil piping and connections to remotely mounted oil cooler shall be AISI Type 316L stainless steel. The oil cooler shall be designed for 110% of the heat rejection at the engine service power at site conditions with the absolute maximum ambient temperature given in the requisition.

Complete instrumentation of the lubricating system shall be provided for alarm indications, control and shutdown purposes.

**7.2.8. STARTING SYSTEM**

The starting system shall be supplied complete with 24V-DC batteries, starter control, starter contactor and starter over-speed limiting switch. A timer shall limit the duration of each start attempt to approximately 12 revolutions at firing speed. Starting control may be integrated with the package control system.

A dual set of starting batteries shall be provided. Batteries shall be of the nickel-cadmium type and rated for six (6) sequential starts within 6 seconds at min. design ambient temperature. Batteries shall be charged either by an AC mains charger supplied by the MANUFACTURER or by an engine driven alternator. Both an engine driven alternator and a main battery charger may be specified in the requisition, in which case an automatic change-over system shall also be supplied. Battery chargers and change-over systems shall be installed in the engine control panel, as supplied. Battery Manufacturer's specification regarding charging voltage, max voltage ripple, charging current, etc. must be provided. All indications and alarms for the engine starting system shall be required (i.e. charging current, battery voltage, alternator status, etc.).

7.2.9. FREQUENCY STABILITY

The requirements for isochronous operation, speed droop operation, or single operation mode shall be stated in the requisition.

The total kinetic energy of the rotating train in combination with the governor gain and the stability adjustment of the total generator set shall provide frequency stability in accordance with governing class A2 as defined in ISO 3046. The governor shall be of an electronic type.

The DG shall be capable of being synchronized with any or all power generators and vice versa.

7.2.10. PIPING

The MANUFACTURER'S on-engine piping shall be designed in accordance with ANSI/ASME B31.3. All connections shall be conveniently located near the extremities of the engine or appropriate auxiliary, without the need for the CONTRACTOR to route piping on the engine or its auxiliaries. All connections shall be rigidly anchored and fitted with flexible connections in a material suitable for the service. Reinforced elastomers are acceptable for no hydrocarbon duty. For lubricants and fuel, convoluted stainless steel reinforced by stainless steel braid flexible connections shall be supplied. Flexible elements shall be flanged to ANSI/ASME B16.5. All external connections from the engine shall be flanged to ANSI/ASME B16.5.

The MANUFACTURER shall review the design of interconnecting piping for correct size, rating and to ensure that unacceptable strains are not imposed on the engine or its auxiliaries.

**7.2.11. ENGINE GAUGE BOARD**

A stainless steel gauge board shall be attached to the engine, equipped with the following:

- Lubricating oil pressure gauge;
- Engine coolant temperature gauge;
- Diesel fuel filter diff. pressure;
- Exhaust gas temperature;
- Air intake filter diff. pressure;
- Fuel inlet pressure;
- Engine over-speed;
- Auto/manual selector switch for start and stop;
- Battery voltage;
- Battery charger failure;
- Lubricating oil temperature gauge;
- Engine tachometer and service hours meter (if not fitted in a control panel);
- Start and stop push buttons;
- Emergency Stop push button;
- Engine ready to start.

7.3. GENERATOR**7.3.1. GENERATOR HOUSING AND FRAME**

The generator frame shall be of heavy duty welded steel construction, suitably braced to withstand the stresses imposed during handling, transport and due to short circuit when in service.

Corresponding mounting surfaces shall be in the same plane and within a tolerance of 0.15 mm per meter distance between surfaces.

Generator frame, including bearing supports, shall have sufficient strength and rigidity to avoid distortion or increased vibration as a result of external mechanical forces.

All welding and welding inspection shall comply with international standards and codes.

Anti-condensation heaters shall be provided and shall be switched “ON” automatically during the stand-by periods.

The connecting leads of the heater elements shall be brought out to terminals in a separate heater terminal box mounted on the machine frame. A prominent warning label shall be provided:

“Warning circuit may be live!”



The generator and exciter shall be air-to-air self-cooled machine with method of cooling IC 0161, IEC 60034-6.

Generator frame shall be bonded to the bed plate. The skid shall be provided with two earthing bosses for connection to the plant earthing grid.

