BID DOCUMENTS

PART-III

EMPLOYERS REQUIREMENT
PARTICULAR REQUIREMENTS

EMPLOYER'S REQUIREMENTS - PARTICULAR SPECIFICATION

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

The abbreviations used in this Specification are as follows: -

AC	Alternating Current
ASTM	American Society for Testing and Materials
BCC	Back-up Control Centre
BIS	Bureau of Indian Standards
BS	British Standards
CPWD	Central Public Works Department
DC	Direct Current
DDC	Detail Design Consultants
DFT	Dry Film Thickness
DLP	Defects Liability Period
E & M	Electrical and Mechanical
EMC	Electro Magnetic Compatibility
EMI	Electro Magnetic Interference
EMU	Electrical Multiple Unit
EMR	DG Sets machine room
EN	European Standard
g	Gravitational acceleration
GCC	General Conditions of Contract
GS	General Specification
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronic “Engineer”
IMP	Interface Management Plan
IS	Indian Standards
ITB	Interface Terminal Board
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LT	Low tension
LMR	DG Sets machine room
m	metre
mm	milli metre
MCB	Miniature Circuit Breaker
MCCB	Moulded Case Circuit Breaker
MMS	Maintenance Management System
MRT	Mass Rapid Transit
N	Newton
NFPA	National Fire Protection Association, USA
N/m^2	Newton per square metre
N/C	Contactor or relays with normally close contacts
N/O	Contactor or relays with normally open contacts
OCC	Operations Control Centre
PS	Particular Specification
RAM	Reliability, Availability and Maintainability
SCADA	Supervisory Control and Data Acquisition
SCR	Station Control Room
TOT	Transfer of Technology
UPS	Un-interruptible Power Supply
VVVF	Variable Voltage Variable Frequency

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 1

INTRODUCTION

1 INTRODUCTION

1.1. Scope and Purpose

1.1.1 This specification defines the objectives, guidelines and requirements for the contractor's Design, Manufacture, Supply, Installation, Testing and Commissioning of DG Sets for Underground stations of JAIPUR MRTS Project Phase-1B .

1.1.2 The works to be executed under the Contract include the design, manufacture, verification, delivery, installation, testing, including integrated testing and commissioning, technical support, maintenance, training of Employer's staff and documentation for a complete System necessary to deliver the requirements of this Specification.

1.2. Relevant Documents

1.2.1 This Specification should be read in conjunction with the General Conditions of Contract (GCC), the General Specification (GS) and any other document forming part of the Contract.

1.2.2 In the event of a conflict between the GS and this Specification, this Specification shall prevail.

1.2.3 In the event of a conflict between this Specification and any other standards or specification quoted herein, the requirements of this Specification shall prevail.

1.2.4 The order of precedence, with item 1 having the highest priority, is:

1 Particular Specification
2 General Specification
3 Indian Standards
4 International Standards referenced herein.
5 Other International Standards
6 Other National Standards.

1.2.5 Notwithstanding the precedence specified in clauses above the Contractor shall always immediately seek advice from the Employer in the event of conflicts between Specifications.

1.3. Design Service of the Works

1.3.1 The Contractor shall be responsible for the design service of the Works and shall satisfy himself that the sizes, ratings and quantities of equipment as specified herein meet the functional and operational requirements of all the stations .

1.3.2 The contract price shall be deemed to include any additional equipment, accessories, assemblies, sub-assemblies, equipment of higher capacities or higher ratings for the systems and sub-systems necessary for the complete, safe, reliable and operable system.

1.3.3 The proposed capacities, sizes, ratings of equipment in system DG Sets, as a result of the design development shall be demonstrated by a proper design of prototype & performance testing and subject to review and approval by the "Engineer".

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 2
OVERVIEW OF THE PROJECT

2 OVERVIEW OF THE PROJECT

2.1 General

This Chapter gives an overview of the Project and the information provided in this Chapter is for reference only.

2.2 JAIPUR Metro Project Phase – 1B.

2.2.1 The Phase – 1B of JAIPUR MRTS Project is expected to have following Corridors:

S.No	Corridor	Expected Date of Commissioning
1.0	Chhoti Chaupar	
2.0	Badi Chaupar	

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 3

SCOPE OF WORK

3 SCOPE OF WORKS

3.1 SCOPE OF WORK

The offer should cover Design, Manufacture, Supply, Installation, testing and commissioning (S.I.T.C.) of Diesel engine alternator sets including S.I.T.C of DG Control Panel, Power Cable with necessary cable end terminations, all the necessary Relays, Control wiring, Earthing, Integration with BMS, Day Fuel Tank along with fuel piping, Exhaust Piping, Silencer(s), Sound proof Enclosure (or Acoustic treatment of DG room) and Fire Safety system, etc.

Model of DG sets offered of required KVA ratings as per BOQ should be CPCB approved and certificate to this effect should be submitted with the Technical offer.

All minor civil, electrical and other works associated with installation and commissioning of the DG set shall be carried out by the contractor. The contractor should quote for the complete lot to be executed under Indivisible works contract.

Scope of work under this bid will include:-

3.1.1. Design, Manufacture, Supply, including all transportation, arranging access to site, storage, loading/unloading, insurance, installation, testing, commissioning and safe custody till handing over of the following of each sound attenuated Diesel Generator set:-

a) Sound attenuated weather proof enclosures.

b) Ventilation and illumination system for acoustic enclosure.

c) Alternator and Engine with Radiator.

d) Hospital grade silencer.

e) Bank of starting batteries with static electrical battery charger for trickle and boost charging.

f) Genset controller & Logic Panel with arrangement for parallel operation of DG sets.

g) All approvals of the DG set Installation Including the EIG approval before the final commissioning of the system.

h) All necessary control wiring.

i) Anti vibration mounting pads.

j) All piping system between engine and radiator.

k) Piping system for fuel line from Engine to day tank.

l) Calibrated Day Services Tank minimum capacity of 990 litres for operation of each DG set. The tank shall be made out of 14 SWG thick MS sheets with all accessories such as oil level indicator, drain plugs, manhole and painting etc. complete as required.

m) Provision of necessary signals for Local and remote monitoring and control of DG sets and for recording of parameters through Building Management System (BMS).

n) Supply and fixing of hot air exhaust duct of 20 SWG GI sheet with DG canopy to remove hot air (if required).

3.1.2. Exhaust piping system including MS pipes, specials, bends, flanges, reducers etc. connection to silencers, insulation and aluminium cladding the exhaust pipe as per specifications.

Most of the MS supports for the Exhaust pipe should be welded type as per design / drawing to be got approved from JMRC. Bolted type MS supports shall be used wherever required to facilitate easy removal / replacement (in future).

As per the CPCB guidelines the Chimney / Stack height has to be higher than the building height, therefore suitable Lightning protection system on the Exhaust pipe, duly approved by JMRC has to be provided.

3.1.3. All wiring and connections between :-

i. Genset Controller and Logic Panel

ii. Genset Controller and DG Power Panel.

iii. Logic Panel and DG Power Panel.

iv. Starting battery bank and Genset controller.

v. Engine mounted battery-charging alternator to static battery charger.

vi. Battery charger to batteries, etc.

3.1.4. Alarms and Protection system should be got approved from JMRC. It should include all parameters for safe operation and safety of equipment & personnel. Load Management should be PLC/Microprocessor based with suitable interface for monitoring and recording of all parameters by BMS. Details of requirements are provided in Specifications.

3.1.5. Interfacing with Station Building Civil Contractor and Electrical contractor.

3.1.6. Testing and commissioning (including arranging suitable consumables and testing equipment).

3.1.7. All other work, not specifically mentioned but required for satisfactory completion of work.

3.1.8. All Cables (Power and Control cables) will be FRLS Zero Halogen only.

3.1.9. Intercom system between Sound proof enclosure and Station Control Room. (Requirements of EMI/ EMC due to Single – phase A.C. traction should be taken care).

3.1.10. OPTIONAL ITEM:- JMRC may need operation of DG sets before Revenue Operation date. For such sets, all consumables except diesel, maintenance of DG set and the DG set operator will have to be arranged by the DG set contractor. For this, JMRC will make the payments as per the item provided in Bill of Quantities. Diesel as per requirement will be provided by JMRC.

3.1.11. Bid Conditions, Specification and Schedule.

a. For any discrepancy between Technical Specifications and Schedule of Quantities, provision of Schedule of Quantities shall prevail.

b. Any item shown in Schedule of Quantities and not called for in the Specifications or vice versa shall be provided as if called for in both.

c. Wherever it is mentioned that the Contractor shall perform certain work or provide certain facilities, it implies that the Contractor shall do so at his cost.

d. Wherever the Technical Specifications stipulate requirements in addition to those contained in the applicable Indian Standard Specifications/Codes these additional requirements shall also be satisfied.

e. The bidder should follow the approved list of makes for minimum requirement as given in the Particular specifications, they may also propose other makes with latest technology with commensurating its benefits & features in details with technical proposal.

3.2 INTERFACING WITH DESIGNATED CONTRACTOR

3.2.1 The employer has appointed DDCs for civil and E&M works of Phase –1B Underground stations. The contractor will be required to interface with these DDCs for all the civil design related activities, associated with the contract.

3.2.2 Civil works are being executed by Station Civil Contractor. The contractor will be required to interface with the Station Civil Contractor for ensuring provisions, required for installation of DG sets at stations. While the foundation will be done by Station Civil Contractor, minor civil works like grouting, chipping etc are in the scope of the contractor. DG set contractor will also interface with the Station Civil Contractor for ensuring provisions, required for fresh air ventilation & hot air discharge in DG room as per requirement.

3.2.3 The DG set contractor will interface with Civil plumbing works contractor to ensure that a water outlet (controlled by suitable Valve) shall be provided near the Acoustic Enclosure / DG room for meeting the water requirement of DG set radiators.

3.2.4 All the power cable for carrying the power from DG Set to DG Power Isolator Panel will be in scope of DG set contractor and from DG Power Isolator Panel to the DG Power Panel, including cable tray will be done by Station Electrical Contractor. DG Contractor will be required to lay the voltage sensing cable for AMF operation and all other power / control cables between DG Set, DG set Isolation Panel, Genset Controller, Logic Panel and DG Power Panel, required as per the design approved by JMRC.

3.2.5 Employer is commissioning Building Management System at all the stations. All signals (digital as well as continuous/ analog) as per the details / requirements provided in Specifications should be available from Genset Controller and Logic Panel through RS – 485 / alternative Communication ports, in consultation / co-ordination with BMS contractor. All the information for the BMS should be compatible with MOD – BUS protocol.

DG set Contractor is required to provide these signals to the BMS Contractor. All energy related parameters shall be made available through a RS 485 Port / alternative Communication ports, in consultation / co-ordination with BMS contractor and Mod Bus

RTU Protocol compliant energy meters. For indication of oil level, Fuel level control indicators will be provided by DG Set Contractor.

3.2.6 DG sets are expected to run at light load/No load. The DG set offered, shall be suitable for operation under light load/No load, without any adverse impact on the service performance or life of the equipment. The bidder should clearly explain that the DG set proposal meets the above requirements.

3.2.7 Stations are provided with independent reliable sources for power supplies and DG sets would be required to operate for a very small duration and after large period of idling. DG set should be designed to work satisfactorily even after prolonged idling period.

3.2.8 Approximately 10 percent of the load shall be non – linear, DG set should be designed to operate under non – linear load environment. DG set should be so designed that the ripples are not created in the energy generated and EMI and RFI are within acceptable limit, specified by standards.

During the Integrated, Testing and Commissioning of the DG set, the set will be tested for the actual linear and non – linear loads at site and the test report furnished.

3.2.9 Equipment offered shall comply with latest pollution norms at the time of delivery of the equipment.

All drawings and other documentation shall be submitted in hard copy format as well as in soft copies in MS word and PDF formats.

3.3 APPROVAL OF PROTO TYPE FOR EACH RATING.

Contractor will manufacture a proto type with complete equipment (DG set inside the Sound proof enclosure with Genset Controller, Genset Isolator and Logic Panel) for each capacity / rating of the Engine Alternator set. However, Genset isolator and logic Panel may be planned in a separate enclosure as per detailed specification outside the Acoustic Enclosure if that can not be accommodated in Acoustic enclosure. The proto type will be inspected and tested at factory premises by the Employer. Subsequently, the firm will manufacture and supply the DG sets as per the approved proto – type. The test shall include, but not limited to the clause 7.6 of chapter 7 of particular specifications.

3.4 ACCESS DATES AND KEY DATES.

The Key dates for the completion of the works are given in Appendix –1A of forms of bid (FOT). The station wise capacity of DG sets and station – wise access dates will be provided to the successful bidder 30 days after the issue of Letter of Acceptance.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 4

DESIGN AND PERFORMANCE REQUIREMENTS

4 DESIGN AND PERFORMANCE REQUIREMENTS

1.1. General Requirements

4.22.1 Diesel Generator Sets shall be provided at each of the JMRC's Underground Metro stations for supply of back-up electrical power to Emergency and Essential services of the station in the event of failure of regular electrical power supply. This section specifies the manufacturing and installation requirements of complete D.G. set for supplying power back up to emergency and essential services of the station.

4.22.2 The D.G. Set shall be complete with Steel Base Frame, Integral / Cap – in type sound-proof enclosure (or acoustic treatment of DG Room), Anti-Vibration Mounting Pads, Engine Mounted Radiator, Battery & Battery Charger, Day Service Tank, Piping with accessories for water & HSD, Exhaust Piping, SS flexible expansion bellows, Hospital grade Silencer, Power & Control Cabling and their termination etc.

The vendor shall provide a report showing:

(a) Smoke generation quantities and its effect in case the generator is installed in a DG room inside a station,

(b) Cooling air and combustion air requirements.

(c) Back pressure calculations of Exhaust.

4.22.3 The generator set shall be designed to provide the following parameters:

(a) Low specific fuel consumption,

(b) Low weight (Kg) to kVA capacity ratio,

(c) Low space (m^2) to kVA capacity ratio.

4.22.4 DG Set should satisfy the requirements of latest CPCB guidelines on Emission and Noise levels. NFPA 110, Emergency and Standby Power Systems.

4.22.5 Not used.

4.22.6 Two Nos. DG Set shall be installed at each underground station and the system should be suitable for paralleling with all accessories. The installed generator sets shall be equipped with all features etc. to suit automatic and manual paralleling requirements as mentioned above. At some stations 3 DG sets may also be installed. System should be designed for the parallel operation of the 2/3 DG sets along with all accessories.

4.22.7 The installation of emergency generator sets and all accessories shall ensure easy and smooth maintenance on a regular basis and confirm availability during any emergency requirements. The complete DG Set Supply, erection, maintenance, spare parts, services etc shall be from a single source with complete responsibility backed by trained manpower and all available tools etc. as required.

4.2. Codes and Standards

4.2.1 Relevant codes & standards

a) BS 60529	IEC 529 Degrees of protection provided by enclosures.
b) BS 6667	IES 801 Electromagnetic Compatibility
c) BS 88	Fuses
d) BS 3535	Isolating transformers
e) BS 171	IES 76 Power transformers
f) BS 6290	Sealed lead acid rechargeable single cells
g) BS 60146	IES 146 Semi Conductor converters
h) BS 4196-6	ISO 3746 Sound level of Noise Source
i) BS 800	VDE 875 Radio Interference Limits
j) BS 5514	Engine Power
k) BS 7226	Performance Tests
l) BS 2594	Storage Tanks
m) BS 799 Part 5	Tanks and Fittings
n) BS 4552	Fuel Filters
o) BS 5486	Fuse-boards
p) IS 1460	Diesel Fuel
q) IEC 60034	Alternator
r) ANSI S12.34	Survey Methods for Determination of Sound Sources, Power Levels of Noise
s) ANSI S12.36	Survey Methods for Determination of SPL of Noise Sources
t) IEEE S 85	Standard Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.
u) IEEE S 112	Test Procedure for Poly-phase Induction Motors and Generators
v) IEEE S 519	Recommended Practices and Requirements for Harmonic Control in Electric Power Systems.
w) NEMAICS-1	General Standards for Industrial Control and Systems.
x) NEMAICS-1.1	Safety Guidelines for the Application, Installation and Maintenance of Solid - State Control.
y) NEMAICS-2	Industrial Control Devices, Controllers and Assemblies
z) NEMAICS-3	Industrial Systems
aa) NEMA MG-1	Motors and Generators
ab) NEMA MG 1 – 12.54	Efficiency
ac) UL S 508	Industrial Control Equipment
ad) BS 4414	Reciprocating Internal Combustion Engines.

ae)	BS5000 Part 99		Machines for Miscellaneous Applications
af)	BS2757	IEC 85	Methods for Determining the Thermal Classification of Electrical Insulation
ag)	BS 89	IEC 51	Electrical Indicating Instruments
ah)	BS 142	IEC 255	Electrical Protective Relays
ai)	IS08528	Part- 10	Measurement of airborne noise by the enveloping surface method.

4.3. Rating

4.3.1 The rating of the set shall be as given in the BOQ under the following circumstances:-

a) Power Factor — The average Power factor of the load shall be maintained at 0.9 lagging or better. However the rated power shall be available when the load power factor is 0.8 (lagging) or better

b) Operating Mode — The set shall be used only for the standby purposes, supplying average load factor of 80 to 85% for periods of up to 24 hours continuously, followed by a rest period of minimum 30 minutes.

c) Power Ratings — The engine and the alternator shall have an inherent capacity as per the Standby ratings as per the relevant standards. The DG sets are required to supply the full capacity as per the standby ratings as per ISO-8528 standards and BS 5514.

d) Ambient conditions — Temperature: 0^{o}C to 50^{o}C, Maximum Humidity: 95% RH, Altitude: 300 M (Above mean Sea Level)

e) Service interval — The set shall be capable of running at full load for not less than 300 hours without maintenance adjustments. The DG set shall be capable of running for 10000 hours between major overhauls.

f) Shaft speed — The rotational speed shall not exceed 1,500 rpm.

g) Loads — The generator set shall be capable of operating in conjunction with non-linear and harmonics generating electronic loads including the UPS System. (which is expected to be 10% of the total load).

between major ovehauls

4.3.2 The generator set shall be able to start automatically even in cold conditions and shall take full rated load within 30 seconds (wake up time) of failure of the normal supply through an automatic changeover switch.

4.3.3 For switching in cold conditions, Jacket water heating facility should be provided as per the recommendations of the Engine manufacturer for the specified ambient operating conditions. Before starting, pre-lubrication arrangement for the engine shall be in – built, as per the recommendations of the Engine manufacturer.

4.4. Housing

4.4.1 The installation of the Generator Sets shall be inside sound-proof enclosure to be installed in the open area. However in some places DG set may be required to be installed at the DG room, the acoustics in this case will be done for the DG room.

