

**MAINS FAILURE STANDBY GENERATING SYSTEM
(D.G. SETS)**

PART 1 – GENERAL**WORK DESCRIPTION**

This specification is intended to cover supply, installation, testing and commissioning of D.G. Sets and associated equipment/ materials, panels, cables etc.

SCOPE OF WORK:

The scope of work shall include under this specification design, manufacture, supply, loading, unloading, storage, installation, testing and commissioning of D.G. Sets with alternators and associated equipment/ materials, panels, cables etc. including labor, tools, tackles and plants, hardware and consumables, steel fabrication and items as described below:

Silent Diesel engine & alternator set complete with base frame, acoustic container and accessories.

Engine mounted/ separately mounted engine control integrated panel duly wired up to terminal box for engine safeties, EFC Governor with solid state potentiometers, sensors and protection for interfacing with PLC.

Fuel oil system including day service oil tank, piping, valves, filters etc. from engine to service day oil tank. Return fuel line with fuel cooler and piping with accessories up to day service tank or collecting point as called for.

Lube oil system with piping etc. (Pre-lube oil pump with controllers as required).

Cooling system with engine mounted radiators.

Exhaust emission shall meet pollution norms (CPCB & SPCB) with or without catalytic converter and residential silencer, exhaust piping with mineral wool insulation and aluminium cladding as called for.

Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.

Painting of steel work.

L.T. / Control cabling.

Auxiliary control panel.

The bidder shall also indicate in his offer the time schedule for routine maintenance/overhauling operations necessary for continuous satisfactory operation of D.G. Set.

The item rate shall remain valid for variation to any extent of the estimated quantities given in the Schedule of Quantities.

All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

Minor civil work is included in the contractor's scope of work. Further, the responsibility of coordination with the civil and other contracting agencies ensuring completion of turnkey contract rests with the contractor.

Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

Also the D.G. supplier shall furnish back up combined guarantee minimum for 2 years from the date of successful commissioning from Engine alternator supplier for smooth running. In case there is any defect, the free replacement of any part or in whole will be made immediately at no extra cost to Owner.

FEE, PERMITS & TESTS:

The contractor shall obtain all sanctions and permits required for the running of DG sets from all the relevant authorities. All actual fees payable in this regard will be reimbursed against receipt/documentary proof (evidence). On completion of the work, the supplier shall obtain N.O.C from concerned authorities including SEB, Chief Electrical Inspectorate, of State. The original of the same shall be delivered to the employer through Consultants.

The Owner shall have full power regarding the equipments/ materials get tested by authorized/ recognized independent agency at the contractor's expense in order to prove their soundness and

adequacy. The contractor will rectify the defects/ suggestions pointed out by independent agency through Owner at contractor's expense.

The installation shall comply in all respects with the requirements of Indian Electricity Act 1910, Indian Electricity Rules (IER) 1956 and other related Laws and Regulations (for F.F. etc.) as amended up to date, there under and special requirements, if any, of the State Electricity Boards etc. The contractor shall be liable to furnish the list of authorized licensed persons/ employed/ deputed to carry out the works/ perform the assigned duties to fulfill the requirement of Rule No.3 of IER 1956 as amended up to date.

CODES & STANDARDS:

The design, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended up to date.

The design engineering, manufacturing and the installation shall be in accordance with established codes, sound engineering, practices and specifications. Further, the same shall conform to the statutory regulations applicable in the country. Contractor shall obtain all approvals from statutory authorities, e.g. Electrical inspector, pollution control boards, SEB or any other agency as applicable before commissioning of electrical system.

Some of the relevant Indian and British Standards are listed below.

Indian Electricity Act.
Indian Electricity Rules.
Factory Act.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation/conflict of this specification with the codes & standards, the following order of precedence shall govern

1. Engineer's decision.
2. Local codes of practice
3. Drawings.
4. Specifications
5. International standards & requirements.

DESIGN:

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the completion of the system and satisfactory & trouble free operation and maintenance of the equipment shall be provided without any extra cost to the Owner. This shall also include spares for commissioning of the equipment.

This specification defines the basic guidelines to develop a suitable electrical system as necessary for the Complex. All data required in this regard shall be taken in to consideration to develop a detailed engineering for the system. Site conditions as applicable are mentioned elsewhere.

Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.

All work to be performed and supplies to be made be as a part of contract shall require specific approval/review of Owner or his authorized representative

The engineering activities shall comprise the submission for approval of the following from Consultants/Owner

BIDDER SHALL BE RESPONSIBLE FOR:

Detailed co-ordination with other services, shop drawings for various electrical layouts such as equipment layout, cabling layouts, earthing layouts, including equipment installation and cable termination details etc. prior to start of work.

Preparation of bill of materials for cabling, earthing and miscellaneous items etc.

Cable schedules.

Interconnection drawing.

Protection co-ordination drawings/ tables for complete power system.

Shop inspection and testing procedures.

Field-testing and commissioning procedures.

Preparation of as built drawings.

Bidder shall also be responsible for:

Any other work/activity which is not listed above, however is necessary for completeness of electrical system

Bidder shall clearly understand and quote accordingly:

To ensure that all clauses given in this part of the specifications shall also apply to all other electrical works of other segments. The bidder shall bring to the notice of the Owner the differences, if any, and get the same clarified failing which the Owner may impose the more stringent of the specification/ clauses at the sole risk and costs of the contractor.

DATE OF COMMENCEMENT AND COMPLETION PERIOD:

- A. The contractor shall be allowed admittance to the site on the date of commencement as described in the General Conditions and he shall thereupon and forthwith begin the works and shall regularly proceed with and complete the same on or before the date of completion subject, nevertheless to the provisions for the extension of time. The time being the essence of the contract, the Contractor will adhere to the time, progress chart and project schedule and will give proportional output/progress in proportional time

SCHEDULE AND MANNER OF OPERATIONS:

- A. Time being the essence of this Contract, the Contractor will be expected to furnish all labour and materials in sufficient quantities and at appropriate times, expedite and schedule the work as required and so manage the operation that the work will be completed within the time stated in the Contract.

