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LODHA CLARIANT

PLOT C, SG

INFRA WORKS

DIESEL GENERATORY SYSTEM

ELECTRICAL TENDER

BH-ZSG-SPE-E-0001

ELECTRICAL INFRA WORKS

BUROHAPPOLD ENGINEERING

Rev	Date	Issue	Prepared by	Checked by	Client
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SECTION A

GENERAL REQUIREMENTS DIESEL GENERATOR SYSTEM

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1 SUMMARY

A. Project is a Hi-end residential project coming up at Mumbai. The site is spread over an area of approx. 1 acre.
   a) Location : Mumbai, Thane Area
   b) Elevation above Sea Level : Less than 10 meters
   c) Maximum DBT with corresponding WBT : 35.3 ºC/22.8 ºC
   d) Minimum DBT with corresponding WBT : 16.5 ºC/13.9 ºC
   e) Design temperature for electrical & electronic equipment/devices : 40 ºC
   f) Relative Humidity: Monsoon- 90% , December to January-63 to 71%
   g) Air quality: Atmosphere generally hot, humid, dusty, polluted conducive to dust and fungus growth.
   h) Earthquake Factor : Zone III as per IS:1893
   i) AC Voltage : Voltage variations ± 10%, Frequency variation ± 3%

   The Intended Usage of the space is as Sales Gallery / Club House.

B. Electrical Supply
   a) Three phase electric supply will be 415 V, 50 Hz, 4 wires.
   b) Single phase electric supply will be 240 V, 50 Hz, 3 wires.
   c) TN-S type of earthing is to be provided throughout.

C. The entire works which is part of this contract shall be completed in all respects and handed over in line with the employers programme.

D. The System must comply with the State PWD, NEC 2011, NBC 2005, IPC, Chief Fire Officer (CFO) of Mumbai, Local Municipal Authorities, MOEF guidelines and subject to approval by the Employers Representatives.

E. The entire work shall be carried out in a manner consistent with good engineering practice. The Contractor shall take into account all site conditions including space allocation for DG System while designing the system and selecting the equipment.

F. The Contractor shall be responsible for engaging a qualified, competent and experienced DG System staff to perform the system design verification, preparation and submission of system proposal, obtaining approvals from relevant authorities and site supervision for installation, testing and commissioning.

G. The Contractor shall perform the system design verification based on the criteria / data and technical requirements specified in this section / drawings and the local Authorities regulations / requirements.

H. The Contractor shall provide systems which comprises products of manufacturers who have designed, developed and used these products successfully for a period of at least five years.

I. The Contractor shall submit catalogue information, design calculations and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. and any other information required by the Employer's Representative for acceptance prior to commencement of installation.

J. The Contractor shall submit analytical test reports for the DG Systems wherever applicable after the commissioning or after the system is put into operation or as required by the Employer's Representative. The result should comply with local authority requirements

2 INSTRUCTION TO CONTRACTOR

A. The Bidder / Tenderer shall furnish all the information called for in the all the sections of this contract, failing which the bid will be treated as incomplete and the Employer's Representative reserves the right to reject the bid. The Contractor is advised to fill information strictly in the format enclosed.

B. The Bidder / Tenderer shall carefully study all sections and drawings enclosed (if any) with specification and indicate deviations in the relevant Sections of the Specification. If no deviations are stated it will be assumed that the offer conforms in all respects to the specification and the Employer's Representative reserves the right to evaluate the Bid as such without further reference to the Contractor.

C. The Bidder / Tenderer is also advised to have discussion with Employer's Representative before preparing the Bid and bring out clearly in the Bid any discrepancies found in the tender package or any items which in his opinion have not been included in the tender package but is required for the completion of the project. Bidders/Tenderer are instructed through this documents to include all such items separately in the BOQ. If such items are not highlighted in Pre Bid techno/commercial meetings and thereafter in the BOQ then all such works are deemed included in the scope of the vendor.

D. The Bidder / Tenderer must obtain for himself on his own responsibility and at his own expense all the information's which may be necessary for the purpose of making a tender and for entering it into a contract and must examine the drawings, inspect the site of the work and acquaint himself with all local conditions means of access to the work, nature of the work and all matters appertaining thereto.

E. Time allowed for carrying out the work as mentioned in the Memorandum shall be strictly observed by the Contractor and it shall be reckoned from the day written order to commence the work is issued. The work shall proceed with all due diligence, if the Contractor fails to complete the work within the specified period he shall be liable to pay a penalty as defined in the General Conditions of Contract. The Contractor shall before commencing work prepare a detailed work programme which shall be approved by the Employer's Representative.

F. Each Bidder shall submit in his bid a list of large works of a like nature he has executed giving details as to their magnitude and cost, the proportion of work done by the Bidder in it and the time within which the works were completed, the Bidder shall also submit along with his bid a list of long lead items & his procurement strategy.

G. The successful Bidder is bound to carry out any item of work necessary for the completion of the job even though such items are not included in the quantities and rates. Schedule of instructions in respect of such additional items and their quantities will be issued in writing by the Consultants with the prior consent in writing to the Employer's Representative.

3 SCOPE OF DIESEL GENERATOR (DG) SYSTEM CONTRACTOR

A. Technical specifications, bill of quantities, Tender drawings and all the other sections enclosed here in cover the design verification, update & design development as required, preparation of shop drawing and required calculations, selection, manufacture, handling at site, supply, installation, testing, commissioning and handing over of completely operational Diesel Generator System for **LODHA, KOLSHET- MUMBAI**.

B. Works to be carried out under this Contract includes detailed design of the system, BOQ verification, update as per drawings, include all items which may not listed tender documents but required to complete the system & highlighting any discrepancy before submission of tender, the preparation of shop drawing, selection, manufacture, supply, installation, testing and commissioning of the DG System and associated installation to comply with the requirements from any authorities having jurisdiction over the said system and installation and the requirements on performance, materials and equipment as stipulated in the Technical Specifications.

C. Contractor's equipment layout must comply with the space allocated for the same and as allocated in the Tender drawings. The Contractor's proposals shall work under the space/area limitations shown on the drawings for compliance. Contractor shall also note the limitation of equipment access as shown on the drawings and shall ensure that all equipment can be safely installed in allocated space to the planned space & maintenance requirement. The Contractor shall include in his scope if necessary the work for dismantling and reassembly / assembly of the equipment to accommodate any access restriction without affecting the warranty of the system.

D. Complete DG system shall be provided under this contract.
   a) Supply, Installation, testing and commissioning of DG itself & accessories under this contract
   b) Supply, Installation, testing and commissioning of Control panel (inc PLC based digital logic controller) & accessories under this contract
   c) SITC of Primary & secondary power supply units including Battery & Battery charging system (With in Acoustic Enclosure)
   d) SITC of Fuel Piping System, including HSD fuel storage pump tank, fuel transfer pumps and all allied systems (With in Acoustic Enclosure)

e) SITC of Exhaust flue piping and stack and all allied systems
f) SITC of DG Acoustic Enclosure along with necessary supports and all allied systems with in Enclosure.
g) SITC of Aluminum louvers with bird screen VCD for fresh air intake and all allied accessories. **(Not Applicable)**
h) SITC of turbo axial fan(s) and all allied accessories**. (Not Applicable)**
i) SITC of residential silencer and all allied accessories
j) SITC of functional and neutral earthing and all allied accessories
k) SITC of all final connection from fire alarm interface device to Control Panel **(Not Applicable)**
l) All cable containment installed under DG works shall be provided under the Contractor.
m) SITC of Fire barriers and fire transits. Fire stopping of all builders work opening and Fire proof (endothermic) spray on cables **(Not Applicable)**
n) SITC of all anti vibration to the Generator, flue support etc
o) DG vendor shall undertake preparation & submission of interface schedule with signing off by all other subcontractor including cause & effect schedule.
p) DG Contractor shall strictly comply to construction schedule & suit SITC per site conditions.

E. Clearing away rubbish. Tools, Tackles, Scaffolding including the provision, maintenance and removal of any special scaffolding as required. Unloading, distribution and placing in position all plant, machinery, etc.

F. Coordination of the other services/trades entering in your work front.

G. Cutting chases for sleeves, containment and the like in walls, floors, partitions etc (except on structural members) and the like and subsequent making good. Cutting or forming holes for pipes, ducts and the like through walls, floors, partitions, roofs and the like (except Structural members), subsequent making good and providing sleeves and/or sub-frames as required.

H. Application of Paint on exposed containment, fittings, equipment and the similar items with Rust proof paint.

I. All equipotential / supplementary bonding of buildings exposed metalwork to earthing system will be in the scope of the Contractor.

J. The Contractor must bear in mind that all the work shall be carried out strictly in accordance with the approved specifications and approved working drawings as instructed by the Employer's Representative and also in compliance with the local public authorities and to the requirements of any acts, rules and regulations. No deviation on any account will be permitted.

K. Providing all necessary documentations/calculations, etc as required to furnish submission for the local authority approval for all the DG Scope of Works defined under the particular contracts. All works associated to provide assistance to LODHA shall be deemed included in the scope of DG Contractors.

L. It is the intent to specify completely herein all details of design and construction of system/ plant/ equipment to be supplied / erected. However the system/ plant/ equipment supplied shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous operation in a manner acceptable to the employers Representative who will interpret the meaning of drawings and specifications and shall have the power to reject any work or material which in his judgement are not in full accordance therewith.

M. The entire works which is part of this contract shall be completed in all respects and handed over in line with the employers programme.

N. The scope of works listed below shall not be considered as comprehensive description of the Contract, but only as an indication of the extent of works.

O. Provision of Detail Design, BOQ Verification & required updates, detailed calculations (viz., voltage drop calculations, selection of panel, Power supply unit, battery capacity, sound pressure calculation, amplifier selection, Cable Sizing with software calculation, etc.,) selection of equipment's, preparation of shop drawings in coordination with other services, working drawings, builders' work drawings, supply, installation, testing, commissioning and handing over for the complete DG System to the client's/project requirement as stipulated in this specification and local government authority shall be in the DG Vendor/ Contractor's scope of works.

P. Testing and commissioning of installation under normal operational conditions shall be conducted. The tests should be Factory Acceptance Test(as required), Functional Test, Routine Test, Installation tests, Integrated System testing but should not be limited to above and should include tests as required for special equipment's. All tests should be non-destructive type tests. Contractors are instructed to list down any/all deviations with regard to testing and commissioning requirements listed/required in tender documents or as required for system functioning.

Q. For Electrical, HVAC, Fire Protection and Plumbing systems the DG works demarcation shall be as described on the Contract drawings, if same is missed Contractor to consider in the **SECTION- I BOQ under relevant item.**

R. Priming and finishing coats painting as per the standards and listed elsewhere in the tender/contract documents. All galvanised surfaces which are cut at site should be cleaned and reapplied with cold zinc paint.

S. As-built drawings and operation / maintenance manual as detailed elsewhere in the specification shall be provided.

T. Where containment for the DG services passes through the fire rated partitions/walls, the space around /within the containment shall be fire sealed. Seal the gaps between containment sleeves and containment / conduit, etc. if any.

U. Warranty and maintenance service for the period as specified in Contract Documentation from the date of handover of the works shall be included in the offer.

V. Fire stopping shall be provide; wherever the services are crossing the floor slab, shafts, fire rated walls.

W. OTHER ASSOCIATED WORKS

a) ASSOCIATED CIVIL WORK

i. Following civil works associated with the DG installation are excluded from the scope of this contract except for all minor civil work like wall chasing by wall chaser, making holes etc. for installation of conduits/cables and making good.

ii. Floor/ wall cut-outs for DG equipment or wherever required.

iii. DG Plinth

b) HVAC SYSTEM

i. NA

c) PLUMBING & DRAINAGE SYSTEM

i. NA

d) FIRE FIGHTING SYSTEM

i. NA

e) ELEVATOR SYSTEM

i. NA

f) FACADE CLEANING

i. NA.

g) ELV SYSTEM

i. NA.

h) SECURITY

i. NA

i) IBS SYSTEM

i. NA.

j) FIBRE TO THE HOME (FTTH)

i. NA.

K) BUILDING MAINTENANCE UNIT (BMU)

i. NA

4 SUMBISSIONS

A. TENDER STAGE

a) All Tenderer shall furnish stamped and signed copy of tender documents. In cases wherein bidder/Tenderer wishes to optimize cost on paper works it is earnestly required that Contractor should submit letter stating the tender compliance and deviations as listed below on company letter head with duly signed by authorised person.

b) Deviations from this specification are only acceptable where the Contractor has listed in his quotation the requirements he cannot or does not wish to comply with proper engineering justification and alternative system/proposal and the Employers Representatives have accepted, in writing, the deviations before the order is placed. If the Contractor is also to offer alternatives resulting in technical or price advantages he should submit a supplement to the main tender with detailed engineering justification and calculations together with detailed BOQ for review and approval. In cases wherein BOQ is not availed or items are not listed in detailed by bidder it is deemed included in the scope of works on contract award for SITC of the system without any cost variation at a later date to the contract and same shall remain rejected.

c) In the absence of a list of deviations, it will be assumed by the Employers Representative's that the Contractor complies with this specification and design intent with strict compliance to the listed codes. In cases wherein Contractor proposes system with upgraded codes it is responsibility of the Contractor to include the same as a proposal in the tender submission.

d) The Contractor shall furnish all the information called for in the relevant sections attached with the tender, failing which the bid will be treated as incomplete and the Employer's Representative reserves the right to reject the bid. The Contractor is advised to fill information strictly in the format enclosed.

e) Preliminary design drawings including system schematic and layout plans showing the arrangement of the DG System to demonstrate adequacy of the allocated equipment space and all being accommodated within the given architectural and structural constraints.

f) Preliminary design calculations if required/in case of any deviations for engineering justifications and approval.

g) Proposed equipment schedule showing capacities and rating required with the corresponding selection of manufacturer, model, types, etc. Relevant technical catalogues shall also be submitted with relevant sections clearly highlighted. In all cases compliance certificates to be provided.

h) Previous local job reference for major plant and equipment for the last 5 years

i) Contractor shall confirm in writing that the design on which this tender is prepared has been verified by them Contractor shall confirm that the design is verified by them and is good enough to maintain the specified design condition as per specifications and drawings.

j) Contractor shall also confirm that in their opinion the design is economical and safe and they have nothing to suggest either by way of effecting further economy or providing additional safety or better performance

k) Tenderer shall confirm that the space provided for various equipment in the tender drawings is adequate to install and maintain all the equipment's.

l) If the spaces provided in the tender drawings are inadequate to install the equipment, it shall be clearly indicated in the tender itself.

B. AFTER AWARD OF CONTRACT

Within 7 days of acceptance or as specified in the Contract Documents of the tender the Contractor shall submit for approval:

a) Construction schedule with WBS based on the LODHA baseline project schedule

b) Shop Drawing Submittal schedule.

c) Material Submittal Schedule.

d) Procurement Schedule.

e) Method statement submittal schedule.

f) Inspection Test Plan Schedule.

g) Logistic plan.

h) Schedule of manufacturers for all major equipment, devices & installation, etc or as required by Employers Representative's

i) Resource allocation schedule,

j) Project Staff Organisation Chart (Engineering, Quality and Execution) together with CV.

k) Contractor's Representatives

i. The Contractor shall employ qualified representatives on full time basis (and shall be available at site) whose name shall have previously been communicated in writing to the Employer's Representative and approved by them to supervise the execution. Any written order or instruction given to the representative shall be deemed to have been given to the Contractor.

ii. The Employer's Representative shall be at liberty to object to any particular representative or any persons employed by the Contractor on the work and the Contractor shall remove the person objected to, on receipt from the Employers Representative's, in writing, a request requiring him to do so. The Contractor shall provide in his place another competent representative acceptable to the Employer's Representative.

C. CONTRACT STAGE:

These submissions shall among other things include the following major items:-

a) Shall make all the necessary submission at such appropriate times to suit the works programme of the Project.

b) Provide builders work documentation (schedules and drawings) as per schedule listed in construction programme of works. This may require detailed site survey work – before installation, - to ascertain the exact conditions on site, any claims arising from this exercise not being undertaken will not be entertained by the Employers Representative's.

c) Submit the documentation to, and obtain approval from, the Employers Representative's before any structural work requiring holes or other modification is executed.

d) Where appropriate, mark on site the actual locations of the following:

i. Holes through walls, partitions, floors, etc.,

ii. Chases in walls, floors, etc.

iii. Pockets cast in concrete.

iv. Inserts and any built in sleeves or similar items

e) Holes may not be cut in steelwork, reinforced or precast concrete without written permission from the Employers Representative's.

f) Builder work drawings with detailed setting-out and dimensions showing requirements for all water tanks, pits, plinth, support, structural and non-structural openings etc. These shall be submitted within 15 days after award of the Contract. (Or As Mentioned in the Contract Documents)

g) System shop drawings with representation of approved material submittal.

h) Co-ordinated services drawings

i) Detailed system schematic diagram.

j) Detailed layout plans for the DG Systems.

k) Installation details

l) Wiring diagram including interface details with other system as stated in contract document. etc.

m) Equipment and material submittals and schedule.

n) Detailed design calculations.

o) Necessary drawings and documents for submission to the local authorities for approval.

p) Establish a method of installation with the Employers Representative's to ensure the works proceed without hindrance and produce method statements as requested.

q) Shipping of equipment's shall suit to the site conditions. Contractor shall include all such requirements in the scope of works of self. As per site condition equipment's equipment can be shipped in single unit/knocked down stage where Contractor to adhere with the warranty clause of the contract and same shall be availed in writing during submission.

r) Provide special project warranty, signed by vendors/suppliers, agreeing to replace, repair, or restore defective materials and workmanship of work for a period as per warranty time clause stated under the Contact Documents after successful commissioning. Warranty to be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

s) Defective Equipment: Is defined to include, but not by way of limitation, operation or control system failures, performances below specified ratings, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unusual, unexpected, and unsatisfactory conditions.

t) Provide coincidental product warranties where available for major components and Submit with maintenance manuals.

u) As-fitted drawings and O&M Manuals.

D. DRAWINGS AND LITERATURE

a) List of Equipment/ Materials:

b) The Following submittals shall be included with the tenders. Failure to provide the required information may cause rejection of the tender. Detailed equipment list, identifying types, models, and all materials & equipment proposed. This submittal shall include manufacturer's data sheets showing the types and models of all equipment and materials. The submittals shall be in the format given in relevant sections of tender documents.

c) When a data sheet shows more than one make, the proposed make shall be clearly indicated by arrows or other suitable means.

d) The data shall be submitted in a ring binder, indexed by product.

e) The data shall not include superfluous cut sheets (i.e. unedited manufacturer's catalogues are not acceptable).

f) Origin of material / components to be included.

g) Shop Drawings / Technical Data:

i. After the award of work, the Contractor shall submit shop drawings including Builders Work Drawings and technical data for approval. Shop drawings and technical submittals shall include sufficient data to indicate complete compliance with Specification, Contract Documents and System Requirements. Submissions shall be in the form of drawings, brochures, catalogues and/or narrative descriptions with certified standards.

ii. Tender Drawings have been prepared by the Architects/Consultants/Employer's Representative showing the equipment and DG system layouts and the space allocated for Plant/ Equipment.

iii. The tender drawings represent the design intent and a feasible scheme / layout that may be re-arranged in the space allocated during the shop drawing preparation subjected to prior approval by the Architects / Consultants / Employer's Representative before the actual shop drawing and execution.

iv. Within 15 days of the award of Contract (Or As Mentioned in the Contract Documents) the Contractor shall submit for approval, Technical submittals for equipment/ System/ Plant including detailed selection chart, performance curves and calculation marking the selection of all equipment, general layout, Equipment submittals, assembly drawings and such additional assembly and sub-assembly detailed drawings as are necessary to demonstrate fully that all parts of the apparatus to be furnished conform to the specifications.

v. Four sets of all catalogues (at least one set original) for all equipment, accessories and materials shall be submitted to the Employer's Representative for approval.

vi. Within 10 days of the award of contract(Or as mentioned in the Contract Documents), the Contractor shall furnish Eight (8) prints and soft copy of the equipment layouts, containment layouts, riser layouts, SLDs and assembly and erection drawings etc for approval. If modifications are proposed by the Employers Representative's, three (3) further prints of the modified drawings shall be submitted. Modifications shall be only made in the drawing after it has been approved by the Employers Representative's with their prior consent. All drawings necessary for assembly, erection, maintenance, repair and operation of the system /equipment/ materials shall be furnished. Scale for the shop drawings shall be minimum 1:100 for the plans and 1:50 for sections. All plans should be provided with adequate sections at critical locations.

vii. After the award of work, all changes in architectural, structural, interior design, facilities planning or any decision of Employer's Representative causes redesign of the system, the Contractor shall carry out the same in shop drawings / calculations and get approval from the Employer's Representative. The Employer's Representative will advise / guide the Contractor to carry out such changes but will not provide any drawing further to the tender drawings, issued with these documents.

viii. Approval by the Employer's Representative of the Technical Submittals and drawings shall not relieve the Contractor of any part of his obligation to meet all the requirements of the Contract or of the correctness of his drawings. The Contractor shall be responsible for and pay for all alterations of the works due to discrepancies or omissions in the drawings or other particulars supplied by him, whether such drawings have been approved by the Employers Representative's/ or not.

ix. Contractor shall furnish and install in or near all the machine rooms the following:

1. A neatly typed/ stencilled set of operating and maintenance instructions for the relevant equipment.
2. Neatly drawn and well-presented schematic diagrams for all the systems viz. DG SLD, wiring diagrams, interface schedules, cause & effect matrix etc. All the drawings shall be glazed and securely framed at convenient locations within the machine room.
3. Samples of materials/fabrications shall be submitted for approval to the Employer's Representative as required or called for by the Employer's Representative before installation.

x. As-Built Drawings:

1. A separate set of approved shop drawings corrected to indicate the as-built conditions shall be kept at the site. These drawings shall be maintained in a current condition at all times and shall be made available for review upon request. All variations from the approved shop drawings, for whatever reason, including those occasioned by modifications, change orders, optional materials and/or required coordination between other Contractors shall be indicated in sufficient detail to accurately reflect the as-built conditions.
2. Upon completion of the work, before final payment, one complete Mylar set and two additional blue-line sets of as-built drawings shall be submitted for approval, which shall include plans, sections, specific details, schematic diagrams, riser diagrams, control diagrams and any other drawing as directed by the Employers Representative's.
3. Contractor shall submit as-built drawings on CD-ROM in addition to the above. All drawings shall be made on the latest version of authentic Auto CAD.

xi. Quality Control Submittals:

1. Proof of compliance to applicable codes and standards.
2. Final commissioning and testing reports.

xii. Operation and Maintenance (O & M) Manuals :

1. Submit two (2) draft copies of O & M manuals for review. After review by Employer's Representative, the Contractor shall incorporate review comments and submit Six (6) final copies together with soft copies of all the contents of O&M manuals in CD- 6copies.
2. During guarantee period, the Contractor shall update the manuals with modifications made to system, providing replacement pages or supplements in quantity stated above.
3. O & M manuals shall be assembled into multi-volume sets as necessary and required by the Employers Representative's.
4. Each volume shall be protected with a heavy duty vinyl plastic binder. Volumes shall have plastic printed dividers between major sections and shall have oversized binders to accommodate up to 20 mm thick set of additional information.
5. Each binder shall be silk screened with project name and volume title on front cover and binder.
6. First page of each manual shall be identified with project name, manual title, Employer's Representative name address and service phone number and person who prepared the manual.
7. Operating and maintenance Manual shall serve as training and reference manual for all aspects of day-to-day operation of the system, such as:
8. Technical descriptions of each system.
9. Step by step direction.
10. Provision of alarms and their sequences.
11. Do's and Don'ts in operation.
12. Fault location and remedy chart.
13. Operation Instructions (full operating information to be attached).
14. Recommended maintenance schedule.
15. Parts List.
16. Schedule of spares.
17. 24/7 Emergency Contact Numbers and Names against each system.

18. Full Warranty Information
19. Modification Instructions
20. Disposal Instructions.
21. Not included above however required to complete the installation as per the Tender Documents.