4.4.2 The sound – proof enclosure and DG room insulation (if required)shall be designed so that the noise level is below 75dB at 1 meter distance from the DG Set enclosure / room (for up to 1000 KVA & minimum 25 dBA insertion loss for above 1000 KVA DG sets) as per latest MoEF / CPCB noise norms).

4.5. Diesel Engine

4.5.1 The engine shall be a four stroke, multi-cylinder, dynamically balanced with electronic fuel injection / actuator, turbocharged and inter cooled, suitable for heavy-duty emergency operations, industrial machine constructed to BS 5514. It shall be fitted with renewable wet cylinder liners and shall be directly coupled to the alternator with both units mounted on a common rigid steel bedplate.

4.5.2 The critical speeds of the crankshaft shall not be within 15% of the rated speed. A flywheel complete with rigid couplings and guard shall be fitted to give smooth running of the engine.

4.5.3 The engine shall be coupled to a dynamically balanced alternator through suitable coupling mounted on the same bedplate.

4.5.4 The engine shall be complete with cooling fan drive, lubricating oil filters, air cleaners, starter motor / exciter, battery charging, alternator, electronic fuel injector / actuator, electronic / digital governor, engine speed adjustment, other standard / operational accessories and protective devices.

4.5.5 The engine shall be fitted with a heavy, dynamically balanced flywheel suitable for constant speed generator duty to meet cyclic variations as per the requirements of BS 649. An efficient, engine electronic speed governor shall be fitted to maintain engine speed at all conditions of load in line with the requirements of BS 5514.

4.5.6 The design shall provide compensation for ingress of dirt, which may clog the fins. Selection shall take into account the place of installation and the flexibility available for locating cooling system, air circulation and smoke exhaust.

4.5.7 The DG Set shall be suitable for working in parallel with another DG Set/sets by installation of an auto – synchronising and auto load sharing arrangement (to be provided by DG set contractor), suitable for Genset Controller operation.

4.5.8 The DG Set shall also be suitable for continuous operation for at least Eight (8) Hours of operation under specified ambient conditions without any adverse effect on its performance. It may again start working after 30 minutes rest for a similar period.

4.5.9 Following major systems shall be completely installed to achieve full performance uninterruptedly for the application,

(a) Basic Engine Components and Assembly

(b) Air Intake System

(c) Turbocharger and After Cooler System

(d) Exhaust System

(e) Cooling System

(f) Lubricating System

(g) Fuel System

(h) Starting and Stopping System

(i) Speed Governing System

(j) Crankcase System

(k) Engine Instrumentation, Alarm and Safety System

(l) Drive-end System

4.6. Basic Engine:

4.6.1 Engine block shall be of cast steel of special alloy to handle the power required. Strength of the alloy casting shall be suitable to work with the wear and tear expected for such ratings of the engine. All joints shall be specially machined and leak-proof joints with matching gaskets capable to handle the operating parameters of the engine with allowable safety factors.

4.6.2 Crankshaft shall be manufactured from heavy-duty special steel with required counter weights etc. and shall be suitable for torsional stress due to jerk loads etc. that will be applied. The crankshaft shall be supported on main bearings at two ends and at intermittent positions to ensure smooth and safe operations. The crankshaft journals shall be smoothly machined and the crankshaft shall be hardened to ensure minimum wear and tear during operations at rated speed. All bearings shall be replaceable and with a long life.

4.6.3 The connecting rod shall be heavy duty and made of forged special steel suitable for handling power transfer from the piston and combustion chamber to the crankshaft. The connecting rod – piston – crankshaft assembly shall ensure efficient and smooth transfer of power with minimum wear and tear. Forced lubrication as required shall be ensured.

4.6.4 Pistons in each cylinder with the piston rings should be able to handle the peak cylinder pressure with minimum power loss. Forced lubrication shall be employed to avoid any hot-spot development.

4.6.5 Cylinder liner shall be specially designed to ensure lubrication on the entire inside surface with close tolerance so that the entire assembly is suitable to offer efficient operations. Cylinder liner shall be with forced and pressurised water-cooling at the outer surface to maintain the operating temperature without any abrupt hot spot etc. Material used for the cylinder liner should offer longer life and minimum wear rate.

4.6.6 Cylinder head assembly with intake and exhaust valves and their operating system shall ensure proper timings and leak-proof joints at the valve insert fittings. Valve operating mechanism shall be thoroughly lubricated and suitable for operating at high operating temperature in the combustion process. Adjustments for valve settings shall ensure leak-proof valve joints and proper timings for operation and thereby avoid nominal wear and tear.

4.6.7 The rotating assembly of all items in engine shall be totally balanced dynamically over the entire speed range of operation. Torsional vibration damper assembly shall be provided to eliminate any torsional vibration of the entire drive shaft assembly including the rotating assembly of the alternator coupled through flexible coupling / flex plates with the engine flywheel.

4.6.8 Engine lubricating sump capacity should allow operation of the engine for 300 hours without any requirement of lubricating oil change.

4.6.9 The engine block and crank assembly shall have covers for inspection of the crankshaft assembly.

4.6.10 An arrangement for manual rotation of the engine shall be provided for requirements of maintenance etc.

4.7. Air Intake System:

4.7.1 Intake air for the combustion shall be from the engine room and the air intake to the engine shall be forced to the combustion chamber by the engine system only through dry type and replaceable air filtration elements. Volumetric capacity of intake air and the filter elements shall ensure adequate quantity of clean air for combustion required by the engine to provide full power. The air filter elements should offer minimum air restriction and shall be suitable for cleaning at regular intervals. Air pressure restriction across the

filter unit, shall be displayed by a vacuum indicator, so that proper maintenance can be done without exceeding the air restriction due to filter element clogging.

4.7.2 Intake air through the filter shall go through exhaust gas driven turbocharger and the air boost pressure requirements shall be maintained.

4.7.3 The pressurised fresh air from the turbocharger shall pass through a water-cooling system / inter cooler before pressurised cool air enter cylinders through air-intake valves at the cylinder head.

4.7.4 Intake air temperature shall be maintained through ventilation system installed in the DG sound-proof enclosure (or DG room). However, in case of any increase of intake air temperature due to any reason whatsoever, the engine power output shall be reduced and thus output power shall be de-rated. Engine control system depending upon the recommendations of Engine manufacturer, will be provided with auto power de-rating and related auto fuel controls to avoid extra fuel injection in the cylinder and avoid incomplete combustion causing damages. Auto power de-rating control in the engine with reference to the intake air temperature shall be provided, if required.

4.7.5 Twin heavy-duty air intake filters in accordance with BS 7226 suitable for operating in dust-laden atmospheres shall be fitted. The filters shall be of the paper element with pre-cleaner type. Turbocharger filters shall be fitted. Breathers shall be fitted with washable filters, which are easily accessible for maintenance.

4.8. Turbocharger and After-cooler System:

4.8.1 The turbocharger shall be driven by the exhaust gas from the cylinders, enable compression of intake air to the engine and increase air quantity to the engine. Turbocharger shall have pressurised lubrication to the bearing for smooth operation at high speed.

4.8.2 The compressed air from the turbocharger shall be after-cooled with water to air heat exchanger as in-built engine component for efficient operations.

4.8.3 The outlet compressed air temperature from the after-cooler shall be monitored for control of fuel injection system if required, as per manufacturer design. This is to enhance engine performance level and avoid pre-mature requirements of maintenance.

4.9. Exhaust System:

4.9.1 The exhaust gas mixture after completion of combustion at each cylinder is passed through exhaust valves at the cylinders to the exhaust manifold and travel through the turbocharger to the exhaust outlets of the engine.

4.9.2 The exhaust outlet temperature at the exhaust manifold shall be monitored by the engine instrumentation system to ensure that the recommended exhaust outlet temperature is maintained.

4.9.3 Exhaust gas emission should be compliant with latest CPCB norms.

4.9.4 Exhaust volume flow at the turbocharger outlet and the restriction at outlet pipes etc shall be maintained within limits to avoid any stress at the turbocharger and thereby affecting the intake air inlet system and engine performance.

4.9.5 The generator set shall be provided with an exhaust system incorporating Hospital grade silencers (as per List of approved makes). Silencers should be placed at the correct position at the exhaust pipeline to ensure that the exhaust noise is minimised and the exhaust noise limits are maintained at the pipe outlet. If possible, the silencers shall be contained entirely within the Acoustic Enclosure / Generator Room, but if necessary the installation shall comprise two silencers in series with one located inside the Acoustic Enclosure / Generator Room, and the second located externally on the roof of the generator building / Acoustic Enclosure. Care shall be taken when locating the exhaust to ensure that exhaust gases are not drawn back into the air inlets of either the generator room / Acoustic Enclosure or the switchgear room.

4.9.6 Flanged connections to the silencer and between pipe sections shall be made. Minimum wall thickness of the silencer shall be 2mm. A stainless steel bellows unit shall be provided for connection onto the engine to take care of expansion of pipeline and ensure that the expansion is not passed on to the high-speed turbocharger. All joints of the exhaust system should be totally leak-free.

4.9.7 Exhaust pipes shall be insulated, cladded with aluminum sheet, for the entire length. No part of any exhaust system installed outside the building shall be less than 3 m from ground level. Passage of exhaust pipes through walls or the roof shall be sleeved and shall be shrouded to prevent ingress of rain or vermin. Exhaust emission control shall be as per JAIPUR pollution control regulation and all other statutes.

4.9.8 As per CPCB guidelines for DG sets the Stack Height / Height of Chimney shall be worked out as per the formula given below:-

H = h + 0.2 x SQRT(KVA).

H = Total height of Stack in metre.

h = Height of the building in metres where the generator set is installed.

KVA = Total Generator capacity of the set in KVA

Based on the above formula the minimum stack height to be provided with different range of Generator sets may be categorized as follows:-

Capacity of Generators Sets		Total Height of Stack in metre
1.	50 KVA	Ht. Of the building + 1.5 metre.
2.	50 – 100 KVA	Ht. Of the building + 2.0 metre.
3.	100 – 150 KVA	Ht. Of the building + 2.5 metre.
4.	150 – 200 KVA	Ht. Of the building + 3.0 metre.
5.	200 – 250 KVA	Ht. Of the building + 3.5 metre.

Similarly for higher KVA ratings a stack height can be worked out using this formula. The Exhaust Pipe and stack is to be provided keeping in view the latest CPCB guidelines.

4.9.9 Exhaust piping shall be fabricated from class 'B' MS pipes conforming to IS 1239 of size suitable to limit backpressure to within permissible limit. The insulation thickness stipulated in the Bill of quantities shall be checked by the bidders to achieve a maximum temperature of 60°C on the outside surface of the insulated pipe and supporting calculation for back pressure shall be furnished. Flanged joints in the exhaust piping shall be covered with removable insulation at suitable intervals for permitting access to the joint, as and when required. All flanged joints shall have spiraget high temperature gasket. The piping shall be installed with necessary thermal expansion facility as required. Exhaust piping shall be graded to a drain pocket inside the building. The pocket shall be fitted with a drain cock and connected to the engine manifold through expansion bellows on one side and to a silencer on the other side along with pipe. The silencer shall be of package type with adequate attenuation for urban use, constructed from heavy gauge galvanized steel. The sound absorbent infill shall be non-hygroscopic, vermin proof, non-combustible material. Hospital grade silencers shall be suitable to achieve sound attenuation of minimum 32 dBA suitably certified by the silencer Manufacturer.

4.9.10 The exhaust piping from silencer onward shall be laid up to the specified / approved level and discharged through a rain cowl. Entire exhaust piping and silencer shall be insulated with 75 mm thick, 150 Kg / m3 density, rock wool. The insulation shall be held in position with 0.63 mm diameter, 20 mesh, galvanized steel wire mesh and finished neatly with 24 SWG Aluminium Cladding.

4.10. Engine Cooling System:

4.10.1 The engine shall be cooled by means of a water jacket, heavy-duty air blast radiator with integral radiator header tank, circulating pump and engine driven pusher type fan. Cooling water circuit shall be fitted with corrosion **inhibitors.** The fan shall draw air in from the vicinity of the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable type vibration isolators and be arranged so that it is located directly behind the acoustic louvers set into the external wall of the engine room / the acoustic enclosure.

4.10.2 A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and running conditions. Drain cocks shall be provided so that all the water / coolant can be drained from the system.

4.10.3 Separate oil cooler shall be used for cooling the engine oil.

4.10.4 Anti-vibration mountings shall be provided under the base plate / as per the practice recommended by DG Set manufacturer.

4.10.5 The engine shall have a separate after cooling circuit to maintain the inlet air temperature within the desired limits.

4.11. Lubricating System:

4.11.1 Engine lubrication shall be by a closed circuit wet sump, forced feed system supplied by an engine driven pump through gear-train arrangement and fitted with pressure regulating and relief valves, sump suction filter and changeover renewable full-flow line filters.

4.11.2 Forced lubrication system shall include lubricating oil filter element. Lubricating oil filter element shall be replaceable type and shall be continuously in the system to filter dirt and deposits cleaned by forced lubrication oil.

4.11.3 Minimum time period / life of the lubrication filter element shall be 300 hours or more.

4.11.4 The system shall have lubricating oil cooler, which should ensure cooling of the lubricating oil in circulation. The water-cooled system should have sufficient capacity to ensure that the lubricating oil temperature is maintained with in the range recommended by the Engine manufacturer.

4.11.5 The flow and pressure developed by engine driven lubricating oil pump should be sufficient to ensure required flow and pressure of oil to all required points.

4.11.6 Lubricating oil shall be stored in the engine sump meant for the purpose. The sump capacity should be enough to ensure engine operation without any requirement of change of lubricating oil in the sump within 300 hours of engine operation in normal operating circumstances. The sump shall be fitted with an easily accessible drain point.

4.11.7 Lubricating oil pressure shall be continuously monitored and in case of fall in lubricating oil pressure below recommended level, an alarm is initiated for remedial actions.

4.11.8 In case lubricating oil pressure falls below acceptable level, engine safety shut down system shall be energised.

4.11.9 A lubricating oil temperature gauge should be included in the Genset controller.

4.11.10 Pre-lubrication system for lubrication of engine before starting shall be provided, as per the recommendations of the Engine manufacturer.

4.12. Fuel System:

4.12.1 Engine fuel system shall be suitable to operate on High-Speed Diesel Oil as per IS 1460.

4.12.2 Engine fuel system shall include Two-Stage Fuel Filtration through primary and secondary fuel filters. The fuel filter elements shall be replaceable type.

4.12.3 Engine driven fuel pump shall be provided to ensure sufficient flow and pressure of fuel inlet to the engine from the day fuel tank. The capacity of the engine driven fuel pump shall be provided.

4.12.4 Fuel control shall be of electronic type and with suitable injection system with fast response characteristics to handle application and withdrawal of step loads on the engine.

4.12.5 Low-pressure fuel lines to the fuel injector shall be preferred in view of safety requirements.

4.12.6 Fuel injection pump shall ensure development of required fuel pressure and measured quantity required to develop full power with overload capacity of the engine.

4.12.7 Fuel injection control shall be with electronic actuators with fuel injection timing control mechanism, which should be fast acting to respond to variable, jerk and step loads.

4.12.8 Sufficient quantity of diesel fuel shall be supplied by the engine driven pump to the fuel injectors / pumps to ensure that more than adequate quantity is available for injection to the cylinders to handle the applied load. Extra fuel supplied shall be returned to the fuel day tank after necessary cooling (if required), etc. so that the diesel fuel temperature in the tank is kept low for better fuel performance.

4.12.9 The fuel system is integrated to the engine speed governor, which shall be electronic type.

4.12.10 A water separator shall be supplied in the supply fuel line to the engine from the fuel day tank.

4.12.11 Specific fuel consumption at rated load should not be more than 150 gms / bhp / hr as per ISO 3046 / BS 5514. During testing of DG set, consumption will be checked and recorded at 25%, 50%, 75% and 100% of rated loads. During interfacing with BMS contractor, this information should be incorporated as the reference Fuel Consumption in the BMS at each station.

4.12.12 The contractor shall provide a flame proof Portable Oil Filling pump- Electrical Type with 100 lpm capacity to deliver the oil upto height of 10 mtrs as per .

4.13. Governor

4.13.1 The range of manual adjustment shall not be less than ± 5% of rated speed. The governor control should be isochronuous type and thus maintain constant speed of the engine at different load up to the maximum rating of the engine. The governor shall be suitable for isochronuous paralleling and load sharing with another generator.

4.13.2 The governor shall meet the following performance requirements for Class A1 governing in accordance with BS 5514 : Part 4 (ISO 3046) :-

(a) Steady state speed band: ± 1% of nominal speed,

(b) Transient frequency change on application or rejection of 60% load: ± 5%,

(c) Recovery time to steady state speed band on application of 60% load: 10 seconds,

(d) Maximum speed drop: 5%.

4.13.3 The automatic electrical over speed trip shall operate at 120% of the rated speed. Resetting of the Over Speed Trip shall be possible manually only at Genset Controller or at Logic Panel.

4.13.4 The performance of the governor under all the load conditions shall be to Class A1 in accordance with BS 5514: Part 4 (ISO 3046). The governor and associated fuel injection system with solenoid controls to be provided.

4.13.5 The engine fuel and speed governing system shall allow large step load applications and fastest possible recovery to accept the load and operate. The transient speed drop on applications and rejection of 60% load should be limited to 8% as per BS 5514.

4.14. Starting System and Battery Charging

4.14.1 The starting system shall comprise a 24 V heavy duty sealed maintenance free lead acid battery and electric starting motor. The battery shall be sized to give not less than six consecutive starts of the engine at 0°C.

4.14.2 Provision shall also be made for starting the engine from remote locations, i.e., from control panel or from control room.

4.14.3 The starting system should be suitable for three successive start attempts with time intervals between attempts. In case of failure of the three attempt start, a failed-to-start alarm shall be energised and the engine shall be stopped for a pre-determined time for further starting attempts.

4.14.4 An engine driven alternator and charging system shall be provided. A mains powered battery charger shall be provided, with sufficient capacity to maintain the battery in a condition to fulfill the starting requirements. Automatic changeover shall be provided such

that battery charging is carried out by the engine driven alternator at all times when the generator set is running.

4.14.5 The mains powered charger shall be suitable for operation on a 240 V single phase supply and shall be complete with the following indications and features:

(a) Battery charge,

(b) Boost charge / trickle charge automatic selection,

(c) On / Off switch,

(d) Fault indication.

(e) Genset Controller should indicate weak battery signal.