The rotor of the generator shall be balanced at rated speed. Generator and Exciter enclosure shall be fitted with suitable inspection plates and access covers which shall be designed for quick and simple removal. Access covers for the rotating rectifiers shall be sized to permit easy maintenance by personnel using both hands.

Generator may be of either single or double bearing design. Bearing housing shall be insulated as necessary to prevent circulating shaft currents. Loads heavier than 25 kg shall have eye bolts, lugs or extension pieces clearly identifiable to be used for hoisting.

VENDOR may specify the best bearing type and lubrication for the generator set.

7.3.2. WINDINGS

Conductors shall be made of high quality enameled copper wire.

The insulation of generator stator, rotor and exciter windings shall be Class H in accordance with IEC 60085. However, the temperature rise above ambient of all parts shall be limited to that allowable for Class B according to operational requirements.

Windings shall be vacuum pressure impregnated and of high quality enameled wire or pre-formed copper bar conductors.

Windings including overhangs and connections to terminals shall be adequately supported and brace to withstand vibration and the dynamic stresses of external short circuits.

The stator winding shall be star connected. All six windings ends shall be brought out to terminals and marked U1, V1, W1 on the line side and U2, V2, W2 on the star point side. The alphabetical sequence UVW shall correspond to the time sequence of the voltages in the required direction of machine rotation.

7.3.3. TERMINAL BOXES, BUSHINGS AND TERMINAL

Separate terminal boxes shall be provided for:

- Stator connections;
 - Stator star point connections;
 - Heater connections;
 - Exciter connections;
 - CT connections;
-



- Other connections.

Terminal boxes shall be designed to provide suitable arrangement for the installation of current transformers required and the connection of the cable type and size specified in the requisition.

Gland plates and glands to be used for single core cable shall be made of nonmagnetic material.

Unless otherwise stated in the requisition, the terminal box should be located at the right hand side of rear side of the generator facing the driven end.

Terminal marking of the main cable connections and the direction of rotation shall be in accordance with IEC 60034-8.

Terminal marking of auxiliary cable connections shall be in accordance with the relevant generator wiring diagrams.

Terminal blocks, bushings and/or post insulators shall be made of synthetic resin. The use of porcelain is not allowed.

Terminal connections shall be constructed in such a way that direct contact between screws, bolts or nuts and the conductor is avoided.

The bushings and insulators shall be fully rated for the generator voltage and be capable of withstanding both the dynamic and thermal effects of a through going short circuit current for at least 5-10 seconds.

The distance between bushings and, between bushings and earthed parts of the terminal box shall be based on the applicable distances for air insulated installation.

Vendor has to consider load list for largest motor starting.

Clamping devices shall be provided inside the main terminal box of machine to separate and support the cable conductors, thereby ensuring that the ability to withstand the short circuit current will be maintained after completion of the non-compound filled type of termination. Materials used for clamping devices shall be non-hygroscopic.

7.3.4. EXCITATION SYSTEM

The excitation system shall be of the brushless type self-excited, consisting of a main AC Exciter made of full wave silicon Diode Bridge and a permanent magnet generator direct coupled and air cooled.



The automatic voltage regulator (AVR) shall be microprocessor based, programmable with diagnostic and serial communication facilities. The regulator shall be equipped with auto and manual control facilities. AVR manual excitation shall be selected upon failure from auto mode. The AVR electronic control unit shall be mounted within the remote and monitoring panel.

The automatic voltage regulator shall be of the static type, high speed compounded for stand-alone operation. It shall exhibit long term stability and freedom from drift.

Voltage regulation shall be as follows:

- Steady state conditions - equal or better than Grade 3.11 (VR3) per BS 4999 Pt 140.
- Transient conditions - equal or better than Grade 2.32 (VR2-32) per BS 4999 Pt 140.

EXCITATION - RATED CURRENT:

The rated excitation current shall be at least 110% of the excitation current at the rated output of the generator under the most stringent operating conditions. The excitation system shall be able to cope with any field forcing conditions that the generator is required to supply, e.g., starting large motors. The field forcing capability shall be sufficient to enable adequately graded relay settings to be made for system fault current protection.