PROJECT SCHEDULE:

- A. The contractor will have to submit a detailed project schedule.
 - 1 For various items of works to be carried out by him.
 - 2 For various associated works to be carried out by other agencies.

so that the work gets completed with in the contractual completion time. This schedule shall be submitted by the contractor in Microsoft project software format. The contractor shall follow this schedule meticulously and shall also coordinate/ follow up with other agencies to expedite the works associated with his own work. Liquidity damages clause will become applicable for any delay in completion of the work.

- B. The contractor will submit within 7 days of the award of work, a detailed schedule of program of work.
- C. No additional payment will be made to the contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Consultant/Engineer-in-Charge.

1.10 DESIGN CONDITIONS:

Design ambient: 45 Deg. C maximum dry bulb temperature & 2 Deg. C minimum dry bulb temperature
 Altitude: 300 m above sea level
 Relative Humidity: 98% maximum
 Site Environment: Normal.

1.11 COORDINATION OF WORK

- A. Contract documents establish scope, materials and quality but are not detailed installation instruction.
- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other divisions will permit. Provide off-sets, fittings, and accessories which may be required but not shown on the drawings. Investigate the site, and review drawings of other divisions to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of thermostats, switches, panels and other equipment indicated on the drawings are approximately correct. Exercise particular caution with reference to the location of panels, thermostats, switches, etc., and have the precise and definite locations accepted by the Engineer before proceeding with the installation.
- E. The drawings show only the general run of services and approximate location of equipment, outlets, panels, etc. Any significant changes in location of equipment, outlets, panels, etc., necessary in order to meet field conditions shall be brought to the determine attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Contract.
- F. Carefully check space requirements with other division works to ensure that equipment can be installed in the space allotted.
- G. Wherever work interconnects with work amongst different installation, coordinate with other trades to insure that they have the information necessary so that the Contractor may properly install the necessary connections and equipment. Identify items requiring access in order that the Ceiling Trade will know where to install access doors and panels.
- H. Consult amongst installation so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- I. Furnish and set sleeves for passage of risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each riser passing through building surfaces.
- J. Provide fire stopping around all pipes, conduits, ducts, sleeves, etc, which pass through fire compartments.

- K. Provide required supports and hangers for equipment suitably so as not to exceed allowable loading of structures.
- L. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of record drawings.
- M. Coordinate with the local utility companies/authorities for their requirements for service connections and provide all necessary provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- N. Before commencing works, examine adjoining works on which this work is in any way affected and report conditions which prevent performance of the works. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.
- W. The Contractor is responsible to any modifications required due to service not properly coordinated.

1.12 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work, based on examination of the site or other information. Failure to examine the drawings or other information does not relieve the Contractor of responsibility for satisfactory completion of the work.

1.13 EXCAVATION AND BACKFILL

- A. Where ever required provide trenches details, duly approved by the consultant with all relevant section etc. as per IS codes to the Civil contractor, minimum before 1 month of laying the pipes, etc. Co ordinate with the civil contractor during the excavation, and ensure that the excavation and backfilling is being properly done as per requirement.
- B. Where ever it is asked by the Owner/ consultant for providing trenches in contractor's scope. It is deemed that the cost of the pipe is inclusive of trench digging and backfilling. The following points needs to be taken care of while making the trenches.
- C. The trench shall be of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum over depth of four inches below the trench depths indicated on the drawings or required. Backfill over depths in the rock excavation and unauthorized over depths with loose, granular, moist earth, thoroughly machine tamped to a compaction level of at least 95% to standard proctor density or 75% relative density or as specified by the Engineer. Wherever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.

- D. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade as required by local authorities.
- E. Trenches should not be placed within 3 meters of foundation or soil surfaces which must be resist horizontal forces.
- F. Do not backfill until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the specifications. Backfill shall consist of non-expansive soil with limited porosity. Deposit in 15 cm layers and thoroughly and carefully tamp until the work has a cover of not less than 30 cm. Backfill and tamp remainder of trench at 30 cm intervals until complete. Uniformly grade the finished surface.

1.14 CUTTING AND PATCHING

- A. All kinds of cutting and repairing of brick Walls or Partitions, etc. for the proper routing of pipe, shall be in the scope of the contractor. However, cutting and repairing of RCC wall, or ceiling shall be in the scope of civil contractor.
- B. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finish plaster, woodwork, metalwork, etc., using skilled trade people of the trades required at no additional cost to the Contract.
- C. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Contract.

1.15 SEALING OF PENETRATIONS

- A. Air Tight Seals
 - 1. All penetrations through the building fabric subject to suction or pressurization shall be sealed airtight.
- B. Holes in Roof
 - 1. Roof penetrations for passage of conduits or circular PVC and PVC Cables shall be sealed watertight using a flexible polypropylene conical sleeve manufacturer to seal the cable to the roof structure, regardless of the roof profile.
 - 2. All sharp metal edges, which may come in contact with the cable, shall be suitably bushed.
- C. Fire Rated Penetrations

Where services penetrate any fire rated barrier, the Contractor shall seal the penetration with the use of an appropriate material to ensure the integrity of the fire barrier.

The Contractor shall seal the cable enclosures through fire rated barriers to ensure the integrity and rating of the fire barrier.
- D. Acoustic Penetrations

Where services penetrate acoustic barriers, sealant shall be supplied and installed to maintain the acoustic separation at least equal to the barrier penetration.

1.16 MOUNTING HEIGHTS

- A. Verify exact locations and mounting heights with the Engineer before installation.