4.14.6 Automatic battery charger with automatic selector of trickle/ boost facility.

4.14.7 To facilitate starting in cold conditions, jacket water heating with automatic controls allowing temperature preset shall be provided as per recommendations of manufacturer, to heat the engine, while not in operation, so that the starting time and thermal shock is reduced as applicable for emergency generator sets. This should also enable smooth starting at low ambient temperature. The jacket water heating circuit shall be operated from 240 VAC, 50 Hz, 1 - Phase power. The heater shall be automatically disconnected at times when the Generator Set is starting or is running.

4.14.8 The jacket water heater and the controller shall maintain recommended water temperature through thermostatic temperature controls as per recommendations of manufacturer.

4.14.9 The engine shall be stopped from the engine control panel and control room electrically.

4.14.10 An emergency lockable Stop push button switch shall be provided to stop the engine locally in the event of any emergency stop requirements.

4.14.11 The starting time of the engine from receipt of start command should not generally exceed 15 seconds to reach rated speed in the first start attempt

4.15. Crankcase System:

4.15.1 A crankcase breathing outlet shall be provided to avoid build-up of pressure at the crankcase.

4.15.2 The crankcase breathing pipe outlet shall be piped outside the acoustic enclosure / DG room to avoid re-circulation of crankcase fumes.

4.15.3 The piping shall not provide restrictions beyond acceptable limits as recommended for the system

4.16. Genset Instrumentation, Alarm and safety System:

4.16.1 The Genset instrumentation control system should be electronic type with digital AVR, digital governor.

4.16.2 Following readings / displays are to be provided on the engine Genset controller,

(a) Speed
(b) Running hour meter
(c) Water temperature
(d) Lubricating oil pressure
(e) Lubricating oil temperature
(f) Battery Voltage
(g) Outlet exhaust temperature (Separate for each bank).
(h) Percentage of Load being applied.

4.16.3 Following alarm signals are provided on the engine,

(a) High water temperature
(b) Low oil pressure
(c) Over Speed
(d) Over Crank
(e) Emergency stop
(f) Coolant level low

4.16.4 Following shut-off signals are provided on the engine,

(a) High water temperature
(b) Low oil pressure
(c) Over Speed

4.16.5 Following records / data are to be transmitted from the engine,

(a) Speed
(b) Water temperature
(c) Oil pressure
(d) Battery voltage
(e) Exhaust outlet temperature
(f) High water temperature alarm
(g) Low oil pressure alarm
(h) Over speed alarm
(i) Over crank protection / alarm
(j) Coolant level low alarm
(k) High water temperature shutoff
(l) Low oil pressure shutoff
(m) Over speed shutoff

4.16.6 The complete instrumentation facility should be provided so that the various running parameters can be recorded for both fault diagnosis and future analysis purposes also. It should have communication facility for suitable interfacing with Building Management System.

4.17. Engine Drive-end:

4.17.1 Drive from the engine shall be from flywheel.

4.17.2 A flexible coupling / flex plates shall be assembled between the flywheel and the alternator shaft.

4.17.3 The entire drive line i.e., from engine driven radiator pulley at one end to the alternator rotor with the entire rotating assembly shall be evaluated for torsional vibration analysis and the engine manufacturer shall recommend the compliance to the acceptable limits of torsional analysis.

4.18. Alternator

4.18.1 The alternator shall be 4 pole, 3 phase, salient pole, self excited, revolving field, brush less type, self-regulating and manufactured in accordance with IS 4722. Output shall be at 415 V. The alternator shall be screen protected, fan ventilated and vertical drip-proof to not less than IP 23. Rating of the alternator shall be continuous at the specified site ambient temperature and altitude.

4.18.2 The alternator star point shall be solidly connected to earth via a CT, which shall be incorporated into a restricted earth-fault protection scheme.

4.18.3 The stator winding temperature display and over temperature protection system shall be embedded in the windings at specific locations to monitor the winding temperature. All terminals shall be brought to a terminal box for connections. Bearings shall have embedded bearing temperature monitors. Minimum one No Bearing Temperature Detector to be provided. Temperature scanner to be considered in Panel to monitor winding and bearing temperature & for trip of engines & alternator breaker.

4.18.4 The alternator shall be capable of withstanding a 10% overload for 1 hour in any 12-hour period under the specified conditions of temperature, humidity and atmospheric pressure. The alternator shall be capable of maintaining a short circuit current of three times full load current for a period of 3 10 seconds. Limitation, if any, shall be highlighted by the manufacturer. The Alternator shall be suitable for taking unbalanced load, limitation, (if any), shall be highlighted by the manufacturer.

4.18.5 The alternator rotor assembly shall comprise exciter rotor, full wave silicon bridge rectifier, surge protection device and salient pole rotating field system. The rotor shall be fitted with interconnected pole face damping windings. A filtration circuit shall be provided to minimise the effect of switching surges generated from electronic loads and eliminate

any requirement for an increased rating of the set due to the UPS or such other non-linear loads. Ample ventilation shall be provided by a shaft mounted centrifugal fan.

4.18.6 The voltage regulator shall maintain the voltage to within ± 1.0% from no load to full load for a power factor between 0.8 and unity, including hot to cold variations. In built automatic voltage regulators will be preferable.

4.18.7 Transient voltage deviation following a step load of 60% of rated load at a power factor of between 0.4 and zero shall not exceed 15% with the recovery time to 97% of rated voltage not exceeding 1 second.

4.18.8 The alternator shall be capable of continuous operation with a phase current imbalance of 33% of rated current whilst maintaining the output voltage within ± 5% of rated.

4.18.9 The alternator shall have pre-packed grease lubricated ball or roller bearings and provided with facilities for re-greasing whilst in service. The alternator shall be foot mounted on a common bed frame with the prime mover and shall be close-coupled to the engine flywheel housing.

4.18.10 Alternator windings shall be Class H insulation for Class H temperature rise and insulated with suitable varnish suitable for use in tropical climates. The alternator shall be fitted with an anti-condensation heater, which shall be automatically disconnected when the generator set is starting or running. The heater shall operate on a single-phase supply of 240 V from the generator control panel.

4.18.11 Solid-state / Digital automatic voltage regulator shall be suitable to handle non-linear and controlled rectifier loads, UPS loads etc. The design should confirm capability to handle non-linear type electronic loads of not less than 40% of rated capacity.

4.18.12 The alternator assembly and rotating assembly shall be dynamically balanced with minimum possible vibrations. Alternator and engine rotating assembly shall pass through torsional vibration analysis and manufacturer will provide certificate and conform to the requirements.

4.18.13 Under frequency protection in the excitation circuit shall be provided to avoid over-excitation. The limit of the under frequency protection shall be specified.

4.18.14 Alternator stator winding terminals shall be brought to the terminal box, which should be suitably sized and shall have sufficient space to accommodate multiple cable entry. A Neutral shall be incorporated, at the neutral side, at the terminal box for connections to the Current Transformer standby Earth Fault Protection. The bus bars and terminal box shall have sufficient size for incorporating 3 Nos Neutral Side Current Transformers for Differential Protection. All bus bars shall have full and rated capacity at the operating ambient temperature and temperature rise class as specified. Space between bus bars should be maintained for multiple cable termination at all phases and neutral.

4.18.15 Alternator shall be equipped with quadrature droop compensation circuits and current transformer. Voltage droop of the alternator should be adjustable up to (+/-) 3% of the rated voltage.

4.18.16 Automatic voltage regulator circuit shall have at least two phase voltage sensing as part of Genset controller.

4.18.17 The output voltage of the alternator should be manually adjusted within a range of 415 V ± 5 % AC.

4.18.18 Alternator excitation and voltage regulation circuit should be suitable for operation of the alternator in single mode or in parallel mode with any other alternator.

4.18.19 Alternator shall be self-ventilated with shaft driven ventilating fan. The ventilation system shall ensure that the temperature rise will be well within the limits of class H while the alternator is operated at 10 % overload at maximum ambient temperature and altitude in the specification.

4.18.20 Alternator shall be fully tested at the factory after manufacture and before dispatch. The test procedure shall confirm compliance to relevant Specifications and Standards. The tests shall also include temperature rise test of the winding at 100% of rated current as per relevant standards and the results are to be recorded.

4.18.21 Automatic voltage regulator shall be tested and performance evaluated along with the alternator and during Factory Load Test of the Package Generator Set.

4.19. Mountings and Package Generator Set

4.19.1 Package generator set shall be complete in all respect with a steel channel common base plate where the engine, radiator and the alternator are mounted. The bedplate shall be of heavy gauge steel construction, stress relieved and free from distortion. Design and construction of the common steel base plate should ensure full structural strength while operated at full load, during starting and during application of variable and step/block loads as per specification. Machined surfaces shall be incorporated for mountings and for leveling. The steel base plate and all mountings are to be fully painted with anti-corrosive paints suitable for the application.

4.19.2 Anti-vibration mountings should be of high quality rubber / spring type and shall be fitted in sufficient numbers between the bedplate and the floor or between the base plate and engine (as per recommendations of the Engine manufacturer) to prevent vibrations being transmitted to the building. The mountings shall be designed to resist horizontal movement of the diesel set.

4.19.3 Anti-vibration mountings shall be provided between the base frame and the equipment or as recommended by the Engine manufacturer.

4.19.4 Alignment between the engine flywheel and the alternator through flexible coupling / directly coupled shall be measured and limits shall be strictly maintained for the type of coupling used

4.19.5 Linear vibrations of the entire package at strategic points shall be measured at no-load as well as full load and the readings are to be within allowable limits, as per ISO 8528 part 9.

4.19.6 The completed package generator set assembly shall be fully inspected and following factory tests of the package shall be done as minimum requirement but testing shall not be limited to these tests only. All required tests as per relevant standards should be carried out.

4.19.7 No load operational checks:

(a) Manual voltage adjustment range
(b) Manual speed adjustment range
(c) Vibration levels at strategic points
(d) Monitoring of all engine parameters
(e) Starting and stopping checks for local and remote operations
(f) Auto-start & Three attempt starting checks
(g) Starting time measurements
(h) Insulation measurement of windings
(i) All alarm and safety parameters shall be checked through simulations

4.19.8 Load trials:

(a) All engine, alternator and electrical parameters are recorded
(b) Loads shall be applied @ 25%, 50%, 75%, 100% of the rated capacity
(c) Fuel consumption shall be measured
(d) All operating parameters shall be within specified & declared limits
(e) Relevant standards and approximations shall be followed
(f) Vibration readings are to be taken at 100% load and to be within safe limits, in case of Prime power rating DGs.

4.19.9 Transient performance trials,

Loads shall be applied in following sequence and transient performance characteristics shall be recorded and complied with

(a) 0% - 25% load
(b) 25% - 50% load
(c) 50% - 75% load
(d) 75% - 100% load
(e) 100% - 60% load
(f) 60% - 0% load
(g) 0% - 60% load

(h) 60% - 100% load

To be demonstrated for each type of DG sets during proto-type tests / Factory Acceptance Tests. Test Reports for each DG set to be submitted at the time of supply. At site performance will be checked visually in accordance with the actual load.

4.19.10 Preferably, all above tests are conducted at 0.8 lagging power factor. In case same is not available, resistive load trials (at unity power factor) shall be accepted.

4.20. Genset Controller

4.20.1 The Genset Controller shall be floor standing / alternator mounted panel and shall be located on / near the generator / in a separate enclosure near the DG set acoustic enclosure. Genset Controller shall facilitate operations & monitoring of the Generator Set. Genset Controller shall have all required protective features essential for the Generator Set of such rating and parallel operations etc. Genset Controller shall be provided individually for each of the Generator Set and shall be suitable for independent operation through local / remote selection.

The panel shall be complete with the following features:

4.20.1.1 Metering:

All metering operations shall be with digital type displays, which may be selectable for the required parameters as under:

(1) Electrical Parameter Monitoring:
- (a) System DC Voltage
- (b) AC Voltages with Selector Switch,
- (c) AC Currents with Selector Switch,
- (d) Frequency,
- (e) Active Power (kW)
- (f) Reactive Power (kVAR)
- (g) Power Factor

(2) Engine Parameter Monitoring:
- (a) Engine RPM
- (b) Engine Jacket Water Temperature
- (c) Lubricating Oil Pressure
- (d) Exhaust Temperature
- (e) Engine Running Hours / Service Hours Run Indicator / Number of Starts.

4.20.1.2 **Protection**:

All protections for engine and electrical operating parameters shall be suitably set and operated to ensure that the maximum allowable limits are not exceeded. The alarms,

shut-off as well as trip command shall also be transmitted to the Generator Logic Panel so that BMS and other facilities are suitably co-ordinated.

(1) Alarms

(a) Over Speed Shutdown Alarm,

(b) Alternator Winding Temperature Shutdown Alarm,

(c) Alarm indicators for service tank “High” and “Low”,

(d) “Start Failed” alarm,

(e) Alarm reset pushbutton,

(f) Low oil pressure

(g) High coolant temperature.

(2) Engine Protection / Shut-Off parameters:

(a) Over-speed

(b) Low Oil Pressure

(c) High Coolant / Jacket Water Temperature

(d) Over-cranking

(e) Emergency Engine Stop

(3) Electrical Protection / Trip parameters:

(a) Over Current,

(b) Under Voltage

(c) Over Voltage

(d) Under Frequency

(e) Over Frequency

(f) Reverse power protection,

(g) Single Phase protection

(h) Loss of Excitation

(i) Breaker failure to close

Two stages of alarm shall be produced for each parameter (excluding electrical protection/trip parameters) with the first stage operating an alarm, and the second stage generating an urgent alarm and shutting the Set down (under certain conditions).

Under normal running conditions, the generator set shall automatically shut down in the event of any of this second stage alarm conditions arising.

4.20.1.3 **Operations:**

Genset Controller shall have following operating features,

(j) Manual Start of Generator Set

(k) Manual Stop of Generator Set

(l) Local / Remote Selection for Operation of Generator Set

(m) Automatic Operations with contacts from Remote

(n) Engine Cycle Cranking / Three Attempt Start with adjustable cranking time followed by cool-down time

(o) Engine Speed Control

(p) Alternator Voltage Control through Voltage Adjusting Potentiometer,

(q) Selection of automatic no-load test facility,

(r) Manual test facility,

(s) Volt-free contacts for remote signaling of all alarms and signals required by the Station Control System, or through Communication Port.

(t) Signal isolators for remote signaling of all analogue values required by the Station Control System, or through Communication Port.

(u) Anti-condensation heater with controls and thermostat,

4.20.1.4 **Power:**

Power output from the generator set / alternator terminal shall be connected to a electrically operated 4 Pole Air Circuit Breaker of suitable rating suitably housed in a lockable steel enclosure (IP – 55) for isolation of power during emergency situation. Power output from the generator set shall be connected through bus bar / Power Cables / bus-duct arrangement, as required.

4.20.1.5 Connections:

All controls and monitoring etc. from the engine, alternator, governor, AVR, and other connected items shall be suitably wired to terminals for onward cable connections to the Logic Panel in ASS in Ancillary Building.

4.20.2 Contacts for remote signaling shall be supervised either at 110 V DC or 24 V DC. Necessary status & safety alarms with required interlocks shall be provided to relay data to the Station Control Rooms or Operation Control Centre.

4.20.3 Potential free contact outputs for the following shall be provided:

(a) Selector Switch Position,

(b) DG Running feedback,

(c) DG Trip Indication,

(d) DG Start / Stop Command,

(e) DG Lube Oil Pressure ‘ LOW ‘,

(f) DG Fuel Oil Level ‘ LOW ‘,

(g) Radiator water level ‘LOW’.

(h) High water temperature

(i) Over cranking

4.20.4 Provisions for the following PLC Inputs/Outputs shall also be made:

(a) DG Battery Voltage

(b) DG Output Voltage.

4.21. LOGIC PANEL

4.21.1 Logic Panel for the Generator Sets shall be located in the ASS Room or may be Engine mounted (combined with Genset Controller) or DG Power Panel mounted or may be provided in a separate IP 54 Class Panel.

4.21.2 Logic Panel shall have following major functions and shall be operated through Programmable Control System.

(a) Manual Start / Stop of Generators from Logic Panel
(b) Auto Start / Stop of Generators from Logic Panel
(c) Automatic Paralleling / Synchronizing of Generator Sets
(d) Active and Reactive Load Sharing for Generator Sets
(e) Load Management /Load based auto start / stop / paralleling
(f) Protection of Generator sets
(g) Metering and Alarm
(h) Performance data transmission

4.21.3 Start / Stop

The Logic Panel shall have Local / Remote (from Genset Controller) selection facility for starting and stopping of generator sets. Control Location selection shall have key operated selector switch.

The GCP should have Auto / Manual selection with indicating lamp to facilitate auto start and stop of the generator sets. In Auto - mode, the generator sets should only be controlled from the Switchgear Room. Auto - Manual selection shall be through lockable selector switch to ensure safe operations and controls.

In automatic mode of operation the generator set shall receive start command in case of failure, under-voltage or under-frequency of grid power supply and the command shall be received from other Generator Power Panel. In case of signals generated for auto start of generator set(s), the command shall initiate cycle cranking and three-attempt start command of the generator set(s). In case of failure in starting, the failed-to-start audio-visual alarm shall be initiated

Stopping of generator set should be interlinked with the circuit breaker through auxiliary contact to ensure that the generator set is not stopped while operating on load or without disconnection of load through circuit breaker. This circuit breaker interlock should be avoided only in case of emergency stop either from local or remote panels.

When the stop command to the generator set is generated, the engine should go through the cool-down time cycle to avoid any possibilities of thermal shock to any of the engine components.

4.21.4 **Paralleling**

Manual and Auto paralleling should be selected through a lockable selector switch. However, manual paralleling operations are not envisaged generally except only in most unlikely case of failures of the auto paralleling system. Manual paralleling system should be ensured through suitable means along with manual operation of circuit breaker control switch.

In Auto Paralleling Mode, the generator sets shall be automatically paralleled at no load or under load conditions with isochronous speed governing system installed in the engine / Genset controller where there will be no frequency variations etc from no load to full load. In this auto paralleling operation the synchronization shall be achieved automatically with auto control of engine speed / frequencies, voltages and the phase sequence and ensured through synchronizing check before circuit breaker close command is provided. Microprocessor based control system shall ensure paralleling of the generator sets under any load or no-load conditions.

4.21.5 **Load Sharing**

The microprocessor based control system shall provide automatic controls of KW and KVAR so that there is automatic active and reactive load sharing amongst operating generator sets.

In case of variations of loads or operation of new loads, the operating load shall be shared in generator sets without any requirement of additional manual adjustments.

Load acceptability and load withdrawal along with load sharing at generator sets shall be through adjustable ramp controls so that the transitions and sharing is smoothly achieved without any appreciable jerks.

4.21.6 **Load Management**

Control system shall have Programming of Logic Controls/microprocessor based controller / adjustable / pre-set load for high level and low level for each generator set. The high level should be adjustable for each set between 75 - 90% of full load rating to utilize best and optimum operating conditions in addition to have available capacity to take care of minor load changes, starting etc. The low level load shall be adjustable between 50 - 70%of full load ratings.

