GALGOTIAS UNIVERSITY
ENG. & ADMIN BLOCK

TENDER DOCUMENT
FOR
ELECTRICAL & ELV WORKS

February 2024

:CLIENT:

Smt. SHAKUNTLA EDUCATIONAL & WELFARE SOCIETY

GALGOTIAS UNIVERSITY

PLOT NO. 2, YAMUNA EXPY, SECTOR 17A,
GREATER NOIDA, UTTAR PRADESH -203201, INDIA

:PROJECT MANAGER:

CBRE South Asia Pvt. Ltd | PJM Group - India
6th & 7th Floor | DLF Square Building | Jacaranda Marg
DLF Phase II | Gurgaon 122002, India

: ARCHITECT:

ARCOP ASSOCIATES PVT. LTD.

E-106, GREATER KAILASH ENCLAVE-I
NEW DELHI, INDIA

: MEP SERVICES CONSULTANTS:

SUNIL NAYYAR CONSULTING ENGINEERS LLP

206, 206A, 2nd Floor, Time Centre,
DLF Golf Course Road, Sector-54, Gurgaon-122 002

GALGOTIAS UNIVERSITY

CONTENTS

SECTION: 1
NOTICE INVITING TENDER

GALGOTIAS UNIVERSITY

NOTICE INVITING TENDER

Tender is invited by The Registrar, M/s **SMT SHAKUNTLA EDUCATIONAL & WELFARE SOCIETY, Galgotias University**, **PLOT 02, YAMUNA EXPY, SECTOR 17A, GREATER NOIDA, UTTAR PRADESH** for **Electrical & ELV Works**, for New Admin & Engg. Block, Greater Noida, Uttar Pradesh.

Bidders to download the Tender Documents and submit the duly filled Tender documents in all respect to **projects.pq@galgotiasuniversity.edu.in** on OR before the date mentioned in the newspaper notification. Please send Pre-Bid queries by email only.

Following Tender Documents are to be submitted by the bidders:

Sl. No	Description	Duly Signed & Stamped
A	Notice Inviting Tender (NIT) & Form of Tender	1 Original (NIT with duly filled-in Form of Tender & Appendix)
B	GCC, SCC & Formats of No Claim Certificate, Articles of Agreement, Indemnity Bond, RBG & Performance Bank Guarantee	1 Original
C	Bill Of Quantities	1 Original
D	Power of Attorney authorizing the signatory of Tender & Contract	1 Original
E	Proposed Methodology of Work	1 Original
F	Proposed Schedule of Work	1 Original
G	List of Plant & Machinery along with Schedule of Deployment at site	1 Original
H	Proposed Site Organization Chart along with Manpower Deployment Schedule	1 Original
I	Details of works in Hand	1 Original
J	Litigation History	1 Original
K	Project Quality Plan	1 Original
L	Environment, Health, and Safety Plan	1 Original

Bidders shall put his stamp and signatures on every page of the Tender including every Tender drawing at the lower right-hand corner.

All the rates mentioned in the tender shall be inclusive of transportation, loading & unloading, government statutory requirement charges, etc., and shall remain firm till completion of work. No escalation of the prices shall be allowed for any reasons whatsoever. GST and Labour Cess shall be mentioned separately.

Bidders are advised to submit the Tenders strictly based on the conditions of contract and specifications contained in the Tender documents and are advised not to stipulate any deviations. Deviations may, however, be stipulated in case of unavoidable circumstances. Exceptions and deviations, which Bidder may desire to stipulate, shall be listed separately. The PMC, client & the Architect reserve the right to reject any such deviations or evaluate the Tender containing deviations having financial implication, by adding the cost for such deviations as may be determined by the PMC or the client or the Architect.

We intend to adhere to a very strict timeline in administering this Tender.

Proposals received beyond the mentioned time and date will not be considered.

Incomplete responses shall be liable to be disqualified at GALGOTIAS UNIVERSITY's sole discretion.

This Notice Inviting Tender shall form part of the contract.

For,

SMT SAKUNTALA EDUCATIONAL & WELFARE SOCIETY
Galgotias University

Authorized Signatory

SECTION: 2
FORM OF TENDER

FORM OF TENDER

To,
SMT SAKUNTLA EDUCATIONAL & WELFARE SOCIETY
Galgotias University
PLOT 02, YAMUNA EXPY,
SECTOR 17A, GREATER NOIDA,
UTTAR PRADESH, INDIA-203201

Dear Sir,

Having examined the conditions of contract, specifications, Tender drawings and Bill of quantities relating to the works specified in the Tender hereinafter set out and having examined the site of the works specified and having acquired the requisite information relating thereto as affecting the tender, I/We hereby offer to execute the works specified, within the time specified & at the rates mentioned in the attached bill of quantities and in accordance, in all respect, with the specifications, designs, drawings and instructions in writing referred to the GCC, SCC, Technical Specifications & (Tender drawings) of the said Tender.

Should this tender be accepted, I/We hereby agree to abide by and fulfil the terms and provision of the said conditions of Contract as per Tender document to so far as they may be applicable or in default thereof to forfeit and pay to **Galgotias University,** the amount as per the said conditions.

I/We have deposited Earnest Money Deposit (If applicable) in the form of Bank Guarantee in favour of **Galgotias University** as specified in Appendix to Form of Tender. Should I/We fail to execute the contract when called upon to do so, I/We do hereby agree that this sum shall be forfeited by **Galgotias University.**

All information and documents as required to be submitted as per Tender Document are enclosed. Our banker(s) (Name & complete address):

The names of partners of our firm are:

1.

2.

Name of the partner of the firm authorized to sign
OR

Name of person having Power of Attorney to sign the Tender & Contract (Certified true copy of the Power of Attorney shall be attached)

Yours faithfully,

Signatures of Tenderer Stamp Name & Address

i. Witness 1 (Signatures, Name & Address):

ii. Witness 2 (Signatures, Name & Address):

GALGOTIAS UNIVERSITY

SECTION: 3

PRE-QUALIFICATION (attached separately)

SECTION: 4

GENERAL CONTRACT CONDITIONS

GALGOTIAS UNIVERSITY

Table of Contents

Schedule II
Contract Agreement

General Conditions of Contract (GCC)

1. **DEFINITIONS & INTERPRETATIONS**

1.1. **Definitions**

The following words and expressions shall have the meanings hereby assigned to them, except where the context otherwise requires:

(a) "**Acceptance Defects Notice**" has the meaning given to it in Clause 11.3.(c).

(b) "**Affiliate**" means any entity which directly or indirectly:

(i) owns or Controls such entity;

(ii) is owned or Controlled by such entity;

(iii) is under common ownership or Control with such entity.

(c) "**Affected Party**" has the meaning given to it in Clause 31.1.

(d) "**Applicable Law"** means, with respect to any Governmental Authority, national, regional or local law, directive, statute, rule, regulation, ordinance, treat, order, decree, judgment, decision, determination, interpretation, certificate, injunction, registration, license, permits, authorization, guideline, approval, consent or requirement of/by such Governmental Authority, as construed from time to time by any Governmental Authority.

(e) "**Application for Change Proposal**" has the meaning given to it in Clause 22.4(a).

(f) "**Approved List**" has the meaning given to it in Clause 16.2.

(g) "**Architect**" means the person/entity appointed as the architect for the Project by the Client and as notified by the Client to the Contractor pursuant to Clause 13.1.

(h) "**Bid**" has the meaning given to it in the Instructions to Bidders.

(i) "**Bidding Documents**" means the Notice Inviting Bids ("**NIB**"), Tender Drawings, Instructions to Bidders ("**ITB**"), Drawings, Technical Specifications, Bid Forms, Technical Bid, Price Bid, Contract and General Conditions of Contract ("**GCC**").

(j) "**Change**" has the meaning given to it in Clause 22.1.

(k) "**Change in Law"** has the meaning given to it in Clause 32.1.

(l) "**Change Order**" has the meaning given to it in Clause 22.3(e).

(m) "**Change Proposal**" has the meaning given to it in Clause 22.3(a).

(n) "**CIBIL**" means Credit Information Bureau (India) Limited.

(o) "**Codes and Standards**" means the codes and standards as more fully detailed in the Technical Specifications, in relation to the design, specification, construction, fabrication and inspection of the New admin. & Engg. Block.

(p) "**Commencement Date"** has the meaning given to it in Clause 7.1.

(q) "**Completion**" has the meaning given to it in Clause 11.1(a).

(r) "**Completion Certificate**" has the meaning given to it in Clause 11.1(b).

(s) "**Completion Date**" has the meaning given to it in Clause 7.2(a).

(t) "**Contract**" means (i) the Contract Agreement; (ii) GCC; (iii) Technical Specifications; and (iv) any other documents listed in the Contract Agreement.

(u) "**Contractor**" means Who has been awarded the Work.

(v) "**Contract Agreement**" means the agreement to be executed on [__] between the Contractor and the Client in the form set out in **Schedule II** for undertaking and completing Works with respect to the Project including all annexures and schedules, as the same may be amended, supplemented or modified from time to time by mutual written agreement. [***input the date of execution of the Contract.***]

(w) "**Contract Price**" has the meaning given to it in Clause 23.1.

(x) "**Contract Schedule**" has the meaning given to it in Clause 5.22(b).

(y) "**Contractor's Equipment"** means all appliances, things or equipment of whatsoever nature required for the execution and completion of the Works and the remedying of any defects therein.

(z) "**Contractor's Personnel**" means the Contractor's Representative, Works Manager and each individual and collectively the Contractor's employees, labour (skilled, semi-skilled and unskilled) Sub-Contractors, and their respective employees, contractors (of the Sub-Contractors), officers, licensees, invitees, agents and representatives, who are provided and/or utilized by Contractor for the execution of the Works and any other personnel notified to the Client by the Contractor as the Contractor's Personnel.

(aa) "**Contractor's Representative**" means the person identified in Clause 5.23.(a), or the replacement of such Person who is nominated and approved in accordance with the procedure provided in Clause 5.23.(d).

(bb) "**Control**" means (and related terms shall refer accordingly to), with respect to any person, (i) the possession, directly or indirectly, of the power to direct or cause the direction of the management and policies of such person whether through the ownership of voting securities, by agreement or otherwise or the power to elect more than one-half of

the directors of such person; or (ii) the possession, directly or indirectly, of a voting interest of more than 50% (fifty percent); or (iii) the power to veto decisions of such person, whether through ownership of voting securities, by contract, or otherwise;

(cc) "**Defects Notice**" has the meaning given to it in Clause 11.1(c).

(dd) "**Defect Liability Period**" has the meaning given to it in Clause 21.2.

(ee) "**Dispute**" has the meaning given to it in Clause 35.2.

(ff) "**Documents**" means the data in the form of text, worksheets, Drawings (including as-built drawings) designs, specifications, plans or reports in print or electronic form and complying with the requirements of the Technical Specifications, to be submitted by the Contractor, in relation to the Works required for developing the New admin. & Engg. Block, including but not limited to engineering data, ELECTRICAL AND ELV and construction drawings, documents required to satisfy all regulatory approvals and other such descriptive material as specified under the Technical Specifications.

(gg) "**Drawings**" means the drawings for the New admin. & Engg. Block including for the ELECTRICAL AND ELV and structural Works required to build the New admin. & Engg. Block and as referred to in the Technical Specifications and any modification to such drawings as approved by the Client, Architect and Project Manager and such other drawings as may, from time to time be provided by the Client to the Contractor.

(hh) "**Environmental Standards**" means Applicable Law, codes, rules and regulations relating to: (a) pollution, contamination, clean-up, protection and reclamation of the environment; (b) health or safety, including, without limitation, the exposure of employees or other persons to any Hazardous Materials; (c) the release or threatened release of any Hazardous Materials; (d) the management of any Hazardous Materials, including, without limitation, the manufacture, generation, formulation, processing, labelling, distribution, introduction into commerce, registration, use, treatment, handling, storage, disposal of materials, the discharge of chemicals, gases or other substances or materials into the environment, the presence of such materials, chemicals, gases or other substances in or around the New admin. & Engg. Block, transportation, reuse, recycling or reclamation of any Hazardous Materials; and (e) any governmental approval issued by a Governmental Authority with respect to the foregoing.

(ii) "**Final Acceptance Certificate**" has the meaning given to it in Clause 11.3.(b).

(jj) "**Final Completion**" has the meaning given to it in Clause 11.3.(a).

(kk) "**Force Majeure Event**" has the meaning given to it in Clause 31.1.

(ll) "**Governmental Authority**" means any Indian national, regional, state, municipal or local government, and any division, ministry, department, agency or other emanation of any of the same, including any judicial body, commission, board, branch or similar authority of such government and anybody empowered to grant, withdraw or determine the terms and conditions of any applicable permit and the organs of the Government of India or as the case may be, the Government of the Indian State where the Site is located.

(mm) "**Hazardous Materials**" means (i) any element, compound, substance, preparation, chemical, physio-chemical properties or biological derivative, radiation, noise, vibration, material or combination thereof which by reason of its composition or characteristics is defined in Applicable Law as a hazardous material, or (ii) any other material which any Government Instrumentality determines from time to time is harmful, toxic, or dangerous, or otherwise ineligible for handling, storage or disposal by unregulated means or is liable to cause harm to human beings, other living creatures, plant, micro-organism, property or the environment.

(nn) "**Indemnified Party**" has the meaning given to it in Clause 28.3.

(oo) "**Indemnifying Party**" has the meaning given to it in Clause 28.3.

(pp) "**Information**" has the meaning given to it in Clause 29.1.

(qq) "**Intellectual Property**" means any licenses, permissions or agreements from licensors of any materials, goods, processes, methods and systems incorporated or to be incorporated in the New admin. & Engg. Block, proprietary information, patents, trademark rights, technology, utility model, registered design, know-how, trade secrets, data bases, industrial processes, source codes, copyrights (including rights in computer software) and any other intellectual or industrial property rights (whether registered or unregistered) subsisting or recognised under the Applicable Law or laws of any other applicable jurisdiction.