1.17 SUPPORTS

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and equipment room.
- C. Provide supporting frames or racks for equipment which is installed in a free standing position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on ducts, pipe, electric conduits, raceways, or cables for support.
- F. Equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splinters, runners, bars and the like in the plane of the ceiling). Provide independent support of equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for equipment so that loading will not exceed allowable loading of structure. Equipment and supports shall not come in contact with work of other trades.

1.18 FASTENINGS

- A. Fasten equipment to building in accordance with the best industry practice.
- B. Where weight applied to the attachment points is 45 kg or less, conform to the following as a minimum:
- | | | |
|---|---|---------|
| 1. Wood screws | : | Wood |
| 2. Concrete and solid masonry Fastener of appropriate ratings -HILTI/FISHER | : | Dash |
| 3. Solid metal screws in tapped holes or with welded studs | : | Machine |
- C. Where weight applied to the building attachment points exceeds 45 kg, but is 135 kg or less, conform to the following as a minimum:
- At concrete slabs provide 60 cm x 60 cm x 13 cm steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top slabs screed line, where no fill is to be applied.
 - At steel decking or sub-floor for all fastenings, provide through bolts and threaded rods. The tops of bolts and rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.

- D. Where weight applied to building attachment points exceeds 135 kg, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:
1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall suitably weld or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
- F. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars.

1.19 IDENTIFICATION

- A. Identify equipment with permanently attached black phenolic nameplates with 13 mm high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates shall be attached with cadmium plated screws; peel and stick tape or glue on type nameplates is unacceptable.
- B. Services runs shall be properly identified as per the requirements in the Contract.
- C. See individual section for additional identification requirements.

1.20 PROHIBITED LABELS AND IDENTIFICATIONS

- A. In all public areas, tenant areas, and similar locations within the project, the inclusion or installation of any equipment or assembly which bears on any surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.
- B. Required test lab certification labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

1.21 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Provide all details with proper sections for the equipment pads and anchor. The equipment pads casting and making provision for anchor fastening shall be as per the final UNALTERED drawing duly approved by the consultant, shall be in the scope of Civil contractor. However, the Contractor shall ensure the proper coordination with the civil contractor.
- B. All equipment pads for all vibrating equipments shall have cork vibration pads sandwiched between the finish surface and the bottom surface of required thickness suggested by the civil consultant, to ensure that the minimum vibration can travel below.
- C. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- D. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an attached to 15 cm square, galvanized metal back plates which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not acceptable.

1.22 MISCELLANEOUS:

- A. A site order book will be maintained at site, which will be in the custody of the Owner, or his representative and all instructions given to the contractor will be recorded in the site order book and the same has to be signed by the contractor to comply with the instructions given therein.
- B. After completion of the work the whole installation shall be tested by the contractor in the presence of the Consultant/Engineer-in-Charge. The tests shall comply the following I.E.E. Regulations and shall be submitted along with the final bill:
1. The result of the insulation test shall comply with the I.E.E. Regulations 1101 to 1108A and 1008B as may be applicable.
 2. Test shall be carried out to ascertain that all the non-linked SP switches have been connected to the phase conductor.
 3. The continuity test of the earthing system shall comply with I.E.E. Regulations 1108 to 1109 to the latest addition.
- C. If the result of the above tests does not comply with the I.E.E. Regulations, the contractor shall be bound to rectify the faults so that the required results are obtained.
- D. The contractor shall be responsible to provide all the necessary testing instruments, such as megger insulation tester, earth tester multi-meter, AVO meter etc for carrying out the above tests.
- E. The work will not be considered as complete and taken over by the employer till all the components of the work after being completed at site in all respects have been inspected/ tested by the Consultant/Owner to his entire satisfaction and a completion certificate issued by the Owner/Consultant to this effect.
- F. Shop drawing for electrical work e.g. equipment, cable earthing and conduit layout for all systems shall be prepared by the contractor and got approved before starting of the work.
- G. At the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit 6 sets of drawing and two tracing of each drawing to Owner of each layout drawings drawn at approved.
- H. Contractor's Superintendence:
1. The contractor shall provide all necessary superintendence during the execution of the works and as long thereafter as the engineer may consider necessary. The contractor or his competent and authorized agent or representative approved of in writing by the owner/ Engineer (which approval may at any time be withdrawn) is to be constantly on the works and shall give his whole time to the superintendence of the same. Such authorized agent or representative shall receive on behalf of the contractor, directions and instructions from the Engineer-in-charge or his representative.
 2. The contractor shall provide detailed organization of the execution team deployed for the works with names and CV's, of all key staff before the commencement of work and get it approved of in writing by the Owner/ Consultant. Contact telephone or pager numbers for emergency and/or twenty-four (24) hour call shall also be included.
 3. If in any case of withdrawal of any worker/ technician/Engineer from the execution team, the replacement of the same shall be done with equivalent qualification, and shall be approved in writing by the Owner/ Consultant.

PART 2 – PROUCT, TESTING & COMMISIONING

2.01 DESIGN CRITERIA

Electrical Details for Incoming Supply:

Supply Voltage: as approved by SEB

Fault Level (Sym.) at supply point (Designated): MVA (to be confirmed from State Electricity Board by Bidder).