Programmable load management and auto operation shall ensure following operations.

(a) Operating generator set capacity is utilized to high set limit while other sets are in Ready mode to start parallel and take loads and share.

(b) In case the load reaches the high set limit the second generator set should automatically start, reach, rated operating parameters and paralleled automatically with the first set and take loads and share loads with the first generator set.

(c) In the event of reduction of loads below preset low level according to the priority level (programmed in the controller) circuit breaker of the least priority set shall be opened automatically after a preset time delay and the generator set shall be stopped automatically through the cool down cycle.

(d) The load based start and stop system shall be fully automatic and operations indicated in the logic panel.

(e) In case of any fault / trip of any operating generator set, when the load is suddenly above high set limit, the auto start and paralleling operation of the balance generator set should be achieved through load sensing system installed in each generator set programmable controller and according to the set limit values.

(f) The load share and auto paralleling system must be independent of any generator set and shall be supplied individually for each set so that in case of any abnormalities, maintenance of any set, the other sets can be operated in auto mode without any additional requirements of programming etc.

4.21.7 **Protection:**

Each Logic Panel shall be equipped with following electrical and system protection features,

(a) Ampsentry Protection.
(b) Over current
(c) Under Voltage
(d) Under Frequency
(e) Reverse Power.
(f) Alternator Winding Temperature High
(g) Alternator bearing temperature High
(h) Differential.
(i) Standby Earth Fault.

Above protective relays shall have settings suitably graded or integrated with the set values at Genset Controller to ensure fail-safe operations. The current transformers should be either 1Amp or 5 Amps secondary rating with primary ratings at higher than full load amps. CT ratings should not be less than 10 VA 5P10 Specifications. All protection CTs for above mention protection relays shall be provided.

4.21.8 Metering:

Meters shall be of digital type and may be scroll-selected type for following parameters,

(a) Voltmeter, RY, YB, BR

(b) Ammeter, R-Y-B

(c) Frequency Meter

(d) KW Meter

(e) KVAR Meter

(f) KWh Meter

4.21.9 **Alarms:**

Audio-visual Alarm system should be provided for following parameters,

(a) CB Tripped

(b) Engine Shut-Off

(c) Emergency Trip

(d) Engine Failed to Start

(e) Over current Fault

(f) Earth Fault

(g) Under Voltage Fault

(h) Under Frequency Fault

(i) Differential Fault

(j) Standby Earth Fault

(k) Reverse Power

(l) Grid Power Failure

(m) Grid Power Restored

4.21.10 Isolator Panel and Circuit Breakers:

E& M Contractor will provide Air Circuit Breaker on the Generator Power Panel, which shall be electrically operated. The generator circuit breaker operation should be electrically interlocked with the grid power circuit breaker to eliminate any possibilities of grid paralleling. Generator circuit breaker should be only closed when the respective generator set output reaches rated values to operate on load.

DG set Contractor shall provide an Isolator Panel with Air Circuit Breaker of suitable rating as per the DG set capacity. ACB should comply with IEC 60947-2 and EN 60947-2 and shall meet the following requirements:

a) Number of poles: Four-pole type.

b) Rated insulation voltage: 1000 V AC,

c) Rated frequency: 50 Hz,

d) Rated uninterrupted current: as per DG set capacity.

e) Rated ambient temperature: 50^0C,

f) Rated short-circuit making capacity: shall be at least 2.1 times of ultimate short ckt breaking capacity at 0.25 power factor,

g) Rated ultimate short-circuit breaking capacity (Icu): min 35 kA and based on actual fault level,

h) Rated short-time withstand current (Icw): 35 kA for 1 second (minimum) subject to actual fault current on board and 22 kA for 3 seconds.

i) Rated service short-circuit breaking capacity (Ics): 100% of Icu, and

j) All ACBs shall be withdrawable type.

k) All ACBs shall be of the air break horizontal withdrawable pattern complete with interlocks to prevent withdrawal when the breaker is closed. Electrical connection between the breaker and “Switchboard” shall be of plug and socket type with automatic screening shutters which will shield the fixed terminals in the “Switchboard” in a manner such that no access can be made to the fixed terminals when the breaker is withdrawn. In order to prevent unauthorised operation, the withdrawable air circuit breakers shall be provided with padlock facilities to secure them in their CONNECTED, TEST and ISOLATED positions.

l) ACB shall have microprocessor based protection releases for type of faults, as required, and shall have an LCD display to show true RMS current in all the three phases and the highest current among three phases. The release should have an internal fault indication by LED’s for fault differentiation. The release shall be equipped with self diagnostic feature with indication.

m) The overload and short circuit characteristics should be front adjustable

n) Fire resistant transparent covers shall be provided over ACB’s to achieve IP-54 protection.

Operating Mechanisms of ACB

a) All ACBs shall be provided with hand charged and motor charged spring closing mechanism rated at 240V AC.

b) All operating mechanisms shall have mechanical ‘ON’ and ‘OFF’ indicators and a manual trip device fitted with means for locking. The spring charging motor shall be suitable for operation within a voltage range of 70% to 120% of the rated control supply voltage.

c) The operating mechanism shall be trip-free.

Interlocks and Test Operation Facilities in ACB

All ACBs shall be provided with interlocks to ensure that:

a) the ACB cannot be plugged in or isolated whilst it is closed,

b) the ACB cannot be closed until it is fully plugged in or completely isolated,

c) the ACB cannot be closed in the service position without completing the auxiliary circuits between the fixed and moving portions,

d) with hand charged and motor charged spring mechanisms the springs cannot be discharged until they have been fully charged and until the means for charging has been removed or disconnected,

e) facilities shall be provided for testing the ACB operation when in the isolated and withdrawn positions by the normal means as in service, and

f) where control circuits are provided and interlock circuits are broken via plugs on withdrawal of the ACB, a minimum of one jumper lead and plug assembly of each size and type shall be provided to facilitate testing in the withdrawn position.

g) The neutral shall be rated for 100%.

Control Switch for Air Circuit Breakers

The handles of control switches for air circuit breakers shall turn clockwise for closing and anti - clockwise for tripping and shall be of the pistol grip type. The control switch shall be clearly labeled as CIRCUIT BREAKER OPEN – NEUTRAL - CLOSE, with spring return to the neutral position. Mechanical interlock shall be fitted to prevent repetitive closing without moving first to the trip position, and shall be capable of padlocking in the neutral or trip position.

4.21.11 **Neutral Controls:**

The neutral of each alternator shall be earthed solidly through 2 nos. separate earth points.

4.21.12 **Data Management:**

Provision should be made in the programmable control unit of each DG Set for data transmission and computer compatibility,

(a) Voltages
(b) Currents
(c) Frequency
(d) KW Power
(e) KVAR Power
(f) DG Set – 1 Status (ON/OFF)
(g) The data bus should be preferable in Modbus.

4.22. Automatic Mains Failure Operation

4.22.1 The generator is required to operate as part of an automatic mains failure system. Potential free contacts in DG Power Panel shall be provided by the E&M Contractor Interfacing with E&M contractor to be done by DG set Contractor and the scheme is to be got approved by JMRC.

4.22.2 The sequence of operation for preparing the scheme is envisaged as follows:

(a) The Grid Incomer Circuit Breakers to DB – 100 and DB – 200 are tripped to ensure isolation of Grid Supply from the DG Supply,
(b) Bus Coupler Circuit Breakers of DB – 100 and DB-200 are tripped to isolate Class D loads.
(c) “START” signal is given to the DG set through the NC contacts of the Incomers and an adjustable Time delay Relay to the Main Distribution Boards,
(d) The DG Breaker closes automatically since DG is in “AUTO” mode,

4.22.3 As soon as Mains power fails the command can go to the DG Set to start. The connection of this to the load can, however be done, following a predetermined period if the power failure has sustained for that period. When the generator has successfully started (i.e. engine up to speed), the generator control panel shall signal back to the control equipment, which shall then open and close circuit breakers as necessary to transfer the load to the generator. Re-starting of large drives shall be staggered by the control system to be provided by E&M / respective System contractor.

4.22.4 When the mains supply has been restored and sustained for a pre-determined period (This period setting should be programmable at site and manufacturer should recommend the setting), the Diesel Generator Set shall be paralleled with the mains power for un-interrupted transition and the control system shall open and close circuit breakers as necessary to transfer the load back to the mains. There shall be provision to by pass the logic for paralleling of DGs with grid supply, and thus its use shall be optional. The generator shall then be required to commence its run-down and stopping sequence in response to a volt-free contact command from the control equipment.

4.22.5 The generator package shall be co-ordinated with the control system as necessary in order to test and commission the automatic mains failure system. Supply interlocks shall be provided to supply the electricity after stabilisation only.

4.22.6 The DG Set should be put ON load only after it has reached steady state condition after starting.

4.22.7 All the generator sets should be able to be paralleled on a dead bus system and share loads (both active loads and reactive loads) equally, when ON load.

4.22.8 Generator Set Starting / Stopping:

4.22.9 Emergency Diesel Generator Set starting operation shall be achieved as follows,

4.22.9.1 Diesel generator set shall have following starting facilities –

(a)	Starting from the Genset controller	Local Mode, Manual Operation
(b)	Starting from the Logic Panel	Local Mode, Manual/ Auto Operation
(c)	Starting from the control room	Remote Mode, Auto Operation

4.22.9.2 Diesel generator set shall have following facilities to stop –

(a)	Emergency Stop from Genset controller	Manual – Emergency
(b)	Stopping from Genset controller	Local Mode – Manual
(c)	Stopping from Logic Panel	Local Mode – Manual / Auto Operation
(d)	Stopping from control room	Remote Mode – Auto Operation

4.22.9.3 The generator set / engine should not be allowed to stop unless the generator circuit breaker is opened / tripped / load is isolated only with the exception of emergency stop operation.

4.22.9.4 Whenever the engine is stopped, (the fault should be reset from at either Genset controller or Logic Panel in case stoppage is due to a fault), all systems for starting should be activated and should be ready for operation to ensure emergency operation during mains failure for which it is installed.

4.22.9.5 The selection of Auto-Manual to Manual mode shall enable starting and stopping of the DG Set manually from the DG Set, panel or control room remotely. The location of starting and stopping can be further selected through the Local-Remote selection.

4.22.9.6 However, for manual operation to start and stop the diesel generator set shall require manual operation of the circuit breaker also. The interlocks for auto-operation shall remain valid for manual operation to avoid wrong sequence of operation etc.

4.23. Failure to Start

4.23.1 If the generator fails to start after an initial period of cranking, two further attempts shall be made with an appropriate interval between each attempt. If the engine fails to start after three attempts the system shall shut down and a local alarm shall be annunciated. Remote indication of the alarm shall be available via a volt-free changeover contact.

4.24. Run-Down Sequence

4.24.1 When the generator is required to stop following receipt of a remote “Stop” command, the sequence logic shall run the set for a run-on period with no load before closing the fuel valve and stopping the set. The manufacturer of the generator set shall determine the duration of the run-on period.

4.24.2 When Mains Supply is restored and sustained for a predetermined period, the control shall open and close CB’s as necessary to transfer the load back to the Mains Supply. Only after load is fully restored to Mains Supply shall the Generator commence its run-down and stopping sequence.

4.24.3 Reverse power paralleling should be provided for avoiding interruption when mains power has resumed after failure and DG is taken out of load.

4.25. Protection Operations

4.25.1 The following parameters shall be measured;

(a) High water temperature,
(b) High lub oil temperature,
(c) Low Lubrication oil pressure,
(d) High and Low speed,
(e) Alternator winding temperature.

4.26. Automatic Testing

4.26.1 If the generator set is available for service, is set to automatic control and has not runs in the last 7 days, the set shall be started and run for a pre-determined period (set in the

range 5 to 10 minutes) in the no-load condition. The Genset Controller / Logic Panel shall actuate an alarm to run the DG Set automatically for 5 to 10 minutes in idle condition if the Engine has not been run for the last seven (7) days. A manual bypass shall be provided to bypass automatic idle run.

4.26.2 Testing of DG Set can be done under load conditions also during non-traffic hours.

4.26.3 An alarm shall be generated to signal that the generator is in automatic testing mode.

4.27. Manual Mode

4.27.1 When the generator is started manually no automatic changeover of mains to generator supply or vice-versa shall take place. The generator shall be loaded by manual switching if required. However, provision for manual initiation of command to activate loading sequence through Control system may be made. For this protection, necessary interfacing with E&M contractor will be done by the DG set contractor.

4.28. Acoustic Damping

4.28.1 It is a requirement that the noise generated while the generator set is running shall be controlled to 75 dB or less at 1 meter as per ISO 8528 part 10 for Gensets upto 800 KW / 1000 KVA or 25 dBA insertion loss for above 800 KW / 1000 KVA as per latest CPCB norms from the external walls and / or roof of the Acoustic enclosure / DG Room.

4.28.2 To achieve this, the generator package shall incorporate a sound reduction package incorporating air inlet and outlet acoustic damping units together with other techniques as necessary (e.g. installation of an acoustic lining for the generator room) to achieve the required sound level.

4.28.3 The DG set placed inside the acoustic enclosure shall be suitable for continuous operation under all the ambient conditions without any adverse effect / deration in the DG set performance.

4.29. Sound Attenuation.

4.29.1 Acoustic Enclosure

4.29.1.1 DESIGN

Sound Attenuating Acoustic Enclosure should have pleasant and aesthetic looks and should be designed to achieve the Final sound level of **75** dB (maximum) at a distance of one meter from the Acoustic enclosure in ideal conditions as per ISO 8528 part 10 for Gensets upto 800 KW / 1000 KVA or 25 dBA insertion loss for above 800 KW / 1000 KVA. (The latest CPCB guidelines will have to be complied, during the execution of the contract). For testing, the measurement of dB shall be done at different points all along the enclosure and then averaged.

The sound attenuating enclosure shall be meticulously designed and it's design, construction etc. should be decided based on ventilation requirement and should be completely weather proof.

In design, proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than **7°C**.

4.29.1.2 CONSTRUCTION FEATURES:

1) STRUCTURE: Enclosure shall be made in modular design and can be dismantled/assembled at site. It shall be made out of heavy gauge mild steel sections and reinforced with fabricated super structure, the supporting frame work shall be of 2.0 mm thickness. Outside covers & doors shall be fabricated in 2.0 mm thick CRCA sheet. Inside cover or perforated sheet should be 0.4mm thick. **"CAP – ON" type Acoustic Enclosure shall be acceptable**. In case of integral type of Acoustic enclosures, the base of Acoustic Enclosure shall be made from suitable size of M.S. Channel and M.S. chequred plate.

2) ACCOUSTIC INSULATION (walls, Roof and Doors): Mineral rock wool slab of minimum density 64 Kgs/m^3, confirming to IS 8183 and with minimum thickness of 75mm covered by fire resistant fiber tissue confirming to AWWA C – 203 specifications.

3) AIR INLET & AIR OUTLET: Specially designed sound attenuators at Suction & Exhaust ends.

4) PAINTING: Outer surface of Acoustic Enclosure shall be painted with Polyurethane paint or powder coated but painting should be done after corrosion treatment of sheet by 7 tank treatment process & synthetic enamel paint on the internal surface. All nuts & bolts shall be zinc coated. The color of the Enclosure should be got approved from the Employer.

5) WIRING AND LIGHTING: Suitable lighting arrangement to be provided in all compartments of Sound attenuating Acoustic Enclosure i.e. E/A set, Fuel tank, Genset Controller with PVC FRLS copper wire of minimum 2.5 mm^2, 1100 V grade concealed in flexible conduit / channel & MCB.

6) EXHAUST OF ENGINE: The Engine Exhaust shall consist of suitable dia M.S pipe (Insulated) along with smooth bends & supported. This pipe shall be suitably brought out at the top of enclosure with suitable arrangement at the outer end for preventing

water to enter in pipe as required. For the Engine Exhaust detailed specifications as per clause 9.0. are to be complied.

7) PROVISION FOR NEUTRAL/BODY EARTHING: Suitable bus bars have to be provided outside sound Attenuating Acoustic Enclosure for neutral/Body earthing separately. The neutral terminals shall be connected to the neutral of Alternator with flexible copper wire insulated braided strip. All the Equipments inside the Acoustic Enclosure shall be connected together with suitable size strip and then connected to the Body Earthing bus bars.

8) VENTILATION & AIR CIRCULATION: The system shall be designed to provide air inlet/exhaust acoustic louvers for efficient air circulation. The ventilation may be natural/forced cooling. The temperature rise of the enclosure with respect to the ambient should be less than **7°C** at site conditions. In case of forced ventilation there should be specially designed circuitry to ensure that the fan(s) starts when the Genset is in operation and when the Genset has been switched off the fan(s) automatically switches over to main supply and runs for 5 – 15 minutes (programmable) before stopping to ensure that set is ready to start in case of another failure.

9) SPECIAL FEATURE:

a) In order to ensure safety of Fuel tank it shall be embedded in to a wall closet / enclosure on all four sides for which required interfacing with the civil contractor shall be done by DG set Contractor. Provision should be there to fill this fuel tank from outside as in automobiles and this should be with a lockable cap.

b) The batteries shall be accommodated in the sound attenuating enclosure in battery tray.

c) Genset Controller and Isolator Panel shall be preferably inside the sound attenuating enclosure with free frontal access.

d) Genset Controller and Isolator Panel may be placed inside / outside the sound attenuating enclosure. In case provided out side the Genset Controller and Isolator Panel shall be provided in an enclosure of same specification as that of sound attenuating enclosure except the sound proofing arrangement. This enclosure should be for IP 67 rating. As far as possible the Genset Controller and Isolator Panel shall be placed adjacent to the enclosure to have minimum length of cable.

e) The sound attenuating enclosure should be as compact as possible with good aesthetic look.

f) From continuous running of engine, the temperature inside the sound attenuating enclosure shall be maintained within 7°C of ambient and canopy shall be provided with temperature safety device to shut down engine if canopy temperature exceeds **50°C**. The measure of difference of temperature shall be as per the prescribed procedure specified by the CPCB.

g) The sound attenuating enclosure shall be complete with ducting & radiator bellow.

h) The sound attenuating enclosure shall have built in receiving tray at base of the Genset for any oil spillage.

i) The sound attenuating enclosure shall have provision of emergency shut down from outside the container.

4.29.1.3 The sound attenuating enclosure door shall be gasketed with high quality EPDN gaskets to avoid leakage of sound. The door handles should be provided with durable weather – proof locking system.

4.29.1.4 All the doors of the sound attenuating enclosure shall be provided with limit switch to sense opening of the door and the opening of door will be transferred as Audio – visual alarm to the Station Control Room.