EXCITATION - RATED VOLTAGE:

The rated voltage of the excitation system shall be at least 110% of the rotor voltage at the rated output of the generator under the most stringent conditions. The ceiling voltage shall be not less than 120% of the rated voltage of the exciter.

The generator reactance and voltage characteristics shall be such that, with the application of sudden loads, the generator output voltage shall not fall below 85% of the rated value. The sudden loads and the generator power factors and loadings at which they are to be considered to be applied are listed on the data sheets. The maximum reduction in frequency, and the recovery time to rated frequency, resulting from the application of the sudden loads shall be stated by the MANUFACTURER.

The generating unit shall be capable of operating continuously at rated voltage and frequency on an unbalanced load at rated current but containing a 12% negative sequence component. The Supplier shall provide details of the I2t characteristics. The generating unit shall be capable of withstanding for 15 seconds a current 50% in excess of its rated output with voltage not falling below 80% of rated value.

The generator shall be capable to withstand short circuit conditions such that it can tolerate faults without damage for 5 -10 sec. for the following faults such as 3-phase short circuit, line- to -line, line- to- earth, double line- to earth faults.



The generator shall also sustain short circuit rating of 300 % for 10 sec. without damage. The regulator shall incorporate automatic high speed overvoltage protection.

The arrangement of the voltage setting rheostats shall be such that loss of the sliding contact shall not interrupt the exciter field current.

The adjustment range on the desired value setting shall provide the facility to control the generator terminal voltage by $\pm 5\%$.

All current transformers, including those required for the operation of the automatic voltage regulators, shall be supplied by the MANUFACTURER.

7.3.5. EFFICIENCY

The Generator minimum efficiency at nominal load and at power factor of 0.8 shall not be less than the following:

RATED OUTPUT	EFFICIENCY
50 – 100 kVA	92%
125 – 300 kVA	93%
330 – 600 kVA	94%
630 – 12500 kVA	95%

Guaranteed values of efficiency shall be given by the VENDOR/MANUFACTURER for 50%, 75% and 100% of rated output.

7.4. FANS & COUPLING

7.4.1. FANS

The external fan, and if applicable the separately mounted internal fans, shall be individually balanced. The external fans shall be of non-corroding material.

7.4.2. COUPLING

An integrally flanged shaft end design or a tapered shaft end design with hydraulically fitted hubs is preferred.

For hydraulically fitted couplings, relative radial position to be marked on shaft and also positively locked to shaft.

Diaphragm type couplings are preferred. MANUFACTURER shall indicate in the quotation the proposed shaft end design.

Maintenance hook shall be provided at each important part of the engine and generator body.

**7.5. CONTROL PHILOSOPHY AND SEQUENCE OF OPERATION**

The mode of operations of the diesel engine driven generators (DG) shall be based on the following requirements and scenarios such as during black start operation, normal and emergency and these are enumerated as follows:

AUTOMATIC START MODE OF THE DIESEL ENGINE DRIVEN GENERATOR SET:

Provision of automatic starting will be initiated on initiation of start signal from the plant's ICCS or control room.

The diesel engine driven generator set shall be completely suitable for safe unattended operation.

MANUAL START MODE OF THE DIESEL GENERATOR SET:

Manual starting shall be carried out locally from the generator control panel. In manual control mode, upon start order, the diesel engine driven generator set shall start and run up to the rated speed and produce the required voltage output.

On receipt of a stop signal, the gen set shall gradually reduce the loads until a minimum load is reached and then trip its main circuit breaker and then shutdown.

On receipt of a stop signal, shutdown will be initiated and shall proceed as above.

All necessary systems shall be provided to ensure safe operation of the equipment.

7.6. PROTECTION, CONTROL AND MONITORING PANEL**7.6.1. GENERAL**

Protection, control and monitoring panel shall be provided as per this scope requirement.

Control and monitoring units shall be fitted with all necessary equipment and components to provide the following functions:

- Control and start/stop;
- Man/machine interface;
- Operating assistance;
- Provision of Interface with plant's Integrated Control and Safety System (ICSS). The control panel shall have serial link facilities to communicate with this ICSS (if required).

Control, sequencing and protection functions as well as detection and annunciation of abnormal operating conditions shall be performed.