Neutral: Grounded
 Voltage Regulations: $\pm 10\%$
 Frequency Regulations: $\pm 3\%$
 Combined Regulations: $\pm 10\%$

LT Power Distribution System:

Voltage: 415 V
 Frequency: 50 Hz
 Neutral: Grounded
 Short Circuit Fault withstand capacity: 35 to 50 KA for 1 sec., as per BOQ and specifications

Control supply for Electrical System:

The various supply voltage to be used in the control panels for the main equipment shall be as under:

Spring charge motor: 230 V AC or 240 V DC (Universal Motor)
 Closing/ Trip Coil: 24 C DC
 Alarm/ Indication/ Relays: 24 V DC
 Heaters: 230 V AC

Painting of Panels:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Painting of Cable Trays and Structural steel:

Powder coating of approved shade as per Specification. (Refer clause of painting)

Cable Details:

LT Control Cables: Copper conductor armoured PVC insulated 1.1 KV grade.
 LT Power Cables: Aluminium conductor armoured XLPE insulated.
 Grounding Conductors: Copper/ G.I. as specifications and BOQ

Accuracy Class of Meters:

Revenue Meters: Class-I or as approved by SEB
 Ammeters, Voltmeters & Other Instruments: Digital Type

2.02 DRAWINGS:

The list of drawings is enclosed along with this specification. These drawings are meant to give general idea to bidder regarding the nature of work covered by these specifications.

Any information/data shown/not shown in these drawings shall not relieve the contractor of his responsibility to carry out the work as per the specifications. Additional information required by the bidder for successfully completing the work shall be obtained by him.

2.03 SHOP DRAWINGS:

The contractor shall prepare detailed coordinated electrical shop drawing indicating D.G. set layout, D.G. Control Panel and Cable Schedule with other relevant services and submit to the Consultant for approval or the Engineer-in-Charge before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system i.e. Control and Relay Panel D.G.'s, cable schedule and routes, manhole trap and fixing details for the above mentioned work. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and full proof system

including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 (two) prints for preliminary approval and finally 6 (six) prints for distribution.

2.04 MANUFACTURER’S INSTRUCTIONS:

Where manufacturers have furnished specific instructions, relating to the material/equipments to be used on this job, covering points not specifically mentioned in this document, manufacturer’s instructions should be followed.

2.05 COMPLETION DOCUMENTS AND DRAWINGS:

- A. Three copies of operation manuals/catalogues of all standard equipment are to be furnished by the contractor immediately after commissioning of plant.
- B. Three copies of write up on preventive maintenance, trouble shooting and operating instructions of the system along with as-built drawings are to be supplied by the Contractor at the time of commissioning.
- C. On completion of the work in all respects, the Contractor shall supply five portfolios (300x450 mm), each containing complete set of drawings on approved scale, clearly indicating complete layouts, location; wiring and sequencing of automatic controls, location of all concealed wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The Contractor shall frame under glass, in the Panel rooms, one set of these consolidated control diagrams.

2.06 MATERIALS AND EQUIPMENT:

All the materials and equipments shall be of the approved make and design. Unless otherwise called for any approval by Owner’s Engineer-in-Charge, only the best quality materials and equipment shall be used.

Space Heaters:

Suitable number of adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

Fungi static Varnish:

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

Ventilation Opening:

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

Degree of Protection:

The enclosures of the control cabinet, junction boxes and marshalling boxes, panels. etc to be installed shall provide degree of protection as detailed her under.

Installed indoor	:	IP-55
Installed indoor in air-conditioned area	:	IP-31
Installed in covered area	:	IP-42

Installed indoor in non air-conditioned area where possibility of entry of water is limited :IP-41
For LT Switchgear (AC and DC distribution boards) :IP-42

The degree of protection shall be in accordance with IS: 13947 (Part –I) IEC-947 (Part –I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

Rating plates, Name plates and Labels:

D.G. Sets, D.G. Control panel and auxiliary items installed in the building is to permanently attached to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of loading conditions of equipment in question has been designed to operate and such diagram plates as may require by the owner. The rating plate of each equipment shall be in accordance to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates on with Hindi and another with English inscriptions may be provided.

First fill of consumables, Oil & Lubricants:

All the first fill of consumables such as oils, lubricants, filing compounds, touch up paints, welding/ soldering/ brazing material for all Copper/ G.I earthing and essential chemicals etc. which will be required to put the equipment/ scheme covered under scope of the specifications, into successful operation, shall be furnished by the contractor unless specifically excluded under the exclusions in these specifications/ documents.

Design Improvements:

The bidder shall note that the equipment offered to him in the bid only shall be accepted for supply. If for any reason, contractor wished to deviate from specification, prior permission from owner/ consultant shall be sought.

If any change is agreed upon and that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/ or schedule of completion before the contractor proceeds with the change. Following such arrangements, the provision thereof, shall be deemed to have been amended accordingly in the specification.

Quality Assurance Programme:

To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's works or at his sub-contractor's premises or at the Owner's site or at any other place of work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Owner after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

1. His organization structure for the management and implementation of the proposed quality assurance programme.
2. Documentation control system.
3. Qualification data for bidder's key personnel.
4. The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
5. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
6. Control of non-conforming items and system for corrective actions.
7. Inspection and test procedure both for manufacture and field activities.

8. Control of calibration and testing of measuring instruments and field activities.
9. System for indication and appraisal of is inspection status.
10. System for authorizing release of manufactured product to the Owner.
11. System for maintenance of records.
12. System for handling storage and delivery and.

The Owner or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor / his Vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after dispatch of the equipment.

1. All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.
2. Welder and welding operator qualification certificates.
3. Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.
4. Raw material test reports on components as specified by the specification and / or agreed to in the quality plan.
5. Stress relief time temperature charts/oil impregnation time temperature charts.
6. Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
7. The quality plan with verification of various customer inspection points (CIP) as mutually and methods used to verify the inspection and testing points in the quality plan were performed satisfactory.

2.07 INSPECTION, TESTING AND INSPECTION CERTIFICATES:

The Owner and the Consultant or duly authorized representative shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Owner and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Owner/Consultant the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test were pending payment would be made on successful completion of type/routine test(s) actually carried out as per Consultant/Owner instructions.

The Contractor shall give the Consultant/Owner thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless

witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the presence of Owner/Consultant and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.