4.30. Sound Proofing of DG Room/Provision of Sound Barrier.

4.30.1 Wherever required, Sound Proofing of the DG room to be done as per material included in Schedule of Quantities under this Contract. DG set contractor to get the drawings for the sound – proofing of the room approved from JMRC shall be carried out to achieve stipulated sound attenuation as per the CPCB norms.

4.30.2 The contractor has to study the DG set installation location for the each DG set at each station and submit a report regarding the installation as per clause 7.7 of Chapter 7 of the Particular specifications. Wherever required the contractor may be asked to provide an additional noise control barrier to achieve the noise pollution limits as per the CPCB norms.

The suitable noise control barrier shall be provided on the wall with necessary inclinations and projections to achieve the sound attenuations. The barrier shall be of outdoor type weather proof made of poly carbonate sheet or any other superior material having good weather stability life, with the approval of the Engineer, as per the requirement of the site.

4.31. Fuel Tanks

4.31.1 Each DG set enclosure shall be provided with an integral / external fuel Day Tank of 990 Litres rated capacity complete with mechanical fuel oil level indicator to indicate ‘High‘ and ‘Low’ levels and isolation valves shall be supplied for storing Fuel Oil from barrels. These fuel tanks will be interconnected .The tank shall be wall mounted and raised from

Ground Level so as to feed the DG Day tanks by gravity. Further a portable electric / semi rotary hand fuel pump shall be provided to transfer fuel from barrels to this tank.

4.31.2 The Tank shall be constructed from Mild Steel in accordance with BS 2594. The associated fittings shall be constructed from materials which are suitable for long term contact with diesel fuel and shall not include yellow brass, low grade of copper and zinc, lead, and galvanized metals. The following fittings shall be included:

(a) Direct reading level indication (hydrostatic gauge),
(b) Level switches for high and low alarm purposes,
(c) Drain pipe situated at lowest point in tank complete with isolating valve,
(d) Outlet pipe compete with manually operated isolation valve and mechanically operated isolation valve (for fire shut-down),
(e) Fuel inlet pipe from the filling point at the top of the tank,
(f) Fuel return inlet pipe connection (from the generator set),
(g) Breather Unit / Vent pipe connected at high level to the tank. The vent pipe shall rise continuously from the tank to a position outside the Generator Room / Acoustic enclosure at high level and shall terminate with an inverted “U” bend and vermin screen.

4.32. Fuel Filters

4.32.1 A supply line fuel filter shall be fitted and shall be of the twin replaceable element type complying with BS 4552.

4.33. Fuel pipe work and valves

4.33.1 The generator package shall include the supply, installation, connection, testing and commissioning of all pipes and valves for the fuel system including, but not limited to the following:

(a) Service tank filling pipe,
(b) Service tank vent pipe / breather,
(c) Generator fuel supply and return pipes.

4.33.2 All pipes, valves, fittings and connection materials shall be designed for use in conjunction with diesel fuel oil. All fuel piping shall be suitably corrosion protected.

4.33.3 The fuel pipe-work shall be connected to the DG through flexible pipe for a short distance for isolation of vibrations.

4.34. Fire Protection and Suppression

4.34.1 Openings for Ventilation in the Generator room shall be provided by the Civil contractor, and DG set contractor will be responsible for the necessary interfacing.

4.34.2 DG set Contractor will prepare the details of Fire Protection and Suppression equipment required for the Acoustic enclosure / DG room as per the relevant standards applicable

and obtain approval of JMRC. After approval from JMRC, DG set contractor will provide equipment included in the Schedule of Quantities under this contract and for remaining equipment, DG set contractor will interface with E&M contractor to ensure that all these equipment are installed before commissioning of DG sets.

4.35. Cabling

4.35.1 The generator package shall include the supply, installation, termination, testing and commissioning of the following cables:

(a) Control cables between the Genset Controller, Logic Panel and the Generator Set and DG set Power panel.

(b) Power and Control Cables between the Genset Controller, Logic Panel, DG Power Panel, Alternator to Genset Isolation Panel, Logic panel and the Genset Auxiliaries,

(c) Power and Control Cables to the engine battery charger,

(d) Control / Instrumentation cables between the Genset Controller, Logic Panel and the service tank level switches.

4.35.2 All Cables (Power and Control cables) will be FRLS Zero Halogen only.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 5

QUALITY ASSURANCE AND SYSTEM ASSURANCE

5 QUALITY ASSURANCE AND SYSTEM ASSURANCE

5.1 General

A Quality Assurance programme shall be developed and implemented as a means of determining compliance with the Employer's Requirements. This programme shall comply with the requirements as set out in ISO 9000. The programme shall include but not be limited to the procedures necessary to ensure that all equipment, materials, systems and sub-systems are properly specified, designed, purchased, recorded, inspected, installed and tested at all appropriate stages. The procedure shall also ensure that handling, storage and delivery arrangements are satisfactory.

5.2 Quality Assurance Programme

The Contractor's quality assurance programme shall include as a minimum, the following functions:-

5.2.1 Inspection System: A system for in process inspection of work operations and manufacturing as well as installation processes, including observations, measurements and tests, to ensure conformance with the requirements of the Contract.

5.2.2 Calibration System: A system for periodic calibration and control of the accuracy of precision instrumentation and gauges.

5.2.3 Record System: Data and records essential to the operation of the quality programme shall be maintained by the Contractor and made available to the “Engineer” upon request. These records shall include work performance, inspection and testing observations and the number and type of deficiencies found. In addition, records shall be maintained for monitoring work performance, inspection and testing which indicate the acceptability of work or products and the remedial action taken in connection with deficiencies.

5.2.4 Supplier Control System: A system for ensuring that all supplies and services procured from suppliers (subcontractors and vendors) conform with the requirements of the Contract.

5.2.5 Manufacturing Control System: A system for providing necessary control over manufacturing operations to ensure that the final product conforms with all requirements of the Contract. This system shall include controls for the following areas:

(a) **Materials**

Suppliers' materials and products shall be subject to inspection to demonstrate conformance with the technical requirements.

(b) **Production Process and Fabrication**

The Contractor's quality assurance programme shall ensure that all machinery, wiring, batching, shaping and basic production operations (of any type) together with all processing and fabricating are accomplished through documented work instructions. These instructions shall be the criteria for acceptable workmanship.

(c) **Completed Item Inspection and Testing**

The quality programme shall ensure that there is a system for final inspection and testing of completed products. Such testing shall provide a measure of the overall quality of the completed product and be performed so that it simulates, to a sufficient degree, product end use and functioning.

The contractor shall do the performance testing capacity testing and submit the report stating the limits of each DG Sets measured parameter as per relevant standards.

(d) **Statistical Quality Control and Analysis**

Statistical methods may be utilised for planning, analysis, tests and quality control whenever such procedures are suitable for maintaining the required control of quality. Sampling plans shall be subject to the acceptance of the “Engineer” prior to use.

(e) **Indication of Inspection Status**

The Contractor shall maintain a positive system for identifying the inspection status of products. Identification may be accomplished by means of stamps, tags, routing cards, move tickets or other control devices acceptable to the “Engineer”.

5.2.6 Installation Control System: A system providing necessary control, monitoring, inspection of the progress, quality of work and protection of equipment, to ensure that the equipment is installed according to the requirements of the contract.

The system shall include but not be limited to the following, which shall be subject to the acceptance of the “Engineer” prior to use:

(a) **Shop Drawings**

All layout and shop drawings giving detailed layout of equipment, structural cut-outs, supports, openings, all dimensions, tolerances setting, etc

(b) **Assembly Procedures and Drawings**

This shall show details of all installation and assembly procedures, including tolerances, tightening torque, alignment, precautions, etc.

(c) **Inspection Checklist**

Checklists giving all items to be checked and inspected with tolerances setting, etc.

5.2.7 The Contractor shall submit checklists to demonstrate compliance with all applicable standards.

5.3 Systems Assurance

The Bidder shall demonstrate a clear understanding of all the requirements of this Clause in his bid submission.

5.3.1 General

a) The Contractor shall develop and implement the requirements for Systems Assurance. These requirements shall be applied also to subcontractors and suppliers and shall be carried out during the design, manufacture, installation, testing and commissioning phases of the Works.

b) The Contractor shall prepare and submit for review and acceptance by the “Engineer” a Systems Assurance Plan thirty days after Contract Award.

c) The System Assurance Plan shall define the Contractor’s approach, procedures and schedules for conduct of Safety Engineering, Reliability Engineering and Maintainability

Engineering. Human Factors Engineering is an integral part of Systems Assurance and shall be considered and reflected within the Systems Assurance Plan.

d) The Contractor shall pro-actively engineer the systems to meet the safety, availability, reliability and maintainability performance requirements listed below and demonstrate that the requirements have been met by the system installed.

e) In the process the potential hazards to safety, availability, reliability and maintainability performance should be further minimised where design options permit.

f) The deliverables listed below are intended to provide the "Engineer" with a sound basis for acceptance of the safety, availability, reliability and maintainability performance; progress information; confidence that the design is proceeding with a low risk of failing to meet the performance requirements; information that will aid the planning of work schedules; and part of the foundation of the safety case for operation of the line.

5.3.2 Not used

5.3.3 Safety Engineering

a) The Contractor shall as part of the safety engineering activity prepare analyses of identified potential hazards to ensure resolution of hazards. The following analyses shall be prepared and submitted by the Contractor:

i) Subsystem Hazard Analysis (SSHA)

ii) Interface Hazard Analysis (IHA)

iii) Operating and Support Hazard Analysis (O&SHA)

iv) Quantitative Fault Tree Analysis (FTA)

v) Failure Modes, Effects and Criticality Analysis (FMECA)

b) The Contractor shall prepare a Fire Safety Design Report for review and acceptance by the "Engineer". At a minimum, this report shall contain documentation of the specific fire hardening and life safety features and attributes the Contractor has incorporated in the DG Sets design; especially those relating to: -

i) Structural fire resistivity

ii) Choice of electrical wiring and insulation for vital safety critical circuitry.

iii) Flammability, smoke emission, and toxicity characteristics of selected materials.

e) Further, the information presented by the Contractor shall be supported by the history of tests conducted and by approved test certificates from accredited laboratories which attest to the materials' characteristics and behaviour.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 6

INSTALLATION

6 INSTALLATION

6.1. The Contractor shall be responsible for the timely and proper setting out of the Works which shall include verifying the positions, levels, dimensions and alignment of DG Sets foundations trenches, cut-outs etc. Any error in the civil construction in so far as they relate to the Works shall be immediately brought to the attention of the "Engineer" and the Designated Contractor to allow prompt rectification by the Designated Contractor so as to avoid delays to the Works. The Contractor shall not be entitled to claim for any additional costs incurred by him arising out of such errors in the civil construction, if such additional costs could reasonably have been avoided had the Contractor carried out timely and proper setting out of the Works. The method adopted for installation shall be in accordance with relevant standards with latest versions/ amendments stated in this specification.

6.2. The Contractor shall be responsible for all aspects of the Work required to install the DG Sets, its equipments, including the fuel tank, power panel etc. The Contractor shall co-ordinate with the Designated Contractors on the necessary precautions to be taken by both the parties to prevent damage to any part of the civil works during installation. The Contractor shall take all necessary pre-cautions including transportation of various part of DG Sets on rubber typed wheel and handling these with proper equipment so that floor finishes are not damaged by the Contractor during erection of DG Sets at the stations. In case any floor finish is damaged by the Contractor the same shall be made good by the Contractor in full panel / area at his cost, so as to maintain uniformity.

6.3. The Contractor shall provide protection, such as plywood box-up etc., to protect its equipments being damaged until the work is handed over at no additional cost. Any damages to the equipment will be the sole responsibility of Contractor and the firm shall replace the damaged part without any extra cost. The complete equipment will be inspected and tested at the time of taking over of the equipment.

6.4. The Contractor shall be responsible for the installation of DG sets, its fuel system , exhaust system, cooling arrangements, ventilation arrangement etc.

6.5. Electrification Panel of DG Sets shall be fully protected against the ingress of grit, dust and moisture and maintenance friendly enclosure.

6.6. All equipment shall be fully protected against the ingress of grit, dust and moisture during delivery, storage and installation.

6.7. The equipment shall be delivered to Site in accordance with an accepted installation programme with a minimum temporary storage period to avoid damage.

Access into the station will be by road which will depend on site environment and constraints.

6.8. The Contractor shall design the equipment to comply with the Site access restrictions and shall ensure that the largest piece of equipment can be brought into the station through the access opening/entrances and passage ways. Method Statement of Installation shall be submitted for Employers review and approval at least 30 days prior to the starting the

installation. As part of the preliminary design submission the Contractor shall submit to the “Engineer” for acceptance a General Method of statement for Installation However, Contractor will submit schedule of tests giving full details of all tests to be carried out

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 7

TESTING AND INSPECTION

7 TESTING AND INSPECTION

7.1 General

7.1.1 As part of the preliminary design submission the Contractor shall submit to the “Engineer” for acceptance a schedule of tests giving full details of all tests to be carried out.

7.1.2 Tests at places of manufacture to be witnessed by the “Engineer” shall be grouped together so far as can be arranged so that as many tests as possible can be witnessed on each visit.

7.1.3 The Contractor shall prepare and forward to the “Engineer” an original and four copies of all Test Reports as soon as practicable after completion of each test whether witnessed by the “Engineer” or not. All test data shall be certified by the Contractor’s Professional Engineer.

7.1.4 The Contractor shall perform all applicable test specified in these specifications as per the relevant standards. Any test required as per the applicable safety standards but not specified in this specification shall be performed without any extra cost to JMRC.

7.1.5 The contractor has to take the EIG (Electrical Inspector to Government) approval of the DG set Installation before commissioning the DG sets. The contractor has to comply with all the requirements for the EIG inspection, make the necessary application & should make all the arrangements, conduct tests and submit the required compliance certificates necessary for the approval. The application should be submitted with approval of the Engineer in charge.

7.2 General Requirements for Type Tests and Acceptance Tests

7.2.1 The Bidder shall provide details of any type and acceptance tests, which have been carried out on equipment offered, or any additional tests he recommends.

7.2.2 In general, certificates of previous type tests may be accepted at the discretion of the “Engineer”, provided that they are for identical equipment and conditions. Where appropriate, new and/or modified components to meet the requirements of this Specification shall be made available for type testing.

7.2.3 All applicable Type tests as per the relevant standards on equipment shall be carried out strictly as specified in the Specification and procedure of testing shall be submitted to “Engineer” for No Objection.

7.2.4 The “Engineer” shall have right to witness tests and inspections on individual materials, components, or sub-assemblies, and details of these shall be agreed between the Contractor and the “Engineer”.

7.2.5 At the conclusion of all type tests, the Contractor shall compile all the test data together with any observations made during the tests, file them into a type test binder and submit it to the “Engineer” for acceptance and record.

7.3 General Requirements for Tests during Manufacture

7.3.1 The Contractor shall carry out all applicable tests during manufacture as specified and propose any additional tests to be carried out as per relevant safety standards. These tests shall be subject to the acceptance of the

“Engineer”. Routine tests shall be integrated with the manufacturing programme. The “Engineer” will, at his discretion, witness the routine tests during the period of manufacture, or accept the records of the Contractor’s in-house quality control scheme, where appropriate, as sufficient evidence for the execution of the routine tests.

7.3.2 Routine tests shall be carried out strictly as specified in the test specification.

7.3.3 On completion of the manufacture of items or sub-assemblies, and following completion of the manufacturer's own tests and inspection, the "Engineer" shall be invited to witness such tests as he deems appropriate. The Contractor shall schedule the routine tests to meet the manufacturing programme, whether or not the "Engineer" will be present at the tests, provided advance notice has been served to the "Engineer" in accordance with Clause 9.8 of GS.

7.3.4 The "Engineer" will determine and advise the Contractor of those tests where certification by the manufacturer may be acceptable in lieu of witnessed tests.

7.3.5 Before equipment is dispatched, the "Engineer" will signify his acceptance by signing certificates releasing such equipment from the place of manufacture or test.

7.3.6 Methods of packing and shipping shall be as specified in the Employer's Requirements, the "Engineer" reserves the right to visit the manufacturers' or packers' premises to ensure that accepted methods are employed.

7.4 Test Specification

7.4.1 The Contractor shall submit for acceptance by the "Engineer", test specifications for type tests, routine tests, tests on site, final acceptance tests and commissioning. The specifications shall detail the methods of conducting the tests, the tools and instruments used. Reference to the accepted documents and drawings shall be included in these specifications. The records/results shall be tabulated in a prescribed format applicable to this Contract.

7.4.2 Nothing in this Specification shall prevent the "Engineer" from calling for extra tests.

7.4.3 These test specification shall include the design values of all quantities to be verified, with allowable tolerance or limits. Summary drawings or diagrams shall be included with the test specifications to show the dimensions and tolerances of all structural assemblies and sub-assemblies. In the case of welded fabrications, key diagrams giving all weld data shall be provided to enable systematic inspection to take place.

7.4.4 Verification of accuracy shall be required for all tools, apparatus, testing jigs, measuring instruments and 'go' or 'no go' gauges used for the purpose of routine tests.

7.4.5 All test instrument shall be calibrated not more than one year prior to their use. The Contractor shall submit calibration certificate or other documents for proof of Compliance.

7.5 Testing of Materials and Details

7.5.1 Where materials or components used in this Contract are not covered by separate test specifications, samples of such materials, or up to two per cent of such components shall, if desired by the "Engineer" be tested at the Contractor's expense at an approved laboratory.

7.5.2 The Contractor shall supply the material required for testing free of charge and shall supply and prepare the necessary test pieces, labour and appliances for making all tests, and for carrying out all gauging and weighing on his premises in accordance with the terms of this Specification. If the Contractor is unable to provide approved facilities at his own factory for making the prescribed tests, the Contractor shall bear the cost of carrying out the tests elsewhere, at a place subject to the "Engineer" acceptance.

Such radiographic examination of welds or castings as the “Engineer” deems necessary shall be carried out.

7.6 DG Sets Prototype Tests

7.6.1 One complete DG Sets of each capacity size shall be made available for prototype testing at Manufacture works.

7.6.2 A complete DG Sets system in addition to the controller shall be assembled on a test bench to undergo a comprehensive running and functional testing in accordance with the accepted test specification to verify compliance with the Specification.

7.6.3 Proto type DG sets shall be tested at varying loads at manufacturers works prior to dispatch of DG sets to site. The performance tests at the works shall be carried out in presence of the authorised representative from the Engineer- in– charge. Due notice for the programme of performance testing at works shall be given to the Engineer- in – charge to enable them to arrange for their representatives for this inspection to be at manufacturers works for this inspection & testing. The cost for the arrangement shall be borne by the contractor.