The following systems shall be provided in the control, protection and monitoring panel, but not be limited to, as follow:

- Metering panel (all engine and generator);
-



- All Indications of engine and generator control panel;
- Excitation system;
- Alarm and Supervisory panel;
- Engine Drive protections;
- Governing system;
- Control selector of engine/generator set;
- Load or unload (auto/manual);
- Auxiliary control power supply and distribution unit;
- Control relays;
- Start and Stop function (Auto/manual);
- Emergency Shut down;

All necessary switches, push buttons with glass proof cover (i.e. for safety protection), meters and indicators for operational status and alarms shall be provided on the front of the generator control panel.

The remote control and monitoring panel shall be of metal enclosed construction, vertical, free standing with front access only via hinged, lockable doors.

The control panel shall be fitted with an earthing terminal for connection to the external earthing system, and continuity of all parts shall be assured, including doors.

The control panel shall be provided with anti-condensation heaters, suitably rated to prevent the formation of harmful condensation inside the enclosure, the heater shall be supplied complete with thermostat and on/off switch.

All external operating, measuring and indicating components shall be clearly identified with permanent descriptive labels that facilitate easy recognition by the operator.

7.6.2. GENERATOR CONTROL AND PROTECTION PHILOSOPHY / REQUIREMENTS

The VENDOR shall prepare a proposal for the setting of the protection relays (i.e. generator protection relay). The final setting of the relays shall be agreed between VENDOR and CONTRACTOR.

All protection relays shall be of the microprocessor based multi-functional type and shall be installed in such a way that they are clearly visible. Components requiring inspection or adjustment shall be accessible from floor level. Protection relays shall be clearly labeled and shall be equipped with visible flag indicators, e.g. LED's. Protection relays shall have manual reset facilities and shall not be sensitive to vibration, shocks or transients. Dustproof flush mounted protection relays of the withdrawable type and provided with calibrating and testing



facilities, should be provided. For withdrawable protection relays, the terminals connected to CT's shall be automatically short circuited on withdrawal of the relays. Multiple function elements such as tripping and alarm duties shall have separate operating contacts for each function and shall be brought out to separate terminals. CT's for over-current protection shall have an appropriate VA rating and accuracy to energize the relays, without causing damage to the latter, over the range of short circuit current that can arise. Contact rating and performance shall be in accordance with IEC 60255.

Automatic cranking logic shall provide six (6) start attempts from each battery in turn before lockout.

7.6.3. AUXILIARY SYSTEMS

All necessary auxiliary equipment shall be provided to operate the diesel generator.

Auxiliary supply shall include:

- 24V DC supply to feed the electric starting system, complete with dual batteries and chargers;
- 400V AC supply for distribution board for auxiliaries.

Two (2) sets of recombination nickel cadmium type batteries shall be provided, sized for six (6) start attempts each at minimum temperature. The starting system shall be locked out after three unsuccessful start attempts from each battery in turn. Electronic items and flammable material shall not be installed in a battery room. Electrical fittings shall be suitable for Zone 2.

Batteries shall be housed in a ventilated corrosion proof, splash proof boxes to be located close to the diesel generator set. Enclosure shall be IP55 minimum. Batteries shall not be housed in the same enclosure as the fuel tank.

An automatic battery charger complete with voltmeter, ammeter and trickle/boost charge facility shall be provided. The battery charger shall be capable of supplying the standing loads as well as provide trickle charging for both batteries. In addition, the battery charger shall be capable of restoring a fully discharged battery within a period of 8 hours. The battery charger shall form part of the control panel.

7.6.4. External Cabling and Terminations

All panels and enclosures shall have facilities for the entry of cables from the top or bottom as specified on the requisition. Control cables shall be accessible from the front of the enclosure.

All connection material, cable supporting system and clamping shall be supplied and suitable for the size and the number of conductors. Ample space for terminating the external cables shall be provided. All outgoing cable compartments shall be provided with fully gasketed removable



gland plates for termination using cable glands. A minimum of 25% spare entries shall be provided. Compression type cable glands suitable for the cables specified on the requisition shall be included in the scope of supply.

A separate compartment shall be supplied for the terminal strips for all incoming and outgoing cables. Separate sections shall be provided for digital, analogue, pneumatic and power cables. Interconnecting cables to remotely located equipment shall be installed by the CONTRACTOR.