(rr) "**Invoice**" has the meaning given to it in Clause 24.4(a).

(ss) "**Instructions to Bidders (ITB)**" means the instructions to bidders issued by the Client or Project manager as part of the Bidding Documents in relation to the Works to be completed by the Contractor dated 07th December 22 bearing no. RMH-ELECTRICAL AND ELV-001.

(tt) "**KMP**" means the key managerial personnel as defined under the Companies Act, 2013.

(uu) "**Latent Defect**" has the meaning given to it in Clause 21.12.(a).

(vv) "**Letter of Award (LOA)**" means the formal acceptance in writing by the Client by way of registered letter or by email notifying the Contractor that its bid has been accepted.

(ww) "**Losses**" has the meaning given to it in Clause 28.1.

(xx) "**Materials**" means and includes all the materials required for undertaking the Works including ELECTRICAL AND ELV works and activities required for developing the Project and building the New admin. & Engg. Block.

(yy) "**Miscellaneous Invoice**" has the meaning given to it in Clause 24.4.(j).

(zz) "**Notice Inviting Bids (NIB)**" means the notice inviting bids issued by the Client as part of the Bidding Documents in relation to the Works to be completed by the Contractor dated 7th December 22 bearing no. RMH-ELECTRICAL AND ELV-001.

(aaa) "**Notice of Completion**" has the meaning given to it in Clause 11.1.(a)(iv).

(bbb) "**Notice of Final Completion**" has the meaning given to it in Clause 11.3.(ix).

(ccc) "**Notice of Provisional Acceptance**" has the meaning given to it in Clause 11.2.(a).

(ddd) "**Occupancy Certificate**" means the final occupancy certificate for the New admin. & Engg. Block issued by Governmental Authority certifying the New admin. & Engg. Block can be occupied and used for its intended purpose.

(eee) "**Pending Agreement Change Order**" has the meaning given to it in Clause 22.3.(i).

(fff) "**Performance Bank Guarantee**" has the meaning given to it in Clause 3.1.

(ggg) "**Performance Parameters**" has the meaning given to it in Clause 9.

(hhh) "**Price Bid**" has the meaning given to it in the Instructions to Bidders.

(iii) "**Prohibited Payment**" has the meaning given to it in Clause 36.9(a).

(jjj) "**Project**" means the development, construction and operation of the New admin. & Engg. Block by the Contractor, located at the Site.

(kkk) "**Project Manager**" has the meaning given to it in the Instructions to Bidders.

(lll) "**Provisional Acceptance**" has the meaning given to it in Clause 11.2(a).

(mmm) "**Provisional Acceptance Certificate**" has the meaning given to it in Clause 11.2(b).

(nnn) "**Provisional Defects Notice**" has the meaning given to it in Clause 11.2.(c).

(ooo) "**Prudent Industry Practices**" means the practices, methods, techniques and standards, as they may be modified from time to time, which are generally followed in the ELECTRICAL AND ELV Works industry; including those expected from a reasonably skilled, prudent and experience person engaged in Works for completion of buildings and performing works and services and providing and supplying equipment and materials as required to be performed or supplied by the Contractor, Sub-Contractors, their employees and other third party agents of the Contractor under the Contract.

(ppp) "**Public Official**" has the meaning given to it in Clause 36.9.(b).

(qqq) "**Purpose"** has the meaning given to it in Clause 29.2.

(rrr) "**Quality Assurance Programme"** has the meaning given to it in Clause 8.2 and means the quality assurance programme as approved by the Client and as set out in the Technical Specifications.

(sss) "**Quality Engineer"** has the meaning given to it in Clause 5.35(d)(i).

(ttt) "**RBI**" means the Reserve Bank of India.

(uuu) "**Request for Change Proposal**" has the meaning given to it in Clause 22.3(a).

(vvv) "**Safety Officer**" has the meaning given to it in Clause 5.35(d)(ii).

(www) "**Serial Defect**" has the meaning given to it in Clause 21.13(a).

(xxx) "**Site**" means all parcels of land on which the New admin. & Engg. Block has to be built and developed as shown in **Schedule XVII**.

(yyy) "**New admin. & Engg. Block**" means the New admin. & Engg. Block to be built on the Site based on the designs and drawings provided by the Architect and other specifications as provided for and detailed under the Technical Specifications, which shall without limitation, include.

(zzz) "**Sub-Contractor**" means any person, including vendor of the Contractor to whom execution of any part of the Works is contracted by the Contractors and includes their successors or permitted assignees.

(aaaa) "**Successful Bidder**" has the meaning given to it in the Instructions to Bidders.

(bbbb) "**Take Over**" means the handing over of the New admin. & Engg. Block by the Contractor to the Client, pursuant to Clause 11.4, pursuant to the issuance of a Take Over Certificate.

(cccc) "**Take Over Certificate**" means the certificate issued by the Client pursuant to Clause 11.4.

(dddd) "**Taxes**" include all taxes, duties, cesses, imposts, fees, levies (including without limitation, all central, state and local government taxes, octroi, excise duties, customs duties, sales tax, countervailing duties, value added tax, works contract tax, service tax, building and construction workers cess and withholding taxes on income) imposed under any

Applicable Law (whether within India or outside India) in connection with the Works, the Project, the Parties or performance by the Contractor/Sub-Contractor of its obligations and responsibilities under the Contract.

(eeee) "**Technical Bid**" has the meaning given to it in the Instructions to Bidders.

(ffff) "**Technical Specifications**" means the technical specifications attached to the Contract.

(gggg) "**Work Product**" has the meaning given to it in Clause 30.1.

(hhhh) "**Works**" means the works and services as set out in the Technical Specifications laid down into the Contract, to be executed by the Contractor in relation to the New admin. & Engg. Block and the Project, in accordance with the terms of the Contract. Works shall also include works to be executed by the Contractor under the Contract, which are contracted by the Contractor to the Sub-Contractor(s).

(iiii) "**Works Manager**" has the meaning given to it in Clause 5.23(h).

1.2. **Interpretation**

(a) Reference to the singular shall include reference to the plural and vice-versa and a reference to any gender shall include a reference to the other genders, except where the context otherwise requires.

(b) The headings and marginal notes in the Contract are included for ease of reference, and shall not affect the meaning or the interpretation of the Contract.

(c) The Schedules and Technical Specifications to and of the Contract form an integral part of the Contract and will be of full force and effect as though they were expressly set out in the body of the Contract.

(d) Unless the context otherwise requires, a reference to any Article, Clause, recital and Schedule shall be to an Article, Clause, recital and Schedule of the Contract respectively.

(e) Reference to any law or regulation having force of law includes a reference to that law or regulation, as from time to time, amended, modified, supplemented, extended or re-enacted.

(f) Reference to time shall, except where the context otherwise requires, be construed as a reference to Indian Standard Time. Any reference to calendar shall be construed as reference to the Gregorian calendar.

(g) The words "include" or "including" shall be deemed to be followed by "without limitation" or "but not limited to" whether or not they are followed by such phrases.

(h) In case of any discrepancy between words and figures, the words shall prevail over the figures.

(i) The provisions of all the documents comprising the Contract and the Documents shall be interpreted harmoniously and only if the provisions of the said agreements and documents cannot be interpreted harmoniously with each other on account of inconsistencies or ambiguities then, unless expressly stated otherwise in the Contract Agreement, the priority of the documents shall be in accordance with the following sequence; (i) the Contract; (ii) GCC (iii) Technical Specifications; and (iv) any other documents listed in the Contract.

(j) Whenever provision is made for the giving of notice, approval or consent by any Person, unless otherwise specified, such notice, approval or consent shall be in writing and the words "notify" and "approve" shall be construed accordingly.

(k) Provisions including the word "agree", "agreed", "agreement" require the agreement to be recorded in writing.

(l) The terms "written" or "in writing" means hand-written, type-written, printed or electronically made, and resulting in a permanent record.

(m) When any timeframe in terms of number of days is prescribed in the Contract, the same shall be reckoned exclusively of the first and inclusively of the last day, except for a payment obligation, in which case, in the event the last day does not fall on a business day, then the last day shall be the next succeeding business day.

(n) The rule of construction, if any, that a contract should be interpreted against the Party responsible for the drafting and preparation thereof, shall not apply.

(o) Reference to any agreement, deed, document, instrument, or the like shall mean a reference to the same as may have been duly amended, modified or replaced. For the avoidance of doubt, it is clarified that a document shall be construed as amended, modified or replaced only if such amendment, modification or replacement is executed in compliance with the provisions of such document(s).

(p) The word "cost" shall be deemed to be all-inclusive also including overhead costs and all taxes under Applicable Law whether on or off the Site.

(q) Wherever provision is made for the giving or issue of any notice, consent, approval, certificate or determination by any person, unless otherwise specified such notice, consent, approval, certificate or determination shall be in writing and the words "notify", "certify" or "determine" shall be construed accordingly.

(r) Any reference to any Applicable Law shall include such law/provision as is from time to time modified or re-enacted or consolidated.

(s) Terms defined in the Schedules, Annexure and Appendices unless contradictory shall have the same meaning throughout the Contract.

(t) Review and comment by the Client or its personnel, with respect to any of such documents or other information shall not relieve or release the Contractor from any of its duties, obligations or liabilities provided for under the terms of the Contract.

2. SCOPE OF WORK

2.1. The Contractor shall execute all the Works as set out in **(attached separately as BOQ),** including all activities required or appropriate to design, fabricate, manufacture, procure and deliver all supplies and Materials required for undertaking the Works for the New admin. & Engg. Block. The Contractor shall carry out and complete the Works in entirety which includes, the supply of all equipment, Materials, plant and machinery, tools, transportation, scaffolding, labour and everything else necessary for the proper execution and successful completion of the Works. The Works shall be undertaken and completed in such a manner that the New admin. & Engg. Block is fit for the purposes.

2.2. The Contractor shall be solely responsible for all means, methods, techniques, sequences, procedures and safety measures programmes in connection with execution of Works.

2.3. The Contractor shall be fully responsible and liable for everything and all matters in connection with or arising out of or being a result or consequence of it carrying out or omitting to carry out any part of the Works. The Contractor is bound to carry out any items of Works necessary for the completion of the New admin. & Engg. Block even though such items of work may not be expressly described in the Bidding Documents.

2.4. The Contractor shall execute the Works consistent with the requirements set forth in the Contract. The Contractor agrees to execute the Works and do all other things required/considered prudent to so do, in relation thereto, in accordance with the parameters set forth in this Clause 2. The Contractor shall be solely responsible for all means, methods, techniques, sequences, procedures and safety programmes in connection with the undertaking the Works under the provisions of the Contract. Without limiting the generality of the foregoing, the Contractor shall execute the Works:

(a) in a continuous manner;

(b) in a proper workmanlike and careful manner and in its entirety, in compliance with Applicable Law and the Codes and Standards, by using methods and Contractor's Equipment which are acceptable as per Prudent Industry Practice;

(c) with safety, dependability, efficiency and economy, in each case, using qualified, competent and where necessary, licensed Contractor's Personnel, so as to successfully achieve the Performance Parameters;

(d) by ensuring that all Works are performed in accordance with the design and instructions provided by the Client;

(e) in accordance with the Quality Assurance Programme; and

(f) with properly equipped facilities and non-Hazardous Materials, except as otherwise specified in the Contract.

2.5. The Contractor shall also execute all such Works and/or supply all such items and Materials that:

(a) can be reasonably inferred from the Contract as being required for attaining Final Completion and Take Over, and which are/is needed for the safe, trouble free and normal operation;

(b) can be reasonably inferred in accordance with Prudent Industry Practice, that the provision or causing the provision of such Works and/or supply of such items and materials, was contemplated as part of the Contract;

(c) is/are necessary to enable the Contractor to fulfill its obligations under the Contract and comply with the warranties set out in the Contract;

(d) is/are necessary to satisfy the provisions of the Technical Specifications; or

(e) although not stated in the Contract, are necessary for stability or for the completion, or safe and proper operation, of the Works;

in each case, as if such Works and/or Materials were expressly mentioned in the Contract and the same shall be considered a part of the Works and shall be executed/supplied by the Contractor, without any additional cost to the Client.

2.6. In the absence of any standard specification in relation to any part of the Works, the Parties shall discuss and mutually agree upon such technical matters pertaining to the Works. In the event the Parties cannot reach a mutual agreement within a period of [15 (fifteen)] days from the date of commencement of such discussions, then the instructions/directions of the Client or Project Manager regarding such technical matters shall be carried out by the Contractor under the Contract.

2.7. Except as otherwise expressly provided in the Contract, the Contractor agrees and acknowledges that it shall perform all its obligations and responsibilities under the Contract, at its own risk, cost and expense.

2.8. As part of the scope of obligations under the Contract, the Contractor shall procure and pay for, in its own name, as an independent contractor and not as an agent of the Client, all items, materials and services necessary in connection with the execution of the Works and all other obligations under the Contract.

2.9. The Client reserves the right to increase or decrease the scope of the Works on any or all items or to change the nature of the Works involved in any or all items or to completely delete any item(s) of the Works under the Contract. The Contractor shall not be entitled to claim for loss of anticipated profits, for mobilization of additional resources, or for any other such reason on account of such instructions. In the event that the Client elects in writing to add an item to scope of the Works or to delete an item from its scope, the Client shall be entitled to increase/reduce (as the case may be) an appropriate amount from the Contract Price.