The Consultant/Owner shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Consultant/Owner shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Consultant/Owner, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Consultant/Owner. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Owner to accept the equipment should, it, on further tests after erection, is found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Owner.

For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labor, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Owner/Consultant or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

The inspection by Owner/Consultant and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

The Consultant/Owner will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

The Owner/Consultant reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Contractor.

2.08 TESTS:

Charging (Pre-commissioning tests):

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Owner/Consultant and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The pre-commissioning tests to be performed as per relevant I.S. / vendor/ bidder submittal and as included in the Contractor's quality assurance programme.

Commissioning Tests:

The available instrumentation and control equipment will be used during such tests and the Contractor will calibrate all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Contractor for the requirement of these tests. The tests will be conducted at the specified load points and as near the specified cycle condition as practicable. The Contractor will apply proper corrections in calculation, to take into account conditions which do not correspond to the specified conditions.

All instruments, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

Pre-commissioning test shall be carried out as per relevant IS and/or as specified in the relevant clause.

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning of the equipment. However necessary fee shall be reimburse by Owner on production of requisite documents.

2.09 PACKAGING:

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

2.1 PROTECTION:

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

2.2 FINISHING OF METAL SURFACES:

General:

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanize. All steel conductors used for earthing/grounding (above ground level) shall be galvanized according to IS: 2629.

Painting:

All sheet steel work shall be degreased, pickled, and phosphated in accordance with the IS-6005 "Code of practice for Phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swab shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After Phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

Powder coating/electrostatic painting of approved shade shall be applied.

The exterior color of the paint shall be as per IS-5 or as approved by Consultant. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments, if required.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

2.3 HANDLING, STORAGE AND INSTALLATION:

In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Owner or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented.

Contractor shall follow the unloading and transporting procedure at site, as well as storing, testing and commissioning of the various equipment being procured by him separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's Engineer(s) and shall extend full co-operation to them.

In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Owner/Consultant. Contractor shall be held responsible for any damage to the equipment consequent for not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than the one section, Contractor shall make all necessary connections between sections. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

The Contractor shall submit to the Owner every week, a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Owner in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Owner, as well as protection of the same against theft, element of nature, corrosion, damages etc.

The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment, which require indoor storage.

The words 'erection' and 'installation' used in the specification are synonymous.

Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

The minimum phase to earth, phase to phase and section clearance along with other technical parameters for the various voltage levels shall be maintained as per relevant IS.

2.4 PROTECTIVE GUARDS

- A. Suitable guards shall be provided for protection of personnel on all exposed rotating and / or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.
- B. The Contractor shall also conform to the general regulations governing personnel on the site and must keep to the working space allocated for their use.

- C. The contractor shall be responsible for any kind of mishap, etc. happened with personnel. The Owner shall not take the responsibility for any of such kind.

2.5 TOOLS AND TACKLES:

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dismantling and maintenance of the equipments.

2.6 PERFORMANCE REQUIREMENTS:

The equipment shall be capable of delivering power continuously at the generator terminals, a net output not less than the specified value at 0.8-p.f. excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Gen. Set should have minimum 50% single step loading capacity and it should be able to take full load in less than 25 sec. from start. (The set shall be suitable for prime duty). The bidder shall furnish the detailed derating calculation due to temperature and other parameters with supporting document.

The design parameters of the generator and excitation system shall be so chosen that the set is stable while running at any load between no-load and full load and also during starting of motors as specified in Annexure-I. It should also have iso-synchronous speed control with load sensing governing system suitable for parallel running of D.G. sets.

Engine should be heavy-duty four strokes, turbo charged after cooler 'V' construction, electric start. Engine should have minimum lube oil change period 300 hrs.

The set shall have vibration limit less than 250 microns (as per BS: 4999 Part-142) and noise level shall be (105-110 db (A)) at 1 Mtr) under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts etc. The efficient residential silencer shall be provided.

The total harmonics contents should be less than 3% as per IS 4722/1969. The graph & calculation for harmonic distortion shall be submitted.

Contractor to specify and guarantee maintenance contract cost and to give an Undertaking to take a comprehensive maintenance contract after expiry of warranty period for which price may be quoted.

The successful bidder will submit shop drawing of the equipments/accessories selected for this work for the approval of Consultant/ Employer.

2.7 DIESEL ENGINE – CONSTRUCTION

- A. Material of construction of major parts shall be as under or as per manufacturer design.
1. M.S. base frame with anti-vibration mountings.
 2. Crankcase – Aluminium alloys.
 3. Crank shaft, connecting rods – Forged Alloy Steel.
 4. Piston – Al. alloy casting
 5. Piston rings – Alloy steel

6. Engine block – Cast iron.
 7. Cylinder liner – Cast
 8. All other materials of construction shall be as per relevant standard/code and the copies of same shall be supplied free of cost to Consultant/Owner.
- B. The Diesel Engine shall be multi-cylinder, 4-stroke, water cooled with engine mounted radiator with shaft driven fan (not motor driven), totally enclosed, continuous duty, direct fuel injection, turbo charged, compression ignition, inter cooled oil engine or with individual cylinder head with provision to measure exhaust temperature.
 - C. One common base frame shall be provided for mounting the engine and alternator complete with electric suspension between DG set and foundation bolts, leveling lines etc. as required.
 - D. All externally mounted hardware shall be high tensile steel only.
 - E. The engine shall be fitted with an exhaust gas driven turbo charger of air/water cooled type complete with its own self contained lubricating system. The turbocharger shall be positioned at the free end of the engine preferably. The turbocharger will be provided with a provision to check its lube oil level.
 - F. The engine shall be fitted with a charge air inter cooled of the air/water type. Air from the turbo-charger compressor passes through the inter cooler and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminium bronze tubes, mild sheet steel and cast iron water headers.
 - G. Diesel engine shall be capable of starting and operating for a few minutes without supply of raw water for cooling. Contractor shall indicate the maximum time for which the Diesel Engine can be operate.