E. TESTING & COMMISSIONING STAGE:

a) All equipment and the whole system shall be tested as required by the various sections of the specifications and test data as required shall be furnished.

b) Routine tests for the various items of equipment shall be performed at the Contractor's works and relevant test certificates to be furnished. If required by the Employer's Representative, the Contractor shall permit the Employer's Representative to be present during any of the tests. After notification of the Employer's Representative that installation has been virtually completed, the Contractor shall conduct under the direction and in the presence of the Employers Representative's, such tests and inspection as have been specified or as the Employer's Representative shall consider necessary to determine whether or not the full intent of the Requirements of the drawings and specifications have been fulfilled. In case the work does not meet the full intent of the specifications and further tests considered necessary, the Contractor shall conduct such tests and bear the expenses thereof.

c) The Contractor shall operate, test and adjust field detectors, devices, panels and other DG equipment's provided in connection with this installation and shall make all necessary adjustments and corrections to establish the specified system / equipment capacity at given designed condition.

d) All cabling shall be tested and visually checked to ensure outer sheeting is not damaged, that the cabling is properly supported and not under stress.

e) All equipment and systems shall be tested after installation and test readings submitted as specified.

f) Any/all equipment's, devices, material, systems and installation not complying with the testing requirements should be replaced by Contractors at their own cost.

g) Any test required to be conducted as required by statutory requirement or CFO, shall be arranged by the DG Contractor to his satisfaction. Any changes if proposed by authority shall be carried out by the Contractor without any cost to LODHA.

h) Detailed commissioning report to be prepared and furnished by Contractor to the Employer's Representative for approval during handing over.

NOTE: No drawings / submittals will be accepted for examination by the Employer's Representative unless entirely complete, first checked and approved by the Contractor.

F. REJECTION OF DEFECTIVE EQUIPMENT

a) If the completed system installation or any portion thereof, before it is taken over or during the guarantee and defects liability period, is found to be defective or fails to fulfil the intent of these specifications, the Contractor shall on receipt of notice from the Employer's Representative forthwith dismantle and replace the defective equipment/ material/ system installations.

b) Should he fail to do so within 15 days (or as noted in the Contract Documents) of notification by the Employers Representative's, the Employer's Representative may reject and replace at the risk and expense of the Contractor, the whole or any portion of the equipment/ material/ system installations found defective or that fails to fulfil the requirements of the Contract.

c) The Employer's Representative shall have the right to operate all equipment or systems whether or not such equipment or systems have been accepted as complete and satisfactory. Repairs and alterations shall be made at such times and as directed by the Employers Representative's.

G. SAFETY CODE

a) There shall be maintained in a readily accessible place first-aid appliances including adequate supply of sterilized dressing and cotton wool.

b) The injured person shall be taken to a public hospital without loss of time.

c) Suitable and strong scaffolds should be provided for workmen for all works that cannot be done safely from the ground.

d) No portable single ladder shall be over 8 metres in length. The width between the side rails shall not be less than 30 cm (clear) and the distance between the two adjacent rungs shall not be more than 30 cm. When a ladder is used an extra mazdoor (labour) shall be engaged for holding the ladder.

e) Every opening in a floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be one metre.

f) No floor, roof or other part of the structure shall be as over-loaded with debris or materials as to render it unsafe.

g) Protective gear such as safety helmets, boots, belts, etc. shall be provided by the Contractor at his own cost to all his manpower at site. The Contractor shall impose such requirements on all Sub-Contractors also. It shall be the responsibility of the Contractor to ensure that such protective gear is worn at all times by all personnel working at site. The Employers Representative shall have the right to stop any person not wearing such protective gear from working on the site.

h) Those engaged in welding works shall be provided with welder's protective eye-shields and gloves. Fire extinguishers must be provided during welding at all times. The Contractor shall employ a welding permit system and shall co-ordinate their works with all relevant parties.

i) The Contractor shall employ a power on permit system along with a lock and tag system. All areas / systems being made live shall be done only after notification of all relevant parties and operatives and after the earthing system has been properly implemented.

j) No paint containing lead or lead products shall be used except in the form of paste or readymade paint.

k) Suitable facemasks should be supplied for use by the workers when the paint is applied in the form of spray or surface having lead paint dry rubbed and scrapped.

l) Overalls shall be supplied by the Contractor to the painters and adequate facilities shall be provided to enable the working painters to wash during the cessation of work.

m) In case the Contractor fails to make arrangements and provide necessary facilities as aforesaid, the Employer's Representative shall be entitled to do so and recover the costs thereof from the Contractor. The decision of the Employer's Representative in this regard shall be final and binding on the Contractor.

n) Use of hoisting machines and tackle including their attachments, anchorage and supports shall be in perfect condition.

o) The ropes used in hoisting or lowering material or as a means of suspension shall be durable and in perfect condition.

p) All electrical connections for construction activity shall be taken through proper receptacles only. No loose wire connections shall be allowed.

H. CONTRACTOR AGREEMENT –

a) The Contractor shall be responsible to read and agree the scope of work as detailed in the Contract Documents.

I. CEA (MEASURES RELATING TO SAFETY AND ELECTRIC SUPPLY) REGULATIONS, 2010

a) Pursuant to CEA (Measures relating to Safety and Electric Supply) Regulations, 2010 the Contractor shall appoint a designed electrical safety officer who shall be responsible for observance of the safety provisions laid out under this act and for ensuring inspection and testing of their works.

b) Safety signage in accordance with Section 18 “Danger Notices “of the CEA shall be provided by the Contractor.

c) All Electrical works undertaken under this contract shall be via an Electrical Contractor licensed by the state government. Staff shall hold certificates of competency recognised by the State Government.

d) The Contractor shall provide two distinct and separate earth connections for all their equipment back to its respective switchboard.

e) Interlocking of suppliers shall comply with Section 45 of the CEA.

f) The Contractor shall ensure such testing is carried out and records maintained – in line with CEA Section 46 – to satisfy the Utility and Chief Electrical Inspectors requirements.

J. GENERAL REQUIREMENTS

a) Ensure all equipment and systems are to provide electromagnetic compatibility within the systems and with any other systems installed in the same location.

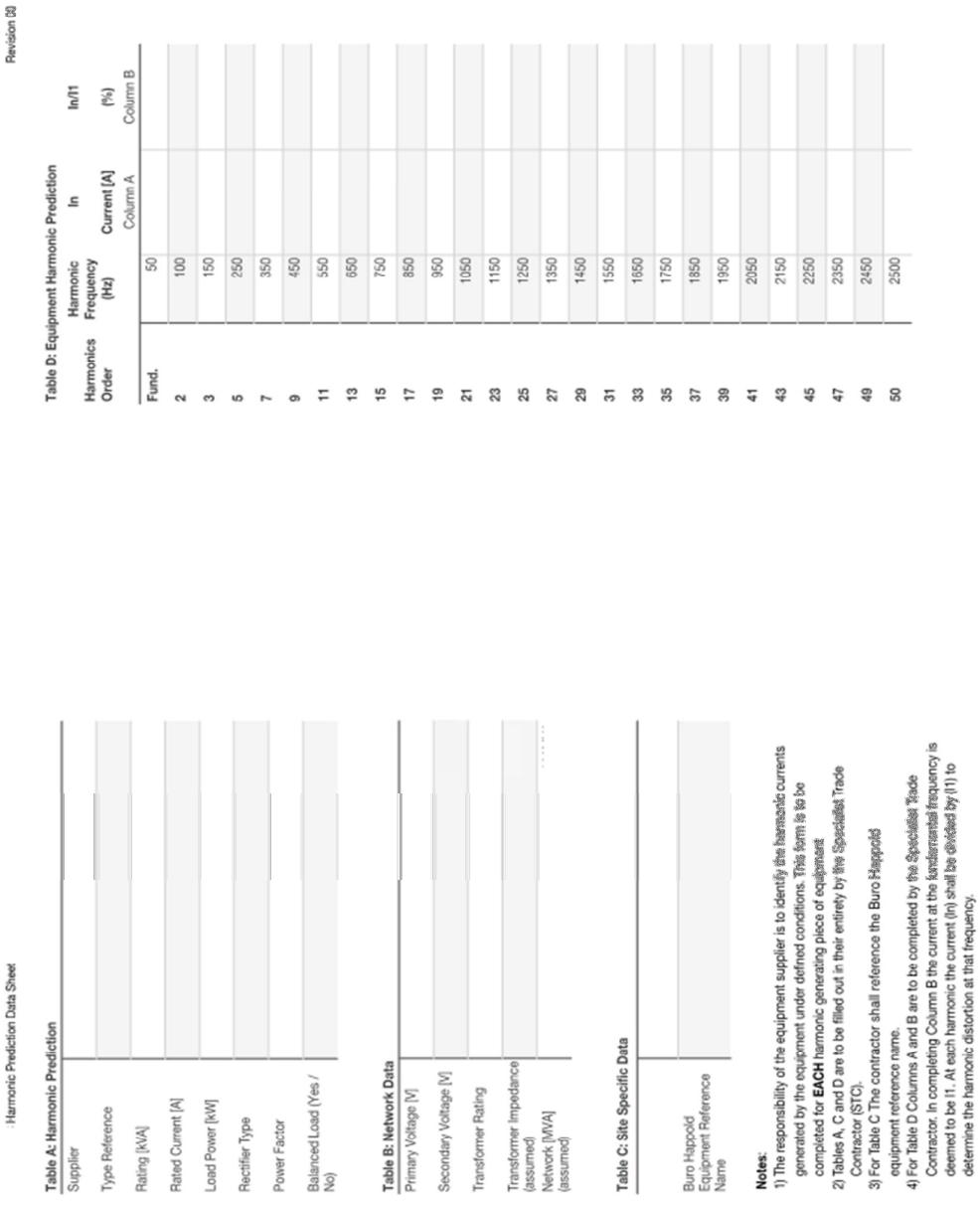
b) The Contractor shall install systems strictly in line with manufacturers recommendations and shall ensure all works are in line with recommended EMC mitigation measures in IEC 61000-5 (Installation and mitigation guidelines).

c) Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both DG equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

d) Harmonic data to be provided by the Contractor for each piece of harmonic generating equipment. This data will list:

i. Equipment Name
ii. Manufacturers reference
iii. Contract document reference
iv. Power Factor of complete unit
v. Input current
vi. Power Requirements
vii. Balanced load (Y/N)
viii. Details of inverter (if applicable)
ix. Harmonic data listing **ALL** harmonic current and % harmonic distortion from the fundamental to the 50^{th} harmonic.

Note: if equipment is designed to operate at part load the power factor, input current, power requirements and harmonic data must be provided for both fully rated and partial load. The Contractor shall be obliged – under this contract to provide completed data sheets for each harmonic generating item of plant in line with the data sheet below:



Harmonic Prediction Data Sheet

Revision 00

Table A: Harmonic Prediction

Supplier	
Type Reference	
Rating [kVA]	
Rated Current [A]	
Load Power [kW]	
Rectifier Type	
Power Factor	
Balanced Load (Yes / No)	

Table B: Network Data

Primary Voltage [V]	
Secondary Voltage [V]	
Transformer Rating	
Transformer Impedance (assumed)	
Network [MVA] (assumed)	

Table C: Site Specific Data

Buro Happold Equipment Reference Name	

Table D: Equipment Harmonic Prediction

Harmonics Order	Harmonic Frequency (Hz)	In Current [A] Column A	In/I1 (%) Column B
Fund.	50		
2	100		
3	150		
5	250		
7	350		
9	450		
11	550		
13	650		
15	750		
17	850		
19	950		
21	1050		
23	1150		
25	1250		
27	1350		
29	1450		
31	1550		
33	1650		
35	1750		
37	1850		
39	1950		
41	2050		
43	2150		
45	2250		
47	2350		
49	2450		
50	2500		

Notes:
1) The responsibility of the equipment supplier is to identify the harmonic currents generated by the equipment under defined conditions. This form is to be completed for **EACH** harmonic generating piece of equipment.
2) Tables A, C and D are to be filled out in their entirety by the Specialist Trade Contractor (STC).
3) For Table C The contractor shall reference the Buro Happold equipment reference name.
4) For Table D Columns A and B are to be completed by the Specialist Trade Contractor. In completing Column B the current at the fundamental frequency is deemed to be I1. At each harmonic the current (In) shall be divided by (I1) to determine the harmonic distortion at that frequency.

e) The DG Contractor shall supply, install, terminate, test and commission all control cables to the Control Panel and to remote mains sensing relays and auto changeover interfaces on MLTPs.

f) Work shall be carried out in accordance with this specification and shall comply with the standard NFPA72 (latest edition), BS, IS, IEC, State PWD, NEC 2011, NBC 2005, IPC, Chief Fire Officer (CFO) of Mumbai, Local Municipal Authorities, MOEF guidelines and subject to approval by the Employers Representatives.

g) The Contractor shall be obliged to provide Declarations of Conformity certificates (DoCs) for all items of equipment supplied. These DoCs shall state the directive and standards the equipment is compliant with. The Contractor shall be responsible for collating the equipment list and compiling DoCs against each item of equipment for their package. All such documentation shall be kept in the projects safety file for handover to the Client.

Suppliers Declaration of Conformity (conform ISO 17050)

1. Number of DoC:	23456
2. Issuer's name:	Electronic Emission Presentation B.V. Immunitystraat 2 Emission City Belgium
3. Object of declaration:	Semiair Presentation Machine Homin: Model de Luxe
4. The object of declaration described above is in conformity with the requirements of the following documents:	
Document No:	Title
2004/108/EC	EU EMC Directive (December 2004)
EU Harmonised standards	EN 55099:2009 EN 55099:2010 EN 55099:2008 Part X except Chapter Y
EEP test method 2009.	Test method XYZ. To cover the parts of EN 55099 not being applied
5. Additional information	A technical documentation nr. Global Presentation nr. YZZ is available to document compliance of the excluded part of the harmonised standard
6. Signed for and on behalf of:	Electronic Emission presentations B.V.
7. Date:	30 August 2010
8. Name and Function:	Mr. E Veen Managing Director
9. Signature	

From the Guide for the EMC Directive 2004/108/EC (21st May 2007), published by the EU.

h) The EMC zoning – based on the likely electromagnetic phenomena, which will be encountered by the electronic and DG equipment installed and located within the building – shall be classed as:

Light Industrial / Commercial / Residential

The prescribed limits set down in the generic standards below will be used as a reference for zoning this development.

The Contractor shall be obliged to ensure the EMC characteristics for each item of equipment proposed for this project does not offend the buildings EMC Zoning noted below:

Description of Environment	**Relevant Standards**	**Applicable Areas**
Light industrial / commercial / residential	IEC 61000-6-1 IEC 61000-6-4 Equivalent Product Codes	All areas
Notes: 1) This table highlights the minimum test standards required to ensure the procured equipment will meet minimum requirements for the local EMC environment. 2) The Contractor shall be responsible for ensuring their equipment suppliers		

Description of Environment	Relevant Standards	Applicable Areas
documentation demonstrates compliance with EMC emissions / immunity based on relevant standards above.		

5 MAINTENANCE

A. General

Provide the following free maintenance for the time period as per the Contract Documents after handing over the Plumbing System to the Client (i.e. during warranty period)

a) Examinations: Bi-Weekly, including adjustments, cleaning and lubrication of equipment.
b) Replacement: Replace components when required, using parts produced by original manufacturer.
c) Spare Parts: Provide necessary spare parts; maintain locally an inventory of all wearing parts of the system.
d) Call Backs: Provide 24-hour emergency call back service at no expense to the Client.
e) Records: Maintain complete maintenance records including check charts, lubrication logs and activity logs; provide check charts and activity logs.

B. Extended Service Contract

At time of Bid, submit cost for full maintenance contract i.e. after the expiry of warrantee and free maintenance period as specified in the Contract Documents.

a) Contract Term: Upon expiration of new installation, free maintenance, provide full maintenance service for five (5) years, including spare parts.

C. Service: Provide examinations, logs, replacements and spare parts as specified for maintenance, including monitoring of power consumption on daily /weekly basis, periodic servicing of the DG equipment's etc.

6 QUALITY ASSURANCE

A. Scope

The following quality assurance, inspection, testing and commissioning procedures shall be required to be carried out upon award of work.

a) Provide quality assurance program (QAP), works quality assurance program (WQAP), field quality assurance program (FQAP) and quality plan.
b) Tests at manufacturer's works.
c) Perform site tests and commissioning.

B. Submittals

a) After award of work following information shall be submitted.
   i. Quality Assurance Program (QAP)
   ii. Works Quality Assurance programme (WQAP)
   iii. Field Quality Assurance Programme (FQAP)
b) For inspection and testing, submit inspection and testing procedures, programme, record sheets applicable at each hold point.
c) After completion of testing, submit test records, packaging, transportation and storage instructions and methods.
d) For site installation and commissioning, submit installation methods or procedures, notification and procedures for pre commission and commissioning.
e) After commissioning, submit site test records, as-built drawings, manufacturer's operation maintenance manuals and list of recommended spares and tools.

C. Quality Assurance Concept And Control

a) Minimum requirements for establishing and implementing a quality assurance programme shall be applied to all aspects of the work necessary for carrying out the contract. Quality assurance shall extend to material parts, components, systems and services as a means of obtaining and sustaining the reliability of critical items, operating performance, maintenance and safety.
b) Acceptance of the Contractor's quality assurance programme does not relieve the Contractor's obligation to comply with the requirement of the contract document. If the

programme is found to be ineffective, then the Owner's site representative reserves the right to request for necessary revisions of the programme.

c) The Contractor is required to produce readily identifiable documentary evidence covering the extent and details of both his own and his sub Contractor's quality assurances system as follows :
   i. Quality Assurance Program (QAP)
   ii. Works Quality Assurance programme (WQAP)
   iii. Field Quality Assurance Programme (FQAP)
   iv. Quality Plan.

d) These documents shall be prepared separately and submitted to the Owner's site representative at the time of starting the work.

e) Quality Plan and Manual shall be prepared by the Contractor for all items and services to be supplied, after the contract has been placed, but before commencement of fabrication, and shall be subject to evaluation and acceptance by the Owner's site representative before start of work.

D. Quality Assurance Manual (QAM)

a) The QAM shall be a general comprehensive document outlining the Contractor's basic organization, policies and procedures. The information to be given in the QAM shall include but not limited to :
   i. Quality Policy.
   ii. Quality Assurance Programme
   iii. Organization Structure showing inter relationships.
   iv. Functional responsibilities and levels of authority.
   v. Lines of communication.
   vi. Customer relations.
   vii. Laboratory Facilities.

E. Works Quality Assurance Programme (WQAP)

a) The WQAP shall identify the Contractor's Quality Assurance Programme at works applicable throughout all phases of Contract performance, including design, procurement, manufacture, inspection and testing. It shall identify each of the programme elements to be designed, developed, executed and maintained by the Contractor for the purpose of ensuring that all supplies and services comply with this specifications.

b) The information to be given under this programme shall include but not limited to :
   i. Organization and Responsibility.
   ii. Contract Review.
   iii. Design and Document Control.
   iv. Procurement Control.

c) Production Control.
   i. Control on Sub-Contractors.
   ii. In-process Quality Control and Traceability.
   iii. Inspection and Testing.
   iv. Control of Non-conformances.
   v. Corrective Action.
   vi. Control of Inspection, Measuring and Test Equipment.
   vii. Handling, Storage, Packaging and Delivery.
   viii. Records.
   ix. Quality Audits.
   x. After - Sales Servicing.

d) Field Quality Assurance Programme (FQAP)
   i. This programme shall identify the Contractor's Quality Assurance Programme at site applicable throughout site construction, erection and commissioning. It is the underlying philosophy that the quality built into the product at works shall be maintained throughout the construction and commissioning stages.
   ii. While, in principle, the FQAP shall include the items discussed in WQAP, it shall, however, be approached differently to take into account site conditions.
   iii. The FQAP shall include, but not limited to the following information :
      1. Organization and responsibility.

2. Control of Drawings and Documentation.
3. Product Checklist.
4. Control and Traceability of Purchased materials and services.
5. Receipt Inspection of materials at site.
6. Material Storage Control.
7. Inspection and Examination Procedures.
8. Control of Painting and Insulation Works.
9. Pre-commissioning.
10. Commissioning.
11. Control of Non-conformances.
12. Corrective Action.
13. Control of Inspection, Measuring and Test Equipment.
14. Records.
15. Complétion Documents.
16. List of recommended spares and tools.
17. Personal Training.
18. Servicing during Defects Liability Period.

F. Quality Plan

a) The Contractor shall be required to prepare manufacturing and construction/erection quality plans for all equipment items and services. The quality plan shall also define the involvement of Owner's site representative in the inspection and test programme.
b) The Quality Plan shall incorporate as appropriate :
   i. Charts indicating flow of materials, parts and components through manufacturing quality control inspection and test to delivery and erection.
   ii. The charts shall indicate the location of hold points for quality control, inspection and test beyond which manufacture shall not continue until the action required by the hold point is met, and the documentation required is generated.
   iii. The control documents associated with each hold point, i.e. drawings, material, specification, Works Process Schedule (WPS), Process Quality Records (PQR), quality control methods and procedures and acceptance standards.

G. Site Quality Control Section
a) The Contractor's Quality Control (Q.C.) section shall be headed by an experienced Quality Control Engineer. He shall be assisted by other supervisors. The section shall be an independent one, reporting to the Contractor's Site Manager only on administrative matters, but otherwise under full control by the Contractor's Corporate Quality System Management.
b) The Contractor's Q.C. Section shall liaise closely with the Owner's site representative in charge of Quality Assurance/Quality Control, and to whom it shall give fullest cooperation. It is the underlying principle of this contract document that while the Contractor's Q.C. Engineer implements the Contractor's Quality Programme, the adequacy and effectiveness of that implementation shall be audited by the Owner's site representative whose recommendations on improving or maintaining quality shall be acted upon promptly by the Contractor's Q.C. Section.

H. Regulatory Requirements: Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

I. Workmanship

The workmanship shall be best of its kind and shall conform to the specifications, as below or Indian Standard Specifications in every respect or latest trade practices and shall be subject to approval of the Employer's Representative. All materials and/or Workmanship which in the opinion of the Employer's Site Representative is defective or unsuitable shall be removed immediately from the site and shall be substituted with proper materials and/or workmanship forthwith.

J. Materials

a) DG Components, Devices, and Accessories: Listed and labelled as defined as per relevant codes & by a qualified testing agency, and marked for intended location and application.
b) Comply with the "Approval Guide," published by IS

c) All materials shall be best of their kind and shall meet minimum requirement of applicable latest Indian & international Standards. All materials shall be of approved quality as per samples and origins approved by the Employer's Representative.

As and when required by the Employer's Representative, the Contractor shall arrange to test the materials and/or portions of works at his own cost to prove their soundness and efficiency. If after tests any materials, work or portions or work are found defective or unsound by the Employer's Representative the Contractor shall remove the defective material from the site, pull down and re-execute the works at his own cost to the satisfaction of the Employer's Site Representative. To prove that the materials used are as specified the Contractor shall furnish the Employer's Representative with original vouchers on demand.

7 DELIVERY, STORAGE & HANDLING

A. Preparation for Transport: Prepare equipment, according to the following:
   a) Ensure that all material to be transported to be protected against rust and corrosion.
   b) Protect the material against damage.
   c) Set material in best position for handling. Set material closed to prevent rattling.

B. During Storage: Use precautions for material, according to the following:
   a) Do not remove end protectors / wrappings etc. unless necessary for inspection; then reinstall for storage.
   b) Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle materials if size requires handling by crane or lift. Do not use hand wheels or stems as lifting or rigging points for handing the heavy materials.

D. Deliver conduits with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent conduits-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored conduits from moisture and dirt. Elevate above grade.

F. Protect equipment from moisture and dirt.

G. Store plastic conduiting protected from direct sunlight. Provide supports to prevent sagging and bending.

8 COORDINATION

A. The DG Contractor shall be responsible to provide detailed layout & information to the Electrical Contractor to prepare overall coordination layout with all the trades.

B. Work shall be carried out in conformity with the specifications and accompanying drawings after approval by the Employer's Representative.

C. The Contractor shall also co-operate with the Employers Representative's other Contractors, to compare and coordinate drawings, and time schedules and so arrange his work that there will be no interferences.

D. The Contractor shall forward to the Employers Representative copies of all correspondence and drawings (prior to the execution) so exchange. Failure to check plans and conditions will render the Contractor responsible for bearing the cost of any subsequent change found necessary.