The performance test on the DG sets shall be of minimum 8 hours duration.

All instruments, material, consumables (fuel oil, lube oil etc.) load and labour required for carrying out of the test shall be provided by the contractor.

Following test acceptance criteria shall be applicable.

1.	Fuel consumption at 50 %, 75 % and 100 % load	± 5 % of guaranteed performance. Actual alternator efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio.
2.	Voltage regulation from no load to full load	± 0. 5%
3.	Frequency regulation from no load to full load	± 0. 5%
4.	Maximum water temperature	± 5 % of guaranteed performance
5.	Maximum lube oil temperature	± 5 % of guaranteed performance
6.	Maximum lube oil pressure	± 5 % of guaranteed performance

7.6.4 The tests shall include the following minimum requirements.

a) Verification of the suitability of the system, its efficiency, etc.
b) Performance testing of DG set for 8 hours. .
c) Capacity testing of the DG set.
d) Any additional testing as required as per relevant standards.
e) Fuel consumption of the DG set.

f) Complete functional tests.

g) Testing of the Sound Acoustics enclosures.

h) Fault Simulation and testing of control & protection devices.

7.6.5 Copies of all the documents of routine tests & type test certificates of the equipment carried out at the manufacturer premises shall be furnished to the Engineer in charge along with the supply of the equipments and these are as below.

a) Routine Test:-

1. Engine separately
2. Alternator Separately
3. DG Set

b) Type test certificates.

1. Engine.
2. Alternator.
3. Pumps.
4. Meters.
5. Governors.
6. All major components.

7.7 DG Sets Site Checking and Inspection

Site Inspection & checking will be done on the each installation site by the contractor and a detailed report about the site installation conditions is to be submitted to the" Engineer" before the installation of the DG sets at the site. The contactor should take all care about the sound attenuation requirements of the Zone/area under which the DG set is being installed & location of its placement.

The metro stations of the Phase-1B are being constructed in the residential/silence/hospital areas. The noise pollution standards, requirements will vary in the residential/silence/hospital areas. The noise pollution standards are required to be complied with according to the latest Noise pollution control norms as applicable at the time of the delivery and execution of the work.

7.8 DG Sets Commissioning and Acceptance Tests

7.10.1 Tests shall be carried out on each DG Sets in accordance with the relevant standards, which shall include but not be limited to the following:-

The following site test are required to be performed after the Installation of the DG sets

a) DG set working test.

b) Load test of the each DG set (with the Essential station loads applied as per sequence)

c) Synchronization of the DG sets.

d) Earthing and bonding checks.

e) Electrical parameter.

All instruments, material, consumables (fuel oil, engine/lube oil etc), engineers and labour required for carrying out at site testing of the DG sets shall be provided by contractor and test shall be witnessed by engineer's representatives.

7.9 Interface and Integrated Tests

The Contractor shall co-ordinate and carry out interfacing and integrated testing together with other System-wide Contractors to ensure that the all integrated systems function as desired. The integral testing & commissioning will be carried out with other system contractors such as Tunnel ventilation System (TVS), E&M Contractor, Environmental Control System (ECS) Contractor and Building Management System(BMS) contractor, with the loading of the DG sets in the sequence & schedule. The contractor has to interface with all the contractors to get the testing done. The system shall be taken over only after the completion of the Integral testing & commission done at all the stations of the schedule/section.

7.10 Certificate of Taking Over

The final acceptance tests of each item of equipment shall be undertaken in the presence of the "Engineer", in accordance with the test specification. Any defects and/or deviations discovered without prior written approval during the tests shall be rectified at the Contractor's own expenses. These shall be entered into a defects list agreed between the Contractor and the "Engineer". The Certificate of Taking Over will not be issued until these tests have been completed and the defect list substantially reduced to such an extent that the "Engineer" considers that the equipment is safe for operation.

7.11 Certification

Upon completion of each DG Sets the Contractor shall submit to the Employer, a Certificate of Supervision issued by the Contractor's Professional Engineer, in a format acceptable to the "Engineer".

APPENDIX-A -CAPITALIZATION OF ADDITIONAL FUEL-OIL

The evaluation of bids shall inter alia take into consideration the fuel efficiency of the diesel engine. For this purpose the bids **shall be loaded by capitalized cost of additional fuel oil consumption** over and above the base consumption at 100% of rated output of the diesel engine. The lowest values of fuel oil consumption at 100% of rated output quoted by the technically compliant bidder shall form the basis for the purpose of comparison and shall be taken as base consumption. The bidders shall indicate fuel-oil consumption in litres per hour at 100 % of rated output of the diesel engine.
The fixed parameters for evaluating the capitalized cost shall be as under: -

1. Life of the diesel engine — 15 years
2. Operating period — 30 hrs.
3. Cost of fuel oil per litre — Rs. 51 per Litre.
4. Rate of interest — 12%

The parameters to be supplied by the bidder are: -

(a) Fuel oil consumption at 100 % of rated output of the diesel engine as per BS-5514 …l/h

Additional fuel-oil consumption will be capitalized by the following formula and shall be loaded on their financial bid for financial evaluation purpose

$$PW = K*30*\left[\sum_{n=1}^{n} \{CF*Fn*Nn\}\right]$$

- PW is the present worth (in Indian Rupees) of annual fuel oil consumption at 12% rate of interest over 15 years
- K is the present worth factor (12% interest, 15 years) $= \frac{\{(1+0.12)^{15} - 1\}}{\{0.12*(1+0.12)^{15}\}} = 6.811$
- Nn is number of DG sets of respective sizes.
- CF is the cost of the fuel oil - Diesel per litre in Indian Rupees
- Fn is the additional Fuel oil consumption over and above the base consumption at 100% of rated output of the diesel engine in l/h for respective size of DG set

In case the fuel-oil consumption during the prototype tests are found greater than the values guaranteed in the offer, a consolidated penalty shall be paid by the contractor according to the following formula:

K*30* {CF*dF} for the respective DG Set.

- dF is the differences between the actual test values of fuel-oil and lubricating oil consumption and the values guaranteed in the offer

DECLARATION TO BE GIVEN AFTER INSTALLATION DG Sets

Contract No: - **Date:-**

We confirm that the work is done as per CEA safety regulations 2010 and tested as per applicable specifications for (a) continuity (b) Insulation resistance (c) Other tests as applicable, with our own equipments, without any additional cost to purchaser. We further confirm that in case the test values are found outside the permissible limit, suitable corrective action will be taken by us without any additional cost to purchaser, JAIPUR Metro Rail Corporation Ltd. The test results will be recorded in presence nominated representative of JMRC.

Signature of Engineer

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 8

ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS

8 ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS (EMC)

8.1 General

The requirements stated below must be read in conjunction with the other EMC requirements mentioned in GS.

The contractor shall take adequate measures to reduce conducted, induced, and radiated emissions, especially the levels of harmonics, to acceptable values as specified by the relevant international standards or by the concerned statutory authority.

8.2 Inter-System EMC

8.2.1 The various electrical systems installed on the Railway under Construction will after installation interact with each other by mutual coupling and all plant and systems shall be designed so that there is no malfunction due to interference.

8.2.2 The Contractor shall ensure that all equipment supplied shall have minimum Radio Frequency Interference introduced onto the main network and comply with the Electromagnetic Compatibility (EMC) requirements of the following standards:

EN 50081-1 : EMC Generic Emission Standard

EN 50082-2 : EMC Generic Immunity Standard

8.3 Harmonic distortion

The total harmonic distortion (THD) caused by the DG Sets equipment to the supply mains at the power supply input terminals of the DG Sets shall not exceed the following values when the DG Sets is travelling up at full load and rated speed:

Rated load Current (I_L)	THD (%)
200A $\leq I_L <$ 400 A	< 12.0
20A $\leq I_L <$ 200A	< 15.0
$I_L <$ 20A	< 20.0

8.4 Installation and Mitigation Guidelines

IEC1000-5 series of guidelines must be observed wherever applicable.

8.4.1 Earthing

An earthing system should be designed to assure personnel safety and protection of installations against damage. It should also serve as a common voltage reference and to contribute to the mitigation of disturbances.

To achieve the primary goal of assuring personnel safety and damage control, a low impedance path must be made available to large currents generated due to lightning or power system fault. The potential differences (touch and step voltages) between any two points must be as low as possible. Safety considerations also require the chassis or enclosure to be earthed to minimise shock hazards to passengers and the maintenance staff.

To achieve the secondary goal of providing protection for sensitive and interconnected electronic and electrical systems, earthing should be designed to minimise the noise voltage generated by currents from two or more circuits flowing through a common earth impedance and to avoid creating earth loops susceptible to magnetic fields and differences in earth potentials.

Earthing shall also be designed to accomplish the following minimum requirements:

i) Protect personnel and equipment from electrical hazards, including lightning, where practical.

ii) Reduce potential to system neutrals.

iii) Reduce or eliminate the effects of electrostatic interference and electromagnetic interference arising from within the system.

iv) Provide a single-point earthing method for all equipment enclosures, cabinets, drawers, assemblies and sub-assemblies.

v) Provide a clean zero-volt reference point for signals in computer and related equipment.

8.4.2 Bonding

Bonding all exposed metallic parts of all equipment and connecting them to the earthing network is a way for meeting safety requirements and minimise noise voltages due to potential differences.

Direct bonding should be used wherever practical. Where indirect bonding via bonding strap is used to connect two isolated items, the bond must satisfy the following minimum requirements and prevailing international standards, for example, IEC1000-5-2.

i) Low bonding resistance from DC to at least 2 Ghz.

ii) Low bonding inductance from DC to at least 2 Ghz.

iii) Proper bonding procedure, including appropriate surface treatment before and after the bonding process is adopted.

iv) Proper use of bond material to reduce electrolytic corrosion.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 9

INTERFACES

9. INTERFACES

9.1 Interfaces

The Contractor shall interface the design and construction of the Works with that of other contractors, principally the Contractors for the Designated Contracts as defined in the General Conditions of Contract. The Contractor shall keep the “Engineer” fully informed in respect of such interfaces, such information being given to the “Engineer” in a manner and form and at such intervals as stated in the Contract or as required by the “Engineer”.

Contract Package for:

Signaling, Communications and Train Control

This contract provides for signalling and automatic train control systems including equipment in the station control rooms and the Operation Control Centre (OCC) such as train mounted control equipment, relay room equipment, independent telephone networks including automatic switching centers and exchanges, main trunk cables, direct telephone lines, communication equipment, emergency telephones, closed circuit television, radio communication and all non-power SCADA system.

Automatic Fare Collection

This contract provides for the revenue control system at stations, including automatic ticket vending machines, barriers, manual control and checking equipment and electronic linkages to station control rooms and the Central Control room.

Rolling Stock

This contract provides for air-conditioned rolling stock in rakes of up to 8 coaches.

Civil, E&M and VAC

The Contract provides for Civil and E&M works including the stations & tunneling. The E&M works include stations lighting, 415V AC distribution, tunnel ventilation, station air-conditioning, fire protection system etc.

The Contractor shall co-ordinate with these Contractors for design as well as installation related issues as part of his interface responsibilities The relevant Contractors shall be referred to as Designated Contractors in this specification.

9.2 Interface Responsibilities

The responsibility for specification and provision of the requirements for the works which interface with Designated Contractor's equipment are tabulated in interface matrix given below.

The list describes the interface requirements between Designated Contractors, which includes Civil Contracts, E&M Contract etc. and this Contract.

The list shall be read in conjunction with the relevant clauses of the Employer's Requirements. The Contractor shall be responsible for ensuring that all requirements of the specifications pertaining to interfaces are properly satisfied.

This list outlines the interfacing requirements during the execution of the Works. However the requirements herein specified are by no means exhaustive and it remains the Contractor's responsibility to develop, update and execute jointly an Interface Management Plan (IMP) after the commencement of the Works and throughout the execution of the Works to ensure that:

a) All interface issues between the contractor and the Designated Contractors are satisfactorily identified and resolved; and

b) All the construction tolerances at the interface shall meet the requirements of the respective specifications relating to the interface points.

Where details of the contractor's design of this contract are required to enable the Designated Contractor to implement interface works, the Contractor shall provide the Designated Contractors with the necessary information including, but not limited to, those described in the summary table appended to this requirement. The level of information provided shall be in sufficient detail to enable the Designated Contractors to design and / or construct the required interface works.

The Contractor shall take a lead in developing the Interface Management Plan. The IMP will be prepared in conjunction with the Designated Contractors to cover all aspects of the implementation of the interface works required. The IMP will define the interface works necessary to complete all the works in this contract and is not limited to those listed in the summary table attached.

Should it appear to the "Engineer" that the progress of the Works, Works Programme or the Three Month Rolling Programme does not conform with the IMP, the Contractor shall be required to revise all such programmes and plans such that they do reflect the progress of the Works, are mutually consistent and conform to other provisions of the Contract.

The Contractor shall review the details of interface works and notify the "Engineer" of any amendments to the summary table required in the process of his works. Unless such requests are reviewed without objection by the "Engineer", the Contractor shall design and construct the works in accordance with the provisions outlined in the list of Interface.

9.3 Scope of Work of Interface Management Plan (IMP)

The information and scope of works to be provided by the Contractor include but are not limited to those outlined in the list of Interface of this PS. The list only defines those tasks at the interface point and is not a complete itemisation of the Scope of Work

The Designated Contractors shall liaise with the Contractor in the design, installation, testing and acceptance of works.

The Contractor shall provide all access and attendance necessary in accordance with the contract requirements.

Where the Contractor's works are identified as failing to meet the requirements of the contract and which will impact the Designated Contractor's works, the Contractor shall

submit the proposed remedial measures to the “Engineer” for review and shall copy the same to the Designated Contractors.

9.4 LIST OF INTERFACE ITEMS FOR DG SETS IN UNDERGROUND STATIONS

All System Contractor to display interface/dependency boards at site in suitable format, so as concerned contractor/department and inspecting officials are aware of the requirements. Architect/DDC to ensure that interface requirements are met with while issuing GFC drawings. All system contractors to ensure it & sign off. Interface with concerned contractor is the responsibility of contractor. Engineer will provide the contact detail of concerned contractors to system contractor to facilitate timely interface.

If they fail to timely ensure, it will be contractors responsibility to get it done. Not getting it done will attract imposition of penalty.

1.BEFORE ERECTION

1	To ensure integration of DG Sets in station drawings	ARCHITECT/DDC
2	DG Set foundation	CIVIL
3	Trench layout for cabling	CIVIL /E&M
4	Accostics requirements of room	CIVIL /E&M
5	Ventilation/Exhaust Cutouts	CIVIL
6	Elctrical Panel location	CIVIL/ E&M
7	DG set Cooling Tower (if required)	CIVIL
8	Water requirements for DG set	CIVIL
9	Proper access to installation site	CIVIL
10	Storage of material at station/depot	Civil
11.	BMS requiremenrts	E&M Contractor

2. DURING ERECTION

1	Power & control Cabling	E&M CONTRACTOR
2	Installation of DG set- cooling system, exhaust	CIVIL/ E&M
3	Power supply	E&M CONTRACTOR
4	Earthing	E&M CONTRACTOR
5	Signage	ARCHITECT DEPARTMENT

3. AFTER ERECTION

1	Sealing of cutouts/holes	CIVIL
2	Testing and commisioning at site after installation	E&M CONTRACTOR
3	Complete Integral Testing with all the systems	E&M / TVF/ ECS/ BMS CONTRACTORS
4	Approval of the EIG	E&M

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 10

SITE ARRANGEMENTS

10 SITE ARRANGEMENTS

10.1 General

10.1.1 In addition to the general conditions and provisions of the Site as described in the General Specification, this Section of the Specification sets out the site arrangements, conditions and requirements for the delivery and installation of the DG Sets supplied under this Contract.

10.1.2 Methods and procedures may vary depending upon site conditions which shall be discussed and agreed with the “Engineer” during the planning and installation stage but the Contractor shall make provision for alternatives in the methods and procedures provided that the basic criteria for delivery and installation as described below remain unchanged.

10.1.3 The conditions and requirements set out in this Section of the Specification shall not relieve the Contractor of his responsibility to deliver the equipment in time to meet the approved programme as defined in Chapter 16 of this Particular Specification and to install the Plant in accordance with the Specification.

10.2 Access and Power on Dates

10.2.1 The Contractor shall note that no exclusive possession of the Site will be granted. The Contractor will be required to work with the Designated Contractors, the Interfacing Contractors and other contractors.

10.2.2 The Contractor shall take note of the access and power on dates shown in the “Engineer” Preliminary Programme and Project Calendar. Except approved by the “Engineer”, the Contractor shall not have exclusive access to the designated areas.

10.3 Works Areas

10.2.3 The Contractor shall coordinate with the Designator Civil Contractor for the works areas allocated within the site in which he may erect offices, workshops and stores. The contractor has to provide the detailed requirements, upon which area will be allocated to the Contractor, Area allocated and the period of availability will be as per the work schedule. The request is to be made to Engineer in Charge for the allocation of land.

10.2.4 The Contractor shall allow for transportation of all materials and equipment to the Works Areas and from the Works Areas to the Site.

10.2.5 The Contractor shall note that works trains are not intended for transportation of material and equipment except to those locations where road access would not normally be available. The Contractor shall coordinate with the relevant Designated Civil Contractors for delivery of major equipment by road access.

10.2.6 General attendance and other services will be made available at the Works Areas in accordance with the General Specification.

10.2.7 The Contractor shall be responsible for the cleanliness and tidiness of the Site after each period of work.

10.2.8 At the notice of the Engineer in Charge, the Works Area shall be returned to the Employer. The Contractor shall remove all facilities erected by the Contractor at the Works Areas before returning the Works Area to the Employer.

10.4 Delivery

10.4.1 Methods of Delivery

The method of delivery of DG Sets to site shall be by road, and access to the Works Areas through a station entrance, and/or temporary access openings if provided, and via a route within the Site. The Contractor shall be responsible for arranging access into the Site with the Designated Contractors for the stations' works. The Contractor shall co-ordinate the routes and time of entry into the stations with the Designated Contractors. The delivery route within the stations shall be agreed between the Contractor and the Designated Contractors. The access plan of each station shall be submitted for the "Engineer" Approval.

The locations and size of the access openings and the size of working area around each opening will depend on site and local traffic conditions and shall be agreed by the "Engineer". The method of delivery for each station shall be governed by the overall installation programme of JAIPUR MRTS and be subject to the "Engineer" Approval, whose decision shall be final.

10.4.2 Delivery, Access to and Through the Site

The Contractor shall make provisions to deliver his equipment by vehicles into the working area around the access opening. In the event that the working area is not large enough or the local traffic conditions cannot permit any container vehicle to gain access into a particular working area during normal working hours, the Contractor shall make arrangements to deliver the equipment by trucks and unload the equipment within a limited working area allocated by the "Engineer".