2.8 GOVERNING SYSTEM

- A. The Governor shall be electronic fuel control type for coupled Genset along with speed control switch (solid state potentiometer) at the end of start on over speed.

2.9 ENGINE STARTING SYSTEM

- A. Starting of the Diesel Engine shall be done by electric starting system.
- B. The electric starting system shall comprise starter motor, starter batteries and battery charger including with all required instruments and accessories. The engine mounted alternator shall charge the batteries while engine is running and floor panel mounted solid state battery charger while engine is at stationery. The battery charger shall be of 2 rate (boost/trickle) with all metering and control instruments and protections for A/C and D/C circuit. The total system shall be suitable for auto and manual operation including their wiring etc. Calculation for the battery and battery charger capacity as well as complete descriptive circuit diagram shall be submitted for review of Consultant based on 6 consecutive start commands.

2.10 CATALYTIC CONVERTER

- A. Catalytic Converter should be suitable for high speed diesel oil available in the country with sulphur contents to control Hydrocarbon (HC), Carbon Monoxides (CO), Total Particulate Matter (TPM) and NOX.

B. The catalytic converter should be suitably designed to avoid sulphation of catalyst up to 550 Deg. C. The converter should be air washable type or can be washed with DG set exhaust gasses in case compressed air is not available. The casing of the catalytic converter should be in stainless steel construction and should have a metal catalyst applied to a wash coat ceramic substrate which will durable at 500 Deg. C temperature. The life of the catalytic converter should be more than 10,000 hrs.

C. The conversion efficiency of the catalytic converter to control exhaust gas pollutants should be as following at the outlet of converter.

CO (Carbon Monoxides)	:	80 – 90%
THO (Total Hydrocarbon)	:	80 – 90%
TPM (Total Particulate Matter)	:	40 – 50%
NOX	:	15 – 20%

Catalytic converter shall be able to reduce the noise level by 10db (A)

2.11 FUEL OIL SYSTEM:

The manufacturer shall furnish a mild steel day tank of required capacity for individual engine. The day tank shall be suitably located to avoid gravity feed to the engine, shaft driven fuel oil pumps and shall be complete with gauges, glasses, filling, draining and vent connection with valves and level switch for auto filling of tank and for alarm in case oil level goes beyond limit.

The fuel system shall be provided with full flow duplex oil cartridge filter preferably changeable during running of the set.

The fuel oil system shall be equipped with a crankshaft driven fuel oil transfer pump which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

Multi point (electronically controlled) fuel injection system or direct injection/through ISO synchronous fuel Governing system shall be designed taking into account the type of fuel used, engine speed etc. so as to achieve safe knock free performance with low emission smoke.

2.12 LUBRICATING OIL SYSTEM:

All lubricating parts of the engine shall be connected to a pressurized lubricating oil distribution piping system being continuously charged by gear type lube oil pump mounted at the free end of the engine and driven from the engine crank shaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler and deliver oil to a main supply header. High-pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high-pressure while starting with cold oil. A timer based, auto running (auto priming pump) shall be provided to keep engine primed all the time complete with control system (if required).

The lube oil system shall be provided with full flow duplex lube oil cartridge filters. The minimum lube oil change shall be 300 hrs.

Arrangement shall be provided to bypass the lube oil pressure switches and safety at the starting till the pressure is built up.

The lube oil sump shall have provision to sense the low level of lube oil in the sump and fill it up manually or automatically from the main lube oil tank/sump and stop the transfer pump, once the lube oil is filled in the sump without stopping the engine. Pressure switches to give alarm under

extreme low pressure of lube oil and subsequently to trip the unit when the minimum safe pressure has been reached, shall be provided.

All necessary accessories such as pressure gauges, temperature indicators, pressure relief valves, bypass valves, pressure switches shall be provided and the safeties shall be wired up to junction box

2.13 EXHAUST SYSTEM:

Engine emission exhaust system shall be residential type silencer ducting, bends, hood/canopy, thermally insulated aluminium clad exhaust piping etc. shall be provided along with structural support with stays for each engine. Heat resistant paint shall be provided on exhaust pipe for the portion, which is of outside the building including canopy. Exhaust system pollution level shall be indicated and shall be got approved by authorities. (Exhaust smoke quality & quantity should be within the norms of central & state pollution control board).

2.14 ENGINE ALTERNATOR CONTROL PANEL:

A. Engine alternator (D.G.) control panel shall be provided with speedometer, lubricating oil pressure gauge, lube oil temp, jacket water temp, battery charging, water pressure, fuel pressure for local indication panel mounted on the engine itself.

B. Engine shall be supplied with engine control module (ECM) for diesel generating set monitoring control system, which should be equipped with (digital) electronic Governor along with solid-state AVR to facilitate discreet control of speed and voltage or as per manufacture design. The system shall be equipped with starting control including integrated fuel ramping to limit the black smoke frequency overshoot with optimized cold weather starting. The engine instrument panel shall be equipped with digital alarm and status to monitor and display the following parameters. The scanner, inter face modules, converter, probe and their wiring up to terminal block in panel with 485 ports etc. making compatibility with PLC. The necessary CT/PT shall be included and wired accordingly to meet the requirements.

C. Engine Indicators:

- Digital tachometer with running hour meter
- Lubricating oil pressure low
- Lube oil temp. high
- Coolant water temp. high.
- Over speed
- Bearing temperature.
- Engine fail to start
- Lack of fuel due to low level.
- Volts RY-YB-BR.
- Amps R-Y-B.