3. CONTRACTOR'S PERFORMANCE BANK GUARANTEE

3.1. The Contractor shall, at its cost, within [15 (fifteen)] days from the issuance of the Letter of Award and on or before the execution of the Contract Agreement, submit to the Client an unconditional and irrevocable bank guarantee from a reputable bank acceptable to the Client for an amount of INR [__] amounting to 5% (five percent) of the Contract Price in the form as set out in **Schedule I** ("**Performance Bank Guarantee**"). The Performance Bank Guarantee shall be valid up to the expiry of the Defect Liability Period and shall have a claim period of 3 (three) months from the date of its expiry.

3.2. If requested by the Client, the Contractor undertakes to extend the validity period of the Performance Bank Guarantee or to issue a further Performance Bank Guarantee in the event that the duration of the Contract is for any reason extended beyond such validity date.

3.3. Notwithstanding anything contained to the contrary in the Contract and/or the Bidding Documents, no payments due to the Contractor from the Client under the Contract shall be payable by the Client to the Contractor until the Performance Bank Guarantee has been delivered to and approved by the Client.

3.4. Without prejudice to the rights to the Client under Applicable Law or otherwise, the Contractor acknowledges and agrees that the Client shall have the right to invoke the Performance Bank Guarantee in the event of:

(a) failure of the Contractor to commence and/or complete the Works to the Client's satisfaction within the time period specified in Clause 7;

(b) any breach of the Contract by the Contractor which breach has not been remedied within 30 (thirty) days of notice from the Client; or

(c) to recover any amount that may become due to the Client from the Contractor.

4. **ELECTRICAL AND ELV Works OF THE NEW ADMIN. & ENGG. BLOCK**

4.1. **Setting Out**

(a) The Contractor shall execute all Works in relation to the ELECTRICAL AND ELV works of the New admin. & Engg. Block in accordance with the requirements of the Technical Specifications and to the satisfaction of the Client and the Project Manager. The Contractor shall set-out the Works in accordance with the procedures set out under the Technical Specifications or provided to it by the Client and/or the Project Manager.

(b) The Contractor shall be responsible for undertaking the Works. If, at any time during the ELECTRICAL AND ELV works of the New admin. & Engg. Block, the Contractor becomes aware of any error, the Contractor shall promptly and in any event, no later than 15 (fifteen) days from the detection of such error, notify the Client and thereafter at its own expense, immediately rectify such error, to the reasonable satisfaction of the Client.

(c) The Contractor shall be responsible for the true and proper setting out of the Works in relation to instructions given by the Client/Project Manager/Architect in writing and for the correctness, subject as above mentioned, of ELECTRICAL AND ELV Works and for the provision of all necessary instruments, appliances and labour in connection therewith. If, at all any error shall appear or arise in the Works of any part of the Works, the Contractor, on being required to do so by the Client and/or the Project Manager, shall, at its own cost, rectify such error to the satisfaction of the Client. The checking of any defect in the Works by the Client/Project Manager/Architect shall not in any way relieve the Contractor of its responsibility for the correctness thereof and the Contractor shall carefully protect and preserve all bench marks, sight-rails, pegs and other things used in the Works.

4.2. **Contractor's Supervision**

The Contractor shall, during the ELECTRICAL AND ELV Works of the New admin. & Engg. Block, provide all necessary superintendence and ensure that the appropriate Contractor's Personnel are at all times present at the Site, to provide such full-time superintendence. In relation to the supervision during the Works to be undertaken at the Site, the Contractor shall deploy only such Contractor's Personnel at the Site, who are skilled and experienced in their respective fields and supervisory staff who are competent to adequately supervise the said Works.

4.3. **Inspection**

(a) The Contractor shall provide to the Client and the Project Manager, access to any place on the Site where the New admin. & Engg. Block is being developed, in order to inspect the progress of the Works.

(b) The Contractor shall give the Client and the Project Manager's personnel full opportunity to carry out the activities set forth in this Clause 4.3, including providing access, facilities, permissions and safety equipment. Provided that, no such activity shall relieve the Contractor from any obligation or responsibility under the Contract.

5. CONTRACTOR'S OBLIGATIONS

5.1. **Contractor's general responsibilities**

(a) The Contractor shall execute the Works in accordance with the terms of the Contract, Applicable Law and Prudent Industry Practices. The Contractor shall be liable and responsible for provision of labour and materials for undertaking the Works required to for the New admin. & Engg. Block in accordance with the Contract.

(b) The Contractor shall take full responsibility for the adequacy, stability and safety of all the Works on the Site.

(c) The Contractor shall keep the Client informed of the progress of the Works at regular intervals as required by the Client.

(d) The Contractor shall keep the Client informed of any and all requirements and claims under any Applicable Laws and keep informed the Client of compliance thereunder.

(e) The Contractor shall be responsible for obtaining all information required for the performance of its obligations under the Contract.

(f) The Contractor has clarified and carefully examined all the documents, information and such other matters as may be necessary or desirable for performing its obligations under the Contract, to its entire satisfaction. The Contractor shall not, except as expressly provided in the Contract, be entitled to any extension of time or to any adjustment of the Contract Price, on grounds of misinterpretation or misunderstanding of any such matter.

(g) The Client shall not be responsible for any error, inaccuracy or omission of any kind in the Bidding Documents and shall not be deemed to have given any representation of accuracy or completeness of any data or information. Any data or information received by the Contractor, from the Client and/or Project Manager or otherwise, shall not relieve the Contractor from its responsibility for undertaking the Works.

(h) The Contractor has, prior to the execution of the Contract obtained all information and taken into consideration the restrictions imposed to coordinate its activities for the Works with the other contractors required for completion of the Project.

(i) The Contractor represents that it is fully informed of all general and local conditions near the Site and other factors that may have an effect on the compliance of its obligations under the Contract. The Contractor cannot claim an extension of time or an increase in the Contract Price as a result of such local conditions or factors.

(j) The Contractor represents and confirms that it has entered into the Contract Agreement on the basis of its proper examination of the Site by its checking or carrying out its own investigations as may be required, including the suitability and availability of the access routes thereto and that it is aware about the conditions of the Site and its surroundings and has satisfied itself as to all technical, commercial, social and general conditions of and all circumstances affecting the Site. The Contractor represents and confirms that by signing the Contract, the Contractor accepts total responsibility for having foreseen all difficulties and costs of successfully completing the Works and that the effect of all contingencies have been considered by the Contractor prior to entering into the Contract Agreement and that the Contractor shall not be entitled to extension of time or an increase in the Contract Price on account of the same.

(k) The Contractor acknowledges that any failure to verify and interpret any data and information in relation to the Site and/or the New admin. & Engg. Block shall not relieve it of its responsibility for properly estimating the difficulty or cost of successfully performing its obligations under the Contract.

5.2. **Water and power for carrying out the Works**

Water and electricity for carrying out the Works shall be arranged by the Contractor at its own risk and costs. The Contractor shall, so far as is reasonably practicable, having regard to local conditions provide on the Site at its own cost, water for the use of the Contractor's Personnel, staff, and work people at the Site.

5.3. **Temporary works and arrangements**

The Contractor shall furnish to the Client full particulars, Drawings, etc., of all temporary works necessary for the completion of the Works and shall allow sufficient time for the Client to consider the same. The Client reserves the right to alter/ comment on the Contractor's proposals if it considers that modifications should be made. The Contractor shall be solely responsible for the stability and safety of all temporary Works and unfinished Works.

5.4. **Demolition and clearance**

The Contractor shall be responsible for undertaking the Works, clearance from the Site of all scrub, debris, rubbish, etc. that shall be carted to an area not objected to by any Governmental Authorities. However, no trees shall be removed without the prior permission of the Client and without obtaining prior approvals as may be required under the Applicable Law.

5.5. **Storage, cleaning and de-watering**

(a) The Contractor shall at all the times during performance of the Works keep the Site clean and free from all debris and unwanted Materials as per instructions of the Client/ PM.

(b) Storage of Materials shall be in organized manner and in proper compartments. Storage on suspended floors shall not be permitted unless specifically approved in writing by the Client for specific Materials in specific locations. The Client shall be furnished with load details, if requested, before seeking approval for storage.

(c) Regular cleaning operations shall be undertaken to remove all dust, debris, waste materials, etc. and disposal of the same. A cleaning schedule shall be maintained by the Contractor to the satisfaction of the Client.

(d) The Contractor shall make its own arrangements for storage of Materials, which cannot be accommodated at the Site. The Contractor shall be fully responsible for safe custody of the same. Materials shall be considered as "Delivered at Site", only after the physical presence of Materials at the Site. Stores elsewhere shall not be eligible for being considered as "Delivered at Site".

(e) The Contractor understands that the Site is free from pollutants at the time of access to the Site and commencement of Works. The Contractor shall comply with all applicable environmental laws and regulations and shall ensure that the Works are undertaken in compliance with such Applicable Laws.

(f) The Contractor shall be responsible to keep entire Site free from water due to water coming from any source at any level and shall protect all Materials and Works from being damaged by the water from any source. The Contractor shall make proper arrangements for drainage prior to use of water.

5.6. **Vehicular movements and temporary roads**

(a) The Contractor shall not make temporary roads until approval from the Client is received in writing. Site access and circulation roads are to be on the lines agreed to with the Client.

(b) No vehicle other than those specifically allowed by the Client shall be permitted on the Site.

(c) All the vehicles and Materials coming in to the Site should be checked for explosive materials by using metal detectors and under vehicle scanner.

5.7. **Care and use of existing facilities and services**

(a) During the completion of the Works, the Contractor shall take all precautions and exercise full care, at its cost, to ensure that no damage is caused to the existing water supply, sewerage, power or telecommunication lines or any other services or works. The Contractor shall provide and erect before undertaking the Works, substantial barricades, guardrails, and warning signs. The Contractor shall furnish, place and maintain adequate warning lights, signals, etc., as required by Client. However, such substantial barricades, guardrails, and warning signs shall not relieve the Contractor of its responsibilities, obligations and liabilities for safety and timely completion of Works.

(b) If any service lines have to be shifted / diverted, it shall be done so with the explicit permission of the Client.

5.8. **Co-ordination of builders work required for services**

(a) The Contractor shall co-ordinate the requirements for holes, fixings and builders work, for internal and external services installations in accordance with the requirements of the relevant Drawings, which shall be made available to the Contractor by the Client.

(b) All holes, chases, etc., shall be left in the building work as it proceeds and cut-out subsequently, except in so far as may be necessary due to subsequent authorized instructions. The Contractor shall therefore obtain necessary builders work details in such order and in such time so as to enable them to be checked and approved by the Client and/or the Project Manager not less than 2 (two) weeks before the actual works are planned to take place.

5.9. **Contract**

The Contractor shall within [__] days of the issuance of the Letter of Award enter into and execute the Contract Agreement with the Client, in the form annexed as **Schedule II** with such modification as may be necessary. The cost of stamp duties and similar charges (if any) incurred with respect to entry into the Contract Agreement shall be borne by the Contractor.

5.10. **Inspection of Site**

(a) The Contractor shall be deemed to have inspected and examined the Site and its surroundings and information available in connection therewith and to have satisfied itself as to the form and nature of the Works. The Contractor shall not rely only on the information provided by the Client.

(b) The Contractor shall not remove/shift any existing services passing through the Site above or below ground deemed to be a hindrance towards the completion of the Works without the prior written consent of the Client.

5.11. **Works to be to the satisfaction of the Client**

Unless it is legally or physically impossible, the Contractor shall undertake the Works in strict accordance with the Contract to the satisfaction of the Client and shall comply with and adhere strictly to the instructions and directions from the Client and/or the Project Manager.

5.12. **Drawings and Documents**

(a) **General**

The Drawings and Documents prepared for the Project shall be treated as confidential documents and must not be copied or loaned or shared with any other party without the express permission of the Client. In the event of termination of the Contract, the Contractor shall forthwith return to the Client, all Drawings and Documents prepared for the Project and all copies thereof in the possession or under the control of the Contractor. The Contractor agrees that the provisions of the Contract pertaining to confidentiality shall survive termination/completion of the Works under the Contract.

(b) **Drawings**

(i) The Drawings furnished by the Architect, if any, as part of the Bidding Documents, are for bidding purposes only and are intended as a guide to the Contractor and give general layout of buildings and structures and general positions of utilities, services and equipment only and in measuring from these Drawings and preparing Bid the Contractor must make due and proper allowance for all necessary diversions from the straight line, rises or falls as may be required for the proper execution of the Works.

(ii) The set of Drawings which are part of the Bidding Documents is only representative of the type and general nature of Works and not the quantum of Works involved. Additional Drawings shall be issued at the relevant stage for actual execution of Works.

(iii) Detail Drawings in all cases shall be worked in preference to those of a more general nature and figured dimensions where indicated shall be followed in preference to scaled dimensions.

(c) **Good for Construction Drawings**

(i) The Architect/Client/or the Project Manager shall issue free of charge [3 (three) sets] of ELECTRICAL AND ELV Drawings, approved for undertaking the Works, to the Contractor. Additional copies as and when required shall be supplied by the Architect or Project Manager and costs shall be reimbursed by the Contractor.

(ii) The Client and/or Project Manager may from time to time during the course of the Contract issue the Contractor with revised Drawings and the Contractor shall ensure that all superseded Drawings are removed from Site and stored in a lockable cabinet as directed by the Client and/or Project Manager and replaced by revised Drawings.

(iii) The Contractor shall ensure that a complete up to date register of Drawings is maintained at Site. All Drawings shall be properly filed and indexed for ready reference.

(iv) The Contractor shall ensure that only the valid up to date Drawings is used for fabrication, setting-out, ELECTRICAL AND ELV etc.

5.13. **Discrepancies**

The Contractor shall bring to the notice of the Client any discrepancies within or between Drawings and/or the other Documents prior to commencement of Works and shall not proceed with Works until the Client/Architect/PM gives clarifications and instructions to proceed.