E. The Contractor shall be required to do part / complete installation work in phases so as to take maximum advantage of the work front as and when it becomes available.

F. INSPECTION, TESTING AND COMMISSIONING.

a) INSPECTION AND TESTING :-

i. All equipment and components supplied may be subjected to inspection and tests by the Consultant/ Owner's site representative during manufacture, erection/installation and after completion. The inspection and tests shall include but not be limited by the requirements of this contract document. Prior to inspection and testing, the equipment shall undergo pre-service cleaning and protection.

ii. Tenderer shall state and guarantee the technical particulars listed in the Schedule of Technical Data. These guarantees and particulars shall be binding and shall not be varied without the written permission of the Owner's site representative.

iii. No tolerances shall be allowed other than the tolerances specified or permitted in the relevant approved Standards, unless otherwise stated.

iv. If the guaranteed performance of any item of equipment is not met and / or if any item fails to comply with the specification requirement in any respect whatsoever at any stage of manufacture, test or erection, the Owner's site representative may reject the item, or defective component thereof, whichever he considers necessary; and after adjustment or modification as directed by the Owner's site representative, the Contractor shall submit the item for further inspection and /or test.

v. The approval of the Owner's site representative of inspection and/or test results shall not prejudice the right of the Owner's site representative to reject an item of equipment if it does not comply with the contract document when erected, does not or prove completely satisfactory in service.

vi. The Contractor shall be responsible for the timely transmission of the relevant and appropriate sections of the contract document to manufacturers and sub-Contractors for the proper execution of all tests at their works as per contract specifications.

b) Tests At Manufacturer's Works

i. All tests to be performed during manufacture, fabrication and inspection shall be agreed with the Consultant/ Owner's site representative prior to commencement of the work. The Contractor shall prepare the details of the schedule and submit these to the Consultant/ Owner's site representative for approval. It must be ensured that adequate relevant information on the design code/standard employed, the manufacture /fabrication/assembly procedure and the attendant quality control steps proposed are made available to the Consultant/Owner's site representative who will mark in the appropriate spaces his intention to attend or waive the invited tests or inspections.

ii. A minimum of twenty-one days' notice of the readiness of equipment for test or inspection shall be provided to the Owner's site representative by the Contractor (whether the tests are held at the Contractors of Sub-Contractor's works). The subject items should remain available for Owner's site representative inspection and test up to a minimum 10 days beyond the agreed date of witnessing the test. Every facility in respect of access, drawings, instruments and manpower shall be provided by the Contractor and sub-Contractor to enable the Owner's site representative to carry out the necessary inspection and testing of the Equipment.

iii. No equipment shall be packed, prepared for shipment, or dismantled for the purpose of packing for shipment, unless it has been satisfactorily inspected, all tests called for have been successfully carried out in the presence of the Owner's site representative or approved for shipment, or alternatively inspection has been waived.

iv. Functional, electrical and mechanical tests shall be carried out on completed assemblies in the works. The extent of these tests and method of recording the results shall be submitted to, and agreed by, the Owner's site representative in sufficient time to enable the tests to be satisfactorily witnesses, or if necessary for any changes required to the proposed programme of tests to be agreed.

v. The Consultant/Owner's site representative reserves the right to visit the Manufacturer's works at any reasonable time during fabrication of equipment and to familiarize himself with the progress made and the quantity of the work to date.

vi. Within 30 days of completion of any tests, triplicate sets of all principal test records, test certificates and correction and performance curves shall be supplied to the Owner's site representative.

vii. These test records, certificates and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Owner's site representative or not. The information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificate refers and should also bear the Contract reference title.

viii. When all equipment has been tested, the test certificates from all works and site tests shall be compiled by the Contractor into volumes and bound in an approved from complete with index and four copies of each volume shall be supplied to Consultant/ Owner's site representative.

ix. Stage wise inspection of equipment in factory in waived.

c) Performance Tests At Manufacturer's Works

i. All equipment may be subjected to routine performance tests at the Manufacturer's Works in accordance with the relevant NFPA, IEC, BS EN, ANSI, ASME, ASTM, BIS, UL standard including operating tests of complete assemblies to ensure correct operation of apparatus and components.

ii. The Contractor shall submit single line diagrams including the layout of the Equipment together with the location of test instrumentation and the principal dimensions of the layout. All calculations to derive performance data shall be made strictly in accordance with format given in the approved standards. Any alterations or deviations from the approved standard test layout or formulae shall be subjected to the prior approval of the Owner's Site Representative.

iii. The performance test shall be conducted as per technical specification & site requirement. Any proposal for the omission of this test shall be to the approval of the Consultant/ Owner's site representative.

iv. On completion of the tests the Contractor shall submit a report showing the test results obtained together with the curves corrected to the site operating conditions.

9 REFERENCES

A. Tender specifications, drawings, schedules, general and special conditions of the Contract apply to this Section.

Standard Code	**Description**
General Codes	
NBC 2005	National Building Code of India 2005
NEC 2011	National Electrical Code 2011
IE Rules	Indian Electricity Rules 1956
CFO-NOC	NOC from Chief Fire Officer
Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.	
NFPA 110	Standard for Emergency and Standby Power
ISO 8528/ ISO 3046	Reciprocating internal combustion engine driven alternating current generating sets
IS 4722	Routine test for alternator
Codes for Earthing	
IS 3034	Earthing Code of Practice

Codes for L.V. Switch-gears	
IS 1570	Schedules for wrought steels for general engineering purpose
IS 13703	Low voltage fuses.
IS 13947 (Part 5/Sec 1) :1993	Specification for Low Voltage Switchgear and Control gear Part 5 Control Circuit devices and switching elements Section 1 Electromechanical control circuit devices (First Revision)
IS 2705	Current transformers.
IS 3156	Voltage transformers.
IS 1248	Electrical indicating instruments.
IS 722	Integrating meters.
IS 3231	Electrical relays for power system protection.
IS 6875	Control switches and push buttons.
IS 694	PVC insulated cables for working voltages up to and including 1100V.
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS 5578	Guide for marking of insulated conductors.
IS 3618	Phosphate treatment of Iron and steel for protection against corrosion.
IS 6005	Code of practice of phosphating of Iron and steel.
IS 5	Colors for ready mixed paints and enamels.
IS 2147	Degree of protection provided by enclosures for switchgear and Control.
OISD-RP-149	Design Aspects for Safety in Electrical System.
IEC 60189	PVC insulated cables for switchgear and control wiring.

IEC 61008	Residual Current Device (RCD)
IEC 60255	Electrical relays.
IEC 60269	Low-voltage fuses.
IEC 60417 DB	Graphical symbols for use on equipment.
IEC 60439	Low voltage switchgear and control gear assemblies.
IEC 60445	Basic and safety principles for man-machine interface marking and identification. Identification of equipment terminals and of termination's of certain designated conductors. Including general rules for an alphanumeric system.
IEC 60529	Degrees of protection provided by enclosures. (IP Code)
IEC 60617 DB	Graphical symbols for diagrams.
IEC 60715	Dimensions of low voltage switchgear and control gear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and control gear installations.
IEC 60947	Low Voltage switchgear and Control gear
IEC 62271	High Voltage Switchgear and Control gear
IEC TR 61641	Enclosed LV Switchgear and Control gear assemblies – guide for testing under conditions of arcing due to internal fault.
IEEE C62.41.2, UL 1283 & UL 1449	Electrical Components, devices & accessories
IEC 60439	Low voltage switchgear and control gear assemblies.
IEC 62052	Class 0.5, 1 and 2 alternating current watt-hour meters.
IEC 60529	Degrees of protection provided by enclosures. (IP Code)
IEC 60947	Low Voltage switchgear and control gear
IEC 60269	Low-voltage fuses.

UL 1008	Standard for Transfer Switch Equipment (ATS)
IEC 947-6-1	Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching (ATS) Equipment
Code for Cables/Cable Trays / ladders / Trunking	
IS:9537 (Part-II)/ CEE 23 & IEC 60695-2-1:1991	Steel Conduit and Fitting Accessories PVC Conduit and Fitting Accessories
ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Tray
ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Ladder
IS 14927, IEC 1084.	Cable Trunking
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
BS 6387	Specifications for performance requirements for cables required to maintain circuit integrity under fire conditions
CONDUITS	
IS:9537 (Part-II)/ CEE 23 & IEC 60695-2-1:1991	Steel Conduit and Fitting Accessories &PVC Conduit and Fitting Accessories

- Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the NFPA72 latest edition, Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.
- CFO NOC

END OF SECTION-A

SECTION-B

DIESEL GENERATOR SYSTEM

1.1 PREAMBLE

A. This section of specification defines the technical requirements for the Diesel Generator system as specified in accordance with the requirements of the Contract Documents and codes.

1.2 SUMMARY

A. The scope of work for the Diesel Generator System outlined in this section of the specification includes the systems design verification, supply, installation, testing, commissioning and handing over of the complete Diesel Generator System (DG) by the Contractor.

B. The entire work shall be carried out in a manner consistent with good engineering practice & **system's performance shall not be compromised**. The Contractor shall take into account all site conditions including space allocation for DG System while designing the system and selecting the equipment.

C. The Contractor shall be responsible for engaging a qualified, competent and experienced DG System staff to perform the system design verification, preparation and submission of system proposal, obtaining approvals from relevant authorities and site supervision for installation, testing and commissioning.

D. The Contractor shall perform the system design verification based on the criteria / data and technical requirements specified in this section / drawings and the local Authorities regulations / requirements.

E. The Contractor shall provide systems which comprises products of manufacturers who have designed, developed and used these products successfully for a period of at least five years.

F. The Contractor shall submit catalogue information, design calculations and samples complete with full technical data and shop drawings for the entire system, test certificates, etc. and any other information required by the Employer's Representative for acceptance prior to commencement of installation. Include for:

   a. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and for designing vibration isolation bases
   b. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights
   c. Wiring Diagrams: Power, signal, and control wiring.

G. The Contractor shall submit analytical test reports for the Electrical Systems wherever applicable after the commissioning or after the system is put into operation or as required by the Employer's Representative. The result should comply with local authority requirements.

H. The DG System must comply with the standard, State PWD, NEC 2011, NBC 2005, IPC, Chief Fire Officer (CFO) of Mumbai, Local Municipal Authorities, MOEF guidelines and subject to approval by the Employers Representatives. Tender specifications, drawings, schedules, general and special conditions of the Contract apply to this Section.

Standard Code	**Description**
General Codes	
NBC 2005	National Building Code of India 2005

NEC 2011	National Electrical Code 2011
IE Rules	Indian Electricity Rules 1956
CFO-NOC	NOC from Chief Fire Officer
Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.	
NFPA 110	Standard for Emergency and Standby Power
ISO 3046-1	Reciprocating internal combustion engines. Performance. Declarations of power, fuel and lubricating oil consumptions, and test methods. Additional requirements for engines for general use
BS ISO 3046-3	Reciprocating internal combustion engines. Performance. Test measurements
BS ISO 3046-5	Reciprocating internal combustion engines. Performance. Torsional vibrations
BS ISO 8528 Parts 1-6	Reciprocating internal combustion engine driven alternating current generating sets
IS 4722	Routine test for alternator
Codes for Earthing	
IS 3034	Earthing Code of Practice
Codes for L.V. Switch-gears	
IS 1570	Schedules for wrought steels for general engineering purpose
IS 13703	Low voltage fuses.
IS 13947 (Part 5/Sec 1) :1993	Specification for Low Voltage Switchgear and Control gear Part 5 Control Circuit devices and switching elements Section 1 Electromechanical control circuit devices (First Revision)

IS 2705	Current transformers.
IS 3156	Voltage transformers.
IS 1248	Electrical indicating instruments.
IS 722	Integrating meters.
IS 3231	Electrical relays for power system protection.
IS 6875	Control switches and push buttons.
IS 694	PVC insulated cables for working voltages upto and including 1100V.
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS 5578	Guide for marking of insulated conductors.
IS 3618	Phosphate treatment of Iron and steel for protection against corrosion.
IS 6005	Code of practice of phosphating of Iron and steel.
IS 5	Colours for ready mixed paints and enamels.
IS 2147	Degree of protection provided by enclosures for switchgear and Control.
OISD-RP-149	Design Aspects for Safety in Electrical System.
IEC 60189	PVC insulated cables for switchgear and control wiring.
IEC 61008	Residual Current Device (RCD)
IEC 60255	Electrical relays.
IEC 60269	Low-voltage fuses.
IEC 60417 DB	Graphical symbols for use on equipment.
IEC 60439	Low voltage switchgear and control gear assemblies.

IEC 60445	Basic and safety principles for man-machine interface marking and identification. Identification of equipment terminals and of termination's of certain designated conductors. Including general rules for an alphanumeric system.
IEC 60529	Degrees of protection provided by enclosures. (IP Code)
IEC 60617 DB	Graphical symbols for diagrams.
IEC 60715	Dimensions of low voltage switchgear and control gear. Standardized mounting on rails for mechanical support of electrical devices in switchgear and control gear installations.
IEC 60947	Low Voltage switchgear and Control gear
IEC 62271	High Voltage Switchgear and Control gear
IEC TR 61641	Enclosed LV Switchgear and Control gear assemblies – guide for testing under conditions of arcing due to internal fault.
IEEE C62.41.2, UL 1283 & UL 1449	Electrical Components, devices & accessories
IEC 60439	Low voltage switchgear and control gear assemblies.
IEC 62052	Class 0.5, 1 and 2 alternating current watt-hour meters.
IEC 60529	Degrees of protection provided by enclosures. (IP Code)
IEC 60947	Low Voltage switchgear and control gear
IEC 60269	Low-voltage fuses.
UL 1008	Standard for Transfer Switch Equipment (ATS)
IEC 947-6-1	Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching (ATS) Equipment
Code for Cables/Cable Trays / ladders / Trunking	
IS:9537 (Part-II)/ CEE 23 &	Steel Conduit and Fitting Accessories PVC Conduit and Fitting

IEC 60695-2-1:1991	Accessories
ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Tray
ISO 9000, ISO 9001, ISO 9002 or Equivalent IS Standard.	Cable Ladder
IS 14927, IEC 1084.	Cable Trunking
IS 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
BS 6387	Specifications for performance requirements for cables required to maintain circuit integrity under fire conditions
CONDUITS	
IS:9537 (Part-II)/ CEE 23 & IEC 60695-2-1:1991	Steel Conduit and Fitting Accessories &PVC Conduit and Fitting Accessories

- Unless specifically mentioned otherwise, all the applicable Codes and Standards published by the NFPA72 latest edition, Bureau of Indian Standards and their subsequent revision/ BS Standards shall govern the design, workmanship, quality and properties of materials and method of testing.
- CFO NOC

1.3 SUBMITTAL

A. Technical Data: Submit data for approval including, but not limited to, the following:

- Part C&D Schedule completed,
- Manufacturer's technical catalogue & Cut sheets
- Block Loading details
- Operating characteristics,
- Furnished specialties and accessories.
- Thermal damage curve for generator.
- Time-current characteristic curves for generator protective device.
- Dimensional and electrical characteristics
- Software Calculations with voltage drop study all field devices.

- Acoustic study to indicate attenuation achieved with their proposed solution.**(Not Applicable)**
- Static and Dynamic slab loading details.
- Anti-Vibration mounts.
- Axial Fan Technical Details. **(Not Applicable)**
- Technical details of proposed acoustic louvers.**(Not Applicable)**
- Technical details of proposed muffler / silencer.
- Technical details of Alternator
- Technical details of fuel transfer system.

B. Shop and Construction Drawings: Submit Drawings for approval including, but not limited to, the following:

- Single line diagram based on design requirement.
- Wiring Diagrams: Power, signal, and control wiring.
- Technical Details: Voltage, Current, KVA, and, efficiency.
- Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
- Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. Calculation for Ventilation Requirements, Calculation for Exhaust Back-Pressures & Calculation of Alternator Sizing.
- Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
- Seismic-Restraint Details: Signed and sealed by a qualified professional engineer.
  - Design Calculations: Calculate requirements for selecting seismic restraints.
  - Detail fabrication, including anchorages and attachments to structure and to supported equipment.
- Details for fuel transfer arrangement.
- Details of condensate drain arrangement.
- Documents shall comprise but not limited to the following :

PART 2 - A : Indicates that the document to be submitted within 7 days after release of the PO (or as specified in GCC & SCC)
PART 3 - B : Indicates that the document to be submitted within 10 days after approval of drawing (or as specified in GCC & SCC)

Sr. No.	Engineering Data	Reqd. With Bid	Required after Purchase Order			
			For approval		As built	
			Qty	Schedule Days	Qty	Schedule Days
1	Outline dimension drawing	yes	4	A	6	B
2	Fuel tank sizing and heat dissipation calculations	yes	4	A	6	B
3	Sections with part description	yes	4	A	6	B
4	Completed Data Sheets	yes				

5	Bill of Materials for scope of Supply	yes	4	A	6	B
6	Installation / Operation / Maintenance Manual				3	With dispatch
7	Priced Spare List for 2 years service	yes				
8	Terminal point schedule / drawing		4	A	6	B
9	Description of Control Sequences	yes	4	A	6	B
10	Type test certificate for short circuit withstand for panel					
11	Inspection Test Reports				6	At the time of inspection
12	Test Certificates for bought out items (Battery, Meter, Relay, etc.)				6	
13	Exhaust pipe sizing & Support Design	yes	4	A	6	B

A. Manufacturer Seismic Qualification Certification: Submit certification that DG Set, accessories, and components will withstand seismic forces. " Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
   a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2. Dimensioned Outline Drawings of Equipment Unit: Identify centre of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control test reports:

1. Certified summary of prototype-unit test report

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements

5. Report of sound generation

6. Report of exhaust emissions showing compliance with applicable regulations

7. Certified Torsional Vibration Compatibility: Comply with BS ISO 8528-5.

C. Certificate of Origin: For each lot of cable supplied, provide a certificate of origin issued by manufacturer stating origin, date of manufacture, composition, Standards to which it complies and test certificates. All test certificates are to comply with the test requirements of the relevant standard to which the cable is manufactured, (i.e. type).

D. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed electrical ducts, and manholes, in accordance with requirements.

E. Product Certificates: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

F. Routine tests at factory.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

I. Product Test Reports: Indicate compliance of DG System and accessories with requirements based on comprehensive testing of current products.

J. Maintenance Data: For DG System. to be included in the maintenance manuals.

K. Source Quality Control Test:

1. Certified summary of prototype-unit test report.

2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.

3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.

4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

5. Report of sound generation.

6. Report of exhaust emissions showing compliance with applicable regulations.

7. Certified Torsion Vibration Compatibility: Comply with NFPA 110.

1.4 MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to those noted in Section G.

1.5 TECHNICAL REQUIREMENT

1.5.1 ENGINE-GENERATOR SET

A. Alternator

Continuous output / Speed : **250 KVA** [NETT Power] / 1500 RPM

Rated Power Factor : 0.8 lag

Rated Voltage	:	440 V, 3Ph, 4 wire
Rated frequency	:	50 Hz
Class of insulation	:	F
Temperature rise limit	:	Limited to class B

B. Provide alternating current generating set driven by a reciprocating internal combustion engine in accordance with ISO 8528. The engine and alternator units will be provided as a composite factory assembled unit mounted on a one piece structural supporting skid.
C. Generator set to be tested according to BS 7698-8. Engine for generating set to be in accordance with ISO 8528 and ISO 3046. AC generator to be according to BS EN 60034-22.Provide completely documented ISO standard functional test report in accordance with BS ISO 8528-6.
D. Unless otherwise agreed in writing by the engineer the supply and extract air louvers shall be separated by a minimum distance of 1.5 x the overall length of the installed set.
E. Change-over panels shall be electrically and mechanically interlocked.
F. Guard all exposed hot or moving parts in accordance with ISO 12100.
G. Provide 24 volt dc supply to start engine from any crankshaft position, by axial type starter motor engaging with flywheel. Ensure starter motor disengages automatically when engine starts or when de-energised. Ensure starter motor is accessible and fit non-conducting protective shrouds to terminals. Ensure system has sufficient capacity to initiate three starting cycles.
H. Provide exhaust system in accordance with manufacturer's recommendations and to meet characteristic requirements. Include all fittings, gaskets, joints and fixings to ensure safe exit of products of combustion.
I. Ensure engine lubricating oil dipstick is accessible and marked to indicate maximum and minimum levels. Provide engine sump with accessible drain point or drain pipe, fitted with plug. Ensure lubricating oil system enables the engine to run continuously for period indicated at any load without replenishment.
J. Design life for equipment shall be 20 years minimum when operated at rated load under the site conditions specified.
K. The following materials are prohibited from use:
    1. Asbestos or asbestos based materials.
    2. Cadmium.
    3. Poly-chloryl-biphenols (PCB's).
    4. Lead.
L. Generator shall be rated stand-by duty. The rating stated shall be the nominal full load continuous rating and shall be at rated voltage, frequency, power factor and design temperature.
M. Steady-State Voltage Operational Bandwidth: 2.5 percent of rated output voltage from no load to full load.
    1. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
    2. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
    3. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
    4. Transient Frequency Performance: Less than 5 percent variation for 50 percent step load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
    5. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics.
    6. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10

seconds and then clear the fault automatically, without damage to generator system components.

7. Start Time: Comply with NFPA 110, Type 10, system requirements.

N. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

O. Cooling System: The engine cooling system shall be of radiator type to cool the engine as well as the body to minimise heat radiated into the generator room. The cooling circuit shall exchange heat through a heat exchanger capable to remove the heat generated under continuous full load operation. Water cooled with Heat exchanger factory mounted on engine-generator set mounting frame and integral engine-driven coolant pump.

P. Silencer: Residential type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Sound level measured at a distance of 1m from exhaust discharge after installation is complete shall be 75 dBA or less complete as per the norms.
   2. M.S. epoxy painted structural support and vibration arrestors for D.G. set chimney to specify along with drawing for statutory clearance..

Q. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in site conditions.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   3. Cranking Cycle: As required by NFPA 110 for system level specified.
   4. Battery: Adequate capacity within ambient temperature range specified site conditions to provide specified cranking cycle at least three times without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in site conditions Include accessories required to support and fasten batteries in place.
   7. The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.
   8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
   9. Battery Charger: Shall be trickle charging type. Unit shall comply with UL 1236 and include the following features:
      a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
      b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
      c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
      d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

R. Fuel Piping and Fuel Tank Installation: The fuel Tank shall be standalone to DG Set with capacity of 990 Ltrs or Day Tank (8 Hours continuous working) and shall be inclusive of all necessary pumps, piping, valves and control system for the satisfactory working. The day tank shall also be equipped

with fuel return connection, vent, sight glass, level switch for transfer pump control, overflow line and drain valve. Day oil Tank shall be provided with high level and low level switches for control of transfer pump. All necessary fuel line pipes, valves and other miscellaneous piping materials from Day Tank to Engine are in Vendor's Scope. Alarm shall be given for fuel low level and fuel high level in Day tank. All fuel / oil transfer piping shall be of MS class C seam less and inclusive of related hanging and supporting arrangement.

S. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

1.5.2 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.
B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments:
C. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated in the equipment schedules, with capacity as required to operate as a unit as evidenced by records of prototype testing
   2. Output Connections: Three-phase as indicated on the schedules
   3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component
   4. Comply with noise levels indicated in section B of this specification.

D Generator-Set Performance for Sensitive Loads:
   1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance:
   2. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
   3. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load
   4. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second
   5. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load
   6. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed
   7. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds
   8. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent
   9. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components
   10. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load
   11. Permanent magnet excitation in subparagraph below is a standard feature of some manufacturers' engine-generator sets larger than 200 kW.
   12. Provide permanent magnet excitation for power source to voltage regulator
   13. Retain subparagraph below if required start time is 10 seconds or less.
   14. Start Time: Comply with NFPA 110, Type 10, system requirements.