When it is unlikely that a mobile power crane can be used within the vicinity of the access opening due to restricted site conditions, the Contractor shall arrange to maneuver his Plant by smaller traction equipment from the unloading working area into the access opening and Works Areas.

Transportation, unloading and delivery equipment such as hoisting frames, gantries, DG Set tackles, chain blocks, trolleys etc., required for delivery, shifting and equipment access to the Works Areas shall be provided by the Contractor, unless otherwise specified herein or as Approved by the "Engineer".

The Contractor shall provide a Schedule of major deliveries of Plant for each station to the "Engineer" at least 2 months prior to the first delivery.

Each DG Sets shall preferably be installed into position immediately after delivery to Site. Long period of storage inside the station will not be allowed, unless written permission has been received from the "Engineer".

10.5 Installation

10.5.1 It is desirable that the installation time of DG Sets on Site shall be kept to a minimum and the proposed design shall take due account of this requirement.

10.5.2 The Contractor's attention is drawn to the restrictions on working area available on Site and shall make his own arrangements to store materials and equipment off-site or at the Depots until such time as they can either be incorporated into the Works or stored within the working area assigned to him.

10.5.3 The Contractor shall co-ordinate with the Designated Civil Contractor for foundations/ trenches, cutouts etc. required at the site for installation of the DG set. Safe working load of such equipment shall be stated and relevant testing certificates shall be submitted for the “Engineer” Approval.

10.5.4 All other equipment as required for installation purposes of DG sets shall be provided and installed by the Contractor.

10.6 Care of Works

10.6.1 The Contractor shall protect the equipment within his own reasonable control, particularly in normal construction site conditions such as dust, dirt, plastering and small particles which may possibly damage the equipments and panels, if they are not properly protected. Such damage, if occurring, shall not relieve the Contractor of his responsibility to repair and/or replace these parts, depending on individual conditions, to the satisfaction of the “Engineer”.

10.6.2 The contractor shall provide adequate protection to the DG Sets during the Stop Work Period and before handing over of the complete installation to the Employer. The protection shall not be removed unless instructed by the “Engineer”.

10.7 Material Recovery

10.7.1 The Contractor shall remove all redundant materials and cables from Site. The Contractor shall handle all redundant equipment with care and deliver to a location designated by the “Engineer” where it shall be stored in a neat and orderly fashion.

10.7.2 Recovery work shall occur after the completion of every stage of the above mentioned Works and as directed by the “Engineer”.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 11

PACKAGING, SHIPPING AND DELIVERY

11 PACKAGING, SHIPPING AND DELIVERY

11.1 General

All the stipulations laid down in the GS shall apply.

11.2 Packaging and Shipping

12.2.1 All equipment Goods and materials shall be properly inspected to ensure that there are no defects before shipment. An inspection tag bearing the words “INSPECTION PASSED” giving reference number to the inspection date and details to permit verification of inspection details shall be attached to those items inspected satisfactorily.

12.2.2 The four adjacent sides of each package shall be marked with permanent paint with the following information:

CONSIGNEE
COMMODITY
CONTRACT No
SHIPPING MARK

12.2.3 Appropriate caution notices such as “FRAGILE”, “HANDLE WITH CARE”, “KEEP DRY”, KEEP UPRIGHT” along with visual display symbols internationally accepted shall be conspicuously displayed on the outside surfaces of boxes, crates and packages.

11.3 Delivery

13.7.1 The Contractor shall be responsible for transportation and delivery of materials to site or to the storage space and shall continue to be responsible for its safe storage, handling, erection and commissioning.

PROFORMA OF TEST CERTIFICATE TO BE ISSUED BY THE CONSIGNEE AFTER SUCCESSFUL COMMISSIONING OF MACHINE/EQUIPMENT

Contract No:- Date:-

Sub:- Certificate for Commissioning of Machine/Equipment.

This is to certify that the machine as detailed below has been received in good condition along with all the standard and special/optional accessories and same has been installed and commissioned and dispatched.

1. Purchase order No.:-
2. Description of Machine:-
3. Machine S. No:-
4. Quantity:-
5. Bill of Lading No.& date:-
6. Name of Vessel:-
7. Railway receipt no.& date:-
8. Name of consignee:-
9. Date of receipt of machine:-
10. Date of call to' the supplier after site/foundation etc. is ready:-
11. Date of commissioning:-
12. Details of accessories! spares not yet supplied & recoveries to be made on this account:-

S.No.	Description	Amount to be recovered
1.		
2.		
3.		

Signature----------

Name ----------

Designation ----------

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 12

MAINTENANCE REQUIREMENTS

12. MAINTENANCE REQUIREMENTS

12.1 Maintenance

In addition to his obligations under the Conditions of Contract, the Contractor shall provide maintenance services throughout the Defects Liability Period (DLP) and also for the specified period for all the DG Sets supplied under the Contract. Maintenance work shall include attendance to all service calls, work described in approved Maintenance Schedule, and the followings:

12.1.1 All defects shall be remedied either when observed on the weekly service call or on an attendance to a service call. Service shall include all work necessary to maintain the entire DG Sets system in good working order at all times.

12.1.2 The Contractor shall maintain adequate quantity of consumable and contingent spare parts as per agreed list at site in order to minimize the shut down time due to repairs and maintenance. All parts rendered defective, including replacement of indicator lamps and programmable circuit board, shall be replaced by the Contractor.

12.1.3 The Contractor shall dispatch competent personnel to rectify stoppages at any time during the day or night when being called on by the Employer within a time of half an hour (maximum). Repairs shall be carried out on a 24 hours per day, 7 days per week basis until the faulty unit / DG Sets is put back in service.

12.1.4 The Contractor shall carry out periodic testing and examination of equipment safety devices as may be required by the provisions of any enactment in force relating thereto or of any enactment, regulations or by-laws of any local or other duly constituted authority which may be applicable to such tests and to provide such copies of the test certificates, duly signed by a Registered DG Sets “Engineer” and Registered DG Sets Contractor, as may be required. A master schedule of such planned tests shall be submitted to the Employer at least two months before commencement of the DLP.

12.1.5 The Contractor shall provide quarterly and half-yearly reports on the condition of the equipment in an agreed format. Such reports shall include event logs and performance data collected from the associated indicative panel stored on diskettes or other agreed medium, over the reporting period. Such data shall enable off-line individual and fleet statistical analysis to be performed on a Personal Computer.

12.1.6 A report in duplicate shall be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored. The monthly summary of failure report along with the analysis giving details of nature of fault, remedial action taken etc in the approved format shall be provided.

12.1.7 Reports on routine visits are not required except where necessary to draw attention to defects of a minor nature, which could not be rectified during the routine visit. Records of each routine visit and call-out visit, together with details of the work done or action taken,

shall be entered on a log book which shall be provided by the Contractor and retained in the location as decided by the “Engineer”.

12.1.8 Not Used

12.1.9 The Contractor shall provide a maintenance plan and a major component replacement programme for review and acceptance by the “Engineer” 90 days before the programmed commencement of the Defects Liability Period.

12.1.10 The Maintenance service shall include all Preventive/Scheduled & Corrective Maintenance. In this context, the Contractor shall submit a PM Schedule and CM procedure for Approval, 3 months before the commencement of the DLP.

12.1.11 In order to ensure that the system functions satisfactorily and Customer Service requirements using the minimum resources, the Contractor shall conduct a detailed Maintenance Requirement Analysis to derive a complete list of preventive maintenance schedules and procedures under the Contract. The Maintenance Requirement Analysis shall identify for each system function the potential functional failures, the failure consequences and the appropriate maintenance approach. failure report analysis shall be submitted quarterly during 2 years DLP.

Based on the Maintenance Requirement Analysis, the Contractor shall indicate in the Maintenance Plan, the final preventive maintenance programme, the proposed skill and manning level, spares level and special tools require. The proposal shall be fully traceable to the maintenance Requirement Analysis output.

The Maintenance Requirement Analysis shall be submitted as part of the maintenance plan, under the main contract bid submission. However, bidders will be allowed to defer submission of this Analysis, latest 12 months before the commencement of the Defect Liability Period, by presenting formal written request for such deferral.

12.2 Employer’s Maintenance Strategy

12.2.1 Maintenance Strategy

The Contractor shall ensure that the system designed, installed and commissioned is supportable throughout the service life of the System to address, as a minimum, the following:

Design errors in the System;
Operational changes;
Environment changes; and
Changes in infrastructure.

According to the maintenance strategy, all equipment and infrastructure supplied for the ‘Project’ must be designed for minimum or no maintenance. Maintenance activities required must be capable of being performed with little or no impact on the train service. In addition, the maintenance work systems shall ensure safety of personnel and equipment.

12.2.2 The Contractor, upon noticing any defects, deficiency in quality and quantity of spares and materials shall without delay, arrange for alternative source of supply and submit his proposal to the “Engineer” for review.

12.3 Maintenance during DLP

During the 2 years’ DLP period, the contractor shall carry out all type of preventive and breakdown maintenance. The preventive maintenance would be done during non-traffic hours whereas breakdown maintenance would be done whenever breakdown occurs. The acceptable response & attention time also needs to be mentioned for minor & major breakdowns.

12.3.1 **Maintenance Management System (MMS) and Maintenance Arrangement**

During non-operation time, sections of line will be closed for maintenance work. The minimum time for possession periods is 6 hours. Ideally, this time shall be the free time available for maintenance.

12.3.2 **Competency of Personnel**

During the DLP the Contractor shall depute sufficient trained and competent personnel for maintenance purpose.

Such persons shall have their generic competence established and must demonstrate their specific competence and knowledge in the particular systems, environment and procedures.

The Contractor shall provide evidence of specific competence and knowledge, which shall include:

- assessment and certified training in particular applications and operations;
- recording of competence and work in the license holders logbook; and
- receiving or in receipt of sufficient and current exposure to the area of work that the holder is licensed for.

Routine spot checks on licensing may be carried out from time to time by the “Engineer” qualified personnel on the proficiency of the Contractor staff.

In the event of a failure, the Contractor shall undertake the management and investigation necessary to identify and rectify the cause.

12.3.3 Testing and Re-commissioning of System and Equipment

In the event of a failure requiring modifications to the System, the Contractor shall undertake any testing and re-commissioning required. Any such modification shall be submitted for review by the “Engineer”.

12.3.4 Temporary Alterations to Restore Service

The Contractor shall undertake any temporary modifications necessary to maintain service. Any such modification shall be submitted for review by the “Engineer”.

12.3.5 Discrepancies between Installation and Design Records

Should the Contractor discover inconsistencies between the maintenance drawings and documentation and the installed equipment, the Contractor shall correct all such errors within two weeks.

12.3.6 Communications

The Contractor shall ensure that adequate communication facilities are provided to its staff during the DLP.

12.3.7 Location of Staff

The Contractor shall be responsible for locating staff such that the Contractor meets its obligations.

12.3.8 Not Used.

12.3.9 Maintenance Regimes

The Contractor shall produce a maintenance regime for the equipment that shall comprise two constituent parts, corrective and routine/preventative maintenance.

Corrective maintenance shall be available 24 hours per day, able to respond to all foreseeable circumstances.

The maintenance regime shall cover all parts and equipment of the system designed, installed and commissioned by the Contractor.

The Contractor shall take into account the requirements of the operations and maintenance when determining and proposing its maintenance regime.

12.3.10 Scope and Hours of Coverage

The regime and structure of corrective maintenance shall be robust in design.

The Contractor shall provide full 24 hour On-Call coverage and shall be such that initial response and rectification of failure are in accordance with the following:

- assistance for first line corrective maintenance within 1 hour, upon request of first line maintainer;
- Within 24 hour from notification for second line maintenance where spare parts replacement is involved; and
- within 2 weeks including transportation time for third line maintenance where replacement or repair of component from factory is involved. Any extension to this time shall be agreed with the “Engineer” and a replacement provided.

All elements of First Line preventative maintenance shall be carried out and completed during non-traffic hours without interrupting train services. Similarly, all elements of second line & third line maintenance also needs to be completed during non- traffic hours.

12.3.11 Failure Investigations

The Contractor shall conduct failure investigations.

Disputes between the Contractor and other Contractors will be resolved by the “Engineer”.

The Contractor shall make available to the Employer all test and failure data as required.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 13

SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

13. SPARES, SPECIAL TOOLS AND TEST EQUIPMENT

13.1 General

13.1.1 The Contractor shall arrange special tools, manpower and test equipment to facilitate the maintenance, repair and overhaul of the DG Sets effectively and efficiently while ensuring their performance to a high standard of safety and reliability consistent with the requirements as detailed in this Specification.

13.1.2 In the event that rectification and/or modifications are introduced to any part of the equipment which are deemed necessary by the “Engineer” in order to comply with the Specification requirement, the Contractor shall modify and replace all spare parts and/or special tools whether delivered or otherwise.

13.1.3 The Contractor shall guarantee that the test equipment supplied shall be well calibrated in accordance with manufacturer's instruction. Appropriate calibration certificates shall be required by the “Engineer” for checking prior to carry out testing and commissioning.

13.2 Commissioning and DLP Spares

The Contractor shall recommend and provide a list of commissioning and DLP spares with sufficient quantities to ensure the successful completion of the testing and commissioning activities and covering of DLP.

13.3 Special Tools

13.5.1 The Contractor has to arrange all necessary tools for normal as well as emergency operation for each DG Sets, shall be provided by the Contractor at the time of trial Operations at site during commissioning.

13.5.2 The Provision of the special tools used during erection testing and commissioning under this part of the Particular Specification shall be deemed to have been included in the Contract.

13.5.3 Certain items of these special tools shall be fixed on to a shadow board or housed in a container mounted at an approved location. Details of the arrangement will be given to the Contractor by the Engineer during the installation stage.

13.4 Second Sourcing for Non-Proprietary Items

13.6.1 The Contractor shall identify principal source suppliers that can supply the Mandatory Spares. For non proprietary items the contractor shall submit the list of alternate / second source of suppliers.

13.6.2 The Contractor shall ensure that second-source supplier information is maintained up to date up to a period of 10 years after taking over of whole works. The Contractor will provide support to the Employer to a reasonable extent regarding the second-source supplier information throughout the service life of the system.

13.6.3 The Contractor shall make the second-source supplier information available to the “Engineer” at the time of submission of the final design and taking over of the works.

13.5 Long Lead Times

13.7.1 The Contractor shall identify the lead times for all spare parts. Parts with long lead times shall be identified in the spares list.

13.6 Routine Change

In the event that any item of the supply requires to be routinely changed or calibrated, regardless of whether it appears in the spares list or not, it shall be identified to the "Engineer" together with the routine change interval.

13.7 Shelf Life

In the event that any of the spares identified have a particular life or storage requirement, this shall be made known to the "Engineer" with the submission of the spares list, including the necessary action for disposal or storage.

13.8 Price of AMC Charges

The Contractor shall furnish price for 3 years comprehensive AMC rates beyond the DLP. The details shall be provided in BOQ

13.9 Vendor Approval Policy

Refer Chapter-17 of this PS for vendor approval Policy.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 14

TRAINING AND TRASFER OF TECHNOLOGY

14. TRAINING AND TRASFER OF TECHNOLOGY

14.1 General Requirements

This section of the specification covers the requirements for a Training Program to train the Employer's maintenance, operations and training personnel. The training Program shall enable the staff to operate, service, enhance, maintain, and interact with, the hardware, software, and firmware, such that the DG Sets systems and associated equipment will perform in accordance with the specifications of this contract.

The Contractor shall provide comprehensive training to the Employer's staff, including Employer's training Instructors. The Contractor shall provide competent training instructors, training manuals, all necessary aids and materials in support of all training courses. The training manuals shall be submitted in original plus five hard copies and in electronic format.

The training instructors shall be qualified, competent, with sufficient years of practical experience in the relevant fields and possesses good communication skills.

The training instructors shall be competent staff of the Contractor, or the subcontractors or the equipment manufacturers.

14.1.1 The training shall be carried out at such locations where the greatest benefit for trainees may be gained. This may be in India, abroad, at place of manufacture, assembly or testing, or at such other locations as may be necessary. All places of training shall be subject to review by "Engineer".

14.1.2 The training courses and/or sessions shall include system performance requirements and all major equipment and works designed, by the Contractor.

14.1.3 The Contractor shall provide full-time on-Site management and co-ordination of the entire training programme to ensure the continuity of classes, and proper distribution of training materials, and be responsible for interfacing with the instructors.

14.1.4 The training courses shall be delivered to all relevant Employer's staff, including instructors, operation and maintenance engineering staff.

14.2 Scope of Training

The training shall be provided by the Contractor to the Employer's personnel in design, manufacturing, testing, system architecture, operation, monitoring and installation practices related to DG Sets. This will cover training in India and abroad including training at manufacturing facilities.

14.3 Training Programme

Contractor shall submit a training programme for imparting training to JMRC employees with batches of approximately 20 trainees for DG Sets systems in following areas:

S. No	Description	Total Period (Trainer working days)	Remarks
1.	Operation and maintenance practices for DG	30	At suitable

S. No	Description	Total Period (Trainer working days)	Remarks
	Sets including trouble shooting, fault diagnosis and emergency handling.		locations (In India)

14.4 Training Plan

The Training Program shall be prepared and submitted by the Contractor as per requirements of GS/PS.

14.5 Training Courses

14.5.1 The Contractor shall provide Training Courses on all facilities, systems, equipment, hardware, and firmware, software. Each Course shall be specific, and shall consist of classroom, hands-on, or field training as necessary to accomplish the Course Objectives specified in the Training Program Plan.

14.5.2 All station operation & security staff needs to be trained in emergency handling.

14.5.3 All training aids shall be used during training followed by practical & demonstrations.

14.5.4 Trainer's kit may be used for imparting training in trouble shooting.

14.5.5 The Contractor shall provide training courses for each of the sub-systems, including, but not be limited to:

(i) Diesel Engine working & Maintenance

(ii) DG Sets Control, Protection, Function & monitoring system

(iii) Maintenance requirements of the DG sets & their maintenance schedules

(iv) Dos & Don'ts of the DG sets working.

Different types of training courses of each subsystem shall be provided for staff from different disciplines. Operations training courses shall be provided for the operations staff. Maintenance courses shall be provided for maintenance staff. Hands on training shall be provided to maintenance staff by simulating different problems & their troubleshooting. The Employer's Training Instructors shall attend all types of training courses such that the Employer's Training Instructors shall be able to subsequently train the Employer's additional staff in future in all aspects of operation and maintenance of the System.

14.6 Training Materials

The Contractor shall provide all Training Aids, Interactive Training Video CD, Training Materials, Training Devices, Special Tools, fixtures, models, or other equipment required to train Course participants.