5.14. **As-built drawings**

The Contractor shall commence preparation of the 'as-built drawings' from the onset of the Contract, in order that all minor amendments and discrepancies are incorporated. To ensure that this requirement is complied with, the Client shall check the Drawings on its request as the Works proceed. [4 (four)] sets of as-built drawings and one soft copy on a CD shall be submitted by the Contractor to the Client within 2 (two) weeks from date of issue of the Final Acceptance Certificate.

5.15. **Programme**

(a) The Contractor shall include in its Bid a preliminary contract schedule. Upon issuance of the Letter of Award and before commencement of the Works, the Contractor shall prepare a detailed and comprehensive contract schedule for review and approval by Client/PM.

(b) The schedule shall show the date on which each part of the Works is to begin and date when such part of the Works is scheduled to be finished along with the relevant milestones under ("**Contract Schedule**"). The Contractor shall ensure that it complies with the Contract Schedule and shall co-ordinate performance of the Works with the Client, Project Manager and the Architect in order to maintain the Contract Schedule.

(c) The Contractor shall also submit weekly/monthly progress reports indicating progress of Works giving scheduled and actual percentage completion, causes for delays if any etc. as well as other reasonable reports and photographs as the Client and/or Project Manager may require from time to time.

(d) The submission to and approval by the Client and/or Project Manager of such schedules or the furnishing of such particulars shall not relieve the Contractor of any of its duties or responsibilities under the Contract.

(e) The Contractor acknowledges and confirms that the development of the New admin. & Engg. Block is a time bound project. The Contractor shall strictly adhere to the milestones as per the Contract Schedule. Any delay in delivering the Project, completing the Works and meeting the milestones will result in substantial losses to the Client.

(f) Subject to Clause 10 (Liquidated Damages) for any delays by the Contractor in achieving the any milestone as per the Contract Schedule, the Client will withhold an amount from the Invoice maximum up to 5% (Five

percent) of the Contract Price until the Contractor meets the subsequent milestone as per the Contract Schedule. On successfully achieving the subsequent milestone, the withheld amount will be paid to the Contractor in the next Invoice. If the Contractor fails to achieve the subsequent milestone, an additional 5% (five per cent) of Contract Price shall be withheld. The entire withheld amount shall be accounted in the Contract Price.

(g) The Contractor will submit schedule of Material delivery and shall obtain approval from the Client/PM before delivering any Material to the Site.

(h) Provision of time will be made by the Contractor for other agencies and contractors to carry out their part of the Works and such lapse of time will be considered by the Contractor in the Contract Schedule. No compensation will be paid to the Contractor for idle labour and Materials due to work of other contractors.

5.16. **Contractor's Representative and Works Manager**

Contractor's Representative

(a) The Contractor has appointed [__], s/o [__] and r/o [__], as the Contractor's representative for the purpose of the Contract ("**Contractor's Representative**"). The Contractor shall within [7 (seven) days] from the date of issuance of Letter of Award, notify the Client, of the duties and authorities of the Contractor's Representative.

(b) The Contractor's Representative shall represent and act for the Contractor, at all times during the term of the Contract and shall provide to the Client all the Contractor's notices, instructions, information and all other communications under the Contract.

(c) All notices, instructions, information and all other communications provided by the Client to the Contractor under the Contract, shall be provided to the Contractor's Representative or, in its absence, its authorized deputy, except as otherwise provided.

(d) The Contractor shall not revoke the appointment of the Contractor's Representative without the Client's prior written consent, which shall not be unreasonably withheld. If the Contractor proposes to appoint another person as its representative, then it shall provide a [14 (fourteen) days] notice to the Client requesting it to approve such appointment. In this regard, the Contractor shall submit the curriculum vitae of such representative along with its request. The Contractor shall ensure that the person proposed to act as its representative shall be fluent in the local language of India and the English language. If the Client does not object to the appointment of such representative within [14 (fourteen) days] of receipt of the request provided by the Client, the representative shall be deemed to have been approved by the Client as the Contractor's Representative. If the Client objects to the appointment of the representative within [14 (fourteen) days] of receipt of the request provided by the Contractor, giving the reason thereof, then the Contractor shall propose a replacement within 14 (fourteen) days of such objection. The provisions of this Clause 5.23(d) shall apply *mutatis mutandis* to such replacement. If the Client consents thereto, the Contractor shall appoint any other person as the Contractor's Representative, pursuant to the procedure set out in this Clause 5.23.(d).

(e) The Contractor's Representative may, subject to the approval of the Client, which shall not be unreasonably withheld, at any time, delegate to any person any of the powers, functions and authorities vested in it. Any such delegation may be revoked by the Contractor's Representative at any time, but shall be subject to a prior notice to the Client, signed by the Contractor's Representative. Such notice shall specify the powers, functions and authorities thereby revoked. No such delegation or revocation shall take effect unless a copy of written authorization of such delegation or revocation, as the case may be, has been delivered to the Client.

(f) Any act or exercise by any person of powers, functions and authorities so delegated to such person in accordance with Clause 5.23(e) shall be deemed to be an act or exercise by the Contractor's Representative and the Contractor shall be fully responsible for the same.

(g) The Contractor's Representative, persons to whom powers, functions and authorities have been delegated pursuant to Clause 5.23(e), and the Works manager shall be fluent in the English language and either proficient in the national language of India.

(h) **Works Manager**

The Contractor's Representative shall, [7 (seven) days] before Site mobilization, appoint a suitable person to manage the execution of the Works, who shall be present at the Site, during normal working hours prescribed under Applicable Law ("**Works Manager**"). Provided that, if at any point of time the Works Manager is not present at the Site, a suitable person shall be appointed by the Contractor's Representative to act as its deputy, who shall then be present at the Site in the absence of the Works Manager.

(i) **Removal of Contractor's Personnel from Site**

The Contractor's Personnel shall be reasonably qualified, skilled and experienced in their respective trades or occupations. The Client may, during the term of the Contract, by notice to the Contractor, object to the retention of any of the Contractor's Personnel and require the Contractor to remove (or cause to be removed) any person comprising the Contractor's Personnel, who,

(i) has behaved inappropriately;

(ii) carries out duties incompetently or negligently;

(iii) persists in any misconduct or lack of care;

(iv) fails to conform with any of the provisions of the Contract;

(v) has committed a serious breach of the Site regulations provided by the Client;

(vi) persists in any conduct which is prejudicial to the safety, health or the protection of the environment; or

(vii) is otherwise not suitable.

The Client shall provide evidence of the same to the Contractor, whereupon the Contractor shall remove such person from the Site and promptly appoint (or cause to be appointed) a suitable replacement in accordance with Clause 5.23(d).

5.17. **Contractor's Employees**

The Contractor shall provide and employ on the Site in connection with the execution of the Works:

(a) only such technical assistants as are skilled and experienced in their respective fields and such sub-agents, foremen and leading hands as are competent to give proper supervision to the Works they are required to supervise;

(b) such skilled, semi-skilled and unskilled labour as is necessary for the proper and timely execution of the Works; and

(c) professionals for safety for undertaking the Works to the satisfaction of the Client.

5.18. **Watching and Lighting**

The Contractor shall in connection with the Works provide and maintain at its own cost all workplace lighting, guards, fencing and watching when and where necessary for the completion of the Works, or for the safety and convenience of the public or others. The care and the safety of the Materials and Works shall be sole responsibility of the Contractor. The constructed barricade on the Site shall be maintained by the Contractor. If such barricade is damaged, the same shall be replaced/rectified immediately without any additional cost to the Client. Adequate fire protection measures should be in place on site to attend to any mishap on the site. Adequate personnel shall be deployed by the Contractor within the Site to control the movement of Material and personnel.

5.19. **Care of Works**

From the commencement of the Works until the date stated in the Final Acceptance Certificate, the Contractor shall take full responsibility for the care of the Works and the loss or damage thereto.

5.20. **Damage to persons and property**

The Contractor shall indemnify the Client against any and all losses and claims in respect of injuries or damage to any persons or material or physical damage to any property whatsoever which may arise out of or in consequence of the execution of the Works and against all claims, proceedings, damages, costs, charges and expenses whatsoever in respect of or in relation thereto.

5.21. **Giving of notices and payment of fees**

The Contractor shall give all notices and pay all taxes, octroi, fees required to be given or paid by any national or state statute, ordinance or other Applicable Law, or any regulation, or bye law or any local or other duly constituted Governmental Authority in relation to the execution and completion of the Works and by the rules and regulations of all public bodies and companies whose property or rights are affected or may be affected in any way by the Works.

5.22. **Compliance with statutes, regulations, etc.**

(a) The Contractor shall conform in all respects with the provisions of Applicable Law which may be applicable to the Works and shall keep the Client indemnified against all penalties and liability of every kind for breach of any such Applicable Law.

(b) The Contractor shall comply with all rules, regulations, and laws including but not limited to labour laws, laws relating to medical and safety of workmen for labour directly or indirectly engaged by the Contractor, its representative, and Sub-Contractor. The Contractor shall register itself wherever and whomsoever required in this connection at local and state level. The Contractor shall indemnify the Client from every expense incurred by the Client under this Clause. The Client is authorized to call at any point of time to its registered office/offices for inspection or copy of such documents as it considers necessary for ensuring statutory compliances to the above by the Contractor.

(c) In particular, the Contractor shall ensure strict compliance with the provisions of the Employee State Insurance Act, 1948, Employee Provident Fund and Miscellaneous Provisions Act, 1952, Factories Act, 1948, Workman's Compensation Act, 1948, Payment of Wages Act, 1946, Minimum Wages Act, 1948, Employees Liability Act, 1938, Industrial Dispute Act, 1947, Maternity Benefit Act, 1961, and Contract Labour (Regulation and Abolition) Act, 1970. Copies of the records and registers maintained under the Applicable Laws shall be provided to the Client at the end of each month. The salaries to all workmen shall be paid in the presence of the Client and/or Project Manager. The Contractor shall procure and maintain the necessary licenses under the Contract Labour (Regulation and Abolition) Act, 1970 after assisting the Client in procuring the registration there under. The Contractor shall also obtain various licenses/ permits/ clearance/ approvals/ consents as

appropriate from the various Governmental Authorities and other statutory authorities in respect of Works to be undertaken by it.

(d) The Contractor shall ensure that the workmen operating the Contractor's Equipment for the execution of Works are licensed under Applicable Law, to the satisfaction of the Client.

(e) The Contractor shall include in its rates all expenses necessary to meet its obligations for making contributions toward employee benefits funds (such as employees state insurance, provident fund, old age pension if any or any other benefits / compensation payable by the Contractor) etc., in compliance with all the statutory regulations and requirements. All records in this connection shall be properly maintained by the Contractor and produced for scrutiny by the concerned authorities and the Client and/or Project Manager whenever called for.

(f) The Contractor acknowledges and agrees that none of the directors of the Contractor are on the RBI's defaulter list/caution list or the CIBIL's wilful defaulter list or is a defaulter or on non-cooperative list of any of the lenders and that no director of the Contractor is disqualified under Section 164 of the Companies Act, 2013. The Contractor further agrees and acknowledges that no person:

(i) who has been named in any list of defaulters circulated by the RBI or CIBIL; or

(ii) whose name appears in any caution list of any nature published by the RBI, CIBIL or any similar Governmental Authority; or

(iii) who has been named in the caution list/defaulters list/ specific approval list; or

(iv) who has been identified as a wilful defaulter/ non-cooperative by any bank or financial institution, as per the parameters determined by RBI, from time to time; or

(v) who is director in any company which has been identified as a wilful defaulter/defaulter / non-cooperative by the RBI, CIBIL or similar Governmental Authority or any bank or financial institution,

shall become a member of the Board or a KMP of the Contractor. If any such person is already a director on the Board or KMP of the Contractor, the Contractor shall intimate the Client and the Project Manager promptly and take expeditious and effective steps to remove such person from its Board and as KMP, and the Client shall have the right to take action as envisaged under the Applicable Law.

(g) The Contractor acknowledges and agrees that no investigation by a Governmental Authority or any regulatory authority is pending against the Contractor, its sister concern, its chief executive officer or any of its directors/ managers/ employees, including but not limited to any charge sheet by an agency of the Governmental Authority, initiation of proceedings in the court of law or a conviction by the court of law for an offence committed by the Contractor or its sister concern or any of its directors/ managers/ employees. In case any investigation is pending against the Contractor or its sister concern or against its chief executive officer or any of its directors/ manager/ employees, the following details shall be furnished to the satisfaction of the Client:

(i) full details of such investigation;

(ii) name of the investigating agency;

(iii) charge/ office for which investigation has been launched;

(iv) name and designation of persons against whom the investigation has been launched;

(v) other relevant information.

(h) The Contractor shall keep the Client informed of any and all claims under any Applicable Laws and keep informed the Client of compliance there under.

5.23. **Interference with traffic and adjoining properties**

All operations necessary for the completion of the Works shall, so far as compliance with the requirements of the Contract permits, be carried on so as not to interfere unnecessarily or improperly with the public convenience, or the access to use and occupation of public or private roads and footpaths, or to or of properties whether in the possession of the Client or of any other person. The Contractor shall save harmless and indemnify the Client in respect of all claims, proceedings, damages, cost, charges and expenses whatsoever arising out of, or in relation to, any such matters in so far as the Contractor is responsible therefore.

5.24. **Extraordinary traffic**

The Contractor shall use every reasonable means to prevent any of the highways or bridges communicating with or on the routes to the Site from being damaged or injured by any traffic of the Contractor or any of its Sub-Contractors and, in particular, shall select routes, choose and use vehicles and restrict and distribute loads so that any such extraordinary traffic as will inevitably arise from the moving of material from and to the Site shall be limited, as far as reasonably, and so that no unnecessary damage or injury may be occasioned to such highways and bridges.

5.25. **Opportunities for other contractors**

The Contractor shall, in accordance afford all reasonable opportunities for carrying out the Works to any other contractors engaged by the Client and their workmen and to the workmen of the Client and of any other duly constituted authorities who may be employed in the execution on or near the Site of any Works not included in the Contract or of any contract which the Client may enter into in connection with or ancillary to the Works.