1.5.3 ENGINE DIESEL FUELLED

A. Fuel: High Speed Diesel
B. Maximum Piston Speed for Four-Cycle Engines: 11.4 m/s
C. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Engine Fuel System:
   1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions
   2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

E. Governor: Adjustable isochronous, with speed sensing.

F. Cooling System Factory mounted radiator: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump:
   1. Coolant: Solution of ethylene-glycol-based antifreeze (if ambient conditions warrant) and water, with anticorrosion additives as recommended by engine manufacturer
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition
   3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer
   4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet- and abrasion-resistant fabric:
      a) Rating: 345-kPa maximum working pressure with coolant at 82℃, and non-collapsible under vacuum
      b) End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

G. Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements:
   1. Minimum sound attenuation of 25 dB at 500 Hz
   2. Sound level measured at a distance of 3m from exhaust discharge after installation is complete shall be 70 dBA or less.

H. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 24-V electric, with negative ground:
   1. Components: Sized so they will not be damaged during a full engine-cranking cycle with normal ambient temperature at maximum
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding
   3. Cranking Cycle: As required by NFPA 110 for system level specified
   4. Battery: Adequate capacity within ambient temperature range of 20 – 45 deg
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Retain first subparagraph below if compartment is required.
   7. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature. Include accessories required to support and fasten batteries in place.

J. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:
   8. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again

9. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 0℃ to plus 60℃ to prevent overcharging at high temperatures and undercharging at low temperatures
10. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent
11. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates:
    a) Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel
    b) Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

1.5.4 FUEL OIL STORAGE

A. Day Tank: Freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:
    1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank:
    2. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
    3. Revise hours in first subparagraph below or delete subparagraph and indicate capacity on Drawings. Coordinate with Drawings and NFPA 110 requirements.
    4. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine
    5. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level
    6. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level
    7. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve
    8. Subparagraph below is not in NFPA 110 minimum requirements.
    9. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine-generator set.

B. Service Storage Tank
    1. Construct Service storage tanks which have a capacity not more than 999l.
    2. All service tanks will be supplied with the following:
        a) Oil drain valve
        b) Water drain valve
        c) Separate vent pipe or return pipe located at the higher end
        d) For oil draw-off and return lines fire valves will be provided
        e) Oil dipstick point
        f) BMS sensor link electronic level sensor manual gauge
        g) Filling pipes and connections
        h) Outlet and inlet valves.
    3. Note that tanks must be of steel construction. Plastic tanks are not permitted. The tank shall be fabricated from mild steel plate to Grade CR 4 suitable for welding as BS 1449-1. Galvanised steel shall not be used. Welding to be as specified in BS 5135 Include all necessary lifting lugs. Thicknesses shall not be less than 1.2mm thick.
    4. The tank shall be hydraulically pressure tested at works and finished externally with 2 coats of zinc rich primer prior to installation after first being wire brushed, degreased and being cleaned of all rust and scale.
    5. The finish coat for the tanks shall be two coats of gloss paint and silver colour finish.

C. Pipes, Tubes, And Fittings

1. Oil lines shall be steel pipe to BS EN 10255:2004 -Non-alloy steel tubes suitable for welding and threading - technical delivery conditions. Fittings for steel pipe should be to BS EN 10241 – Steel threaded pipe fittings and threads shall be to BS 21 – Specification for pipe threads for tubes and fittings. Galvanised pipe or fittings must not be used.
2. Protective coating for underground piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
3. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

D. Fuel filter:
1. Provide on the common oil feed to the oil circulation pumps an 80mm diameter cast steel duplex oil filter with lift out replaceable bronze wire mesh elements
2. The filter will be a combined filter and water separator capable of removing particles down to 5 microns
3. The oil filter will be lever operated to allow the oil stream to be diverted separately through each filter element or as a combined flow through both. Each filter will be provided isolating valves on either side of the filter and a drain cock.

E. Tank Accessories
1. Tank manholes: 600 minimum diameter; bolted, flanged, and gasketed; centred on top of tank.
2. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gauging. Include cast-iron plugs for shipping.
3. Striker plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
4. Lifting lugs: For handling and installation.
5. Ladders: Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
6. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall:
7. Cage: Include welded steel cage around ladders for tanks 4 m high or higher.
8. Supply tube: Extension of supply piping fitting into tank, terminating 150 mm above tank bottom and cut at a 45-degree angle.
9. Sounding and gage tubes: Extension of fitting into tank, terminating 150 mm above tank bottom and cut at a 45-degree angle.

F. Simplex Fuel-Oil Transfer Pumps
1. Description: Comply with UL 343:
2. Listed and labelled for fuel-oil service by a testing laboratory
3. Type: Positive-displacement, rotary type
4. Impeller: Steel gear with crescent or Carbon vane
5. Housing: Cast-iron foot mounted
6. Bearings: Bronze, self-lubricating
7. Shaft: Polished steel
8. Seals: Mechanical
9. Base: Steel
10. 9Pressure relief: Built in
11. Discharge check valve: Built in.
12. Drive: direct, close coupled.
13. Controls:
    a. Run pump to maintain minimum manifold pressure with outdoor-air temperature less than 16 deg C
    b. Run pump on seven-day schedule
    c. Alarm motor failure
    d. Manual reset dry-run protection. Stop pump if fuel level falls below pump suction
    e. De-energize and alarm pump locked rotor condition
    f. Alarm open circuit, high and low voltage
    g. Indicating lights for power on, run, and off normal conditions

14. Interface with automatic control system and indicate the following:
    a. Start/stop pump set when required by schedule, fuel-fired appliance operation, day tank level control, or weather conditions
    b. Operating status
    c. Alarm off-normal status.
15. Motor: Comply with IP designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
16. Motor sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
17. Capacities and characteristics: As detailed in schedules of equipment.

G. Liquid-Level Gauge System
1. Description: Calibrated, liquid-level gage system complying with UL 1238 with probes or other sensors and remote annunciator panel.
2. Alarms specified in first paragraph below may be used as part of leak-detection system.
3. Annunciator panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in litres, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
4. Controls: Electrical, operating on 24V ac.

H. Controls, Leak-Detection And Monitoring System
1. The fuel handling control system shall be part of a packaged system. The system shall interface to the BMS for start/stop and fault signals.
2. The pumps and day tank motorised valves shall be controlled by the high and low level sensors within each day tank. Each day tank shall be filled on demand. Each pump shall include an hours run meter within the control panel. The low level alarm shall indicate to BMS and fill point controls that the fuel storage is low and requires filling. The extra low level alarm shall shutdown the pump system and relay the level status and pump status to the BMS workstation as an 'Urgent' task.
3. Differential pressure switches across each strainer set shall initiate a fault at the panel and on the BMS to indicate the necessity for cleaning.
4. Differential pressure switches shall be fitted across the 'Duty' and 'Standby' pumps and shall be automatically switchover in the event of failure or manual shutdown. The fault and operational signal shall be provided for the BMS.
5. The BMS shall provide a fire alarm derived shut down signal which shall close all motorised controlled fire valves. A manual reset facility shall be provided adjacent the control panel.
6. Manually reset push buttons marked by a white plastic plate not less than 100mm long × 75mm high, with an inscription in 10mm red lettering stating "IN CASE OF FIRE STRIKE KNOB" shall be positioned at all exits from the following areas:
    a. Generator room.
7. Activation of one of these buttons shall close all motorized fire valve and stop the oil transfer pumps.
8. A screwdown gate valve or glanded cock shall be fitted at the lowest part of the underside of the tank. Unlubricated plug valves shall not be used. Drain valves shall be of gunmetal or steel. Cast iron valves shall not be used. Drain valves and cocks shall be capable of being locked in the closed position.
9. Cable and Sensor System: Comply with UL 1238:
    a. Calibrated, leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping
    b. Include fittings and devices required for testing
    c. Controls: Electrical, operating on 24V ac
    d. Calibrated, liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel
    e. Remote annunciator panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in litres, and overfill alarm. Include gage volume range that covers fuel-oil storage capacity
    f. Controls: Electrical, operating on 24-V ac.

10. Hydrostatic system: Comply with UL 1238:
    a. Calibrated, leak-detection and monitoring system with brine antifreeze solution, reservoir sensor, and electronic control panel to monitor leaks in inner and outer tank walls
    b. Include fittings and devices required for testing
    c. Controls: Electrical, operating on 24V ac
    d. Retain three subparagraphs below for an optional feature that replaces system described in "Liquid-Level Gage System" article
    e. Calibrated, liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel
    f. Remote annunciator panel: With visual and audible, high-tank-level and low-tank-level alarms, fuel indicator with registration in gallons (litres), and overfill alarm. Include gage volume range that covers fuel-oil storage capacity
    g. Controls: Electrical, operating on 24V ac.

1.5.5 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down generator set.

C. Remote start and remote shutdown: Provision shall be made in the control circuitry for remote start and remote shutdown signals for the diesel engine. Remote engine start shall be initiated by closing a normally open contact; remote engine shutdown will be initiated by opening a normally closed contact. Remote start and stop signals shall be available through an AMF panel.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 2 system, and the following:
    1. AC voltmeter.
    2. AC ammeter.
    3. AC frequency meter.
    4. DC voltmeter (alternator battery charging).
    5. Engine-coolant temperature gage.
    6. Engine lubricating-oil pressure gage.
    7. Running-time meter.
    8. Ammeter-voltmeter, phase-selector switch.
    9. Generator-voltage adjusting rheostat.
    10. Fuel tank high-level shutdown of fuel supply alarm.
    11. Generator overload.

A. Indicating and Protective Devices and Controls:
    1. AC voltmeter.
    2. AC ammeter.
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    4. DC voltmeter (alternator battery charging).
    5. Engine-coolant temperature gage.
    6. Engine lubricating-oil pressure gage.
    7. Running-time meter.
    8. Ammeter-voltmeter, phase-selector switch.
    9. Generator-voltage adjusting rheostat.
    10. Start-stop switch.

11. Over speed shutdown device.
12. Coolant high-temperature shutdown device.
13. Coolant low-level shutdown device.
14. Oil low-pressure shutdown device.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Generator overload.

B. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

C. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
1. Over-crank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.
4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

D. Common Remote Audible Alarm: Signal the occurrence of any events listed below without differentiating between event types. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset.
1. Engine high-temperature shutdown.
2. Lube-oil, low-pressure shutdown.
3. Over-speed shutdown.
4. Remote emergency-stop shutdown.
5. Engine high-temperature pre-alarm.
6. Lube-oil, low-pressure pre-alarm.
7. Fuel tank, low-fuel level.
8. Low coolant level.

E. Remote Alarm Annunciator: Comply with NFPA 99. An LED labelled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush mounting type to suit mounting conditions indicated.

F. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labelled. Push button shall be protected from accidental operation.

1.5.6 DG CONTROLER BASED AUTOMATIC MAINS FAILURE / AUX. PANELS.

A. The panels shall be suitable for operation on 3 Phase 415 volts, 50 cycles. The degree of protection for enclosure shall be IP-52. All panels shall be CPRI approved. AMF panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

B. AMF panels shall be fitted with a PLC based Digital Logic Controller which includes generator protection relays as noted in the Contract documents.

C. The Voltage monitoring signal / AMF feature shall be co-ordinated with proposed ATS. Generator Control Panel / AMF panel shall be able to communicate & process Start / Stop Signals from the ATS.

D. Construction Feature
1. AMF panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor / wall mounting type and shall be Form 3B construction. The AMF panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. Panels shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of AMF panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-

8623-1993 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

2. All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self-threading screws shall not be used in the construction of AMF panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of AMF panels and the lowest unit.
3. AMF panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Switches shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the AMF panels in conformity with the location of cable/conduit connections.
4. AMF panels shall be suitable for top cable duct connection for incoming from alternator and cable duct connection bottom entry for outgoing to LT panel. Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.
5. All panels shall have provision of pad locking of breaker handles in OFF position.

E. Bus Bar Connection

1. Bus bar and interconnections shall be of high conductivity electrolytic aluminium as per BOQ and of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bars and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid strips of proper size to carry full rated current and insulated with insulating sleeves.

F. Temperature Rise Limit

1. Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.
2. AMF panels shall be provided with MCCB's of appropriate capacity as per Single Line Diagram. AMF Panels shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit shall be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits shall be distinctly marked with a small description of the service installed.

G. Cable Compartments

1. Cable compartment of adequate size shall be provided in the AMF panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

H. Air Circuit Breakers (ACB) / Moulded Case Circuit Breaker(MCCB)

1. ACBs / MCCBs shall be Current Limiting and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's upto 250 Amps shall have thermal magnetic releases and above 250 amps shall have microprocessor based release with adjustable magnetic short circuit pickup. Wherever ACBs/MCCBs with earth fault protection mentioned in BOQ, the protection shall be an integral part of the release with adjustable magnetic short circuit and earth fault protection with time delay.
2. The trip command shall override all other commands. ACBs/MCCBs shall employ maintenance free double break contact system to minimize the let thru' energies and capable of achieving

discrimination upto full short circuit capacity of downstream ACBs/MCCBs. The manufacturer shall provide both discrimination tables and let thru energy curves.

3. The breaking capacity of ACBs/MCCBs shall be as asked for in the schedule of quantities. The breaking capacities specified shall be ICU=ICS i.e Type-2. Co-ordination as per IEC-60947-2, 1989/IS 13947-2, 1993.
4. The ACBs/MCCBs shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole ACBs/MCCBs the neutral shall be defined and capable of offering protection.

I. Miniature Circuit Breaker(MCB)

1. Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.
2. The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the external operating handle.

J. Earthing: Earthing shall be provided as per IS:3043-1987.

K. Painting:

1. All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivating (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be RAL-7032 of IS Code No.5.

L. Labels

1. Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

M. Meters

1. All voltmeters and indicating lamps shall be through MCB's.
2. Meters and indicating instruments shall be digital electronic type.
3. All CT's connection for meters shall be through Test Terminal Block (TTB).
4. CT ratio and burdens shall be as specified on the Single line diagram.

N. Current Transformers

5. Current transformers shall be provided for Synchronizing / AMF / AUX panels. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.
6. The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

O. Selector Switch

1. Where called for selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

P. Contactor

1. Contactor shall be built into a high strength thermoplastic body and shall be provided with an are shield for quick are extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.
2. Starter's contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6

times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta Starters. The insulation for contactor coils shall be of Class "E".

3. Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 240 / 415 + 10% volts, 50 cycles AC supply.

Q. Thermal Overload Relay

1. Thermal overload relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.
2. Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from –5deg C + 55 deg C.
3. All overload relays shall be of three element, positive acting ambient temperature compensated time logged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity.

R. Time Delay Relay

1. Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

S. Toggle Switch

1. Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS codes an shall be of 5 amps rating.

T. Push Button Stations

1. Push button shall be provided for manual starting and stopping of motors / equipment "Green" and "Red" colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for 'Stop' push buttons. The push button contacts shall be suitable for 6 amps current capacity.

U. Indicating Panel

1. All meters and indicating instruments shall be in accordance with relevant Indian Standards. The meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB.

V. Testing : Testing of panels shall be as per following codes:

1. IS: 8623 (Part -I) 1993 for factory built assemblies of switch gear for voltages upto and including 1000 VAC, IS: 13947 : 1993 Degree of protection , IS: 5578 & 11353:1985 Arrangement of bus bars.

W. Anti Condensation Space Heater

1. 1 No. 1000 W, 240 Volts single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and protected by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of AMP / Synchronizing panel and 1 No. 60 watt Anti Condensation space heater shall be provided in each cable alley of DG Auxiliaries panel and sub distribution boards. Supply and control equipment for the above shall be provided by the vendors.

1.5.7 TRANSFER OF POWER FROM NORMAL TO GENERATOR POWER SUPPLY AND FROM GENERATOR SUPPLY TO NORMAL POWER AUTOMATICALLY

A. In the case of failure of Utility fed normal power supply

1. Generator to start after a prefixed time of three second on any of the following conditions:
   i. Total absence of voltage.
   ii. Failure of one or two phases.
   iii. Under voltage below 380 volts.

2. After a lapse of 10-12 seconds normal power supply breaker to open and Generator supply breaker to close.

3. All auxiliaries (D.G. Sets Exhaust Fans, Pump etc.) to start & run automatically.

B. In the case of Resumption of Normal Power supply :
   a. Breakers change back will be manually carried out at each MLTP
   1. Generator to over run for the three minutes and stop automatically.
   2. All auxiliaries to stop automatically.
   3. Generator to be ready for the next operation automatically.

1.5.8 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Air Circuit Break fitted with Microprocessor-based adjustable LSIG release to provide for time and current adjustment for Long, Short and Instantaneous time and current plus Ground Fault protection:
   1. Tripping Characteristic: Designed specifically for generator protection.
   2. Trip Rating: Matched to generator rating.
   3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
   4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signalled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:
   1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
   2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
   3. As over-current heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
   4. Senses clearing of a fault by other over-current devices and controls recovery of rated voltage to avoid overshoot.

C. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

1.5.9 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified. Adjusting rheostat on control and monitoring panel shall provide plus or minus 2.5 percent adjustment of output-voltage operating band.

1.5.10 AUXILIARY SUPPLIES :

B. Auxiliary supplies (closing, tripping, control, indication, heaters, etc.) shall be in accordance with the one-line diagram(s).

C. Where motor charging spring operating mechanism is specified for circuit breaker, it shall be rated for the rated auxiliary control supply operation.

D. Circuit breaker closing, tripping, control and indication power shall be supplied from suitably rated 24Volt DC supply units. They supplies are deemed to be part of the DG Contractors scope and wil provide for 24h standby autonomy.

E. All auxiliary supplies shall be individually protected within each circuit breaker housing. Individual protection shall be by suitably rated fuses.

F. For shunt trip circuits the protection shall be rated at least 300% of the load.

G. Anti-condensation heater supplies shall be derived internally from each busbar section.

H. Incoming Auxiliary Supplies shall be protected by suitably rated fuses at the point of entry to the switchboard. The Contractor shall ensure discrimination with individual circuit fuses. Volt free group contact shall be provided via internal bus wiring for remote common alarm.

1.1.1. MONITORING BY REMOTE COMPUTER :

A. Provides a Communication module in each unit to provide capability for remote monitoring of status, parameters, and alarms. The remote computer and the connecting signal wiring themselves are not included in this Contract. Include the following features:
   - Connectors and network interface units or modems for data transmission via RS-485 link.
   - The OEM shall have Software solution designed for control and monitoring of DG functions and to provide on-screen explanations, interpretations, diagnosis, action guidance, and instructions for use of monitoring indications and development of meaningful reports. The actual supply of this software is not included . The software solution shall under this contract. Permit storage and analysis of power-line transient records.

1.5.11 VIBRATION ISOLATION DEVICE

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

1.5.12 ACOUSTIC TREATMENT (NOT APPLICABLE)

A. The DG Set shall be installed in an acoustically treated room
B. The room shall be provided with suitable air intake openings lined with noise attenuators and louvers designed to maintain steady air flow in to the enclosure and prevent ingress of external foreign matter.
C. Attenuators shall be placed on the hot air outlet and cooling air inlet. Exhaust silencers of Residential type as required shall be mounted within the space, exhausting to atmosphere and the enclosure to be equipped with all outlet baffles /attenuators shall be with corresponding mesh to allow sufficient airflow for the set to operate even under the harshest ambient conditions whilst maintaining specified noise levels .The louvers and attenuators should be so designed that maximum temperature difference between the ambient and inside of the enclosure is maintained at 10 deg C.
D. The room shall be provided with high performance noise reduction, fire resistant and airtight doors with EPDM gaskets, robust hinges, door locks with keys and handles. The specification for the room acoustic Insulation shall be as follows. 50 mm thick,32kg/m3 rigid board fibre glass insulation backed with black colour fibre glass tissue and covered with 26 G GI perforated sheet complete with sealant, fixing clips and in accordance with drawings.
E. The above specifications are indicative and vendor shall guarantee that the room is so specified and constructed to achieve a sound attenuation of 70 dB(A) at one meter distance from the room to be measured as per Norms.

1.5.13 DG ROOM Ventilation (NOT APPLICABLE)

1.5.13.1 Tube Axial Fan

Fans shall be direct driven Tube axial type. Fans shall be complete with motor, drive arrangement, motor mount, and vibration isolation arrangement as per approved for construction shop drawings.

A. Casing shall be constructed of 14 gauge sheet steel. Fan casing and motor mount shall be of welded steel construction. Motor mounting plate shall be minimum 12 mm thick and machined to receive motor flange. Casing shall be provided with wide hinged doors which should open easily for removal of wheel, shaft and bearings. A small inspection door with handle and neoprene gasket

shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be primed and finish coated with enamel paint.

B. Rotor hub and blades shall be cast aluminum construction. Blades shall be die formed airfoil shaped for maximum efficiency and shall vary in width from hub to top to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Maximum clearance between blade tip and fan housing at the specified duty blade setting shall be 5 mm. Rotor blades shall be whirl tested to a speed of 25% above the design operating speed and certification of the test shall be provided by the manufacturer. Extended grease leads for external lubrication shall be provided. Rotor shall be statically and dynamically balanced. The fan pitch control shall be manually readjusted at site upon installation for obtaining actual air flow values as specified and quoted.

C. Motor shall be squirrel cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, suitable for 415 ± 6% volts 50 cycles, 3 phase power supply as per latest IS specifications. Motor nameplate horsepower shall exceed brake horsepower by a minimum of 20%..Motors shall be quiet operation and motor speed shall not exceed 1500 rpm. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible conduit.

D. Motor starters shall be automatic direct on line for rating up to 7.5 H.P. and automatic Star Delta for motors 10 HP & above. The starters shall incorporate (a) thermal overload (b) under voltage protection (c) single phase preventor and are to be included in the prices of starter panels.

E. Drive to fan shall be direct driven.

F. Vibration Isolation: The assembly of fan and motor shall be suspended from the ceiling or mounted on walls by vibration isolators.

G. Accessories : The following accessories shall be provided with all fans:

   I. Outlet cone for static pressure regain.
   II. Inlet cone.
   III. Fan silencers, if required.
   IV. Wire guards on fan outlet / inlet not connected to duct work and shall be made freely accessible for maintenance.

   Fans shall be factory assembled and shipped with all accessories factory-mounted. For smoke extraction fans, the gaskets shall be suitable for continuous operation in an air stream temperature of 250°C for two hour or 300^{0}C for one hour.

1.5.13.2 GI Ducting

Galvanizing shall be Class VIII – light coating of zinc, nominal 120gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by Employer's Representative/consultant shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

Fabrication of ducts shall be through well conditioned Triplex lock former or multiple lock formers, conforming to relevant SMACNA Codes.

Rectangular Ducts G.S.	External Pressure 250 Pa		
	Duct Selection Length 1.2 Mtr. (4 feet)		
Maximum Duct Size	Gauge	Joint Type	Bracing Spacing

1-750 mm	26	C & SS	Nil
750 - 1000 mm	26	4 Bolt Transverse Duct Connector - E (TDC) with built in sealant	Nil
1001 - 1200 mm	24	4 bollt TDC - E	Nil
1201 - 1500 mm	24	4 bollt TDC - H	Nil
1501 - 1800 mm	22	4 bollt TDC - H	Nil
1801 - 2100 mm	20	4 bollt TDC - J	Nil
2101 - 2700 mm	18	4 bollt TDC - J	Nil

'C'-cleat; 'S'-S cleat; 'SS'-Standing S cleat; 'AI' -Angle Iron in mm

*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

Fabrication Standards & Equipment

a. All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.
b. Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.
c. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.
d. All edges to be machine treated using lock formers, flanges and rollers for turning up edges.
e. All ducts shall be fabricated and installed in workmanlike manner, generally conforming to relevant SMACNA Codes. Round exposed ducts shall be die-formed for achieving perfect circle configuration.
f. Ducts so identified on the Drawings shall be acoustically lined and insulated from outside as described in the section “Insulation” and as indicated in Schedule of Quantities. Duct dimensions shown on Drawings are overall sheet metal dimensions inclusive of the acoustic lining where required and indicated in Schedule of Quantities.
g. Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.
h. All exposed ducts up to 60 cm width within conditioned spaces shall have slip joints - or flanged joints. The internal ends of slip joints shall be in the direction of air flow. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.
i. Changes in dimensions and shape of ducts shall be gradual. Air-turns (Vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence’s. Ducts shall be fabricated as per details shown on Drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles, of ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

j. All sheet metal connection, partitions and plenums required to confine the flow of air to and through the filters and fans shall be constructed of 18 gage GSS / 16 gauge aluminum, thoroughly stiffened with 25 mm x 25 mm x 3 mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Doors shall be not less than 45 cm x 45 cm in size.

k. Plenums shall be panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards G S sheet and riveting shall be done from outside.

l. Self adhesive rubber lining minimum 5 mm thick instead of felt shall be used between duct flanges and between duct and duct supports in all ducting installation.

m. All ducts shall be installed generally as per tender Drawings, and in strict accordance with approved shop drawings to be prepared by the Contractor.

n. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these Specifications and Drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.

o. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the Drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

p. If a duct cannot be run as shown on the Drawings, the Contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owner's site representative.

q. All duct work shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel under ducts at no greater than 2 meter centre. All vertical duct work shall be supported by structural members on each floor slab. Duct supports may be through galvanised steel insert plates left in slab at the time of slab casting. Galvanised steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods and angles/ channels shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash /anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats.

r. Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All

s. metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building.

t. Where ducts pass through brick or masonry openings, it shall be provided with 25 mm thick TF quality expanded polystyrene around the duct and totally covered with fire sealant such as fire barrier mortar for complete sealing.

u. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of flame retardant, water proof, silicon rubber impregnated flexible connection at least 10 cm long securely bonded and flange bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

v. Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

1.5.13.3 Fire retardant canvas Flexible Connections

A. Flexible connectors at inlet and discharge to air handling equipment shall be pre-assembled 0.7 mm galvanized steel with minimum of 150 mm width (exposed) fire resistant fabric. For higher pressure applications 25 mm of width of fabric shall be used for each 25 mm of static pressure.
Flexible connectors attached to acoustically treated ductwork shall be insulated with 25 mm Fibre glass insulation packed between flexible connector and 16 gauge (1.5 mm) galvanized steel housing. At equipment collar caulk between collar and flange on housing with 10 mm thick permanently flexible sealant. Care shall be taken to ensure that ducts on both sides of the connection are independently supported and that no "bridging" occurs.