7.7. GOVERNOR, ELECTRONIC - SPEED CONTROL

The engine governor shall be a Woodward 1724 or equal Electronic Speed Control and Load Sensor with 24 volts DC Electric Actuator. The governor shall have maximum speed regulation of 2-2 1/2% through the load range of the generator. Speed droop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Steady state frequency regulation shall be +/- 0.25. Speed shall be sensed by a magnetic pickup off the engine flywheel ring gear. A provision for remote speed adjustment shall be included. In the event of DC power loss, the forward acting actuator will move to the minimum fuel position.

The governor system shall be latest state of the art technology, reliable and compatible.

7.8. RATING PLATES

The rating plates shall be made of corrosion resistant metal and be fixed to a non-removable part of the frame. Information provided on the rating plates shall be in accordance with IEC 60034-1.

7.9. VIBRATION

When free suspended, the bearing vibration of the generator shall not exceed 1.8 mm/s rms in any direction and at full load conditions.

The measurements shall be taken in the direction of the three mutually perpendicular axes at the bearings and mounting points of the generator. Details regarding the location of the measuring points are given in IEC 60034-14.

The vibration of the generator frame, including main terminal boxes, shall not cause damage and should be limited to 2.8 mm/s rms.

Vibration absorber spring shall be provided as required.

8. ENCLOSURE REQUIREMENTS

8.1. ENCLOSURE

Supplier/Manufacturer shall provide an acoustic enclosure over all the equipment requiring noise limitation treatment & weather protection (IP-54) of Genset.



The acoustic enclosure shall allow access for routine on-line maintenance and for overhaul of the enclosed equipment. All doors shall be fitted with emergency opening bars on the inside. Opening any door for access during generator set operation shall provide an alarm, but shall not cause a shutdown of the generator set.

Mechanically induced ventilation shall be installed, such as to provide not less than 20 changes of air per hour within the enclosure, or to limit the temperature rise within the enclosure to not more than 50°C above the ambient air temperature, whichever requires the greater flow rate. Either failure of the air flow to the enclosure or excessive temperature rise in the enclosure shall shut down the generator set. Ventilation air shall be filtered by a two-stage filter comprising an inertial stage followed by a viscous impingement stage.

An enclosure surrounding a diesel fueled engine installed in a non-hazardous area shall have extractor fans maintaining a negative pressure within the enclosure.

The enclosure shall be fitted with two (2) heat detectors above the engine, either of which shall shut down the engine upon fire detection. Initiation of a shutdown shall cause a release of extinguishant into the enclosure and simultaneously cause shutting of a damper in the exhaust air from the enclosure and shutdown of the ventilating fans.

For free access to the enclosure the fire extinguishing system shall be inhibited when using carbon-dioxide or other asphyxiating gases. An alarm shall be provided to indicate that the system has been inhibited.

An enclosure surrounding a diesel fueled engine shall be fitted with gas detectors on the ventilation air outlet, utilizing a two out of three voting system to shut down the engine upon gas detection. The ventilation shall remain in operation and extinguishant shall not be released upon gas detection.

9. SPECIAL REQUIREMENTS FOR DIFFERENT MODES OF OPERATION

9.1. GENERAL

In addition to the requirements specified which apply to generator sets in single operation, the following requirements apply to this mode of operation.

9.2. GENERATOR SET

Mode of operation is mentioned in Section 6.0.

Low voltage generator set with 3-Phase/4-Wire connections shall be capable of operating continuously with unbalanced load current of up to 20%, or the value specified in the requisition.

The unbalance is defined as:



$$\frac{(I_{\max} - I_{\min}) \times 100\%}{I_{\max}}$$

I_{\max}

Where;

I_{\max} = Maximum Phase Current

I_{\min} = Minimum Phase Current

The maximum time allowed for the generator set to accept the nominal load after initiation of a start command from cold shall be 10 seconds.

10. INSPECTION AND TESTING

10.1. GENERAL

All inspection and testing procedures (FAT and SAT) shall have prior approval of the COMPANY/CONSULTANT. In the equipment specification shall be listed any special test required at VENDOR's shop or at construction site, to test proper performance of the equipment.