5.26. **Contractor to keep Site clear**

During the progress of the Works, the Contractor shall keep the Site free from unnecessary obstruction and shall store or dispose of any material and clear away and remove from the Site any wreckage, rubbish or Materials no longer required, on a daily basis. Regular cleaning operations on daily basis shall be undertaken by the Contractor to remove all dust, debris, waste materials etc., and disposal of the same to the nearby waste dumping yard. If Client and/or Project Manager notices the Contractor's inability/unwillingness to do the said job, the Client shall have the right to get the same cleaned by an external agency and debit the same to the Contractor's account.

5.27. **Clearance of Site on completion**

On the completion of the Works, the Contractor shall clear away and remove from the Site all surplus Materials, rubbish and debris and Site office and stores etc. of every kind, and leave the whole of the Site and Works clean and in a workmanlike condition to the satisfaction of the Client.

5.28. **Contractor's Personnel**

(a) The Contractor shall within 7 days from the date of issuance of Letter of Award depute the Contractor’s Personnel, at the Site so as to seek clarification with regard to the Works to be executed. Further, subject to

details as provided in the Technical Specifications, the Contractor shall, in terms of this Clause 5.36, from the date of Letter of Award till Final Completion, engage sufficient and properly qualified Contractor's Personnel who are proficient in English language and skilled and experienced in their respective callings, to enable the Contractor to efficiently perform its obligations under the Contract. The Contractor shall ensure that the Contractor's Personnel include:

(i) professional engineers licensed in accordance with the licensing requirements prescribed under Applicable Law to perform the Works pursuant to the Contract;

(ii) a team of engineers from various disciplines, adequate number of qualified and competent supervisory staff, craftsmen or other personnel, each of whom shall have extensive experience in executing works of a magnitude similar to the Works, shall have knowledge of the Applicable Laws; and

(iii) a team of sufficiently qualified and experienced welders which are required for the execution of the Works.

(b) The Client shall have the right, but not the obligation, to approve any of the Contractor's Personnel. The Contractor shall, upon the request of the Client, provide the Client with the curriculum vitae of, and arrange interviews by the Client of, any or all of the Contractors Personnel. The Contractor shall not remove any of the Contractor's Personnel without the prior written consent of the Client, which shall not be unreasonably withheld.

(c) The Contractor shall not permit any of the Contractor's Personnel to maintain any temporary or permanent living quarters within the structures forming part of the Site. The Contractor shall be responsible for the recruitment, transportation, accommodation, catering and other welfare facilities of the Contractor's Personnel, and for all payments in connection therewith. Further, if specified in the Technical Specifications, the Contractor shall also provide all such facilities for the Client's personnel. The Contractor shall at all times take all reasonable precautions to maintain the health and safety of the Contractor's Personnel. In collaboration with the relevant Governmental Authorities, the Contractor shall ensure that medical staff, first aid facilities, sick bay and ambulance services are available, at all times, at the Site and at the respective accommodation of the Contractor's Personnel, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The Contractor shall indemnify and hold harmless the Client from and against any claim, liability, assessment, damage, loss, penalty or fine stemming from any breach by the Contractor or any person for whom it is responsible, of this Clause 5.36.(c).

(d) The Contractor shall, within [15 (fifteen) days] from the date of issuance of Letter of Award, appoint suitable and qualified persons, who shall be:

(i) responsible to ensure quality of the Works undertaken for construction and development of the New admin. & Engg. Block and shall co-ordinate with the Client and the Project Manager for all matters in relation to the quality of the Works (the "**Quality Engineer**");

(ii) responsible for all matters in relation to the safety and protection against accidents at the Site and shall, at all times during the term of the Contract, ensure that the safety manual provided to the Contractor by the Client and the safety regulations at the Site provided under **Schedule VII** (Safety Regulations) are strictly adhered to (the "**Safety Officer**"). The Contractor shall, no later than [15 (fifteen) days] from the date of issuance of the Letter of Award, submit to the Client, the job safety analysis of the Safety Officer. The Safety Officer shall have the authority to issue instructions and take protective measures to prevent accidents and during the term of the Contract, the Contractor shall provide whatever is required by the Safety Officer to exercise such responsibility and authority. The Safety Officer shall:

(A) ensure that copies of the safety manuals provided by the Client pursuant to **Schedule VII**, are at all times available on the Site, along with Codes and Standards of practice in relation to the same, to be referred to and followed by the Contractor's Personnel;

(B) submit to the Client, as soon as practicable after the occurrence of an accident or dangerous occurrence, the details of such accident or dangerous occurrence, as the case may be; and

(C) maintain all records and make reports concerning health, safety and welfare of persons, and damage to property, as may be reasonably required by the Client.

The Contractor shall indemnify and hold harmless the Client from and against any claim, liability, assessment, damage, loss, penalty or fine stemming from any breach by the Contractor or any person for whom it is responsible, of this Clause 5.36.(d).

(e) The Safety Officer shall be present at the Site, during normal working hours, prescribed under Applicable Law, or a suitable person shall be appointed by the Contractor's Representative to act as its respective deputy, who shall be present at the Site in the absence of the Safety Officer.

(f) The Contractor shall, at its own expense, provide, as and when required, the means of repatriation to all of the Contractor's Personnel and labour and personnel of the Sub-Contractor's to their respective home countries/states. Further, the Contractor shall also provide suitable temporary maintenance of all such persons, from the period commencing from the cessation of their employment with the Contractor, till the scheduled date of their respective departures. If the Contractor fails to comply with its obligations under this Clause 5.36.(f), the Client may provide the same, at the cost of the Contractor.

(g) The Contractor shall ascertain the availability of labour (skilled and unskilled), personnel and Sub-contractors in the vicinity in which the Site is located and shall, to the extent possible, engage such labour (skilled and unskilled), personnel and Sub-contractors, as the Contractor's Personnel.

(h) The Contractor shall ensure that the Contractor's Personnel are entitled to the prescribed number of holidays, as per Applicable Law and unless otherwise provided in the Contract, no Works shall be executed outside normal working hours and on holidays, prescribed under Applicable Law. Provided that, provisions of this Clause 5.36.(h) shall not apply to any Works which are customarily carried out by rotating or double-shifts.

(i) The Contractor shall, and shall ensure that the Contractor's Personnel, in all dealings with the labor and personnel of its Sub-Contractors, pay due regard to all recognized festivals, official holidays, religious or other customs prevailing in the State of Uttar Pradesh, India and all Applicable Laws in this regard. Further, the Contractor shall ensure that the Contractor's Personnel act in a culturally sensitive manner at all times, giving due regard to the local community and cultures when on Site.

(j) The Contractor shall at all times, during the term of the Contract, use its reasonable endeavors to prevent any unlawful, riotous or disorderly conduct or behavior by or amongst the Contractor's Personnel, the other Contractors and/or the labour, personnel and employees of the Sub-Contractors and to preserve peace and protection of persons and property on and near the Site and under no event shall the Client be responsible for the same. The Contractor shall promptly provide the Client, a notice in relation to any actual or anticipated labour dispute which may affect the execution of the Works. The said notice shall indicate the steps being taken by the Contractor to mitigate the effects of any actual or contemplated labour disputes.

(k) The Contractor shall pay rates of wages to the Contractor's Personnel, as per rates prescribed under Applicable Law and observe conditions of labour in accordance with the Applicable Law. The Contractor shall, during the term of the Contract, withhold from wages and salaries of the Contractor's Personnel, sums required to be withheld as per the Applicable Law and pay the same promptly and directly, when due, to the respective Governmental Authority and upon request by the Client, in this regard, provide to the Client evidence of the payment of such withholding taxes as per the Applicable Law. In this regard, the Contractor

shall comply with all accounting and reporting requirements under the Applicable Law and bear the cost of such compliance. In the event the Client becomes liable, under Applicable Law, due to any act or omission of the Contractor under this Clause 5.36.(k), the Client may make such payments and shall recover the same from the Contractor or deduct the amounts so paid from the Contract Price.

5.29. **Sanitation and drainage during the Works at the Site and labour camp**

(a) The Contractor shall provide sanitation and drainage facilities on the Site and labour camp as required and stated under the Contract.

(b) The Contractor shall strictly control the labour so that the Site is not polluted, made dirty or littered with debris, wastes or the likes.

(c) Any person found creating mess or litter or pollution or illegally squatting on the Site shall be removed from the Site immediately at Contractor's cost.

(d) The Contractor shall provide sanitation facilities at convenient locations on Site and labour camp to preserve the cleanliness of the Site. The effluent shall be directed as follows:

(i) waste water: Collection and pumping out and disposal off the Site in approved manner: and

(ii) septic tank provision - sludge to be collected and disposed of at intervals as directed.

(e) The Contractor shall clear and deodorize the ground after their removal and meet all statutory requirements.

5.30. **Worker's camp**

The Contractor shall make its own arrangements at its cost to provide accommodation for its staff and labour outside and away from the Site. No extra cost is payable to the Contractor on this account. The Contractor shall provide the following welfare arrangements in the labour camp area within [__] km of the Site and as further detailed in the Technical Specification:

(a) the Site activities include setting up a colony for the workers. Well laid out labour camp with all amenities (light, drinking water, cooking area with cooking facilities, wash areas, wash rooms for both male & female workers, crèche & learning area) shall be arranged at a suitable place;

(b) labour camp shall be located away from Site premises;

(c) access to the labour camp shall be provided;

(d) maintain proper hygiene all times;

(e) a warden to be appointed for labor camp and as single point responsibility;

(f) drainage of sludge water /rain water shall be provided;

(g) drinking water, bathing facilities and field washrooms should be provided at suitable places;

(h) suitable arrangements for labour to purchase weekly provisions shall be made;

(i) weekly off to the labour shall be ensured for rest;

(j) food and transport (to & fro from Site to labour camp) facilities should be provided;

(k) sufficient number of fire extinguishers should be provided;

(l) an emergency assembly point should be provided;

(m) security should be provided;

(n) crèches/learning/play centre should be provided;

(o) provision of pumps to drain out flood water from site/ labour camp;

(p) electricity (with power back up) should be provided;

(q) first aid facility, ambulance & along with doctor shall be provided;

(r) labour camp monsoon precautions;

(s) prevent contamination of drinking water;

(t) collection and disposal of food waste & garbage regularly;

(u) secure all loose [G. I. Sheets] to prevent from flying off in case of stormy and gusty wind;

(v) standard earthing to partition with effective functioning of [ELCB's]

(w) all temporary electric connections must be rooted through 30 mA cut off rating [ELCB];

(x) all wires / cables are not laid on sharp edges or through a hole within the G. I. Sheet as to prevent damage to insulation. If, possible route through conduit pipes and support wire / cables by suitable hook;

(y) no wooden material to be used for labor camp construction; and

(z) all wire / cable joints are water and shock proof to prevent from shock.

5.31. **Alcoholic liquor or drugs**

Use of any alcoholic liquor, drugs, chewing of pan, gutka or smoking etc., is fully prohibited on the site. The Contractor shall not import, sell, give, barter or dispose any alcoholic liquor or drugs or cigarettes / beedies /etc. by its Sub-Contractors, agents or employees.

5.32. **Arms and ammunition**

The Contractor shall not give, barter or otherwise dispose of to any person or persons, any arms or ammunition of any kind or permit or suffer the same as aforesaid.

5.33. **Festivals and religious customs**

The Contractor shall in all dealings with labour in its employment have due regard to all recognized festivals, days of rest and religious or other customs. The Contractor shall intimate [7 (seven) days] in advance to the Client of any festival for any resource/ labour shortfall presumed with proper mitigation plan in place.

5.34. **Epidemics**

In the event of any outbreak of illness of an epidemic nature at Site and/or labour camp for the workmen engaged for the Works (directly or indirectly) the Contractor shall comply with and carry out such regulations, orders and requirements as may be made by the Governmental Authority, or the local medical or sanitary authorities for the purpose of dealing with and overcoming the same under Applicable Law.

5.35. **Disorderly conduct, etc.**

The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by any of its Sub-Contractors, employees or agents and for the preservation of peace and protection of persons and property in the neighborhood of the Works against the same.

5.36. **Safety Standards and Requirements**

The Contractor shall follow the rules and guidelines laid down in safety requirements as listed in **Schedule VII**. The cost so incurred by the Contractor in providing for safety standards and requirements as above shall be deemed to be included in the Contract Price and no extra amounts shall be payable to the Contractor on this account.

5.37. **Reports by the Contractor**

(a) The Contractor shall file daily category-wise labour returns. The report shall indicate scheduled requirement against actual strength.

(b) The Contractor shall prepare weekly reports of planned and actual progress of Works and subsequent week's scheduled Works. These will also include Material procurement status. These reports shall be submitted to Client and shall be reviewed in weekly co-ordination meeting.

(c) The Contractor shall submit monthly report along with monthly bills. The reports shall include photographs taken from pre-determined locations which illustrate progress of the Works.

(d) Further progress charts and schedules shall be prepared by the Contractor as directed by the Client and/or Project Manager.

(e) The submission to and approval by the Client of such programmes/ reports or the furnishing of such particulars shall not relieve the Contractor of any of its responsibilities and liabilities under the Contract.

5.38. **Night or Sunday work**

Subject to Applicable Law and the terms of the Contract, the Contractor shall not perform any activity at the Site at night on any day or on Sundays except with the prior written consent of the Client and the Project Manager.

5.39. **Taxation**

The Contractor shall be responsible to pay personal and company taxes of its staff and its organization wherever applicable. The Contractor shall be responsible for deduction of tax at source while releasing payment to their staff, Sub-Contractors, workers, etc.