The fabric shall be rated for use up The material shall also be impervious to moisture, dimensionally stable, and

B. Dampers
a. All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.
b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.
c. Dampers shall be placed in ducts at every branch supply or return air duct connection, whether or not indicated on the Drawings, for the proper volume control and balancing of the air distribution system.

1.5.13.4 LOUVERS

a. Materials of Construction / Fabrication: Louvers shall generally be fabricated from extruded aluminum sections with mitered joints; unless otherwise stated or dictated by selection with minimum free area of 60%.

b. Finishing:

Louvers shall have anodized / polyester powder coated colored finish, selected to match with the surrounding architectural finishes.

c. Manufactures to submit performance data based on AMCA 500 - Test Method for Louvers, Dampers and Shutters

d. Construction :

Single angled louvers of 2.5 mm (12 gauge) thick, 100 mm (4 inch) deep blades set at 45° slope with centre baffle and return bend; set in heavy channel frame.

e. Accessories (for air intake):

i) Exterior flat flange for installation on walls

ii) 19 mm (3/4 inch) square mesh, bird screen; opposed blade, gang operated, volume control damper with removable key operator, adjustable from the grill face

iii) 100 mm (4 inch) panel type washable air filter

f. Accessories (for exhaust):
13 mm (½ inch) square mesh, bird screen

g. Louvers which are adjacent to the car park / habitable area shall be of accoustic type and shall be cable of reducing the noise levels upto acceptable limits as specified.

1.5.13.5 Sound Attenuators

Attenuators shall be installed in ducts in accordance with requirements of drawings and as included in Schedule of Quantities.

Noise levels within conditioned spaces shall be not greater than those set out in schedule below :

w. Noise Level Design Criteria

S.No.	Area Acceptable Noise	Levels (NC)
A.	Plant room Areas	45-50

a. Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, non-hygroscopic, vermin proof, fiber glass of required density adequately protected against corrosion and covered with 26 Gauge perforated aluminum sheet. Attenuators shall be supplied complete with flanges.

b. Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the values listed below

	OCTAVE BAND CENTRE FREQUENCY HZ							
	63	125	250	500	1K	2K	4K	8K
Insertion loss dB 900 mm long attenuators	22	7	12	19	23	23		11
Insertion loss dB 1500 mm long attenuators	6	10	18	30	42		23	14

c. The pressure drop values of the silencers shall be indicated for each duty.

d. Manufacturers shall submit a test certificate for acoustic and aerodynamic performance of the attenuators. Attenuators shall be tested in accordance with ACMA test methods/BS 4718 and insertion loss and self generated noise for each octave band and pressure drop shall be stated in the schedule.

e. Contractor shall submit detailed acoustic calculation along with sound attenuator selection.

1.5.13.6 Protective cladding

All piping and duct which are insulated shall be cladded with 26 G aluminium sheet

1.5.14 CABLE TRAYS

A. Ladder and perforated type Cable Trays shall be of Hot dip Galvanized type as per IS:209-1992., IS:6745-1972 and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below :

1. Cable trays shall be galvanized as per Specification:
   a. 1500 mm wide
      1) Runners 25 x 100 x 25 x 3 mm
      2) Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C

3) Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

b. 1200 mm wide
1) Runners 25 x 100 x 25 x 3 mm
2) Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
3) Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

c. 1000 mm wide
1) Runners 25 x 100 x 25 x 3 mm
2) Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
3) Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

d. 750 mm wide
1) Runners 20 x 75 x 20 x 2.5 mm
2) Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
3) Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

e. 600 mm wide
1) Runners 20 x 75 x 20 x 2.5 mm
2) Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
3) Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

f. 450 mm wide
1) Runners 20 x 75 x 20 x 2.5 mm
2) Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
3) Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

B. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

1. 600 x 40 x 40 x 2 mm thick
2. 450 x 40 x 40 x 2 mm thick
3. 300 x 40 x 40 x 2 mm thick
4. 150 x 40 x 40 x 2 mm thick

Note : Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

1.5.15 CABLING

1.5.15.1.1 PVC/SWA/FR 1.1kV Grade

Intended Usages: General Purpose power distribution & control

Construction: **Conductors:**

Conductor of cables up to and including 16 mm2 shall be of stranded copper conductor and above (including) 25mm2 shall be Aluminium.

Conductor shall be of electrolytic Aluminium/ copper conforming to IS : 8130 and are compact circular or compact shaped.

Drain wire:-

N/A

Insulation, bedding & over sheath :

PVC FR.

Core Identification

Up to 4 Cores –colours

1C - Black

2C - Red, Black

2C + earth – red, black, green/ yellow

3C - Red, Yellow, Blue

4C – Red, Yellow, Blue & Black

5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying Up

Cores to be laid up together with non-hygroscopic fillers.

Bedding

FR

Armouring

Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

Over Sheathing

FR Type ST-1 of IS: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 70ºC, colour black.

Fire Performance

IEC 60331 Fire Resistance Test

IEC 60332 Flame Retardant test

IEC 61034 Smoke Emission Test

IEC 60754 Halogen Content Test

ASTM D 2863 Oxygen Index test

Terminations :

Proper types of lugs are crimped to cable leads. Single compression or double compression cable glands shall be used. Nylon glands shall be used as required.

1.5.15.1.2 XLPE (Cross linked polyethylene) compound of IS- 7098-19-88 for Maximum conductor Temperature 900c).

Intended Usages: General Purpose power distribution & control

Construction:

Conductors:

Conductor of cables up to and including 16 mm2 shall be of stranded copper conductor and above (including) 25mm2 shall be Aluminium.

Conductor shall be of electrolytic Aluminium/ copper conforming to IS : 8130 and are compact circular or compact shaped.

Drain wire:-

N/A

Insulation, bedding & over sheath :

XLPE (Cross linked polyethylene) compound of IS- 7098-19-88 for Maximum conductor Temperature 900c).

Core Identification

Up to 4 Cores –colours

1C - Black

2C - Red, Black

2C + earth – red, black, green/ yellow

3C - Red, Yellow, Blue

4C – Red, Yellow, Blue & Black

5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying Up

Cores to be laid up together with non-hygroscopic fillers.

Bedding

FR Type ST-2 of IS-: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 850 C.

Armouring

Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

Over Sheathing

FR type ST-2 of IS: 5831-1984 (Reaffirmed 2001) for maximum conductor temperature 850 C..

Fire Performance

IEC 60331 Fire Resistance Test

IEC 60332 Flame Retardant test

IEC 61034 Smoke Emission Test

IEC 60754 Halogen Content Test

ASTM D 2863 Oxygen Index test

Terminations :

Proper types of lugs are crimped to cable leads. Single compression or double compression cable glands shall be used. Nylon glands shall be used as required.

1.5.15.1.3 XLPE EPR/SWA/ FS/ PH120 1.1kV grade

Intended Usages: Life Safety Power distribution & control

Construction:

Conductors:

Conductor of cables up to 300 mm2 shall be of stranded copper conductor/ Aluminium conductor shall be of electrolytic Aluminium / copper confirming to IS : 8130 and are compact circular or compact shaped.

Drain wire:-

N/A

Insulation, bedding & over sheath :

Glass mica fire barrier tape covered by an extruded layer of cross linkable halogen free Ethylene Propylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 latest edition.

Core Identification

Up to 4 Cores –colours

1C - Black

2C - Red, Black

2C + earth – red, black, green/ yellow

3C - Red, Yellow, Blue

4C – Red, Yellow, Blue & Black

5 or more cores –numbered (Black numbers printed on grey coloured insulation).

Laying Up

Cores to be laid up together with non-hygroscopic fillers.

Bedding

Cross linkable halogen free Ethylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 (latest edition) suitable for maximum conductor temperature 8500 C.

Armouring

Multi core cables - single layer of galvanised steel wires (round or flat). Single core cables - single layer of aluminium wires.

Over Sheathing

Cross linkable halogen free Ethylene Rubber (EPR) insulation and LSZH inner & outer sheath as per BS7846, IEC60520-1, BS 8519 (latest edition) suitable for maximum conductor temperature 8500 C.

Fire Performance

Fire survival FS, PH120 (Defined as a catagory3 cable under BS 8519).

Terminations :

Proper fire survival types of lugs are crimped to cable leads. Single compression or double compression cable glands shall be used. Nylon glands shall be used as required.

1.5.15.1.4 10/20 pair X 2.5 SQ MM, FS /PH120 INSULATED,MULTI-STRANDED, TWISTED PAIR, SHILEDED / UNSHIELDED CU.CONDUCTOR CABLE (BS 8519-2010)

Intended Usages: **Unshielded :** Exposed Fire Alarm cabling runs.

Construction: **Conductors:**

Conductors of Cables shall be of multi-stranded, Copper.

Drain wire:-

Drain wire of suitable size to be provided as required by FAVA specialist.

Insulation, bedding & over sheath :

The conductors are covered with 2 layers of glass mica tape & polyester tape covered by an extruded layer of cross linkable halogen free Ethylene Propylene Rubber (EPR) insulation, shielding if shielded cable and Flame retardant barrier/binding tape covered with LSZH inner & outer sheath as per BS7846, IEC60520-1,BS 8519 (latest edition) suitable for maximum conductor temperature 950ºC.

Core Identification

As per OEM

Laying Up

Cores to be laid up together with glass mica fillers

Fire Performance

BS 6387:2013 CWZ: Performance requirements for cables required to maintain circuit integrity under fire conditions. Applicable to cables rated at voltages not exceeding 450/750 V

a) First sample is tested for fire only @ 950℃ for 180 mins (C)

b) Second sample is tested for fire and water spray@ 650℃ for 30 mins(W)

c) Third sample is tested for fire with Impact @ 950℃ for 15 mins (Z)

Terminations :

Proper types of lugs are crimped to cable leads. Single compression or double compression cable glands shall be used. Nylon glands shall be used as required.

1.5.15.1.5 10/20 pair X 2.5SQ MM, FR, MULTI-STRANDED, TWISTED PAIR, SHIELDED UNSHIELDED CU.CONDUCTOR CABLE (IS 694)

Intended Usages: **Unshielded :**Embedded Fire Alarm cabling runs

Construction: **Conductors**

Conductor shall be of Copper conforming to IS : 8130 and are compact circular or compact shaped.

Drain wire:-

Drain wire of suitable size to be provided as required by FAVA specialist.

Insulation, bedding & over sheath

Fire Retardant PVC compound of IS-694 for Maximum conductor

Temperature 70ºC.

Core Identification

As per OEM

Fire Performance

FR Type ST-1 of IS: 5831-1984 (Reaffirmed 2001)

IS 5837

IS 8130

IS694

Terminations :

Proper types of lugs are crimped to cable leads. Nylon glands shall be used wherever required

1.5.15.1.6 Communication (TWISTED PAIR) FR CABLE

Intended Usages: CONNECTIVITY BETWEEN DIFFERENT PANELS

Construction: 1.5mmsq Multi-stranded (7x32), copper conductor, twisted pair.

Insulation, Bedding & Over sheath

Minimum of 5mm of Polyethylene insulation, overall aluminium foil-polyester tape (100% coverage),copper braid shield of 24 AWG (90% coverage) 24 AWG stranded TC drain wire, outer PVC/FR Jacket of 0.87mm.

UL Operating temperature range

Maximum conductor Temperature 70ºC.

Terminations :

Cable will be crimped as per Standards & OEM requirement for the data communication port.

1.5.15.1.7 SPLICE (JOINTING) KITS

A. Connectors and Splice (jointing) Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions. Splicing and terminations shall be by an experienced person and duly approved by the Employers Representative.

1.5.15.1.8 SOLID TERMINATIONS

A. Multi-conductor Cable Sheath Seals: Type recommended by seal manufacturer for type of cable and installation conditions, including orientation.

B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations, allow also for gland and bimetallic termination lugs.

1.5.15.1.9 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

1.5.15.1.10 QUALITY ASSUARANCE

A. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Country, State, and authorities having jurisdiction & applicable Standards.

B. Standards: The FAVA System must comply with the standard NFPA72 (latest edition), State PWD, NEC 2011, NBC 2005, IPC, Chief Fire Officer (CFO) of Mumbai, Local Municipal Authorities, MOEF guidelines and subject to approval by the Employers Representatives

C. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a certified testing agency for the testing work and that is acceptable to authorities having jurisdiction.

D. Testing Agency's Field Supervisor: Person currently certified by the “OEM” to supervise on-site testing.

E. Source Limitations: Obtain complete FA & VAS system through one source from a single manufacturer.

1.5.15.1.11 DELIVERY, STORAGE & HANDLING

A. Preparation for Transport: Prepare equipment, according to the following:

1. Ensure that all material to be transported to be protected against rust and corrosion.

2. Protect the material against damage.

3. Set material in best position for handling. Set material closed to prevent rattling.

B. During Storage: Use precautions for material, according to the following:

1. Do not remove end protectors / wrappings etc. unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

3. Electronics components to be stored as per OEM recommendation.

C. Deliver conduits with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent conduits-end damage and to prevent entrance of dirt, debris, and moisture.

D. Protect stored electronics & electrical accessories from moisture and dirt. Elevate above grade.

E. Cable ends shall be sealed and fixed to the bundle so that both ends are accessible. To protect the cable during shipment battens shall be fitted around the entire periphery of the drum. Each cable run shall be manufactured in one length where no through joints shall be allowed.

F. All cable bundles shall be provided with labels showing the Purchase Order Number, Purchase Order Item Number, Drum Number and Stock Code Number clearly stenciled on the outside of both flanges.

G. Bundle identification labels shall be of non-corrosive, non-hygroscopic material and attached to the outside and inside of the drum flanges. Labels shall be protected by transparent plastic envelopes and give the following information:

H. Bundle identification number and its direction of rotation for cable removal.

I. Cable voltage grade

J. Cable construction (e.g. FS/PH 120, etc.)

K. Number of cores and cross sectional area

L. Cable quantity (Meters)

M. Purchase order number and item number

1. Total weight of cable and bundle (kg)
2. Manufacturer's name
3. Year of manufacture
4. Stock code number

N. The Contractor shall provide the following data with his quotation:

1. Standard and maximum bundle lengths for all the types of cable offered and his proposed bundle lengths for all items.
2. Inspection test plan.
3. Cable dimensions (together with tolerances) as follows:

    a. Diameter of (individual in case of multi stranded) conductor wire
    b. Percentage of compaction as per data sheet.
    c. Diameter under conductor screen (where applicable)
    d. Diameter over conductor screen (where applicable)
    e. Diameter over individual core insulators
    f. Lay of cable in case of multi-core cable
    g. Diameter over inner sheath (mm)
    h. Diameter over centre sheath (mm)
    i. Diameter over lead sheath (mm) where applicable
    j. Diameter under armour (mm)
    k. Diameter over armour (mm)
    l. Diameter of armour wires (mm)
    m. Overall diameter (mm)

4. Cable Physical Properties

    a. The filler materials to be used.
    b. Cable weight in kg/km
    c. Minimum bending radius (x OD)
    d. Maximum conductor continuous operating temperature (950℃)
    e. Suitability of outer sheath to resist attack from chemicals.

5. Cable electrical data as follows:

    a. Conductor dc resistance per km at ambient temperature 40℃
    b. Conductor ac resistance per km at operating temperature and system frequency

c. Conductor inductive reactance per km at system frequency
d. Conductor impedance per km at operating temperature and system frequency
e. Conductor capacitance per km
f. Cable armour resistance per km

O. The current carrying capacity of single and multi-core cables when installed in defined conditions in air, in ducts and direct buried in the soil, together with rating factors for varying ambient temperatures, grouping and installation conditions and methods.

P. Cable short circuit withstand capacity to include derating factors for temperature, grouping and burying in the ground as per BS 7671 shall be presented in graphical form or by formulae approved by the Employers Representative.

Q. Descriptive literature (catalogues etc.).

R. Cross sectional view of the physical make up of each cable.

S. Recommended temperatures below which installation of cable should not be carried out.

T. Minimum ambient temperature at which cables can be used.

U. Maximum pulling force for each cable and any special pulling instructions.

V. Maximum unsupported run of cable both horizontally and vertically.

1.5.15.1.12 Testing of Cables

A. Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site by the project team:

1. Insulation Resistance Test.
2. Continuity resistance test.
3. Sheathing continuity test.
4. Earth test.(in armoured cables)
5. Hi Pot Test.

B. Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Employer's site representative.

1. Insulation Resistance Test(Sectional and overall)
2. Continuity resistance test.
3. Sheathing continuity test.
4. Earth test.

C. All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Employer's site representative, results will be noted and signed by all present and record be maintained.

1.5.16 EARTHING

A. Earthing: The system shall be TN-C-S with four wire supply system (R,Y,B,N and 2 Nos. E) brought from the main L. T. Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth. All earthing shall be in conformity with IS:3043 1987, and the basic system of earthing shall be TN-C-S.

B. Earthing Conductors: Earthing conductors shall be of GI / Copper as mentioned in the layouts and shall be protected against mechanical injury and corrosion.

C. Body Earthing shall be Galvanized steel as specified with sizes shown on drawings. Galvanized steel buried in the ground shall be protected with bitumen and hessian wrap or polythene faced hessian and bitumen coating. At road crossing necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

D. Neutral Earthing shall be PVC coated Copper as specified with sizes shown on drawings. At road crossing necessary hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

E. Sizing of Earthing Conductors: The cross sectional area of earthing conductor shall be as per OEM Manufacturer requirement.

F. Connection of Earthing Conductors

- Main earthing conductors shall be taken from the earth connections at the DG Neutral and DG Body to an earth electrode with which the connection is to be made. All joints in tapes shall be with four rivets and shall be welded bolting in case of GI, wires shall be connected with crimping lugs, all bolts shall have spring washers.
- The installation shall be complete in all respects for efficient and trouble free service. All work shall be carried out in a first class quality and neat workmanship. Grounding conductors shall be handled carefully to avoid kinking and cutting of the conductors during their installation. All exposed ground conductors run shall be taken in a neat manner horizontal, vertical and parallel to the building walls or columns and shall not be laid haphazardly. All connections to the grounding grid shall be made with **earthing** strip welded to grid and bolted at equipment ends.

G. Prohibited Connections

- Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system. The electrical resistance measured between earth connection at the main L T panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate or circuit breakers, and shall not exceed 5 ohm. All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical injury by running the same in G I pipe of adequate size. The overlapping in strips at joints where required shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding / bolting in case of GI in an approved manner. Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

H. Earthing

- The following must always be ensured in earthing system.

i. All earths must be interconnected at the earth pits. This includes generator neutrals, transformer neutrals, transformer body, lightning protection system earths, UPS earths etc.
ii. Extraneous conductive parts such as ducting risers exposed metalic parts of the building structure.

I. The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located before starting the installation.

J. Resistance to Earth: The resistance of earthing system shall not exceed 10 ohm.

K. PIPE EARTH ELECTRODE

1. G.I. pipe shall be of medium class as specified in Drawing.
2. G.I. Pipe electrode shall be cut tapered at bottom and provided with holes of 20mm dia drilled not less than 7.5cm from each other up to 3m of length from bottom.
3. The electrode shall be buried in the ground vertically with its top being 20cm minimum below ground level.
4. Clamping of the earth leads to the earth rod shall be made by earth clamp. The clamps shall be capable of providing high pressure contact between the earth rod and the earth leads to achieve low contact resistance.
5. When two or more electrodes are driven to form a group, the heads of the electrodes in the group shall be bonded to each other by means of a GI strip, laid at a depth of at least 600 mm in soil.
6. Recommended water seal insert sleeve approved by Engineer-in-charge shall be provided with all earth electrode penetrations through basement water proofing membranes and the installation is done under strict supervision.

L. EARTH INSPECTION CHAMBER

1. Earth electrode shall be fitted with a heavy-duty pre-cast concrete inspection chamber/pit complete with heavy-duty cover as specified on drawings.
2. For earth electrodes located outside or on the apron of the building, earth inspection chambers shall extend to a depth of not less than 500 mm below finished ground level and kept free of soil. Each earth electrode shall be clearly marked 'Safety Electrical Earth Connection – Do Not Remove'.
3. The chamber and cover shall be heavy duty detail to consider the traffic load at the location of installation.

M. EARTH STRIP

1. Earth strips/grids shall be of bare GI strips as specified in Drawings.
2. Earth strips shall be riveted or jointed with proper connection to the earth electrodes.
3. In order to minimise the mutual inductance between strips, earth strips shall be positioned at a distance not less than 6m apart unless otherwise specified.

1.5.17 INSPECTION & TESTING

A. The DG Panel & their accessories shall be inspected by the purchaser or their nominated Third party inspection agency representative.

B. The vendor/Manufacturer shall submit detailed Quality Assurance plan (QAP), Inspection Test Plan (ITP) & test procedures for review/approval of LODHA.

C. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

D. All the travelling & accommodation expenses towards the Inspection or witnessing the testing of equipment by the LODHA Representative will be in Contractor scope.

E. The results of all tests carried out shall be tabulated and signed jointly by manufacture and Engineer-in-charge. In case the test results are not satisfactory and in accordance of contract specification and there are defects in the materials the same shall be attended and notified to Engineer-in-charge. The equipment shall be dispatched to site of work only after receipt of acceptance of materials and clearance from Engineer-in-charge.

F. Factory Routine Test: Prior to despatch the out of the factory, each panel & field devices shall be routine tested (in presence of representatives of the Purchaser or their nominated).

G. Type Test: As per relevant code & manufacturer practice.

H. The Cables shall be tested at works for all routine tests as per IS including the following tests before being dispatched to site:-

1. Insulation Resistance Test.
2. Continuity resistance test.
3. Earth test.

I. All tests for cables shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Employer's representative on Site, results will be noted and signed by all present and record be maintained.

J. All the travelling & accommodation expenses towards the Inspection or witnessing the testing of equipment by the Employers Representatives will be in the Contractors scope.

K. The vendor/Manufacturer shall submit detailed Quality Assurance Plan (QAP), Inspection Test Plan (ITP) & test procedures for review/approval of client.

L. The Employers Representative has the right to have the tests carried out at his own cost by an independent agency whenever there is dispute regarding the quality of supply.

M. The results of all tests carried out shall be tabulated and signed jointly by manufacture and Employers Representative. In case the test results are not satisfactory and in accordance of contract specification and there are defects in the materials the same shall be attended and notified to Employers Representative. The equipment shall be dispatched to site of work only after receipt of acceptance of materials and clearance from Employers Representative.