In addition to performing final inspections and witnessing final simulation tests, the CONTRACTOR/COMPANY/CONSULTANT reserves the right to carry out inspection/expediting visits during the course of manufacture on any material which form the technical design and intent of the CONTRACTOR's contract with the VENDOR/SUPPLIER without additional cost to the CONTRACTOR/COMPANY/CONSULTANT.

All proprietary and bought out items / equipment shall be inspected by the CONTRACTOR/COMPANY/CONSULTANT or his designated representative, at his discretion, at the MANUFACTURER's work before shipment to the VENDOR. This inspection shall only be waived on the written agreement of the CONTRACTOR/COMPANY/CONSULTANT.

The scheduled witnessing of tests by CONTRACTOR/ COMPANY/CONSULTANT shall be provided by VENDOR for at least two (2) weeks prior to start of any test.

All drawings and documents used during the inspection/tests shall be "highlighted" and copies kept for the records.

The VENDOR shall also provide documentation for recording discrepancies, errors, faults, component failure and changes. Each entry shall be dated and signed by a Senior Member of the VENDOR'S Quality Control Department and witnessed by the CONTRACTOR's and COMPANY's/CONSULTANT's representative. This document shall be attached to the drawings/ documents used for the tests. The degree of re-testing required after a fault/error rectification or component replacement shall be at the discretion of the CONTRACTOR's/ and COMPANY's/CONSULTANT's representative.



All equipment shall be subject to shop tests in accordance with applicable engineering standards and codes. Compliance with the requirements of this specification, the material requisition and associated documents shall also be demonstrated. The equipment shall not be dispatched by the MANUFACTURER until material and equipment test certificates have been approved by the CONTRACTOR/COMPANY/CONSULTANT at the time of the shop test acceptance.

10.2. GENERATOR

The Generator set shall be subjected to the following tests (i.e. on 12 Hours full load 100 % test) and according to IEC regulation:

- Insulation resistance tests (on generator, exciter, space heaters,);
- Dielectric test;
- No-load characteristic;
- Short circuit characteristic;
- Temperature rise at rated voltage, current, power factor and frequency;
- Over speed tests;
- Load test at site;
- Calculation of efficiency;
- Phase sequence test;
- Insulation test of bearing pedestals;
- Voltage wave form and harmonic analysis;
- Determination of reactances, saturated and unsaturated values;
- Frequency.

Note: VENDOR shall provide all test certificates including calculations on its bid offer.

10.3. ENGINE/GENERATOR COMBINATION (STATIC LOAD TEST)

The engine/generator unit shall be tested after assembly. The tests shall include as a minimum one full load run, maintained for 8 hours and be followed with one overload run (at 110% load) for one (1) hour, to demonstrate that the set can deliver the power requirements as specified.

Where applicable, the following parameters shall be recorded every half hour during the load run:

- Generator power output;
 - Generator current;
 - Generator voltages;
 - Generator frequency;
 - Generator power factor;
 - Engine oil pressure;
 - Lube oil temperature from cooler;
-



- Lube oil temperature from both generator bearings;
- Engine cooling water to radiator;
- Engine cooling water from radiator;
- Speed;
- Fuel consumption;
- Vibration at engine input shaft / output shaft; (Measurement to be done at three directions H, V,A)
- Exhaust temperature;
- Field voltage;
- Field current.

The action of the governor shall be tested to demonstrate the specified frequency response requirements by application of instantaneous 25%, 50%, 75% and 100% load acceptance and load rejection. Voltage and frequency variations shall be recorded on oscillograms.

The automatic voltage regulator performance shall also be verified in this test.

Noise level at rated full load of coupled unit shall be verified.

10.4. REMOTE CONTROL PANEL

The panel shall be tested together with its engine/generator combination tests. Insulation and dielectric tests shall be carried out on the panel before and after the above combination tests.

10.5. FUNCTIONAL TEST

The VENDOR shall perform functional tests on the complete generator set including the generator and engine control panels. These tests shall be witnessed by COMPANY's/CONSULTANT's representative.