5.40. **NGT Guidelines**

The Contractor shall comply with all the provisions of National Green Tribunal (NGT) laws, rules, orders, notifications, and amendments made from time to time at his own cost, nothing extra shall be paid on this account. Any penalty, imposed by the NGT for construction of aforesaid building due to non-compliances shall be borne by the contractor itself. The item rates of BOQ are inclusive of all such cost to manage the activities as suggested by NGT If site shutdown/

work held due to NGT/ Govt. orders then, the Contractor shall only be entitled to Extension of time and no claim shall be entertained on account of this by the owner on account of idle labour, staffs tools & plants, machineries etc.

6. CLIENT'S OBLIGATIONS

6.1. Rights of Way and Facilities

(a) The Client shall provide and bear all costs and charges for special and/or temporary rights of way, which the Contractor may require, including those for access to the Site.

(b) The Client shall provide clear, unhindered, freely accessible Site to the Contractor for execution of the Works.

(c) The Client shall, in respect of the Works, provide adequate space for the storing of Contractor's Equipment (including equipment which is being procured by the Client under a separate contract) until the Completion Date.

6.2. Access to the Site

The Contractor and Contractor's Personnel shall be permitted access to the Site for the purposes of carrying out the Works. The Client, may at any time, remove or cause to be removed any of the Contractor's Materials, articles, things, personnel or labour without notice to the Contractor. This shall not, in any manner, prejudice or affect the Contractor's liabilities and obligations in respect of the Works and in particular the liability arising due to any damage to any person or Material at the Site.

7. TIME FOR COMMENCEMENT AND COMPLETION

7.1. Commencement of works

The Contractor shall commence the Works at the Site from the date of issuance of the Letter of Award ("**Commencement Date**"). The Contractor acknowledges that time is the essence of the Contract for commencement and completion of Works by the Completion Date.

7.2. Time for completion and extension of time

(a) The Contractor agrees and undertakes to complete the Works in accordance with the terms of the Contract and the Bidding Documents within 6 months from the Commencement Date ("**Completion Date**") subject to Clause 7.2.(b) below.

(b) In the event that the Contractor is delayed in performing the Works under the Contract solely as a result of:

(i) an event of Force Majeure; or

(ii) on account of Change in Law; or

(iii) breach by the Client of its material obligations herein,

then the Contractor shall issue a written notice to the Client and the Project Manager promptly upon occurrence of any of the events specified above indicating the reasons for the delay, the additional time required by the Contractor to complete the Works and the corrective action already undertaken or to be undertaken. The Client upon receipt of notice from the Contractor shall determine the time period for extension and whether such extension shall take place retrospectively or prospectively. Provided that, the Contractor shall be solely responsible for all costs and risks on account of such extension of time.

(c) The Parties agree that any extension of time shall only be considered when work on the critical path of the program for the Works is affected. It shall be the duty of the Contractor at all times to use all reasonable endeavors to prevent any delay being caused by any of the events or circumstances mentioned in this Clause 7.2, to minimize any such delay as may be caused thereby, and to do all that may be reasonably required, to the satisfaction of the Client, to proceed with the Works.

7.3. **Notice of Claim**

(a) Except where otherwise specifically provided in the Contract, the Contractor shall submit to the Client and the Project Manager a notice of a claim for an extension of the Completion Date, together with particulars of the event or circumstance justifying such extension, as soon as reasonably practicable, after the commencement of such event or circumstance. Such notice provided by the Contractor to the Client and Project Manager shall include:

(i) the material circumstances of the event including the cause or causes;

(ii) the nature and extent of any delay;

(iii) the corrective action already undertaken or to be undertaken;

(iv) the period of any extension of time required for each component of the Works, so effected (as applicable); and

(v) a statement that it is a notice pursuant to this Clause 7.3.

(b) The Contractor shall ensure that the particulars provided to the Client and Project Manager under this Clause 7.3 are kept up to date and shall continuously submit such further particulars as may be necessary or which may be requested by the Client, from time to time.

7.4. **Minimize Delay**

The Contractor shall, at all times, use its reasonable endeavor's to minimize any delay in the performance of its obligations under the Contract.

7.5. **Concurrent Delays**

If there are concurrent causes of delay and both delays would entitle the Contractor to an extension of time under this Clause 7.5., then, to the extent of that concurrency, the Contractor shall only be entitled to claim an extension of time for that cause of delay which would entitle it to the longer period of extension.

7.6. **Rate of progress**

If for any reason, which does not entitle the Contractor to an extension of time, the rate of progress of the Works is at any time, in the opinion of the Client and/or the Project Manager, too slow to ensure completion of the Works within the time period specified in Clause 7.2., the Client shall notify the Contractor in writing and the Contractor shall promptly take all steps as are necessary and the Client may approve to expedite progress so as to complete the Works or such section by the prescribed time or extended time. The Contractor shall not be entitled to any additional payment for taking such steps.

8. MATERIALS AND WORKMANSHIP

8.1. **Quality of Materials and workmanship and tests**

All Materials and workmanship shall be as described in the Contract and in accordance with the Client's instructions and shall be subject from time to time to such tests as the Client may direct.

8.2. **Quality Assurance Programme**

The Contractor before the start of Works shall submit for approval a quality assurance programme to the Client indicating measures that it proposes to implement to ensure that the quality of Works shall be in accordance with requirements laid down in the Contract ("**Quality Assurance Programme**"). The Client and/or Project Manager may add such additional quality assurance measures as it considers appropriate for ensuring quality compliance of the Works. The Contractor shall strictly adhere to this programme and any failure attributable to the Contractor shall attract the penal provisions laid down in the Contract.

8.3. **Cost of samples/ Mock-ups / Tests**

(a) All samples/mock-ups shall be supplied by the Contractor at its own cost if the supply thereof is clearly intended by or provided for in the Contract.

(b) The Contractor shall provide samples for the approval of Client and shall provide alternative samples until the approval of the Client has been obtained. Samples approved by the Client shall be kept at Site under custody of the Contractor until completion of the Project.

(c) The cost of conducting any test shall be borne by the Contractor if such test is clearly intended by or provided for in the Contract and in the cases only of a test under load or of a test to ascertain whether the design of any finished or partially finished work is appropriate for the purposes which it was intended to fulfill, is particularized in the Contract in sufficient detail to enable the Contractor to price or allow for the same in its tender.

(d) The Contractor shall provide normal testing facilities at Site at its cost as directed by the Client and/or the Project Manager.

8.4. **Inspection of Works**

The Client and the Project Manager or any person authorized by them shall at all times have access to the Works and to all workshops and places where Works are being prepared or from where Materials, manufactured articles or machinery are being obtained for the Works and the Contractor shall afford every facility for and every assistance in or in obtaining the right to such access.

8.5. **List of approved brand and makes**

A list of approved brands and makes for Materials to be incorporated in the Works should be furnished by the bidder along with its tender. The Contractor shall submit samples of processed raw materials and Materials procured in conformity with Prudent Industry Practices for the approval of the Client and/or the Project Manager. Procurement of the Materials for the Works shall be after the approval of the Client and/or the Project Manager in writing.

8.6. **Basic Prices**

Basic price shall mean the cost of the Material per unit inclusive of all Taxes and duties, cost of transportation, loading, unloading, breakage, incidental charges, etc. All costs and expenses shall be deemed to be included in item rate quoted by the Contractor for that relevant item and shall not be entitled to claim any extra amounts on this basis. Goods and service tax, if applicable, in performance of the Works shall be calculated and shown separately in the Bidding Documents. The Contractor must provide break-up of all the tax components as applicable separately from the basic price.

8.7. **Removal of improper Materials**

The Client shall during the progress of the Works has power to order in writing from time to time:

(a) the removal from the Site, within such time or times as may be specified in the order, of any Materials, which, in the opinion of the Client, are not in accordance with the Contract or otherwise not fit for use in respect of the Works;

(b) the substitution of proper and suitable Materials and;

(c) the proper re-execution of any Works which in respect of Materials or workmanship is not in accordance with the Contract.

8.8. **Default of Contractor in compliance**

In case of default on the part of the Contractor in carrying out such order, the Client shall be entitled to engage and pay other persons to carry out the same and all expenses consequent thereon or incidental thereto shall be recoverable from the Contractor by the Client or may be deducted by the Client from any monies due to or which may become due to the Contractor.

8.9. **Quality Control Tests**

The Contractor shall perform the relevant tests as required under the scope of Works. The cost of all such tests so performed shall be borne by the Contractor and no extra amounts shall be borne by the Client on this account. The details of the quality tests to be carried out shall be as set out in Technical Specifications or notified by the Client and/or Project Manager.

9. PERFORMANCE PARAMETERS

9.1. **Tests**

The tests shall be conducted by the Contractor in the presence of the Client and/or the Project Manager in accordance with the testing procedures set out in **Schedule VIII** to the Contract, so as to ensure the operation of the New admin. & Engg. Block as an integrated whole to establish the Performance Parameters.

9.2. **Performance Tests**

The performance tests shall be conducted by the Contractor in the presence of the Client and/or the Project Manager in accordance with the performance testing procedures to the Contract, so as to ensure the operation of the New admin. & Engg. Block as an integrated whole to establish the Performance Parameters.

9.3. **Attainment of Performance Parameters**

The Contractor guarantees that during the performance tests, the New admin. & Engg. Block and all parts thereof, shall attain the Performance Parameters, subject to and upon the conditions specified herein.

9.4. **Consequences of Performance Parameters Not Being Met**

Subject to Clauses 9.1 and 9.2, if pursuant to conducting the tests and performance tests, the Performance Parameters are not met, either in whole or in part, the Contractor shall, at its cost and expense, make such changes, modifications and/or additions to the New admin. & Engg. Block, or any part thereof, as may be necessary to meet the Performance Parameters to the satisfaction of the Client. The Contractor shall notify the Client upon completion of the necessary changes, modifications and/or additions, carried out in accordance with this Clause 9.4, and shall request the Client to

facilitate the repetition of the performance tests until the Performance Parameters have been met. If the Performance Parameters are not met, either in the whole or in part, even after 2 (two) such re-tests (after carrying out necessary changes, modifications, and/or additions), and the cap for the liquidated damages as provided in Clause 10.2. has been reached, then the Client may, at its sole discretion, exercise any one of the following options:

(a) reject the New admin. & Engg. Block, and recover all the payments already made to the Contractor in terms of the Contract;

(b) terminate the Contract and find a replacement contractor for undertaking the Works at the cost and risk of the Contract; or

(c) accept the deficient Works and proportionately reduce the Contract Price to reflect the diminished value to the Client, and such reduction shall be determined by the Client. The Client shall deduct from the Contract Price, the amounts payable for the defects in New admin. & Engg. Block and the Contractor shall proceed in accordance with all other obligations under the Contract.

9.5. **Liquidated Damages and Termination**

If the total amount of liquidated damages for shortfall in performance exceeds the amount of liquidated damages specified in Clause 10, the Client shall have the right to either:

(a) reject the Works and recover all the payment already made to the Contractor in terms of the Contract; or

(b) terminate the Contract pursuant to Clause 34 of the Contract.

10. LIQUIDATED DAMAGES

10.1. **Liquidated Damages for Shortfall in Performance of the Works**

The Contractor shall pay the liquidated damages as set forth in this Clause 10.1, if the New admin. & Engg. Block, or any part thereof, fails to meet:

10.2. **Liquidated Damages for Delay**

(a) If the Contractor fails to achieve completion of the Works on or before the expiry of the Completion Date, then the Contractor shall pay to the Client [1% (one percent)] of the Contract Price per week subject to maximum of [5% (five per cent)] of the total Contract Price as liquidated damages for every week or part thereof which shall elapse between the Final Completion and the date of issuance of the Final Acceptance Certificate. The Client may, without prejudice to any other method of recovery, deduct the amount of such damages from any monies in its hands, due or which may become due to the Contractor. The payment or deduction of such damages shall not relieve the Contractor from its obligation to complete the Works or from any other of its obligations and liabilities under the Contract.

(b) The Contractor recognizes and acknowledges that the Client would suffer substantial losses and damage if there is a delay in the completion of the Works.

(c) The payment of liquidated damages for delay under this Clause is in addition to, and without prejudice to, any other remedies that may be available to the Client under the Contract or Applicable Law.

(d) Without prejudice to any other rights the Client may have, the Client shall have the right to reject the Works if the quality of the Works does not meet the Technical Specifications set out in **Schedule X** and the Contractor is unable to correct the deficiencies in Works within [5 (five) days] of being asked to by the Client.

10.3. **Genuine Pre-estimate**

The Parties acknowledge that the damages, losses and costs incurred by the Client for delay in achieving completion of the Works by the Completion Date and for shortfall in performance are uncertain and difficult to determine with precision at the date of signing the Contract. The sums for liquidated damages for delay and liquidated damages for shortfall in performance as set out in this Clause 10.3 represent a reasonable, genuine and appropriate pre-estimate of the damages, losses and costs likely to be suffered by the Client if the delay or the shortfall in performance described in this Clause 10 occurs and are calculated as a best efforts attempt to quantify the Client's actual losses, costs and damages associated with such delay and shortfall in performance. The amounts due under this Clause 10.3, as liquidated damages, shall be payable by the Contractor, without any requirement of proof of the actual loss or damage caused by such delay and/or breach. The sums set out in this Clause 10 seek to limit the potential liability of the Contractor and constitute liquidated damages and not a penalty.

10.4. **Contractor's Obligations**

The payment of liquidated damages by the Contractor in terms of Clause 10.3, does not in any way relieve the Contractor from any of its duties, obligations and responsibilities under the Contract and shall be without prejudice to any other rights available to the Client under the Contract.

10.5. **Rights at Law**

If this Clause 10 (or any part hereof) is found for any reason to be void, invalid or otherwise in-operative so as to disentitle the Client from claiming liquidated damages, the Client is entitled to claim, damages in accordance with Applicable Law for the Contractor's delays or shortfall in performance of the Works for the New admin. & Engg. Block.