1.5.18 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
   3. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
   1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
   2. Full load run.
   3. Maximum power.

4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.
8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Employer's representative.
9. Report factory test results within 10 days of completion of test.

1.6 EXECUTION

1.6.1 DG SYSTEM

1.6.1.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting system performance.

A. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1.6.1.2 INSTALLATION

A. All equipment and components shall be installed in strict compliance with manufacturer’s recommendations. Consult the manufacturer's installation manuals for all wiring & fiber optic diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to the riser/connection diagram for all specific system installation /termination / wiring data.

A. The installation should be as per statutory requirements & as recommended by the major equipment manufacturer.

B. All minor civil works such as opening-up false ceiling, boxing, rack coverings, partition walls, making openings, cut-outs, chases, grooves, etc. in walls, floors, making good the civil work, construction brick/concrete pedestals, supports etc. including all materials required during installation shall be carried out by the contractor at no additional cost to the Employer.

C. All conduits, junction boxes shall be concealed throughout. Wherever conduits, trunking or raceways are already installed by the Employer, the cables/wires shall be installed through that. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period measures shall be taken to protect detectors and other items from contamination, physical damage and theft.

D. All termination at the panel & field equipment’s shall be checked & rectified if required in coordination with the installation team.

E. Continuity Resistance value of cable (Megger value) shall be checked & recorded. It should show resistance in mega ohms.

F. Interference suppression arrangements shall be ascertained.

G. In general, the entire installation shall be inspected and all shortcomings shall be brought to the notice of the Project Manager/Engineer Necessary rectification shall be carried out by the installation engineer.

H. The system shall be tested as brought out in System Feature and Manufacturer’s Manual. Handing over personnel shall co-ordinate with the system integrator. A handing over report shall be prepared. All tests

conducted shall be repeated in the presence of the Employer's Representative. Operating Instructions/ Maintenance manuals shall be prepared and handed over to the Employer's Representative. As built drawing shall be part of this document. The Employer's Representative team shall be trained to operate and maintain the system.

I. Mains simulation tests shall be carried out. If required, adjustment to PLC digital logic controller shall be done. The tests shall be carried out for checkup sequential operation of following devices:
   1. Tripping power supply and load acceptance of the DG System
   2. Manual transfer back of supply to mains and auto run-on of the DG system

J. Faults found tests of various devices shall be noted down and rectified.

K. Comply with packaged engine-generator manufacturers' written installation and alignment instructions and with NFPA 110 and NBC 2005.

L. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

M. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of 1 inch on 4-inch- high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base.

N. Install black steel piping with welded joints for cooling water piping between engine-generator set and heat exchanger.

O. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector.

P. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

Q. Acoustic Treatment: Installation of acoustic panels and louvers complete as per the approved Dwg, site condition & the standards.

R. Piping System

1. Piping System Preparation
   a. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
   b. Comply with BS EN 60079 requirements for prevention of accidental ignition.

2. Indoor Piping Installation
   a. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
   b. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
   c. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   d. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   e. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
   f. FInstall piping free of sags and bends.
   g. Install fittings for changes in direction and branch connections.
   h. Verify final equipment locations for roughing-in.

i. Comply with requirements for equipment specifications in Y10&Y11 Sections for roughing-in requirements.

j. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.

k. No pipe to pipe connections are allowed, it shall be strictly through the weldolet fittings.

l. Prohibited locations:

1) Do not install fuel-oil piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts

2) Do not install fuel-oil piping in solid walls or partitions.

m. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

n. Connect branch piping from top or side of horizontal piping.

o. Install unions in pipes DN 50 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

p. Do not use fuel-oil piping as grounding electrode.

q. Install strainer on inlet side of fuel-oil pump.

r. Install sleeves for piping penetrations of walls, ceilings, and floors.

s. Install sleeve seals for piping penetrations of concrete walls and slabs.

t. SInstall cover plates for piping penetrations of walls, ceilings, and floors.

3. Valve Installation

a. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.

b. Install valves in accessible locations.

c. Protect valves from physical damage.

d. Install metal tag attached with metal chain indicating fuel-oil piping systems.

e. Identify valves.

f. Install oil safety valves at inlet of each oil-fired appliance.

g. Install pressure relief valves in distribution piping between the supply and return lines.

h. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.

i. Install manual air vents at high points in fuel-oil piping.

j. Install emergency shutoff valves at building entry points.

4. Piping Joint Construction

a. Ream ends of pipes and tubes and remove burrs.

b. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

c. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1) Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified

2) Damaged threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

d. Welded joints: Construct joints using qualified processes and welding operators:

1) Bevel plain ends of steel pipe

2) Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

e. Flanged joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

5. Fuel-Oil AST Installation

a. Install tank bases and supports and comply with BS 799-5. Design supports and foundations to accept the loading that would occur if the tanks were completely full of water. Ensure that the bearing capacity of the ground has been assessed and is adequate for the proposed installation. Ensure that tanks are designed to take account of wind loadings including when empty.

b. Provide a suitable means to prevent moisture accumulation between the metal tank plates and the supports on which they rest. Use a waterproof mastic membrane.

c. Where vertical tanks are placed directly on foundations (e.g. vertical tanks), the foundation ring of the tank should be sealed to the foundation with a bitumastic compound. Shape compound so that water drains away from the toe of the tank.

d. Painting and cleaning should be in accordance with BS799-5. The external surfaces of the tanks should be thoroughly cleaned and free from rust, oil or grease and protected with a suitable rust inhibiting primer by the manufacturer. Use a zinc rich metallic priming paint to BS4652 and gloss finishing coat where indicated. Comply with requirements of BS54693 and BS6150.

e. Ensure that gloss finishing paints are of machine finish grade having high adhesion, high resistance to solvents, mineral oils, chipping and impact damage.

f. The following types of paint and preparations will be considered acceptable:

1) Ferrous metal - Internal - zinc rich primer to BS 5493 Table 4F Type PF3A (min 40% zinc phosphate) plus oil based flat finish

2) Ferrous metal - External or damp conditions - 2 Pack epoxy zinc phosphate primer to BS 5493 Table 4K Type KP1A.

g. Internal surfaces should be wire brushed but not painted except for the underside of roof on large vertical tanks which should have a primer applied.

h. Connect piping and vent fittings.

i. Install ground connections.

j. Install tank leak-detection and monitoring devices.

k. Install steel ASTs according to BS799.

l. Install insulated and concrete-vaulted, steel ASTs according to BS799.

m. Fill storage tanks with fuel oil.

6. Transfer Pumps:

a. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories

b. Set pumps on and anchor to concrete base.

c. Install two-piece, full-port ball valves at suction and discharge of pumps.

d. Install mechanical leak-detector valves at pump discharge.

e. Install strainers on inlet side of simplex fuel-oil pumps.

f. Install check valve on discharge of simplex fuel-oil pumps.

g. Install suction piping with minimum fittings and change of direction.

h. Install vacuum and pressure gage, upstream and downstream respectively, at each pump to measure the differential pressure across the pump.

7. Liquid-Level Gage System Installation
   a. Install liquid-level gage system. Locate panel inside DG Room.

8. Leak-Detection And Monitoring System Installation
   a. Install leak-detection and monitoring system. Install alarm panel inside building where indicated:

   b. Double-wall, fuel-oil storage tanks: Install probes or use factory-installed integral probes in interstitial space

   c. Double-containment, fuel-oil piping: Install leak-detection sensor probes in fuel-oil storage tank containment sumps and at low points in piping

   d. Install liquid-level gage.

9. Connections
   a. Install piping adjacent to equipment to allow service and maintenance.

   b. Install unions, in piping DN 50 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

   c. Install flanges, in piping DN 65 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

   d. Connect piping to equipment with ball valve and union. Install union between valve and equipment.

   e. Install flexible piping connectors at final connection to burners or oil-fired appliances that must be moved for maintenance access.

10. Labeling And Identifying
    a. Nameplates, pipe identification, and signs

    b. Equipment nameplates and signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator, and service meter:

       1) Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

       2) Install detectable warning tape directly above fuel-oil piping, 300 mm below finished ground level, except 150 mm below pavements and slabs. Terminate tracer wire in an accessible area, and identify as "tracer wire" for future use with plastic-laminate sign:

       3) Piping: Over underground fuel-oil distribution piping

       4) Fuel-oil storage tanks: Over edges of each UST.

11. Field Painting Of Above Ground Storage Tanks
    a. After cleaning, remove dust or residue from cleaned surfaces.

    b. If surfaces develop rust before prime coat is applied, repeat surface preparation.

c. Prepare surface of AST and supports and apply painting systems according to this specification "High-Performance Coatings" for severe environment high-gloss finish for ferrous metal.

12. Field Painting Of Aboveground Piping
    a. Paint exposed, exterior metal piping, valves, and piping specialties, except components with field applied paint or protective coating:
        1) Alkyd System: MPI EXT 5.1D:
        2) Prime coat: Alkyd anticorrosive metal primer
        3) For a premium grade system, "MPI Manual" requires intermediate coat; delete intermediate coat for a custom grade system
        4) Intermediate coat: Exterior alkyd enamel matching topcoat
        5) Topcoat: Exterior alkyd enamel gloss
        6) Colour: BS colour for oil (Brown).

13. Damage and touch-up: Repair marred and damaged applied finishes with materials and by procedures to match original.

14. Concrete Bases
    a. Concrete bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions.

1.6.1.3 FIELD QUALITY CONTROL

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL, CPRI approved/ASTA/KEMA approved), and that is acceptable to local India authorities.

B. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection for "AC Generators and for Emergency Systems" specified in IS standards. Certify compliance with test parameters.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

D. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Remove and replace units that do not pass tests and inspections and retest as specified above.

F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed Satisfactory Test" label to tested component.

G. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA110 and NEC.

2. System Testing and Inspections as follows to be followed:

    a. Lubrication System
        1) Check, top-up or renew lubricating oil in the engine and turbo-charger systems

2) Service the filters – check pressure drops; fit new elements and joints; clean bowls
3) Take oil samples for laboratory analysis
4) Inspect for leakages

b. Fuel System
1) Drain water and sediment from filter bowls and water traps
2) Service the filters – renew elements and joint rings; clean bowls
3) Check fuel pump(s) drives
4) Service or renew fuel injectors
5) Check injection pump timing
6) Check / adjust control linkages between governors and injection pumps (where applicable)

c. Cooling System
1) Check coolant levels; top-up where necessary
2) Check specific gravity of coolant mixture and its pH value
3) Service raw water pumps; replenish oil cups; drain system; clean filters and refit.
4) Service heat exchanger tube packs

d. Air Induction System
1) Check restriction indicators; reset after filters have been serviced
2) Service air cleaners; wash elements in warm solution of detergent or paraffin (as applicable) check sealing rings; clean intake ducting

e. Turbochargers
1) Checks for security, and exhaust systems leaks
2) Clean compressor and check bearings
3) Check s for freedom or rotation
4) Remove and check induction trunking

f. Cylinder heads
1) Check tightness of holding-down set bolts and nuts
2) Check tappet clearances, adjust if necessary

g. Switchgear
1) Clean equipment and check all connections for tightness
2) Test all main and control fuses (or protective devices)
3) Check indicator lamps at all local and remote positions; replace were necessary
4) Check the insulation resistance of all control wiring
5) Check contact alignment, contact pressure and blow-out arc chutes
6) Checking main and auxiliary connections for tightness
7) Cleaning insulators and visually inspecting them for cracks
8) Check insulation to earth of all auxiliary and control wiring; checking the resistance of shunt trip and closing coils
9) Checking operation of power switching device from all control points, including emergency stopping stations from the protection relays.

h. General
1) Check condition and tension of drive belts
2) Check electrical auxiliaries such as starter motors and battery charging alternators: grease bearings; clean slip rings; check bush gear
3) Check drain cocks and water traps on air starting systems, replenish air line lubricator with clean oil
4) Check operation of all alarm and shutdown switches
5) Investigate and rectify any incidents recorded in operating logs
6) Check crankcase breathers; clean filter elements

i. Completion checks
1) Clean exterior and check holding-down bolts/ dowels
2) Clean Air grilles / meshes and air filters (if fitted) replace filter elements if necessary
3) Inspect tubes of air cooled or water cooled heat exchangers; clean if necessary with compressed air or a non-metallic tube brush
4) Check security of terminals and clean out terminal boxes if necessary
5) Check insulation resistance and winding continunity
6) Check continunity of conditioned heaters
7) Check embedded (stator) temperature detector circuits
8) Check frame earth connections for security and continunity
9) Check natural earth connections for security and continunity
10) Grease bearings with OEM approved grease using a gun

11) Drain oil from sleeve bearings; inspect for signs of uneven wear or overheating; clean with flushing oil; record salient dimensions; refill with the specified grade oil, to the correct level
12) Check stator / rotor radial air gap readings and record results
13) Check all rotating diodes on brushless machines; care should be taken when screwing diodes back into their assemblies. Use a torque wrench for this purpose
14) Inspect the automatic voltage regulator; check for loose connections and retighten if necessary; dry out if moisture is present; remove any dirt with fine brush.

j. Battery
1) Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
2) Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
3) Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
4) Verify acceptance of charge for each element of the battery after discharge.
5) Verify that measurements are within manufacturer's specifications.
6) Verify specified rates of charge for both equalizing and float charging conditions.

k. Exhaust-System
1) Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
2) Exhaust Emissions Test: Comply with applicable government test criteria (MPCB/CPCB).

l. Voltage and Frequency Transient Stability Tests
1) Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

m. Harmonic-Content Tests
1) Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

n. Noise Level Tests
1) Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

o. Infrared Scanning
1) After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.
2) Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
3) Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
4) Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

H. Coordinate tests with tests for transfer switches and run them concurrently.

I. Test instruments shall have been calibrated within the last 12 months, traceable to standards of and adequate for making positive observation of test results. Make calibration records available for examination on request.

J. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

K. Annual Test and Inspection: One year after date of Substantial carry out the following tests:

1. General
a. Clean exterior and blow out any fitted air ducts

b. Check sleeve bearing for wear; ensure lubrication holes and oil ways are not obstructed
c. Check ball and roller bearings; renew if required; otherwise degrease; pre-oil and repack with OEM approved grease ready for reassembly
d. Check rotors (main and exciter) for any signs of rubbing with their stators
e. Examine the stator windings for any signs of visible damage
f. Check the stator laminations are free from burrs and the that ventilation airways are free from obstructions
g. Thoroughly clean all major components of the machine.
h. Replace all gasket materials or sealing components where necessary
i. Check cleanliness of all terminal boxes
j. Check that sleeve bearings are filled with OEM specified oil

2. Switchgear
   a. Clean equipment and check all connections for tightness
   b. Test all main and control fuses (or protective devices)
   c. Check indicator lamps at all local and remote positions; replace were necessary
   d. Check the insulation resistance of all control wiring
   e. Check contact alignment, contact pressure and blow-out arc chutes
   f. Checking main and auxiliary connections for tightness
   g. Cleaning insulators and visually inspecting them for cracks
   h. Check insulation to earth of all auxiliary and control wiring; checking the resistance of shunt trip and closing coils
   i. Checking operation of power switching device from all control points, including emergency stopping stations from the protection relays.

L. Cable shall be tested at site for insulation between phases and between phase and earth for each length of cable, before and after jointing.

M. On completion of cable laying work, the following tests shall be conducted in the presence of the Employer representative.

1. Insulation Resistance Test(Sectional and overall)
2. Continuity resistance test.
3. Earth test.

N. Piping Field Quality Control
   a. A Manufacturer's field service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
   b. Perform tests and inspections.
   c. Manufacturer's field service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   d. Tests and inspections:
      1) Tank and pipe test pressures in this article are required by BS799. Verify requirements with authorities having jurisdiction
      2) Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the QA code stamp or a listing mark acceptable to authorities having jurisdiction
      3) Maintain the test pressure for one hour
      4) Inspect and test fuel-oil piping according to BS799 and according to requirements of authorities having jurisdiction

5) Test liquid-level gage for accuracy by manually measuring fuel-oil levels at not less than three different depths while filling tank and checking against gage indication

6) Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication

7) Start fuel-oil transfer pumps to verify for proper operation of pump and check for leaks

8) Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment

9) Bleed air from fuel-oil piping using manual air vents.

e. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.

f. Prepare test and inspection reports.

1.6.1.4 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

1.6.1.5 CONNECTIONS

A. Piping installation requirements as per IS Standards & vendors Dwg.
B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.
C. Connect cooling-system water piping to engine-generator set and heat exchanger with flexible connectors.
D. Connect engine exhaust pipe to engine with flexible connector.
E. Connect fuel piping to engines with a gate valve and union and flexible connector.

Ground equipment as per to IS & IE rules

1.7 DEMONSTRATION

A. Allow for 4 hours running of the DG as part of factory acceptance testing of the DG Set with 1 hour under overload conditions. Include for fuel costs associated with testing.

B. For Site Acceptance Testing site available loads to be used for testing purposes. No separate site load bank testing required.

C. General: Manufacturer's factory-authorized service representative to train the Employer's Representative in the operation of the Unit.

D. Equipment: Check operation of each unit with the Employer's Representative present and before Substantial Completion. Determine that operational systems and devices are functioning properly.

E. Instruction: Instruct the Employer's Representative in proper use, maintenance, adjustment, and repair of each system.

1.8 SYSTEM SETUP & CONFIGURATION

A. Provide the services of a factory trained and authorized technician to perform all system.

B. Software modifications, upgrades or changes. Field technicians shall be NICET Level 1(minimum) certified.

C. The factory trained technician shall install initial data and artwork at each interactive firefighter's display.

D. The factory trained technician shall design the graphic layout based on area diagrams and floor plans.

1.9 INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system function properly in every respect.

1.10 INSTRUCTION/TRAINING

A. Provide instruction as required for operating the system. Hands on demonstrations of the operation of all system components and the entire system including user-level program changes and functions shall be provided. A factory trained and certified representative shall provide instruction.

END OF SECTION

SECTION - C & D "Schedule of Technical Requirements & Information Required From Contractor"

DG SET

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
1	**General**			
1.1	Rated Output	1 Nos.DG Set with a Nett Power Output of 250 KVA @ 0.8 P.F., 415V, 3 PHASE + Neutral, 50 Hz		
1.2	Voltage regulation	AVR Control - Voltage Regulation		
1.3	Overall dimenssions (L x B x H mm)	4650x1700x2050		
1.4	Engine make & model	As per Section G		
1.5	Alternator make & model / frame size	As per Section G		
1.6	Engine RPM	1500		
1.7	Reference Standards			
1.8	a) For Engine	ISO8528/BS 5514/ISO 3046		
1.9	b) For Alternator	I.S:4722/1970		
1.10	Engine Cooling	Water Cooled		
1.11	Design ambient Temprature			
1.12	a) For Engine	40 ^{o}C		
1.13	b) For Alternator	40 ^{o}C		
1.14	Ventilation & Breathing Required (Requirement of additional exhaust fans, blowers etc.)	As per OEM Recomandations		
1.15	DG to AMF interconnections	Required		
1.16	Insulation Class	Class H		
1.17	Designed for temp rise upto	Class H		
1.18	DC Source voltage level	24V		
1.19	Batteries	As specified in the Tender		
1.2	NCT for differential protection in Enclosure.	As specified in the Tender		
1.21	Fuel Consumption for Load 25% of rated continious power output.	Vendor to furnish		
1.22	Fuel Consumption for Load 50% of rated continious power output.	Vendor to furnish		
1.23	Fuel Consumption for Load 75% of rated continious power output.	Vendor to furnish		
1.24	Fuel Consumption for Load 100% of rated continious power output.	Vendor to furnish		
1.25	Fuel Consumption for Load 110% of rated continious power output.	Vendor to furnish		
1.26	Emergency Stop Push Button	To be provided and shall be housed in a protective enclosure		
2	**AMF / Synchronizing Panel**			
2.1	AMF Controller	AMF Feature to be co-ordinated with the proposed ATS.		
2.2	Control & instrumentation devices	All C & I devices shall be provided in the AMF panel as per specs		
2.3	Protection Relays	Earth Fault, Over Current, Under Voltage, Over Voltage & Over Frequency relays shall be provided		
2.4	Potential Free contacts for:			
	1. Common Generator Fault	Required		
	2. Generator Running	Required		
	3. Generator Shut Down	Required		
	4. Low Fuel Level	Required		
	5. Battery Fault Condition	Required		
	6. DG set not in Auto	Required		
	7. RS 485 / RS 232 Serials Ports	Required		
	8. BACnet Gateway	Required		
	9. Combined Type 1/2 Surge Arrestor (IEC 61643-1)	Required		
3	**Audio Visual Annunciation for**			
3.1	Overspeed of DG set	TRIP Signal		
3.2	Low lubricating oil pressure after engine has attained 90% speed	ALARM annunciation, TRIP signal		
3.3	Incomplete start after a preset time	TRIP Signal		

SECTION - C & D "Schedule of Technical Requirements & Information Required From Contractor"

DG SET

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
3.4	Excitation failure due to tripping of field breaker to build up voltage	ALARM annunciation, TRIP signal		
3.5	High Jacket Water Temp.	ALARM annunciation, TRIP signal		
3.6	D.C. Control supply failure	TRIP Signal		
3.7	Engine trip due to generator fault	ALARM annunciation, TRIP signal		
3.8	Battery Charger	Trickle Charge & Float Type		
3.9	Mounting arrangement of Panel			
3.10	Cable Entry	From TOP		
3.11	Fabrication	With 2mm thick CRCA sheet steel		
4	**Room Treatment / Details :**	(DG WITH ACOUSTIC		
4.1	Exhaust Flue Piping and Stack System	Required		
4.2	Ducting	Not Applicable		
4.3	Tube Axial Fan (low sound power)	Not Applicable		
4.4	Acoustic Treatment	Not Applicable		
4.5	Acoustic Louvres	Not Applicable		
4.6	Acoustic Lined Ducts	Not Applicable		
4.7	Caulking in Exhaust pipe wall opening	Required		
4.8	Vibro-isolated inertia block	Required		
4.9	Flexible sections in services for noise control	Required		
4.10	Engine Exhaust Mufflers	Residential Standard Multi-step reactive exhaust muffler		
4.11	Silencer Type / Minimium Attenuation	Residential / 35dB		
4.12	Noise Level	75 dB(A) Maximum at 1Mtr.		
4.13	Anti Vibration Treatment - Engine and Alternator	Spring Isolators with neoprene rubber to be provided		
4.13	Anti Vibration Treatment - Hangers	Spring Isolators with neoprene rubber to be provided		
4.14	Fresh air / and exhaist air silencner / Attenuation	Required / 45dB		
4.15	Room Sound Transmission Class (STC)	55		
4.16	Solid Concrete Wall	250mm		
4.17	Wall Density	2000kg/m3		
4.18	Doors Constrcution	Metal Type, STC 50 with peimeter and drop seals		
4.19	Absorption Walls and Ceilings	100mm channel to be installed on walls and ceiling @ every 600mm centres then 100mm thick Rockwool 48Kg /m3 density to be adhered to wall and ceiling using SR adhesive and covered with 22 gauge 0.85mm thick		
5	**HSD FUEL DAY TANK :**			
5.1	Capacity	Day Tank (Continous Running for 8 Hours at 100% Load)		
5.2	Construction Material	Min. 2.5 mm thick MS CRCA sheet		
5.3	Mounting arrangement	Stand alone tank		
5.4	Pumpred Fuel Transfer System	Required		
5.5	Float / limit switch indicator	Required		
5.6	Accessories	All accessories to be provided as per specs		
6	**Engine Details**			
6.1	Manufacture / Model no	Vendor to furnish		
6.2	Type	Internal Combustion Diesel		
6.3	Stroke	4		
6.4	No of Cylinders	16		
6.5	Displacement in litres	Vendor to furnish		
6.6	Configuration Inline / Vee	Vee		
6.7	Bore / Stroke	Vendor to furnish		
6.8	Compression Ratio	Vendor to furnish		

SECTION - C & D "Schedule of Technical Requirements & Information Required From Contractor"

DG SET

Sr. No.	Content	TENDER SPECS	Vendor Data.	Remarks / Deviations if Any
6.9	Average piston speed	Vendor to furnish		
6.10	Brake Mean Effective Pressure	Vendor to furnish		
6.11	Direction of Rotation Facing DE	Vendor to furnish		
6.12	Turbocharged	Yes		
6.13	GD2 Value of Engine	Vendor to furnish		
6.14	Back Pressure Calculations	Vendor to furnish		
7	**Alternator Details**			
7.1	Manufacturer & Model No.	Vendor to furnish		
7.2	AVR Manufacturer & Model No.	Vendor to furnish		
7.3	Rated Continuous Power Output	Vendor to furnish		
7.4	Rated Voltage (No load)	415		
7.5	Rated Continuous Full Load Current (FLC)	Vendor to furnish		
7.6	Rated Power Factor	0.8		
7.7	Rated Frequency	50 hz		
7.8	Number of Poles	4		
7.9	Rated Speed	1500		
7.10	Stator Winding Insulation Rating	Class H		
7.11	Stator Winding Insul Temp Rise Limit	Class H		
7.12	Stator Winding Connection	Star		
7.13	Stator Winding Leads	Vendor to furnish		
7.14	Stator Winding Pitch	Two Third		
7.15	Stator Winding Phase Sequence	R-Y-B		
7.16	Stator Winding RTDs (3 wire Pt100)	Vendor to furnish		
7.17	Stator Winding Temp Settings	Vendor to furnish		
7.18	Stator Winding Neutral Terminal	Vendor to furnish		
7.19	Stator Winding Neutral Grounding	Vendor to furnish		
7.20	Stator Winding Type	Vendor to furnish		
7.21	Stator Winding Treatment	Vendor to furnish		
7.22	Stator Winding Surge Protection	Yes		
7.23	Stator Winding Resistance	Vendor to furnish		
7.24	Rotor Winding Resistance	Vendor to furnish		
7.25	Rotor Damper Windings	Vendor to furnish		
7.26	Rotor Winding Neg. Phase Seq. Current Limit	Vendor to furnish		
7.27	AVR Location	Vendor to furnish		
7.28	AVR Quadrature Droop CT	Vendor to furnish		
7.29	AVR Cross Current Compensation mode	Vendor to furnish		
7.30	AVR Cross Current Comp Phase Shift CT	Vendor to furnish		
7.31	AVR Voltage Sensing Step-Down Transformer	Vendor to furnish		
7.32	AVR Voltage Sensing Type	Vendor to furnish		
7.33	Main Exciter (brushless)	Vendor to furnish		
7.34	Pilot Exciter (permanent magnet generator)	Vendor to furnish		
7.35	Anti-Condensation Heaters	Vendor to furnish		
7.36	RFI Suppression Standard	Vendor to furnish		

SECTION-E

SCHEDULE OF DEVIATIONS FROM TECHNICAL SPECIFICATION

1.1 GENERAL

A. The Tenderer shall carefully study all the requirements of the specifications and drawings and indicate all deviations from technical specifications and Tender Drawings in this section only. Deviations indicated elsewhere in the package or bid will not be considered for evaluation.