The functional tests to be performed shall include, but not be limited to, the following tests:

- Engine start-up system, including measurement of the starting time. A minimum of two start and stop tests shall be performed;
 - Manual and Automatic start-up system as provided;
 - For diesel generator sets verification of the time between initiation of a start command and acceptance of the nominal load for a cold start;
 - All engine alarm and shutdown functions;
 - All generator alarm and trip functions, including the verification of protection relay operation;
 - Operation of the battery charger and change over;
 - The status/alarm/trip/shutdown indication of the control panels;
 - Local manual start/stop/emergency stops functions;
-



- Remote start/stop/emergency stop functions (input signals);
- The remote signaling contacts for CONTRACTORS use;
- Operation of the AVR;
- Operation of the AVR automatic transfer system; (if provided)
- Operation of the automatic power factor controller; (if provided)
- Calibration of measuring and protective devices.

11. PAINTING AND PROTECTIVE COATING

Equipment shall be delivered fully painted and/or coated as required by this Equipment Specification.

- Color shade for generator shall be green RAL 6011.
- For the Remote Control Panel, the VENDOR painting process could be used. Color shade shall be green RAL 6021. The VENDOR painting specification shall be supplied at bid stage.

The control panels, base plate and auxiliaries shall be painted in accordance with the VENDOR'S standard for a marine environment, subject to approval by the CONTRACTOR/ OWNER. The VENDOR shall submit the painting specification for approval. The specification shall include surface preparation, paint materials, application, film thickness and the paint Supplier's data sheets.

12. NAMEPLATE

The nameplate shall be Series 300 Stainless Steel securely fastened by pins of similar material and shall be located for easy visibility.

The rated conditions and other data, in English language, as below, shall be clearly stamped on the nameplates:

- Manufacturer's name.
 - Serial number.
 - Model Number.
 - Item Tag Number.
 - Duty Type.
 - Enclosure type.
 - Frame Size
 - kW and kVA rating.
 - Voltage.
 - Phases.
 - Frequency.
 - Efficiency.
-



- Power Factor.
- Full Load Amperes (FLA)
- Nominal Speed (RPM)
- Temperature Class.
- Direction of Rotation
- Oil flow rate
- Oil pressure required

13. SPARE PARTS

Commissioning and two (2) years operation spare parts (i.e. v-belt, gasket, o-ring, bolts, filters for fuel, lube oil & coolant etc.) and associated accessories shall be provided by the VENDOR.

All the spare parts list shall be submitted to COMPANY/CONSULTANT for approval & accordingly incorporating by EPC without quoting additional price or else.

VENDOR shall include parts manuals, drawing, data sheets and manual for purchased parts from SUBVENDOR'S.

VENDOR shall ensure that the equipment will be adequately supported by spares throughout its operational life and major guarantee spares availability for minimum of 10 years after delivery.

14. SPECIAL TOOLS

The VENDOR shall provide all necessary special tools and lifting bars/equipment for maintenance and erection.

15. GUARANTEE AND PERFORMANCE

MANUFACTURER shall guarantee, in accordance with General Terms & Conditions that the equipment shall meet the performance conditions specified in this specification and data sheets.

16. SCHEDULE OF METERING, ALARMS, INDICATIONS, STATUS AND SHUTDOWN /TRIP

VENDOR shall submit alarms monitoring schedule as shown on TABLE-1 below, enumerating as a minimum, the various alarms, indications, status, etc. during normal and abnormal operating conditions.

**TABLE-1**

EQUIPMENT	STATUS	INDICATIONS	ALARMS	SHUTDOWN OR TRIP
DIESEL ENGINE DRIVER	RUNNING			
NORMAL SPEED		YES	NO	
OVER SPEED		YES	YES	SHUTDOWN
NORMAL VIBRATION		YES	NO	
EXCESSIVE VIBRATION		YES	YES	SHUTDOWN
GENERATOR SET	RUNNING			
OVER VOLTAGE		YES	YES	BREAKER TRIP
NORMAL VOLTAGE		YES	NO	
UNDER VOLTAGE		YES	YES	BREAKER TRIP
OVER FREQUENCY		YES	YES	BREAKER TRIP
FREQUENCY NORMAL		YES	NO	
UNDER FREQUENCY		YES	YES	BREAKER TRIP
3-PHASE SHORT CIRCUIT		YES	YES	BREAKER TRIP
GROUND FAULT		YES	YES	BREAKER TRIP