2.15 AMF CONTROL PANELS:

Control Philosophy:

Automatic Starting and Stopping of Engines:

The system should come in operation after sensing of GRID FAILURE and / or the voltage drops below preset value. For this purpose the NB-2 or equivalent "ENGINE CONTROL & AUTOMATIC MAINS FAILURE STAND BY SYSTEM" shall be provided to perform the following functions.

- Sensing the healthiness of supply from Supply Company, the engine shall be at rest.
- On sensing the supply healthiness (the supply fails or drop below the preset value) the command shall be issued to start the D.G. Set.
- In case the D.G. Set does not start in the 1st command, the two more commands shall be given to start the D.G. Set at an equal interval of time (5 Sec). Even then if the engine does not start, the indication shall appear on window / screen "Set fail to start" and alarm shall be generated.
- On starting of D.G. Set & monitoring the healthiness of supply, the load shall automatically be transferred on D.G.
- On restoration of the supply & monitoring the healthiness of the system, the load shall be transferred to Mains automatically & vice versa.

Manual Mode:

Select manual mode on the relay unit.

The Set shall only be started by pushing the "start button" on the relay.

On attaining the requisite voltage & frequency, the D.G. breaker / Contactor will be closed or tripped manually without shutting down the engine.

The Engine shall be shut down manually by pressing the push button.

Test Mode:

The test mode operation is independent of the conditions of the mains supply & thereby enables routine testing or exercising of the D.G. Set without closing the D.G. breaker / contactor. (Select the switch on selector mode & is similar to the auto mode except closing of the breaker).

The relay shall have following features such as:

Mode selector switch (Auto/Manual/Test/Off)

Engine Control switch (On/Off push button)

Reset/Acknowledge push button.

Breaker close/open push button.

Test push button.

Set of visual indication shall be

Load on Mains.

Load on D.G. Set.

Set fails to start.

Low-pressure alarm & Trip.

High temperature alarm & Trip.

Engine over speed.

Alternator overload & short circuit.

Voltages, phase to phase & phase to neutral.

Ammeter Line / Phase current.

Power factor meter.

Kilowatt-hour meter.

Frequency meter.

Tachometer.

2.16 ALTERNATOR (415V – 3 PHASE, 4 WIRE SYSTEM):

The Alternator shall be industrial type screen protected drip proof. IP-23. Class – H insulation with temperature rise limited to Class-'H', self ventilated, air cooled, rotating field, salient pole, brush less, machine with self excited, self regulated exciter and shall be rated for continuous duty.

The Alternator shall have a continuous rating of not less than the value specified under specific requirement shall be at 0.8. The alternator shall be suitable to run for P.F.0.99 (lag) with capacitor controlled by APFC relay.

The short circuit ratio (SCR) of the generator at rated KVA and rated voltage shall not be less than 0.48.

The Alternator shall withstand without mechanical damage, an over speed of 20% for a period of 3 minutes.

The generator/alternator shall withstand over load of 10% for 1 hour every 12 hourly. The terminal voltage shall be adjustable and the range of adjustment shall be + 5% of nominal voltage.

The Alternator shall be capable of withstanding without damage/injury for 3 secs., 3-phase short circuit at its terminals, when operated at rated KVA and power factor at 5% over voltage with fixed excitation (3 times the line current for 10 Sec.).

The Alternator shall be capable of withstanding for thirty (10) secs. a current of fifty (50) percent in excess of its rated current, the voltage being maintained, as near the rated value as possible, consistent with max. capacity of the prime mover.

Six Nos. embedded Resistant temperature detector (RTDs) of platinum. 100-ohm resistance at 0 Degree to measure the winding temperature and 2 Nos., BTDS bearing temperature shall be provided.

The leads of embedded RTDs shall be wired up to the terminal block in a separate auxiliary terminal box. Manufacturer shall indicate the setting values for each RTD/BTD for alarm and trip.

All external nuts and bolts shall be of high tensile steel only.

Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz., 1ph A.C. supply and shall be wired up to a separate terminal box. Thermostatically controlled shall work when the machine is in idle condition only (wiring and equipment shall be provided by D.G. supplier).

Two independent earth terminals on the frame, complete with nuts, spring washer and plain washer shall be provided.

Alternator shall be provided with suitable terminal box for terminating TP&N bus-duct/cables droop and protection. CTS within the terminal box duly wired up to the panel should be provided.

The alternator shall be capable to sustain the unbalanced current between the phases minimum 40% of rated current provide that the KVA rating and maximum current does not exceed 11% of rated current in any phase as per BS-4999 Part-101.

The alternator shall be fitted with radio interference suppressors in accordance with BS-613-1977 and shall be within the limit of CISPR standard also.

The alternator shall be dynamically balanced complete with rotor and shaft.

Alternator should have bearings at both shaft ends.

Damper winding shall be provided in the pole to damp the oscillations and ensure satisfactory performance during parallel operation.

Winding of 3 phase alternator shall be of star connected and neutral point shall be brought out to the terminal box through protection and earthed with independent earth or through contactor as per scheme.

Protection CT's/PT's shall be mounted above the terminal box with enclosure. Bus duct/cable shall be terminated on terminals through this.

Diesel generating set shall be able to start motor of 30% capacity of D.G. set with a 20% base load.

2.17 AUTOMATIC VOLTAGE REGULATOR:

An automatic high speed, dead band channel voltage regulator shall be provided with all accessories. The regulation system shall be with equipment accessories for automatic as well as for manual switchover control.

The voltage regulator shall be dual be dual control type i.e. the voltage regulation shall be through compound transformer or magnetic amplifier and the electronic regulation through solid state devices automatically both shall be secured from all three phases. The combined voltage regulation shall be $\pm 1\%$ from full load to no-load from hot to cold at unity power factor and 0.8 to 0.99 power factor with 4% speed regulation of the engine.