SR.NO	REFERENCE CLAUSE	DESCRIPTION	DEVIATION DETAILS

We confirm that all the deviations from Technical Specifications and Tender Drawings are listed as above.

Seal of the Tenderer **Name:**

Designation:

END OF SECTION

SECTION-F

SCHEDULE OF DEVIATIONS FROM GENERAL & SPECIAL CONDITIONS OF CONTRACT, BOQ/SCHEDULE OF PRICES

1.1 GENERAL

A. The Tenderer shall carefully study all the requirements of the general & special conditions of contract and BOQ / Schedule of prices & indicate all deviations in this section only. Deviations indicated elsewhere in the package or bid will not be considered for evaluation.

SR.NO	REFERENCE CLAUSE	DESCRIPTION	DEVIATION DETAILS

We confirm that all the deviations from Technical Specifications and Tender Drawings are listed as above.

Seal of the Tenderer **Name:**

Designation:

END OF SECTION

SECTION-G

LIST OF APPROVED MANUFACTURERS

1.1 GENERAL

A. The Contractor shall offer all materials for inspection prior to dispatch. All materials not otherwise specified shall be in accordance with the latest Indian Standard Specification, or with Standards as listed in the Contract documents. The Contractor - where deemed necessary by the Client and at the Contractors expense - shall be bound to offer samples of materials, which are claimed to be conforming to IS Specifications, for testing at an approved Test Laboratory.

B. The Contractor shall purchase all materials from the makers or their authorized stockiest only. Necessary Purchase Orders / Delivery Dockets or such documentary evidences as deemed necessary must be provided to the Client on demand.

S.No.	**Details of Materials / Equipment**	**Manufacturer's Name**
1.	Cu/Al/GI. Strip (CPRI APPROVED)	Indiana Bharti
2	Maintenance free Earthing/earth pit material (Ground enhancement material – Chemical earthing) (CPRI Approved)	Furse Erico
3	Electrical Cabling Fire Rated (FR) PVC insulated multi-stranded copper wire 1.1 KV grade	Avocab Finolex Polycab RPG Ravin RR Kable HAVELLS
4	Electrical Cabling LV Cables 1.1kV Fire Rated (FR) PVC / XLPE/ Copper/ Cables	Avocab Finolex Polycab KEI CCI Unistar Torrent Cables Ltd.(TCL) RPG AEI Cables Ltd. Paramount
	Electrical Cabling LV Fire Survival Cables 1.1kV PH30 & PH120 fire resistance	Avocab India Impex KEI Polycab Tyco AEI Cables Limited Cavicel Firecel Prysmian Cables
5	Cable Glands & Bi-metallic crimping type lug	Comet Dowel Comemex Gripwell
6	Cable Trays / Trunking	Profab Indiana Globe Obo bettermann Powersmith
7	G.I. Pipes (ISI Marked)	Jindal Tata
8	GI Conduit (ISI marked)	Vimco B.E.C. NIC AKG Jindal

S.No.	Details of Materials / Equipment	Manufacturer's Name
		TATA
8	PVC Conduit pipe HMS (ISI marked)	Precision Plastic B.E.C. AKG POLYPACK A-D Technologies : DURALINE DPLAST
9	Conduit accessories	Vimco B.E.C. NIC AKG BE
10	M.S. Steel (Angle. Channel, Strip, sheet)	Tata Sail
11	Measuring Instruments	Schneider Electric GE ABB L&T MECO Conzerv Areva
12	Panel Accessories	Siemens Teknic Rishab BCH GE
13	Protective relays	Siemens ABB AREVA L&T GE
14	Control Fuses with base	Siemens GE ABB Schneider L&T
15	CTs/ PTs	AEI Kappa Pragati Gilbert & Maxwell
16	Selector switch	Siemens Salzer L&T BCH KACEE
17	Crimping lugs/ Thimbles	Dowell Comet
18	Terminal strip	Obo Bettermann Wago Connectwell Phoneix Elmex

S.No.	Details of Materials / Equipment	Manufacturer's Name
19	Contactors & Timers	GE Siemens Schneider Telemechanic ABB L&T
20	Programmable timer	Siemens Schneider ABB L&T
21	Auxiliary relays	Siemens AREVA ABB Schneider GE L&T
22	ELCB, MCB, RCCB & DBs	GE Siemens Schneider-Merlin Gerin Legrand L&T/Hager ABB
23	Copper control Cable	Avocab Finolex Polycab Lapp RPG
24	MCCB	Siemens – SENTRON 3VL Schneider –COMPACT NS Legrand - DPX ABB - Isonmax L&T-D SINE GE - Record Plus MITSUBISHI - Super Series
25	Battery Charger	Hitachi Amara Raja HBL Nife Exide BOSCH
26	Battery (Maintenance Free)	Amara Raja Exide HBL Nife
27	ACBs (electronic protection)	Seimens - SENTRON 3WL Schneider-Merlin Gerin - Masterpact NW ABB - Emax Legrand - DMX^3 L&T - C-Power GE - EntelliGuard G
28	Cubicle LV Panels	Arrow Engineer Scoot Engineering Marine Electricals Zenith Engineering

S.No.	Details of Materials / Equipment	Manufacturer's Name
		Square Automation
29	Generators & Alternator	**Engine:** Perkins Mitsubishi MTU Caterpillar Cummins, **Alternator:** Leroy Somer, Stamford Mitsubishi Electric Caterpillar
30	AMF Controller	Dipsy Woodward
31	LV Protection Relay- Numeric Type	Siemens ABB Schneider AREVA L&T
32	ATS	Asco Schneider Siemens
33	INDICATING LAMP- LED TYPE	ESBEE Teknic GE Vaishno
34	Energy Meters (Electronic & Dual)	AREVA Secure ABB L&T Conzerve
35	LV Jointing Kit/Termination	RAYCHEM (Tyco Electronics) 3M India REPL
36	Fire Stop Material	HILTI 3M India KBS Fire Stop PROMAT
37	Fire Spray On Cable – Endothermic	KBS Passive Fire HILTI SGS
38	Tube Axial Fans	Greenheck Kruger Flaktwoods Nuaire Dynair Carryaire
39	GI Sheet	Jindal Nippon Essar Sail TATA
40	Flexible duct connector	Mapro Kanwal Industries Corporation Resistoflex Easy flex

S.No.	Details of Materials / Equipment	Manufacturer's Name
	Double Wall Corrugated- DWC duct/pipe	Rex Alcorr
41	M.S. Pipe upto 200 MM Dia	Jindal , Tata Steel Zenith
42	MS PIPES above 200 mm dia factory rolled	Jindal Tata steel Mukund Steel SAIL
43	Sound Attenuator	Caryaire George Rao Ravistar UNIFLAIR
44	Louvers – Normal and Accoustic	Air Master Caryaire Cosmos George Rao & Co. Dynacraft Ravistar
45	Insulation Fiberglass (Foil Faced)	Owens Corning UP Twiga
46	Insulation Expanded Polystyrene (TF Quality)	Beardsell Coolite DEBS Products Styrene Packaging Toshiba

Notes to Contractor

1. All the materials shall be ISI marked wherever available from the list of manufacturer given above, wherever ISI marked materials are not available, the materials shall be from the best quality available in the market, subject to submission of satisfactory test reports and prior approval from the Client.

END OF SECTION- B

STANDBY POWER DG BOQ

Item Nos.	ITEM DESCRIPTION	UNIT	Quantity	RATE	AMOUNT	
					Rs.	Paise
	POWER GENERATION SYSTEM					
1.0	**DG SET**					
	Scope:					
	Include for the complete supply, installation, Testing and Commissioning of DG set as detailed in the Specifications, BOQ and on the Drawings and to the complete satisfaction and approval of the Engineer and all concerned Statutory Authorities and under the following sections.					
1.01	Supply, install, connect, commission and test test generator sets (**250KVA**) cooling system, lubrication system, starting system, battery charger, safety shut-offs, mounting system, Day Tank, Fuel Piping System, MS base along with neccessary support & Misc. Accessories etc., complete including inertia bases, and all works as specified	SET	1			
a	Generator control panels (Inside D.G. Enclosure)-1 Set					
b	Generator Fuel Piping system with Day tanks, complete (Inside D.G. Enclosure)-1 Set					
c	Exhaust System with insulation and Al. cladding.-1 Set					
d	Breaker Panel (400A MCCB) (Inside D.G. Enclosure)-1No					
2	CONTROL CABLING WITH TERMINATIONS					
	PVC insulated copper conductor armoured control cables					
2.01	8 C 2.5 sq mm	M	20			
2.02	12 C 2.5 sq mm	M	20			
2.03	2 C 2.5 sq mm	M	20			
3	CONTAINMENT FOR CONTROL CABLING					
3.01	GI Trunking 50mm X 40mm	M	20			
4.0	**EARTHING SYSTEM**					
	Include for the complete installation as detailed in the Specifications and on the Drawings ....etc. (cont'd.)					
	Earthing including earth pit, rods, earth seal, conduits, cables, containment including accessories, fittings, fixing complete as per codes and guidelines					
4.01	Maintenance Free Earth Pits	Nos	4			
	Supply and fixing of following bare copper tapes / wires including all necessary fixing accessories, earth bars and effecting connections as per specifications.					
4.02	50 x 10 mm GI	M	60			

STANDBY POWER DG BOQ

Item Nos.	ITEM DESCRIPTION	UNIT	Quantity	RATE	AMOUNT	
					Rs.	Paise
	POWER GENERATION SYSTEM					
5.0	**DOCUMENTATION, TESTING & COMMISSIONING**					
	Generally for the complete electrical engineering installations					
5.01	Drawings, manuals, approvals & instruction books	Item	1			
5.02	Testing and commissioning	Item	1			
5.03	Training	Item	1			
5.04	Labels, special tools, etc.	Item	1			
5.05	Protective and decorative painting	Item	1			
5.06	Liaison and co-ordination with Local Authorities	Item	1			
5.07	Spare parts for normal operation for 2 years	Item	1			
6.0	The Contractor will list here and price any items shown on the drawings, mentioned in the Specifications or required for the satisfactory completion of this section, but not mentioned here. Any such items not listed below shall be deemed to be included :					
	TOTAL					

SECTION-I

BOQ

BH-ZSG-BOQ-E-0001

SECTION-J

List of Drawings

1.1 GENERAL

A. The Contractor shall refer to the following drawings in relation to this package:

Drawing Number	**Drawing Name**
BH-ZSG-SLD-E-1100	LV system schematic
BH-ZSG-SLD-E-1101	Earthing Schematic

END OF SECTION

SECTION-K
SCOPE OF WORKS DG SYSTEM

DG SYSTEM – SCOPE OF WORKS

1. GENERAL:

The Diesel Generator Package Contractor is required to undertake the complete scope of works detailed in the Invitation to Tender. The Scope of Works is to indicate the generality of the works required but does not limit to the works to be undertaken by this package under this package under a lump sum Contract.

Table of Abbreviations

DG	Diesel Generator
DMS	Document Management System
FAT	Factory acceptance test
SAT	Site Acceptance Test
SITC	Supply, Installation, Testing and Commissioning
ITC	Installation, Testing and Commissioning

2. STRATEGY OUTLINES:

In general, the tender package will include all works related to the supply, installation, erection, testing & commissioning of radiator cooled type D.G. sets with associated AMF/Synchronizing Panels with associated control/power cabling/termination. The Contractor shall be further responsible for full acoustic treatment within the DG space itself. The Contractor shall take up design verification of Tender Drawings & development, design for specialist work, supply, optimization, co-ordination, selection of equipment, detailed calculations required if so, install, test, commission and handover the complete electrical services installations in accordance with the Contract Conditions and as described within specification, general technical preliminaries specification, applicable sections of the standard specification for Electrical Engineering Services and as outlined on the Tender drawings.

The Contractor is deemed to be competent enough to understand the complexity of the job with regard to the scope of work listed below and is responsible for all co-ordination with other trades, structure and architectural finishes related to design, installation, testing & commissioning of the all work included in this Package.

The Contractor shall visit the site to envisage site wide logistic and accessibility.

The scope of work shall comprise, but is not limited to the following:

1. SITC of Diesel Generator(s) (DG) and associated works

    a. 415V, 50Hz 1500RPM Radiator cooled D.G. set(s)
    b. AMF Panel
    c. PLC based digital logic controller
    d. Interconnecting cabling between panels, DG fuel system etc.
    e. Generator Control Panel
    f. Battery Charger
    g. Fuel Piping System
    h. High Speed diesel (HSD) fuel storage tank, transfer pumps and all allied accessories
    i. Exhaust Flue Piping and Stack and all allied accessories
    j. DG Acoustic Enclosure
    k. Silencer
    l. Provision of associated switchgears and cabling
    m. Neutral and Functional Earthing
    n. Containment (Cable tray, ladder rack, trunking and conduit installations)
    o. Fire barriers and fire transits. Fire stopping of all builders work opening and Fire proof (endothermic) spray on cables
    p. Structural supports for above

Provide all necessary project management personnel, skilled labor and trained installation technicians required to complete the works in accordance with the main Contract program complying to Project Specifications, Drawings, Technical documents & Local authority requirements.

2.1. Supports / Hangers

1. The Contractor shall submit the following calculations for hangers and supporting System for Employers representative / Client's review, Calculations shall be prepared and sealed by a qualified Structural Engineer and shall show compliance with the loading requirements. Furnish engineering calculations including, but not limited to, the following items.

    a. Hanger design criteria.

    b. Point loadings.

    c. Wall and column attachments.

    d. Embedment's for supporting for all horizontal and vertical piping.

    e. Stresses and forces on mountings and hangers from expansion and contraction of piping.

    f. Engineering calculations to demonstrate compliance with requirements as specified in clause 2 above.

2.2. General Considerations to be provided

1. Cast-in inserts & cast-in conduits wherever required as per site condition & Tender documents.

2. Contractor to verify the size of the containment (Cable tray, ladder rack, trunking and conduit) indicated in design drawings & update wherever required as per cable selection.

3. SITC of containment (Cable tray, ladder rack, trunking and conduit installations) as per Tender document.

4. Fire barriers and fire transits. Fire stopping of all builders work opening and Fire proof (endothermic) spray on cables.

5. During commissioning The Contractor shall perform both Factory Acceptance Tests (FAT) and Site Acceptance Test (SAT) in the presence of Consultant, LODHA engineers, as per Tender documents. Test reports shall be documented & submitted formally to LODHA.

6. The Contractor to provide relevant calculations, short circuit study, co-ordination study, protective device study for Electrical System as per Tender document.

7. The Contractor shall be responsible for protection devices setting for DG system in co-ordination with buildings Electrical Contractor to achieve full co-ordination as per Tender documents.

8. Wherever required Integrated Testing & Commissioning activity shall be carried out in co-ordination with other services.

9. SITC of supporting System, Vibration isolators to adhere to building sway requirements for all the containments, cables etc.

10. Prepare & submit documentation as required by Liaison department to for utility company, supplier/agency to get approval.

11. The Contractor to demonstration the functionality of the System, equipment and handover to the Employer as required.

12. The Contractor to provide handover documentation including Operating and Maintenance manuals, provision of warranties, service agreements and Planned Preventative Maintenance schedules.

13. The Contractor to arrange Training for LODHA FM staff.

14. Till completion of Defect Liability Period, The Contractor to maintain, provide preventative maintenance, log book keeping for the entire Electrical System.

15. Provide all necessary project management personnel, skilled labor and trained installation technicians required to complete the works in accordance with the main Contract Program complying with Project Specifications, Drawings, Technical documents& Local Authority requirements.

2.3. In addition to the above the Contractor shall allow for the following Miscellaneous / Auxiliary items:

a. The Contractor shall carry out design check to ensure correction & bring to the notice of Client any discrepancy prior to award of Contract. If Contractor does not issue any such notification he shall be deemed to undertake design and performance responsibility.

b. To verify the Tender documents & quote the Contract as per lump sum which shall deemed include verification of Tender documents, drawings, Bill of Quantities (BOQ) items, quantities, interfaces, sundries etc & quote for all items under the Tender documents. Any item not in BOQ or correction in quantities Contractor to quote in the BOQ separately.

c. Preparation of Shop Drawings and technical submittals with detailed equipment schedule.

d. Design Development and preparation of shop fabrication and erection sequence drawings. The Contractor shall submit only stamped drawings for review and approval.

e. Detailed co-ordination drawings & builder's work drawing for wall and floor penetrations through structure including dimensioned drawings showing co-ordinated setting out include full co-ordination with all facets of the Contract works.

f. The Contractor is deemed to co-ordinate with other trades and Civil Contractor to facilitate construction. All approved builders work opening in slab shall be casted with rebar (without concrete), Contractor to cut the rebar to suite the approved opening. Invert levels of all main cable containment systems and Electrical services pathway systems. Location of all supports systems including drop rods to support the following - Cable trunking, Bus riser System, Cable tray and ladder rack, Conduit, Back boxes, Junction boxes, etc, Luminaires. Any rectification/remedial requirements at later date resulting in modification in the RCC structure shall be borne by him unless officially proved and agreed with Employer's Representative in writing pertaining to the changes in design.

g. The Contractor to undertake detailed co-ordination work for services in Dry Wall Partition and false ceiling.

h. The Contractor is deemed to undertake the responsibility of mobilizing resources to follow Pirmal Milestone Program & Civil Contractor schedule for casting of structure pertaining to time stated and agreed together with Civil Contractor and Employer's Representative.

i. The Contractor Shall verify the switchgear discrimination with the Electrical Contractor, based on design the Contractor shall present a detailed discrimination study for LODHA and Consultant approval with all requirements.

j. The Contractor is responsible to submit voltage drop calculations, Cable, Breaker & Electrical devices selection charts fulfilling the design criteria, calculation for conduits, trunking, and cable tray/ladder loading. Complying with the codes mentioned herein and specifications together with local Authority requirements is deemed to be responsibility of the Electrical Contractor.

k. The Contractor to ensure that THD @ full load shall be limited to 5% not exceeding 7% on part loads.

l. Detailed LV System layouts including Electrical switchgear and plant elevations indicating equipment layouts and support systems. Provision of raised concrete plinths below MCC's in plant rooms/service floor as required. All such requirements shall be raised to the Civil Contractor well in advance.

m. Site mock-ups indicating installation details.

n. Record drawings, operating and maintenance manuals, training documentation, log-books, schematics, mimic diagrams, -Site Accept test (SAT) records, Factory acceptance test (FAT) report, for all equipment.

o. Supply and installation of field and construction bolts for anchoring, etc.

p. Provision for securely fixing in place of any cast-in inserts / bolts / box outs that are needed for and related to the Electrical Package onto the form work / Rebar in co-ordination with the Civil Contractor.

q. Crainage and hoisting of Electrical works by providing all types of mobile cranes and banks men as necessary for the work sequencing and Program as per schedule including any lifting hooks / beams as per GCC/SCC.

r. In case of any doubt Contractor to raise RFI to clarify the doubts.

s. The Contractor shall have a "Controlled/Scheduled" use of Cranes available on site but upon co-ordination with the Civil Contractor who primarily controls the Cranes on site at agreed cost between the two parties. For all requirements of Civil Contractor Cranes, vertical transportation & other lifting equipment- The Contractor to submit schedule of requirement to Civil Contractor with copy to Employer's Representative.

t. Delivery of Equipment / materials to site, site storage including safety and security of your materials till final handing over.

u. Provision of all plant and equipment as per your requirement. Those equipment will include but will not be limited to welding machine, Scaffolding, Scaffold less climbers, trailers, pick-up's etc.

v. Supply, erection, moving and removal of access scaffolding and/or scaffold less platforms up to 8 meters.

w. Provision of samples in acceptable condition.

x. Any touch up's to the paint on site after erection. All supports shall be 2 coats of cold galvanized (Galvafroid or Equivalent zinc rich paint) painted after removal of all cuts and burrs.

y. Allowance of free access to 3rd Party Surveyor-appointed by Employer's Representative in order to check any works whether completed or in progress and whether related to the Structural Steel works or not and to liaise with such surveyor in terms of any queries/issues he might has.

z. Multiple visits to site during construction of all area pertaining to DG Package.

aa. Provision of Safety arrangements during the full installation period and provision of safety fall arrest nets, edge protection, barricades and the likes as necessary in addition to the supply of safety equipment and protection means for the Contractor's manpower on site. Protection of others work and other Contractor's personnel as necessary while carrying out works e.g. while lifting equipment / material. The Contractor to submit Project Safety Plan listing all activities and provisions employed to restrict any incident occurring.

bb. Design Verification, optimization and validation of sizes of cable trays/containment, etc.

cc. The Contractor shall be responsible for ensuring that the engineering services comply with all statutory requirements, together with the requirements of the specification suiting the space requirement as per site condition with regard to structural penetration.

dd. The Contractor shall ensure that the systems are adequately co-ordinated and liaised with the Civil, Architectural, all Mechanical Contractor and all Specialist Sub-Contractors and that all items necessary to provide a fully complete installation are included. Any additional costs resulting from failure to provide a fully complete installation shall not be provided. Any additional costs resulting from failure to comply with this clause shall be borne by the Contractor.

ee. Detailed co-ordination of the Electrical services with the building structure but not limited to sections mentioned herein shall be the responsibility of the Contractor.

ff. Installation warrantees and materials guarantees as detailed in the specification / GENERAL CONDITION OF CONTRACT (GCC) / SPECAIL CONDITION OF CONTRACT (SCC).

gg. The Contractor to follow approved vendor list under the division specifications. Approval for alternate vendors with technical compliance & cost benefit to be provided pre Tender stage. Post Tender award no alternate vendor to be approved.

hh. During Tender the Contractor to submit a comprehensive list of vendors selected from approved vendor list.

ii. Handover of the completed works to allow other Contractors to follow on, snagging and obtaining the final inspection for the work.

jj. Daily housekeeping of the area of work and shifting the same to a common dumping bin failing which action shall be initiated by Employer's Representative and all associated cost shall be recovered from the Contractor.

kk. The Contractor shall undertake all painting and identification of different services under the scope of work as mentioned herein or elsewhere.

ll. The Contractor shall validate the development of Schematics and infrastructure requirements for Lift regenerative braking power back feed to System as required.

mm. The Contractor to ensure that all requested builders work opening shall be duly fire stopped with approved fire stopping material. The Contractor to undertake and facilitate inspection of all fire stops from approved vendor with each fire stopped signed off from approved vendor/material manufacturer.

nn. Warranties on equipment and installation shall commence after issue of letter for handover of the System (partial/complete) after due testing and commissioning and witness by Employer's Representative.