11. COMPLETION AND ACCEPTANCE OF WORKS

11.1. **Completion** The Works shall achieve completion, when each of the following has been completed to the Client's satisfaction ("**Completion**"):

(i) the New admin. & Engg. Block is functional in accordance with the requirements of the Contract, and the tests have been successfully completed in accordance with Clause 9.1.;

(ii) the Contractor has complied with all provisions of the Contract relating to the Works;

(iii) the Contractor has performed all its obligations and provided to the Client all Documents, that are due on or prior to the Completion Date, in accordance with the terms of the Contract; and

(iv) the Contractor has delivered to Client, the notice of completion: (a) certifying that all the conditions stated in this Clause 11.1 have been fully satisfied; and (b) accompanied by a report of results of the tests and the Works completed with sufficient detail to enable the Client to determine whether Completion has been achieved ("**Notice of Completion**"). Provided, however, that if Client subsequently raises an objection to such Notice of Completion in accordance with Clause 11.1.(c), such notice will not be deemed to be delivered until any such objection is satisfied.

(a) Upon the Client and Project Manager being satisfied of completion with the Contractor set out in Clause 11.1.(a) above, they shall issue the completion certificate in a form and manner set out in **Schedule XI** ("**Completion Certificate**").

(b) Within 30 (thirty) days of receipt of the Notice of Completion, the Client shall notify the Contractor, of deficiencies and defects, if any, in relation to satisfying the provisions of Clause 11.1.(a) ("**Defects Notice**"). The Contractor shall, promptly upon receipt of the Defects Notice, perform at the Contractor's sole cost and expense, corrective measures to remove such deficiencies and shall deliver to the Client, a new Notice of Completion when completion of the applicable Works has been completed.

(c) Within 30 (thirty) days of receipt of the subsequent Notice of Completion, the Client shall notify the Contractor of additional or remaining deficiencies, if any, that must be corrected by Contractor as a condition to the Completion. Any Disputes regarding the existence or correction of any such alleged deficiencies shall be resolved pursuant to Clause 35 (Dispute Resolution).

(d) For the avoidance of any doubt, it is clarified that the issuance of the Completion Certificate by the Client shall in no way relieve the Contractor of its other obligations under the terms and conditions of the Contract or give rise to any liabilities for the Client.

11.2. **Provisional Acceptance**

(a) The New admin. & Engg. Block shall achieve provisional acceptance, when each of the following has been completed to Client's satisfaction ("**Provisional Acceptance**"):

(i) the Contractor has achieved Completion (Clause 11.1);

(ii) the Contractor has performed all its obligations under the Contract required to be performed;

(iii) the Contractor has successfully completed the tests required to ensure that the Works are reliable;

(iv) the Contractor has obtained the Occupancy Certificate for the New admin. & Engg. Block;

(v) the Contractor has removed from the Site, all scaffolding, rubbish, etc., and has cleaned the Site off all debris;

(vi) Client has received copies of all permits obtained by the Contractor required for the Works;

(vii) the Contractor has submitted all Documents (including the as-built plans pursuant to Clause 5.19 and Clause 14, and all other items and deliverables required to be submitted by the Contractor under the Contract;

(viii) the New admin. & Engg. Block is capable of being operated in accordance with Prudent Industry Practices;

(ix) the New admin. & Engg. Block is capable of being operated in accordance with Applicable Laws;

(x) the Client has received copies of all permits obtained by the Contractor pursuant to Clause 5.29.(c);

(xi) all Works have been completed to the satisfaction of the Client; and

(xii) no default pursuant to Clause 11.1.(c) exists.

The Contractor shall deliver to the Client, a notice of provisional acceptance, certifying that all the conditions set forth in this Clause 11.2.(a) have been fully satisfied, accompanied by a report of the Works completed with sufficient detail to enable the Client to determine whether Provisional Acceptance Certificate should be issued ("**Notice of Provisional Acceptance**").

(b) Upon the Client and Project Manager being satisfied of completion with the Contractor set out in Clause 11.2.(a) above, they shall issue the provisional acceptance certificate in a form and manner set out in **Schedule XII** ("**Provisional Acceptance Certificate**").

(c) Within [30 (thirty) days] of receipt of the Notice of Provisional Acceptance, the Client and/or the Project Manager shall notify the Contractor, of deficiencies, if any, in relation to satisfying the provisions of Clause

11.2.(a) ("**Provisional Defects Notice**"). The Contractor shall promptly upon receipt of the Provisional Defects Notice, perform at Contractor's sole cost and expense, corrective measures to remove such deficiency and shall deliver to Client a new Notice of Provisional Acceptance when completion of the applicable Works has been completed. Within [30 (thirty) days] of receipt of the subsequent Notice of Provisional Acceptance, Client and/or Project Manager shall notify Contractor of additional or remaining deficiencies, if any, that must be corrected by Contractor as a condition to the issuance of the Provisional Acceptance Certificate. Any Disputes regarding the existence or correction of any such alleged deficiencies shall be resolved pursuant to Clause 35 (Dispute Resolution).

(d) In the event the items stated under Clause 11.2(a)(v) have not been removed within [30 (thirty) days] of the issuance of the Provisional Acceptance Certificate, the Client may sell or otherwise dispose of the same. The Client shall be entitled to be paid the costs incurred in connection with, or attributable to, such sale or disposal and restoring the Site. Any balance of monies from the sale shall be paid to the Contractor.

(e) The issuance of the Provisional Acceptance Certificate by the Client and/or Project Manager shall in no way relieve the Contractor of its other obligations under the terms and conditions of the Contract or give rise to any liabilities for the Client.

11.3. **Final Acceptance Certificate and Final Completion**

(a) The New admin. & Engg. Block shall achieve final completion, when each of the following has been completed to Client's satisfaction and the Contractor has performed all other obligations under the Contract, which are required to be performed prior to the issuance of the Final Acceptance Certificate ("**Final Completion**"):

(i) the Contractor has achieved Provisional Acceptance;

(ii) the Contractor has executed Works to the sole satisfaction of the Client;

(iii) the Contractor has paid all liquidated damages, indemnity sums and other payments due from the Contractor under the Contract;

(iv) the Contractor has assigned to the Client or provided Client with all warranties or guarantees that Contractor has received from Sub-Contractors to the extent Contractor is obligated to do so pursuant to the Contract;

(v) all Contractor's Materials and other supplies, equipment, surplus, waste, huts, wreckage, debris, rubbish, and temporary facilities to which Client does not, and is not entitled to hold title, have been removed from the Site, and the Site have been restored in accordance with the terms of the Contract provided that, all activities in relation to clearing and disposal shall be conducted in accordance with all Applicable Laws;

(vi) all the Contractor's Personnel and the personnel of the Sub-Contractors and their personnel, have been removed from the Site;

(vii) all Sub-Contractors have been paid their dues by the Contractor and Contractor has delivered the final release and waiver of Liens and claims pursuant to the Contract and has delivered such other documents and certificates as Client has reasonably requested to ensure compliance with all Applicable Laws;

(viii) all activities required as per Applicable Law on account of the completion of the Works have been completed by the Contractor;

(ix) the Contractor has delivered to Client a notice of final completion: (a) certifying that all the conditions set forth in this Clause 11.3.(a) have been fully satisfied; and (b) accompanied by a report of the Works completed with sufficient detail to enable the Client to determine whether Final Completion has been achieved ("**Notice of Final Completion**"). Provided, however, that if the Client subsequently raises an objection to such notice in accordance with Clause 11.3(c), such Notice of Final Completion will not be deemed to be delivered until any such objection is satisfied.

(b) Upon the Client and Project Manager being satisfied of completion with the Contractor set out in Clause 11.3.(a) above, they shall issue the final acceptance certificate in a form and manner set out in **Schedule XIII** ("**Final Acceptance Certificate**").

(c) Within [30 (thirty) days] after receipt of the Notice of Final Completion, the Client and/or the Project Manager shall notify the Contractor, of deficiencies, if any, in relation to satisfying the provisions of Clause 11.3.(a) ("**Acceptance Defects Notice**"). The Contractor shall promptly upon receipt of the Acceptance Defects Notice perform at Contractor's sole cost and expense, corrective measures to remove such deficiency and shall deliver to Client, a new Notice of Final Completion when completion of the applicable Works has been completed. Within [30 (thirty) days] of receipt of the subsequent Notice of Final Completion, Client and/or the Project Manager shall notify Contractor of additional or remaining deficiencies, if any, that must be corrected by Contractor as a condition to the Final Completion. Any Disputes regarding the existence or correction of any such alleged deficiencies shall be resolved pursuant to Clause 35 (Dispute Resolution).

(d) Without prejudice to Clause 11.3.(a), additional conditions may be agreed to between the Client and the Contractor, as conditions for issuance of the Final Acceptance Certificate.

(e) For the avoidance of any doubt, it is clarified that the issuance of the Final Acceptance Certificate by the Client shall in no way relieve the Contractor of its other obligations under the terms and conditions of the Contract or give rise to any liabilities for the Client.

11.4. **Take Over**

(a) Upon the issuance of the Final Acceptance Certificate, the Contractor shall handover to the Client and the Client shall take possession and control of the New admin. & Engg. Block ("**Take Over**") and shall issue to the Contractor, a take over certificate in a form and manner set out in "**Take Over Certificate**". Upon such Take Over, the Client shall, except as otherwise provided, be responsible for the risk of loss or damage to the New admin. & Engg. Block.

(b) Prior to the possession and control of the New admin. & Engg. Block being handed to the Client in terms of this Clause 11.4, the Contractor shall be responsible and take care of the New admin. & Engg. Block/ Project in a manner consistent with Applicable Laws, Prudent Industry Practice and the other requirements set forth in the Contract. The transition of such possession and control of the New admin. & Engg. Block from Contractor to Client as set forth in this Clause 11.4 shall be accomplished in accordance with the procedures to be set forth in a transition plan to be submitted by Contractor (in a form acceptable to the Client) to the Client, for its approval, no later than [15 (fifteen) days prior] to the anticipated date of Final Completion.

12. PROJECT MANAGER

12.1. The Contractor acknowledges and agrees that the Client has appointed the Project Manager for the supervision and management of the Works to be undertaken by the Contractor and ensure completion of Works in the time period specified under Clause 7. The Contractor shall coordinate with the Project Manager while carrying out the Works. The Contractor acknowledges and agrees that any approval, check, certificate, consent, examination, inspection,

instruction, notice, proposal, request, test, or similar act by the Project Manager shall have the same effect as though the act had been an act of the Client. However:

(a) it shall not relieve the Contractor from any responsibility it has under the Contract, including responsibility for errors, omissions, discrepancies and non-compliances;

(b) any failure to disapprove any Works, Contractor's Equipment or Materials shall not constitute approval, and shall therefore not prejudice the right of the Client to reject the Works, Contractor's Equipment or Materials; and

(c) if the Contractor questions any determination or instruction of the Project Manager, the Contractor may refer the matter to the Client, who shall promptly confirm, reverse or vary the determination or instruction.

12.2. The Project Manager may issue to the Contractor instructions which may be necessary for the Contractor to perform its obligations under the Contract. Each instruction shall be given in writing and shall state the obligations to which it relates and the sub-clause (or other term of the Contract) in which the obligations are specified.

12.3. The Contractor shall comply with instructions from the Project Manager, or from the Client, including but not limited to:

(a) inspect and examine the Works before covering up and generate quality report;

(b) certification of bills in the manner satisfactory to the Client; and

(c) inspect and approve the mock-ups, quality of Materials and workmanship.

Notwithstanding any of the above, the Project Manager and the Architect shall, without prejudice, perform actions and deeds as also listed elsewhere in the Contract or in the agreement for appointment of the Project Manager by the Client.

12.4. The Project Manager shall be at liberty to object to and require the Contractor to remove forthwith from the Site engaged in the undertaking of Works any person provided by the Contractor who, in the opinion of the Project Manager, misconducts himself, or is incompetent or negligent in the proper performance of its duties, or whose presence on Site is otherwise considered by the Project Manager to be undesirable, and such person shall not be again allowed upon the Works without the consent of the Project Manager. Any person so removed from the Site for the performance of the Works shall be replaced as soon as possible.

13. ARCHITECT

13.1. The Client has appointed an architect for the purposes of designing the New admin. & Engg. Block ("**Architect**"). The Contractor shall co-operate and coordinate with the Architect and the Client to ensure that the Works are completed in accordance with the provisions of the design of the Architect as supplied to the Contractor as part of the Technical Specifications.

13.2. The Architect may shall depute a representative at the Site for performing the duties and obligations of the Architect specified herein and as set out in the agreement entered into between the Architect and the Client.

13.3. The Contractor acknowledges and confirms that the Architect or any representative of the Architect shall be entitled to inter alia the following items:

(a) give instructions to the Contractor in matters pertaining to the design, Drawings and specifications and completion of the Works; and

(b) give notice to the Contractor of non-approval of any Works or Materials, and such Works shall be suspended or the use of such materials shall be discontinued until the decision of the Client, but such examination shall not in any way exonerate the Contractor from the obligation to remedy any defects which may be found to exist at any stage of the Works or after the same is completed.

13.4. The Contractor shall provide the Architect access to the Site to inspect the Works and provide every facility and assistance for inspecting the Works.

14. DOCUMENTS

14.1. Documents Schedule

The Contractor shall, in accordance with the timelines specified in the Technical Specifications, provide to the Client a complete list of all Documents, which shall be utilized by the Contractor for the purpose of completion of the Works. The said list of Documents shall clearly indicate the Document number in accordance with the codes, title, revision number, and issue number in accordance with Prudent Industry Practice together with the date on which such Document has been issued. Further, Drawings in relation to the layout of the New admin. & Engg. Block shall clearly provide for the north direction and shall depict grid lines at the scale of [__] meters which lines shall be submitted after a detailed survey carried out by the Contractor. The Contractor shall, if required by the Client, submit a revised schedule of the said Documents, till such time that all Works in relation to the fabrication of the New admin. & Engg. Block are completed by the Contractor. The Contractor shall, at its own cost, supply reduced size prints of all Documents, as and when required by the Client.