Voltage regulation and steady state modulation shall be within $\pm 1\%$ of the line voltage and with manual voltage adjustment capability within $\pm 5\%$. The maximum permissible wave from distortion should not exceed 5% at any load.

Necessary equipment for field suppression and surge protection shall be provided.

The response time of the exciter and the generator shall be matched to avoid hunting.

AVR system shall be provided with equipment for auto-manual operation from remote (PLC – joystick or push buttons)

In the event of AVR failure, the generator excitation control is transferred automatically without any change in the excitation current.

Necessary equipment shall be furnished for the following:

To prevent rise of field voltage in case of failure of potential supply.

To initiate from automatic to manual control of excitation on fuse failure in the generator potential signal.

To facilitate reactive load sharing of parallel operating generator shall be in proportion to their ratings. The quartrative droop current transfer compensation feature should be provided on exciter regulation and droop voltage shall be within 1% variation.

D.G. Set Vendor shall inspect the existing system and include all necessary hardware, input/ output modules and junction box with terminal block and its wiring complete as required to make the system operational in PLC/ Manual mode and to be included in price bid.

2.18 COMMISSIONING CHECKS:

In addition to the checks and test recommended by the manufacturer, the Contractor shall supervise the following commissioning checks to be carried out at site.

A. Load Test (site and factory):

The engine shall be given test run for a period of at least 6 hours. The set shall be subjected to the maximum achievable load as directed by Owner without exceeding the specified D.G. Set rating: During the load test, half hourly records of the following shall be taken:

Ambient temperature

Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.

Lubricating oil temperature where oil cooler fitted.

Lubricating oil pressure.

Color of exhaust gas.

Speed.

Voltage, wattage and current output.

Oil tank level.

The necessary load to carry out the test shall be provided by the Owner.

- B. Insulation Resistance Test for Alternator:
Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 1000V megger shall not be less than

$$IR = 2 \times (\text{rated voltage in KV}) + 1$$

- C. Fuel consumption Check:
A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.
- D. Insulation Resistance of Wiring:
Insulation resistance of control panel wiring shall be checked by 500V megger. The IR shall not be less than one mega ohm.
- E. Functional Tests:
Functional tests on control panel.
Functional test on starting provision on the engine.
Functional tests on all Field devices.
Functional tests on AVR and speed governor.
- F. Vibration Measurement:
The vibration shall be measured at Load as close to maximum achievable load and shall not exceed 130 microns.

2.19 TEST CERTIFICATES AND REPORTS:

Test Certificate shall be submitted in eight (8) copies.

The test certificates shall be furnished to the owner for prior approval before dispatch of any equipment from works and the approval in writing from owner shall be essential to effect dispatch of the equipment.

The test reports shall furnish complete identification of the data including serial number of each equipment.

2.20 NOISE CONTROL IN DIESEL GENERATOR ROOMS:

- A. Construction Features/ Requirements:
1. The container shall be designed for easy access to serviceable parts of the D.G Set.
 2. The acoustic container shall be made of Modular construction for easy assembling and dismantling.
 3. The container shall be fabricated out of CRCA sheet of 14 Gauge. Base frame should be made out of ISMC of suitable sections or made out of sheet steel minimum of thickness 5 mm.
 4. All the hard ware used shall be of high tensile grade.
 5. Fuel tank shall be kept outside of enclosure and shall have 990-liter capacities. The fuel piping shall be carried out to connect the D.G set kept inside.
 6. Battery shall be accommodated in the container itself.
 7. The container doors should be gasketed to avoid leakage of sound.
 8. All the door handles shall be lockable type.
 9. The D.G set shall be integrated part of the container .The complete assembly shall be one unit

- B. Painting:
The sheet metal components should be hot dip and seven tanks pretreated.
To have long life of container it shall be painted with P.P. based powder coated (inside as well outside)
- C. Acoustic Insulation:
Sound proofing of enclosure should be done with quality rock wool/mineral wool
The Residential silencer should be provided within the DG to control exhaust noise as per noise emission laws
Interconnection between silencer and engine should be through stainless steel flexible hose/ pipe.
The insulation should be designed to have 75 dB (A) at a distance of one meter to meet the noise limitations of pollution department
- D. Ventilation and Air Circulation:
1. The system should be designed to provide air inlet/exhaust acoustic louvers for efficient air circulation
2. The ventilation should be designed to restrict the temperature rise above ambient as five to seven degree centigrade.
3. The manufacturer of acoustic container shall have approval from engine manufacturer for the design parameter as specified above and laid down by them from time to time for engine performance and warrantee.
- E. Electrical:
1. Provision for Neutral/Body Earthing:
Points shall be available at side of the enclosure with the help of flexible copper wires from alternator neutral, and electrical panel body respectively. The earthing point shall be isolated through DMC insulator mounted on enclosure.
2. Control Panel shall be mounted outside the container.
3. Safeties:
 - Low lube oil pressure
 - High water temperature
 - High enclosure temp.
 - There should be provision for emergency shut down from outside the container.
- F. Exhaust Pipe Insulation:
Exhaust pipe insulation shall be carried out with mineral wood (rigid pipe sections) of 150 kgs/m³ for temp above 250 °C. The material for pipe insulation shall be factory faced with aluminium foil reinforced with Kraft paper. The aluminium foil shall extend by min. 50 mm on one side of pipe side along the length to seal all longitudinal joints etc.

2.21 TESTING AND COMMISSIONING:

- A. Testing and commissioning shall be done as per the programme/instructions to be given by Owner/Consultant's authorized representative. All testing equipments necessary to carry out the tests shall be arranged by the electrical Contractor.
- B. Before the electrical system is made live, the electrical Contractor shall carry out suitable tests to the satisfaction of Owner/Consultant that all equipment wiring and connections have been correctly done and are in good working condition and will operate as intended.

END OF SECTION