3. CO-ORDINATION:

a. The Contractor shall be responsible for work in the area where D.G. Set(s) are located. The Contractor is responsible for undertaking all services co-ordination works with structural, architectural and all trades for the preparation of combined services drawings and builder's work drawings.

b. The Contractor shall liaise with common area, parking & apartment HVAC Contractor, Plumbing& Drainage, Fire Fighting, Façade, IT & Security Contractor, BMS, Pools & water feature Contractor, external services Contractor, sewage treatment plant, Utility agency, Gas supply agency, IBS, FTTH, solid waste management any other agency not mentioned herein however required to complete the job. The Contractor shall submit combined co-ordinated services drawings as required by Employer's Representative for final submission and approval from Employer's Representative& Consultants.

c. The Contractor shall depute following staff, full time at the Contractors site office. They shall appoint Co-ordination Manager (1No) undertaking the sole responsibility of co-ordination with other services Contractors mentioned above. They shall further appoint MEP co-coordinators and co-ordination draughtsman. Co-ordination Manager is deemed to hold weekly co-ordination meeting (MOM to be issue officially) with all other services Contractor where they are deemed to undertake responsibility for their scope of work failing which The Contractor shall notify Employer's Representative for further course of action.

d. All Contractor shall submit approved services drawings to the Electrical Contractor for final services co-ordination drawings after which each Contractors authorized representative shall sign off the final drawing for submission to Employer's Representative. The Contractor shall undertake the responsibility to co-ordination the services to ensure the impact on RCC structure, architectural & individual services Contractor scope of work is minimal. On approval the Contractor shall submit final builder's work drawing for final approval from Employer's Representative. All cost involved including rectification shall be recovered from responsible party (decided by Employer's Representative) for any miss out by individual services Contractor or by the Contractor to the requirement of builder's work drawing.

e. Contractor is required to prepare a compressive submittal schedule with clear Program dates against each submittal. Contractor is responsible to ensuring this to keep up to date and the same to be issued to Client team for review and progress reporting.

4. PROCEDURES AND DOCUMENTS:

a. The Contractor will comply with the SCC & GCC and all procedures and requirements as required by Employer's Representative including: Quality Management (QA/QC,ITP, NCR's etc), Environmental Management, Design Management, Document Control, Materials Management, Procurement, Construction, Commissioning and Handover, Post Completion, Project Control, Logistics, Method statements, Health and Safety, Cost Management, Planning, Programming and Reporting.

b. The Electronic Document Management System (DMS) shall be used for transfer of all documents relating to the works between the The Contractor, LODHA team and Design Consultants.

5. CERTIFICATION:

a. Have Code Authority acceptance inspection performed. Verification that such tests have been completed, all corrective work accomplished and installation approved for issuance of a permit to operate shall be required before acceptance of any unit. As mentioned in the relevant specifications and to the requirements elsewhere The Contractor is responsible to submit Code compliance certificates issued from ASTA/KEMA/BASEC/CPRI/etc to Employer's representatives.

b. The Contractor is responsible for the relevant Requests for Inspection at least 24 hour in advance.

c. The Contractor will be required to participate in obtaining the Building Completion Certificate where applicable to the Scope of Works. The Contractors involvement with this may include but not be limited to participating and/or providing the relevant information required for the following:

   1. Local Authorities (Electrical Inspector) including Final Inspection.
   2. Fire Department Inspection.
   3. MOEF Approvals.

6. TECHNICAL SUBMITTALS:

a. The Contractor shall submit Shop Drawings & material submittal, samples, etc for all sections and sub-elements of the works within the Contract scope as detailed under specifications. These Shop Drawings & technical submittal will be reviewed and commented on by the LODHA team / Design Consultant.

b. The Contractor shall be responsible for the design development, design (as mentioned in specifications) and co-ordination of the complete engineering services installation as detailed in this specification. The Contractor shall be responsible for ensuring that the engineering services comply with all statutory requirements, together with the requirements of the specification.

c. The Contractor shall include for the preparation of combined services coordinated working drawings (Shop Drawings) which shall include and indicate the minimum as follows:

   1. Invert levels of all main cable containment systems, Electrical services and all other services.
   2. Location of all supports systems including drop rods to support the following:
      a. Cable trunking.
      b. Busbar trunking.
      c. Cable tray and ladder rack.
      d. Conduit.
      e. All other Electrical services.

d. Details shall include (but not limited to) the DG itself, diesel storage tanks, fuel transfer lines, exhaust duct work and support, acoustic provision, silencers, electrical switchgear and plant elevations indicating equipment layouts and support systems. Submit drawings to Civil Contractor & Employer's Representative for all raised concrete plinths below all LV main and sub-main switchgear that are not located over a trench.

e. Provide layouts of all equipment indicated in the Tender drawings fully co-ordinated with the other Mechanical and Electrical services. The drawings shall be provided by the Contractor to meet the following requirements:

   1. General arrangement drawings - scale 1:50.
   2. DG Area and associated panel areas - scale 1:20.
   3. Specialist details - scale 1:10.
   4. Schematics - not to scale.

f. Eight complete sets (7No A1and 1No A3 size) of the above shall be submitted to the Engineer for approval well in advance to any work commencing on site.

g. Technical Submissions shall be provided and issued to the Employer's Representative for comment for all items of work and procurement of systems, plant and items of equipment. This includes all drawings, wiring diagrams, samples of materials, samples of products, manufacturer's technical literature, calculations and supporting documentation. Contractor shall submit 3 sets of Technical submittal for review and approval by LODHA team & Design Consultants. All submittals shall be done at LODHA site office.

h. Each technical submission shall consist of the following documentation:

1. Covering issue sheet with individual tracking number or reference.
2. Material or product sample.
3. Drawings or diagrams.
4. Manufacturers literature.

i. Technical submissions shall be submitted to Employer's Representative office in accordance with the Procurement schedule complying to Program of works (Contract & Construction) allowing a minimum of 21 days for comment by Employer's Representative & Consultants. Three copies of all documents/drawings shall be provided.

j. The Contractor shall prepare operating and maintenance instruction in accordance with these conditions. These shall consist of Operating and Maintenance Manuals and As-Installed/Built Drawings.

k. The maintenance and operating instruction manuals shall include:

1. General descriptions of all systems installed.
2. Setting up and operating instruction for all equipment and systems installed and for emergency operation.
3. Control sequences for all systems installed.
4. Copies of all commissioning certificates.
5. Frequency and details of routine maintenance requirements for all plant and equipments shown on a set of schedules produced for this purpose.
6. Fault finding charts for each plant and System.
7. Manufacturers literature, test certificates, detailed drawings and Electrical circuit details, printed operation and maintenance instructions for all specific items of equipment and plant supplied and systems consisting of such equipment and plant.
8. Schematic drawings of each System indicating the principal item of plant and equipment with the number code and asset register of each item indicated.
9. Spare parts lists and recommended spare parts holding.
10. Manufactures guarantees or warranties.
11. Test reports and certificates.
12. Contents and checklists.
13. Schedule of all M&E "As-Installed" drawings including specifications and details as to their location.
14. Schedule of test certificates.
15. Planned preventative maintenance schedule.

l. The content and layout of the manuals shall comprise the following sections which shall be separated in the manuals by dividers:

1. Contractual Details.
2. Equipment Schedule.
3. Parts Identified and Recommended Spares.
4. Factor Acceptance Tests (FAT) record sheets.
5. Site Acceptance Tests (SAT) and Commissioning Data.
6. Names, addresses and contact details of all Manufacturers.
7. Index of Plans and Drawings.
8. Manufacturers Literature.

m. The manuals shall comprise loose-leaf, A4 pages on good quality paper of weight at least 100g/sq m. Loose-leaf four ring binders shall be used for the binding constructed from PVC covered, heavy weight card. Dividers between sections and parts shall be stepped, overlapping, printed card. An information sheet shall be provided in the front of the manual listing the name and address of the installation, the name and address of the author, the Company, the Authority, the Contractor and the Contract number. Manual details, logos, addresses, contact number (where applicable), and other relevant information shall be provided on the front cover or the spine. Any written material prepared on computer shall be retained by the Contractor on a CD. A copy of this disk shall be handed to the Employer.

n. The "As-Installed/As-Built" drawings shall include, but not be limited to, the following information (where applicable to the service concerned):

1. The location of the incoming service connections for all utility services.

2. The location of all main isolating points for all services, either inside the building or outside.
3. Comprehensive System, circuit and wiring diagrams for all engineering systems illustrating the configuration, interconnection, and method of operating and control.
4. The detailed layout, exact location, method of installation and service of all Electrical cables, trunking and conduit showing the reference, type, number of cores and size of all cable, type, size and contents of all trunking and conduit, provision, and the location, type of all isolators, switches and protection devices.
5. The detailed layouts of all Electrical services showing the exact location, reference, circuit, size and service of all equipment installed. Details of characteristics, degree of protection against ingress of solids and liquids, class of protection against corrosion and manufacturers name and references shall be given.
6. Distribution systems diagrams showing incoming supply details, prospective short circuit current and earth-fault loop impedance measured at required point within the distribution System, and showing details of switchgear, protection and recording instrumentation, together with their respective settings (if applicable).
7. Drawings showing all earthing conductors, main equipotential bonding conductors, main earthing terminals, protective conductors and supplementary equipotential bonding conductors, including functions, origin route, destination, conductor size and material, type of insulation.
8. All "As-Installed" drawings shall be correlated to ensure that the terminology and reference used are consistent with those used in the identification of plant equipment labels or in other record documents, in particular the Operating and Maintenance Instruction Manuals. Standard symbols and notations used shall be in accordance with details shown in the relevant schedules.
9. Drawings shall be produced using latest AUTOCAD software at the time of submission, and stored on CD. Provide PDF copy on a separate DVD for archiving.
10. The Contractor shall issue 6 no. proof copies of the Operating and Maintenance Manuals and 6 no. proof sets of the "As-Installed" drawings to the Engineer for checking and review 2 weeks prior to final commissioning & taking over date specified in the Program. The proof documents shall be complete excepting test certificates and final commissioning data not available at the time of the issue. The Employer's Representative shall be comment within 2 weeks on the proof documents upon receipt.
11. On receipt of comments from Employer's Representative Contractor shall update the documents and finally submit the following:
    a. 6 copies of the Operating and Maintenance Manuals.
    b. 4 set of "As-Installed" drawings at full size.
    c. 2 set of "As-Installed" drawings at A3 size - bound together.
    d. 3 DVD set containing all drawings and documents in original format.
    e. 3 DVD set containing all drawings and documents in archive PDF format.
    f. 6 copies of tests made on completion.
    g. 6 sets of all manufacturers information and literature for all products installed on the Project.

7. SETTING OUT AND SURVEYING

a. The Contractor shall satisfy himself in good and sufficient time before commencing any part of the works as to examine and verify that no irregularities exist that would affect quality of execution of works as specified and shall promptly advise LODHA team in writing if any such previous work is out of position, wrongly dimensioned or in any other way unsuitable.

b. The Contractor shall inspect the works on regular basis (at least twice per month) to check the work progress and to answer/report to LODHA team any discrepancies that may impact the permanent installation.

c. The Contractor site engineering and survey team is to cooperate with the Civil Contractor's survey team/s when necessary and jointly work together and share data throughout the construction process.

8. PROJECT REQUIREMENT SUMMARY

a. Project requirements include but are not limited to the following:

1. Compliance with the SCC & GCC, general and particular divisions of the specification, drawings and other documents detailed in the Invitation to Tender.
2. The complete management of the DG Package Contractor direct and sub-contracted works.
3. Planning of the works in conjunction with LODHA team and other Contractors.
4. Co-ordination with the overall site works including interface with other work package and External Contractors employed on and associated with the project.
5. Preparation of Shop Drawings and technical submittal.
6. Value engineering studies including technical and financial evaluation.
7. Preparation of mock-up- if necessary.
8. Provision of samples.
9. Submittal and obtain the Employer's Representative /Consultants / Local Authority approval.
10. Procurement of materials and services to complete the works.
11. Off site visits.
12. Delivery to site of all items necessary to complete the works.
13. Installation of the works in accordance with the Employer's Representative overall Program and any subsequent amendments.
14. Provision of all labor, supervision and management required.
15. Provision of all plant and equipment including, fuel, maintenance and operators.
16. Testing of materials/ equipment in accordance with the specifications.
17. Testing and commissioning of the complete works, phased to meet the overall project requirements and interfaces with other packages.
18. Provision of operation and maintenance documentation prior to completion of the works.
19. Maintain a record of changes to the working drawings in AUTO-CAD format-and prepare as-built drawings as the works are completed.
20. Maintenance of the works and attendance to defects as per the specifications.
21. Installation warrantees.
22. Provision of spares, tools and consumables
23. Training of the Employer's facility management staff.
24. Installation warrantees as per the specification commencing on issue of partial/complete handover certificate from Employer's Representative.
25. Temporary works until the permanent works are completed i.e. any propping, temporary supports etc and the responsibility for the design thereof.
26. Handover of the completed works to allow other Contractors to follow on, snagging and obtaining the final inspection for the work.
27. Final Cleaning: Upon completion of the Contract works, the Contractor shall dismantle and remove from the site all plant, temporary buildings and temporary works, surplus materials and rubbish and make good all work disturbed or damaged. However prior to the completion of the Project the Electrical Package Contractor will carry out final cleaning, replace any damaged and make good his works to LODHA team approval.

9. KEY WORKS PACKAGE INTERFACE:

a. The Contractor will interface with all other Contractors and attend meetings and provide information to fully co-ordinate the DG Package works with that of all other Contractors working on the project, including but not limited to:

1. Civil Contractor.
2. Electrical Contractor
3. HVAC Contractor.
4. Fire Alarm Contractor.
5. Security access control System.
6. Information Technology Contractor.
7. Interior finishes Contractor (common area & apartment).
8. Façade Contractor for Lightning Protection & any other associated works.
9. Utility agencies.
10. Elevator Contractor.

11. Interior, Common area & Exterior lighting Consultants.
12. Air Craft Warning Light Contractor (Under Electrical Package).
13. Landscaping Consultants & Contractor.
14. Fire Fighting Contractor.
15. STP consultants, supplier & Installer.
16. Infrastructure Contractor.
17. Pools & Water Feature Consultants and Contractors.
18. BMU supplier and installer.
19. Gas supply agency & installer.
20. Plumbing & Drainage.
21. Jacuzzi/Hot Tub/Plunge Pools.
22. GSM service provider (IBS).
23. Fiber To The Home (FTTH).
24. Garbage room Contractor.
25. Residential car park (car park).

END OF SECTION- K

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CONSTRUCTION.

MAINTENANCE/CLEANING/OPERATION.

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Notes

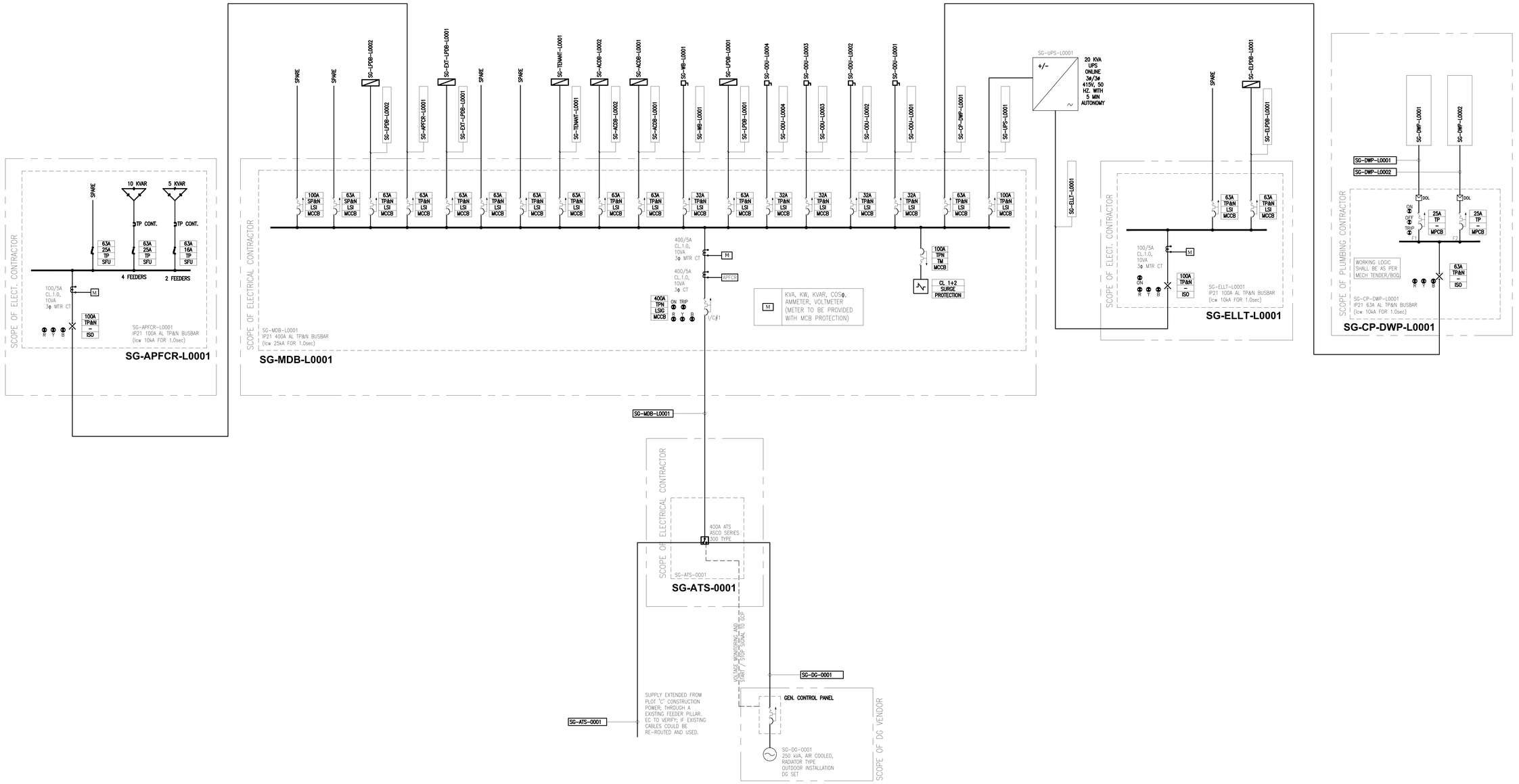
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2	A-102	FSND	30-01-2015	R2

STRUCTURAL REFERENCE DRAWING

SL	DRAWING NO.	FROM	DATE	REV
-	-	-	-	-



NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE INDICATED.

Key Plan



Rev	Description	Date	Drn	Chkd
00	FOR TENDER	OCT 2015	JV	JV

INFORMATION

Status of drawing

BUROHAPPOLD ENGINEERING

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Architect: ARCHITECT HAFEEZ CONTRACTOR

Project: LODHA KOLSHET,THANE

Drg Title: SALES GALLERY
LV SYSTEM SCHEMATIC

Scales@A0	N.T.S	Job No.	033629
Drawn by	JV	Drawing No.	BH-ZSG-SLD-E-1100
Checked by	JV	Rev	00
Date	OCT 2015		

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2	A-102	FSND	30-01-2015	R2

STRUCTURAL REFERENCE DRAWING

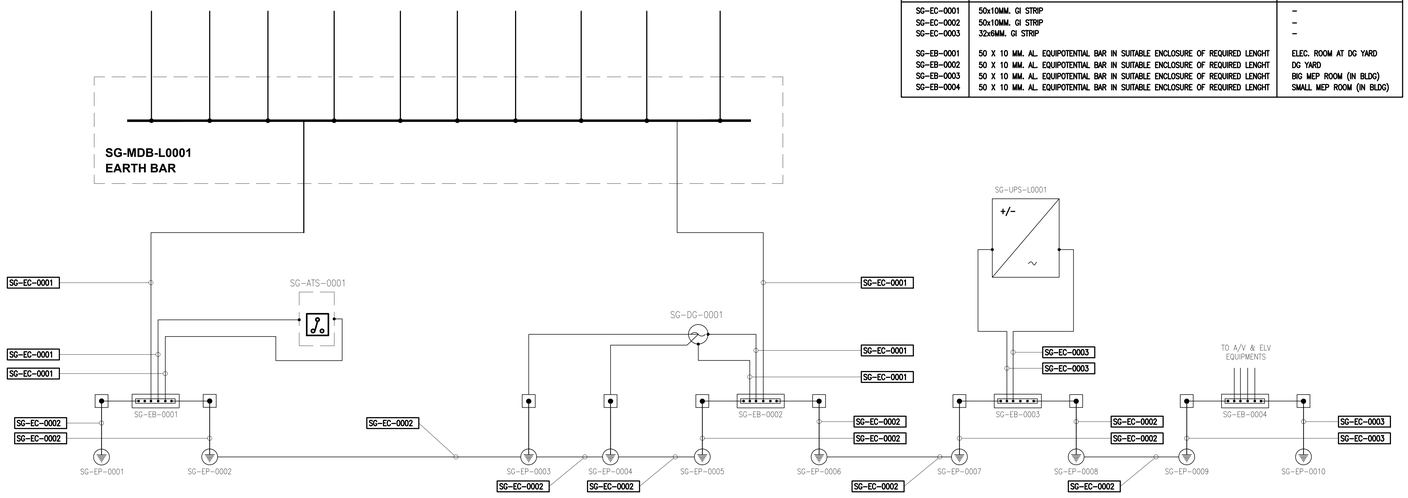
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NOTES:

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE INDICATED.

FOR FURTHER SIZE OF CPC; REFER CABLE SCHEDULE: SG-E-VDC-001 & ELECTRICAL SLD

TAG	DESCRIPTION	LOCATION
SG-EC-0001	50x10MM. GI STRIP	–
SG-EC-0002	50x10MM. GI STRIP	–
SG-EC-0003	32x6MM. GI STRIP	–
SG-EB-0001	50 X 10 MM. AL. EQUIPOTENTIAL BAR IN SUITABLE ENCLOSURE OF REQUIRED LENGHT	ELEC. ROOM AT DG YARD
SG-EB-0002	50 X 10 MM. AL. EQUIPOTENTIAL BAR IN SUITABLE ENCLOSURE OF REQUIRED LENGHT	DG YARD
SG-EB-0003	50 X 10 MM. AL. EQUIPOTENTIAL BAR IN SUITABLE ENCLOSURE OF REQUIRED LENGHT	BIG MEP ROOM (IN BLDG)
SG-EB-0004	50 X 10 MM. AL. EQUIPOTENTIAL BAR IN SUITABLE ENCLOSURE OF REQUIRED LENGHT	SMALL MEP ROOM (IN BLDG)



Key Plan



Rev	Description	Date	Drn	Chk'd
00	FOR TENDER	OCT 2015	JV	JV

INFORMATION

Status of drawing

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Architect ARCHITECT HAFEEZ CONTRACTOR

Project **LODHA KOLSHET,THANE**

Drg Title SALES GALLERY
LV SYSTEM SCHEMATIC

Scales@A0	N.T.S	Job No.	033629
Drawn by	JV	Drawing No.	BH-ZSG-SLD-E-1100
Checked by	JV	Rev	00
Date	OCT 2015		