Training Manuals are a convenient source document for use in the field.

For every lecture hand – outs with Interactive Training Video CD should also be given. The Contractor may prepare Training Manuals bi-lingual (i.e. in Hindi and English both) as per requirement of the project.

Training Manuals shall be separate from Operation and Maintenance Manuals.

The Contractor shall prepare Training Manuals, and submit them to the Employer for review and approval at least 60 days prior to the start of the Training Demonstration.

Throughout the Contract and DLP, it shall be the responsibility of the Contractor to supply the Employer with all changes and revisions to the Training Manuals.

Training Manuals shall become the property of the Employer.

The Contractor shall provide the master and five hard copies of the Training Manual as directed by “Engineer” for each course/subject.

The Employer reserves the right to copy all Training Manuals for use in Training Courses.

The contractor shall give complete training plan for each category of O&M staff well in advance before commencement of training which shall contain training details, training methods, training aids, profile of instructors etc. At least one copy of the training manual shall be submitted 3 months before the commencement of the training.

The Contractor shall, for each course, distribute one set of training handout for each trainee, one sets of trainer’s guide and three additional sets of training handout to the Employer before the commencement of the training course.

All the training materials shall be accurate and match with the actual design of the System.

All types of audio/visual aids shall be used during the training. The O&M staff shall be trained to cater all types of emergency situations.

14.7 Transfer of Technology (TOT)

Bidder shall submit the detailed plan of transfer of technology along with MOU with suitable Indian companies or company having proven track record and are working in related areas for all major systems/subsystems.

TOT shall be essential and shall include system assembly, installation, maintenance and software modification/customization and training of Indian Company’s personnel to cover;

All configuration/application programmes for DG Sets system for:

Engineering of extensions and upgradations of stations.

Re-engineering to suit changed application conditions.

Incorporation of additional features.

Incorporation of optional facilities.

Addition /Modifications to equipment and components

Maintenance of DG Sets.

The Transfer of Technology may require involvement of Indian Company’s personnel in design, manufacturing, testing and installation of DG Sets Sub-Systems during the Contract period. The Contractor shall undertake to supply or make arrangement with the original manufacturer to supply additional equipment required for replacement or upgradation of the DG Sets systems in future. The Contractor shall undertake to provide to the above Indian Company, during the life of the equipment ordered technical assistance in the form of additional drawings, maintenance practices and technical advice.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 15

OPERATION AND MAINTENANCE DOCUMENTATION

15. OPERATION AND MAINTENANCE DOCUMENTATION

15.1 General

15.1.1 The Contractor shall provide Operation and Maintenance manuals bi-lingual (i.e. in Hindi and English both), Interactive Training Video CD, As built drawings for use by supervisory, operating and technical staff of Employer.

15.1.2 Requirements of submission have been furnished in Chapter 11 of GS.

15.1.3 Each and every manual shall be divided into indexed sections explaining the subject matter in logical steps. Most manuals shall consist of A4-size printed sheets bound in stiff-cover wear-resistant binders clearly and uniformly marked with the subject matter and reference number. Where alternative sizes are proposed, (e.g. A5/A6 pocket books of schematic wiring diagrams) these shall be submitted for review of Employer' Representative. The binding shall allow for all subsequent changes and additions to be readily effected.

15.1.4 Information shall be provided in pictorial form wherever possible and shall include step-by-step instructions and views of the particular equipment including exploded views. Programmable equipment shall be supplied with sufficient flow charts and fully documented programmes to enable faults to be quickly identified and system modification to be undertaken at any time.

15.1.5 The Contractor shall provide clarifications and amendments to the Operation and Maintenance manuals as necessary during the Defects Liability Period or in AMC period(if applicable). Updates shall be provided for the originals and all copies.

15.2 Operation Manuals

The Contractor shall provide operation manuals explaining the purpose and operation of the complete system together with its component subsidiary systems and individual item of equipment. The characteristics, ratings and any necessary operating limits of the Equipment and Sub-systems shall be provided. The Operation Manuals shall focus on operation aspects under normal and emergency conditions. The operation manual shall be supplied at the same time when training manuals are supplied.

15.3 Maintenance Manuals

15.3.1 The Contractor shall provide particulars of operating parameters, tools for dismantling and testing, methods of assembly and disassembly, tolerances, repair techniques and all other information necessary to set up a repair and servicing programme.

15.3.2 The manual shall also include inspection/overhaul procedure and periodicity of various inspection/overhaul schedules in detail including the tools, special tools/plants, and facilities required. The manual shall be subject to review by the "Engineer".

15.3.3 The maintenance manual shall also include an illustrated parts catalogue of all plant supplied and shall contain sufficient information to identify and requisition the appropriate part by maintenance staff. The catalogue shall comprise 2 sub-sections.

15.3.4 The first shall be an alphanumeric parts list, which shall include the following information:

(i) Part number
(ii) Description
(iii) Name of manufacturer
(iv) Quantity and Unit
(v) Part number of next higher assembly (usually a line replaceable unit).
(vi) Cross-reference to figure number.
(vii) Category: e.g. consumable, line replaceable unit, repairable.
(viii) Life-expected life, Mean time between failure or mean distance between failure where available.
(ix) General or specific purpose

15.3.5 The second is a series of illustrations to indicate the location of each replaceable item which shall be clear and progressive with exploded views to enable parts to be identified easily by cross-reference with the alpha-numeric list.

15.3.6 Maintenance Manual shall include the following ;

a) Infrastructure required for the maintenance.
b) Maintenance check sheets for I line, II line & III line maintenance.
c) Illustration of DG Sets components, sub-assemblies, assemblies etc with a sketch.
d) Detailed explanation of safety items.
e) Detailed coverage of trouble shooting.
f) Reliability Centre maintenance (RCM), Maintenance Requirement Analysis, condition Monitoring based Maintenance & Reliability, Availability & Maintainability data.
g) Check Sheets & scope of work for comprehensive annual maintenance.

The Operation & maintenance manuals include the documents, presentations, electronic files, models etc as required for the complete demonstration of the working and maintenance of the DG sets. The price of Operation & maintenance Manuals is to be inclusive in the DG set supply as per the Bill of Quantities.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 16

PROGRAMME REQUIREMENTS

16. PROGRAMME REQUIREMENTS

16.1 General

The date of commencement of the commercial services of various section of JAIPUR MRTS project are defined in Clause 2.2.1 of Chapter 2.

In addition to the requirements specified in the General Specification, the Contractor shall programme the Works in accordance with a pre-determined sequence to meet various Key Dates and Access Dates so as to meet the Target Dates of commercial opening:

16.2 Key Dates

The contractor has to complete the work as per the Key dates as stated in the Annexure-1A of FOT. The work includes a number of stages. These stages are inter-related and essential to the completion of the DG Sets works to be achieved within the Key Dates.

The Key Dates indicated in the schedule of Key Dates are mentioned in terms of the time period reckoned from the commencement of the works, and the deliverables for each Key Date shall be achieved by the midnight of the last day of the week mentioned.

If the identified work is not achieved by the stated Key Dates, liquidated damages may become applicable as set out in the Contract.

16.3 Access Dates

The contractor shall require Access to information as well as to various locations at stations / depots / guide-ways etc, in stages, in order to plan his activities for time- bound completion of his obligations under the Contract.

The dates on which such Access becomes available are indicated in terms of the time period reckoned from the commencement of works, and shall mean guaranteed access by the mid-night of the last day of the week mentioned.

These sequence, timings and extent access within any location will be further refined and reflected in the Master Programme developed by the “Engineer”, based on the Installation Programme from the Contractor and Project Contractors.

The exact timing to access a specific location (or any part of the location) shall then be confirmed by the “Engineer” in the weekly Works Meeting during the construction stage.

Major installation works in the stations and ancillary buildings which require co-ordination with the Civil Project Contractors shall be followed as per the Co-ordinated Installation Programme to be prepared by the Civil Project Contractors.

END OF CHAPTER

EMPLOYER'S REQUIREMENTS
PARTICULAR SPECIFICATION

CHAPTER 17

LIST OF APPROVED MAKES

LIST OF APPROVED MAKES

Contractor shall use the material of approved make as indicated below unless specified other than BOQ or as approved by the Engineer.

The Contractor shall ensure the correct selection of the approved make meeting the specifications and application duties. Before placing order for procurement, the sample of approved make shall be got verified for its suitability to the specification and application duty. However, Engineers reserve the right to opt for best preferred listed make.

The Contractor shall quote the rate for material and equipment as per list of approved makes. In the event of the Contractor wanting to use alternate makes, other than those stipulated, for any reason, the contractor can submit a proposal as part of the bid after ensuring that what he proposes, at the least meets both the quality, and safety standard of the stipulated makes, and the financial benefit that will accrue to the Employer. He shall also stand full guarantee to his alternate proposal. The alternate makes can be used only after an approval accorded by the employer, whose decision will be final in the matter. The offer submitted should be fully technically compliant and the alternatives will not be part of the evaluation of Lowest bidder. Only the alternatives of the Lowest bidder will be considered.

S. No.	Item	Approved Makes
1.	Diesel Engine	Cummins, Caterpillar, Perkins, Deutz, MTU.
2.	Alternator	KEC, Stamford, NGEF, Leroy Somer
3.	GI conduit pipes ISI marked	BEC, AKG, Steel Kraft
4.	GI conduit accessories	Conforming to BIS as per approved samples
5.	Copper conductor FRLS, PVC insulated wires, IS marked	National, Ecko, Skyline, Finolex, Havells
6.	Modular System switches, socket outlets, and wiring accessories with molded cover plates.	Crabtree, MK Electric, CPL-obsession, North-west, Roma (Anchor), MDS-Legrand, LK(Schneider), SSK
7.	Miniature circuit breakers / Residual Current Earth Leakage circuit breakers	L&T Hager, MDS-Legrand, Siemens, Merlin-Gerin, ABB
8.	MCB Distribution Boards	L&T Hager, MDS-Legrand, Siemens, ABB, INDO-ASIAN, HAVELL'S, GE, Schneider
9.	Moulded Case Circuit Breakers (compact design)	L&T, Siemens, ABB, Merlin-Gerin, ABB, MDS-Legrand,
10.	Switch fuse units with HRC fuses	L&T, Siemens, Control & Switchgear Ltd., ABB, Merlin Gerin, GE, Crompton Greaves
11.	415 volts ACB's	L&T, Siemens, ABB, Merlin Gerin
12.	Protective Relays	Alstom, ABB, L&T, Siemens, Merlin Gerin, BCH
13.	PLC make	Woodward, Power-R-CON, DIEF, Schneider, Allen Bradely, Siemens.
14.	AMF Panels	Tricolite Electrical Industries, ECS, L&T, GE, Associated Switchgears, Schneider, Unilec, Neptune, Anand Power, Adlec, ABB, Sudhir Genset Limited.
15	Silencers	Neilson or any other equivalent confirming the CPCB Norms.

17.1 Vendor Approval

It shall be obligatory for the Contractor to obtain Notice of 'No Objection' from the Engineer for the selection of the vendors for all items of work, even if the name of the vendor is specified in the Contractor's Technical Submission and the works to be done including purchase of materials and equipment is in accordance with the Standards specified in the Contract.

In case of vendor selected from the approved list provided in the contract,

(a) A list of approved vendors is provided. These are the vendors, who have been approved by JMRC in such installation of JMRC commissioned earlier.

(b) Contractor in general shall use the material of approved make as per approved vendor list unless specified in BOQ or makes meeting the bid specifications as approved by the Employer's representative.

(c) The contractor shall ensure the correct selection of the approved make meeting the specifications and its application. Before placing the order for procurement, the sample of approved make shall be verified for its suitability to the specification and application. In case Employer's representative/ engineer, (whose decision will be final and binding on both parties) considers that the make/ model proposed by the contractor does not meet the bid requirement, the contractor will be required to propose an alternative make acceptable to the Employer's Representative.

(d) The contractor will submit a list 'A' of vendors for all the items of the BOQ contract

(i) The list should include the items for which the contractor is proposing the product of the approved vendor.

(ii) The contractor will be advised 'No Objection' with following caveat:-

- The model etc. to be supplied will be the latest or superior one.
- The contractor will be required to submit the technical proposal for the scrutiny

(iii) For the items, contractor desires to propose new vendor, proposal to be submitted in accordance as List 'B'.

(iv) The contractor will submit the undertaking that above lists i.e. List 'A' and List 'B' includes all the items required in the contract.

Vendor to be selected who are capable to provide good after sales services available in JAIPUR during DLP and thereafter.

17.2 Vendor Approval and Selection Procedure

(1) The contractor can send a proposal for the vendor after ensuring that what he proposes at least meets the specifications both, the quality and safety standard of the stipulated makes, the proposed product should be a proven one. He shall also stand full guarantee to his proposal and if at any stage it is found that the material is not suitable or meeting the bid requirement, the contractor shall replace the material and provide the material from the alternate vendor after approval from JMRC without any additional cost to JMRC. The alternate makes can be used only after an approval accorded by the Employer, whose decision will be final in the matter.

(2) The approval of any equipment or product to be used shall be done in two stages:-

(a) Stage-I

- Assessment of capability of proposed Vendor to supply a particular equipment or product, with quality and performance requirements, as required by Specifications as well as other contract conditions. The proposed product should be a proven product in service for at least 3 years.
- Assessment of the financial and functional strength of the Vendor to supply the requisite quantity of equipment and product as per delivery schedule acceptable to contractor and engineer to deliver the project in time.

(b) Stage-II

Stage-II called as Technical Submission Approval Stage, selection of Equipment or product from the equipment / products manufactured / supplied by the approved vendor will be done. This stage includes thorough technical assessments about the conformance of the offered equipment / product to the Specifications and other requirements.

(c) To obtain Vendor Approval the Contractor must apply with the four sets of the following documents to the Engineer

i. Company Profile and Experience of the Vendor
ii. Clause wise compliance of the relevant Clauses of Specifications.
iii. Details of supplies / orders executed in last ten years for the type of equipment / product offered. Supplies / orders executed for Underground Metro Systems shall be specifically mentioned
iv. Details of the facilities available at the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured.
v. ISO 9000 Certification for the Works / Manufacturing Unit where the proposed equipment / product shall be manufactured (The Works / Manufacturing Un cvit

where the proposed equipment / product shall be manufactured must have ISO 9000 Certification)

vi. Proof regarding compliance to Manufacturer's Qualifications. The offered products must be proven in service.

vii. Audited Financial Statements of the Vendor for the last three years.

viii. Type test certificates/ Performance certificate from accredited laboratories for the proposed type of equipment / products to establish the technical capability of the vendor (In case, specific requirements are mentioned in the relevant sections of Specifications with regard to type testing, same shall also be complied additionally).

ix. The vendor shall not have been blacklisted by any Govt. Agency in India.

x. Any other item as required by Employer / Employer's Representative.

(d) Contractor must certify the check list provided that vendor Proposal is complete and all the above documents are available in the Vendor Proposal. In addition, the Contractor must check / certify compliance to the Specifications before forwarding the same.

(e) Incomplete Vendor Proposal will not be treated as a submission and will be returned.

(f) Engineer will give Approval to the Vendor Proposal (received complete with all the documents mentioned above) expeditiously.

(g) Technical submission shall be accompanied with the calculations / other technical documents to justify the selection of any particular model of equipment / product, detailed technical features / parameters of the selected product, type test certificates from the accredited laboratories for the offered products, any other document required by the Engineer.

(h) Engineer will give Approval to the Technical Proposal (received complete with all the documents mentioned above) expeditiously.

(3) It may be noted that Approval of Vendors as per Point (3) above shall only be done by Employer / Engineer after the award of the work. Vendor submissions shall not be evaluated during the bid evaluation. Conditional Bid offers received from Bidders with particular Vendors for supply of equipment/ products will not be evaluated during evaluation and will be dealt with after award of the work.

(4) It may further be noted that Employer / Engineer shall be under no obligation to accept equipment / products manufactured by the successful Bidder, unless it meets the entire criterion mentioned above.

For Design and Build Contracts

In addition to above, in Design and Build Contracts the following shall also be ensured for the Vendor Approval and Selection:-

1. Proven Design

The Contractor shall develop the design based on this specification and on sound proven and reliable engineering practices. The broad design details shall be submitted with technical support data in the technical bid. Detailed calculations shall be submitted to the Engineer during the design process stage for review and approval.

1.1 Systems and Sub-Systems

Manufacturer shall have at least 5 years experience of design and manufacturing of similar system. Proposed systems from the proposed manufacturing unit shall have been in use and have established their satisfactory performance and reliability for 3 years in minimum.

All sub-systems, equipments and major components etc. (hereinafter referred as 'sub-systems') shall be state-of-art and of proven design.

Proposed Systems/ sub-systems shall have been in use and have established their satisfactory performance and reliability on at least Two mass rapid transit systems (including Railway or Airports) in revenue service over a period of three years or more either outside the country of origin at an average in two different countries or in JMRC. Systems/ Sub-systems/ components used in JMRC do not get automatically qualified for use unless specifically approved by the Engineer for this project. If required by the Engineer, Contractor shall provide certificate of satisfactory performance for a period of five years or more from the Metro operators. Where similar System/ Sub-systems of a different rating are already proven in service as per the above criteria then the supply shall be based on such sub-systems.

All 'sub systems' shall be procured from the approved vendors and sourced from only such manufacturing units that have supplied the sub-systems that fulfill the proven design requirements as above.

In case the contractor proposes to use systems or sub-system(s) that do not fulfill the above said criteria then the contractor shall furnish sufficient information to prove the basic soundness and reliability of the offered systems and sub-system(s) for review of the Engineer.

The Engineer's decision on contractor's proposal shall be final and binding.

For sourcing the equipment from indigenous manufacturing facilities, following conditions shall be complied:-

(i) In case the vendor uses his own facilities for indigenization after part supply of equipment from the approved manufacturing unit, no change in design, component type/make, quality standards, manufacture procedure, etc. shall be made without specific approval of the Engineer.

(ii) In case OEM wants to use manufacturing facilities in India (other than his own) for items for which the OEM has been approved, it shall enter into an agreement with such selected Indian equipment manufacturer and obtain prior approval from JMRC. No change in composition, rating, type, model no., manufacturing process, quality standards, design, etc. and make of the components used in assemblies/sub-assemblies of such equipment as manufactured by the approved parent vendor shall be made without specific approval of the Engineer.

(iii) In case OEM wishes to change/make/type specifications, etc. of any sub-components for supplies to be sourced from Indian facility, specific prior approval of the Engineer shall be obtained for changes made, model, specification, etc. Responsibility for obtaining such prior approval shall rest solely with the contractor.

Format for submitting the vendor approval request shall be given to the contractor during initial stages and approved format shall be followed throughout the contract

END OF CHAPTER