14.2. Specification and Data Sheets

The Contractor shall, within the time specified in the Technical Specifications, submit to the Client, an updated list of all specifications and data sheets required for undertaking the Works. The said data sheets shall indicate the account number, title, revision number and date of issuance of such sheets, so that an updated summary of the latest specifications, is at all times available with the Client, for reference. The procedure for the submission of revisions, if any to the said data sheets shall be as per the procedure set out for the revision of Documents pursuant to this Clause 14.2.

14.3. As-Built Plans

(a) The Contractor shall prepare and maintain an updated and complete set of as-built records of the New admin. & Engg. Block, identifying the precise as built locations, sizes and details of the Works executed. The Contractor shall ensure that all such records are maintained at the Site and shall be exclusively used for the purpose of the Contract.

(b) The Contractor shall, in accordance with this Clause 14, submit to the Client, for its review and comments, (along with the other Documents), plans of the Works for the New admin. & Engg. Block, depicting all executed Works. If any errors are found in the as-built plans, such errors shall be corrected at the Contractor's cost and expense. Unless otherwise provided, as-built plans of the New admin. & Engg. Block and related documents submitted by the Contractor for review under this Clause 14.3.(b) shall be reviewed within 15 (fifteen) days from the date of submission to the Client. If the Client does not provide any comments on the Documents submitted by the Contractor within such 15 (fifteen) days review period then it would be deemed that the Client has no comments on the said as-built plans.

(c) The Contractor shall submit 2 (two) copies of the as-built records to the Client. Further, upon completion of the ELECTRICAL AND ELV phase of the New admin. & Engg. Block, the Contractor shall complete the related plans in relation to the as-built stage (excluding all vendor drawings) and submit to the Client the following:

(i) [3 (three)] complete sets of all Documents on compact disc or other acceptable electromagnetic or electronic media, as may be required by the Client;

(ii) [5 (five)] complete sets of full size prints of the Documents;

(iii) [5 (five)] complete sets of data books specifying all details of the New admin. & Engg. Block in hard binders including certified prints and data for specialty materials to be provided under the Contract. All data books provided by the Contractor under this Clause shall be complete with index for tag numbers associated with the manufacture's data. Data books shall be bound in volumes, limited to a maximum of 3 (three) inches in thickness;

(iv) [3 (three)] sets of as-built data filled in computer data entry forms; and

(v) [3 (three)] copies of all the Documents information in the form of compact disc or other acceptable electromagnetic or electronic media, as may be required by the Client.

(d) Provided that, in the event the Contractor designs the soft copies, it shall also provide a copy of that version along with its complete documentation. The Contractor shall, [15 (fifteen)] days prior to the issuance of the Final Acceptance Certificate, submit [5 (five)] sets of hard copy outputs of all the Documents to the Client.

14.4. **Data**

(a) The Contractor shall, in accordance with the timelines specified in the Technical Specifications provide such other structural drawings, instruction systems descriptions, Documents and Drawing indexes, computer control keys, computer programs, passwords and all other related data for the New admin. & Engg. Block containing the information necessary to enable the Client to use the New admin. & Engg. Block in accordance with Applicable Law.

(b) The Contractor shall, in accordance with the timelines specified in the Technical Specifications provide the Client with data books, vendor prints, complete Drawing lists, descriptions of the New admin. & Engg. Block and other specific information on the New admin. & Engg. Block.

14.5. **Review of Documents by the Client and/or the Project Manager**

(a) The Contractor shall provide to the Client, free of cost, all Documents in accordance with the Technical Specifications and Applicable Law. All Documents submitted by the Contractor shall be written in English language. The Contractor shall prepare all the Documents, and shall also prepare any other documents that are necessary so as to instruct the Contractor's personnel with regard to the completion of the Works.

(b) The review of Documents by the Client shall cover only general conformity of the Documents to the Technical Specifications, interfaces with the specification of the New admin. & Engg. Block provided under the Technical Specifications, external connections and of the dimensions which may affect the layout of the New admin. & Engg. Block.

(c) This review by the Client may not indicate a thorough review of all dimensions, quantities and details of the New admin. & Engg. Block, any devices or items indicated or the accuracy of the information submitted. This review by the Client shall not be construed by the Contractor, as limiting any of its responsibilities and liabilities for mistakes and deviations from the requirements, specified under the Technical Specifications and the Contract. Any activity forming part of the Documents not particularly described in the Contract shall also be included in the obligations of the Contractor and the omission from the Documents of such activity necessary and obviously intended shall not relieve the Contractor from performing such activity. For the avoidance of doubt, it is clarified that Contractor shall await the expiry of the period specified in Clause 14.2 during which the Client is required to review the Documents, prior to commencing the related Works, and if the Contractor executes the related Works prior to the expiry of such period of the Documents, the same shall be at the sole risk and cost of the Contractor.

14.6. **Mode of Submission**

(a) Unless otherwise provided or agreed to by the Client, the Contractor shall, in accordance with the timelines specified in the Contract, submit to the Client, all Documents specified in the Contract, as being required to be submitted for the review by the Client, along with a notice as specified below.

(b) The Documents to be submitted by the Contractor in accordance with this Clause 14.6 shall be submitted:

(i) in 2 (two) sets of soft copy using an internationally recognized web-based document viewing system, acceptable to the Client, linking the Client, the Contractor and the Sub-Contractors and [4 (four)] sets of hard copy;

(ii) along with a notice which shall state that the said Document is considered ready for both, (i) review by the Client in accordance with this Clause 14.2, and (ii) for use. The notice to be submitted by the Contractor shall also state that the said Document complies with the provisions of the Contract, or, if applicable, the extent to which it does not comply.

(c) Without prejudice to the above, any Document, when issued to the Client, shall clearly evidence on such Document itself, the prior approval of the Contractor with respect to such Document. The Client may reject, without further review, any Document submitted by the Contractor, which in the opinion of the Client (i) has not been subjected to the Contractor's quality assurance system submitted pursuant to Clause 9.2; or (ii) contains an unusual amount of errors or (iii) is otherwise sub-standard.

(d) Notwithstanding review by the Client of the Documents to be submitted by the Contractor pursuant to this Clause 14.2, the Contractor shall continue to be responsible for any errors, omissions or discrepancies therein. The Contractor shall bear any costs as a result of delay in providing such Documents or as a result of errors, omissions or discrepancies therein. The Contractor shall bear the cost of any alterations or remedial work necessary due to such errors, omissions or discrepancies for which the Contractor is responsible and shall modify the Documents accordingly. The performance of its obligations under this Clause 14.2 shall not relieve the Contractor of liability for delay in the completion of the Works under the Contract.

(e) Unless otherwise provided in the Technical Specifications or the Contract, Documents submitted by the Contractor for review, shall be reviewed within 14 (fourteen) days from the date of submission of the respective Document along with the notice specified in Clause 10.2(b), to the Client. If the Client fails to intimate the Contractor with regard to its decision on a Document, within the 14 (fourteen) day period specified in this Clause 14.2, then, such Document shall be deemed to have been reviewed by the Client. The Contractor shall, within 5 (five) days of intimation from the Client with regard to the review of the Documents, or a deemed review of such Document in accordance with this Clause 14.6., as the case may be, submit 6 (six) hard copies and 6 (six) soft copies in electronic form (in compact discs). Any Documents submitted by the Contractor, if in electronic form, shall be in a format acceptable to the Client.

14.7. **Correction of Documents**

(a) Without prejudice to Clause 14.3.(b), the Client may, at any time during the 15 (fifteen) day period specified in Clause 14.3, provide a notice to the Contractor that a Document has failed (to the extent stated) to comply with the provisions of the Contract. Upon receipt of a notice from the Client in terms of this Clause 14.7, the Contractor shall, at its own cost, promptly and in any case no later than 15 (fifteen) days from the receipt such notice, rectify the said Document and resubmit the same for the approval of the Client.

(b) Unless otherwise provided, if any of the information submitted to the Client, in the Documents is substantially in variance with the Technical Specifications, which in the opinion of the Client is unacceptable, such Documents shall be returned to the Contractor marked "**Rejected**" and the Contractor shall re-submit the said Documents. For the avoidance of doubt, it is clarified that no extension of time shall be granted under this Clause 14.7 due to the Documents not being acceptable to the Client, in the first instance. In addition, the

Client shall have the right to request the Contractor to make any change in the Documents that may be necessary to make the New admin. & Engg. Block conform to the Technical Specifications and the Contract, at the cost and expense of the Contractor.

14.8. **Responsibility of Documents**

(a) The Contractor hereby acknowledges that certain identified Documents forming part of the Technical Specifications have, as at the date hereof, been reviewed by the Client and the Contractor shall not, while executing the Works, depart from such Documents, unless consented to in advance by the Client. The Contractor shall be responsible for the accuracy of the Documents and any discrepancies, errors or omissions in the Documents and other particulars supplied by it, regardless of whether such Documents and particulars have been reviewed by the Client. If a Party becomes aware of an error or defect of a technical nature in a Document which was prepared for use, for the purpose of executing the Works, the Party shall promptly give notice to the other Party of such error or defect. If errors, omissions, ambiguities, inconsistencies, inadequacies or other defects are found in any Document provided by the Contractor, such Document, along with the Works corresponding to such Document, shall be corrected at the Contractor's cost and expense, notwithstanding the review by the Client of such Document. If the Documents have been previously reviewed by the Client, the Contractor shall not, during the completion of the Works, depart from the reviewed Documents, unless consented to in advance by Client. Review by the Client shall in no way relieve the Contractor of its obligations under the terms and conditions of the Contract or give rise to any liabilities for the Client.

(b) The Contractor's obligation to complete the Works shall not be reduced or affected by review of any Documents or specifications by the Client.

(c) Unless handed over by the Contractor to the Client, in accordance with the provisions of this Clause 14, the Documents shall, at all times, be in the care and custody of the Contractor.

14.9. **Documents and Specifications for Works**

(a) The Contractor shall, in accordance with the timelines specified in the Technical Specifications, submit to Client, for its review, in accordance with the procedure set out in Clause 14, details of the process package, layout Documents, detailed Documents, design specifications, detailed calculations and purchase specifications, etc., and any other information required by Client prior to issuing the same for the purpose of construction and development of the New admin. & Engg. Block. Within 7 (seven) days of the review by the Client of the Documents to be submitted in terms of this Clause 14.9.(a), the Contractor shall submit to the Client, Document lists, indicating the date of availability of the latest copy of such Document with date of review by the Client of each such Document released for ELECTRICAL AND ELV purposes.

(b) The Contractor shall ensure that all Documents submitted in terms of this Clause 14.9.(b) are made to a reasonable scale and are made in sufficient detail, as mutually agreed between the Parties, and in the event of any non-compliance with the same, necessary changes shall be made by the Contractor, at its own cost.

(c) Unless the Contractor requests the Client for a specific deviation from the specifications in relation to the Documents submitted pursuant to this Clause 14.9. and the Client issues a written authority to deviate from the said specifications, the submission and correction, if any, of the Documents submitted pursuant to this Clause 14.9.(c), shall not relieve the Contractor of its responsibility to comply with the specifications specified in the Contract.

(d) The Contractor shall ensure that all Documents to be submitted by it pursuant to this Clause 14 are submitted in accordance with the time lines specified in the Technical Specifications. For the avoidance of doubt, it is

clarified that at no given point of time, will the Contractor rely on preliminary drawings for the purpose of construction and development of the New admin. & Engg. Block.

(e) The Parties shall follow the following procedure in relation to the submission and subsequent review of the Documents submitted under this Clause 14:

(i) The Contractor shall submit to the Client, no later than the time specified in the Technical Specifications, copies of all preliminary Drawings and specifications in accordance with the requirements of the Technical Specifications;

(ii) The Client shall review the preliminary Drawings submitted in terms of Clause 14 and notify the Contractor, of any comments or suggestions by returning a marked-up print or copy of the said Drawings to the Contractor.

(iii) If the Client returns to the Contractor, marked-up Drawings or if the comments on Drawings and specifications are returned pursuant to Clause 14, the Contractor shall, promptly and in any event no later than 7 (seven) days from the receipt of the same, carry out the requisite corrections and obtain the Client's approval in relation to the said corrections, before issuing the same for the purpose of construction and development of the New admin. & Engg. Block.

(iv) The Contractor shall not modify any Documents submitted pursuant to this Clause 14 after the same have been reviewed by the Client. Provided that, if the Contractor is desirous of modifying any item issued for the purpose of construction and development of the New admin. & Engg. Block, as depicted on the Documents which have been submitted and reviewed in terms of this Clause 14, it shall submit to the Client the revised Documents and modified prints in relation to the same and follow the procedure set forth in this Clause.

(f) The procedure stated in this Clause 14 shall apply *mutatis mutandis* to all applicable Documents submitted by the Contractor, during the construction and development of the New admin. & Engg. Block.

15. CONTRACTOR TO INFORM ITSELF FULLY

15.1. Information

(a) The Contractor shall be responsible for obtaining all information required for the performance of its obligations under the Contract.

(b) The Contractor has clarified and carefully examined all the Documents, design criteria, calculations, (if any) data, Technical Specifications and such other matters as may be necessary or desirable for performing its obligations under the Contract, to its entire satisfaction. The Contractor shall not, except as expressly provided in the Contract, be entitled to any extension of time or to any adjustment of the Contract Price, on grounds of misinterpretation or misunderstanding of any such matter.

(c) The Client shall not be responsible for any error, inaccuracy or omission of any kind in the Technical Specifications as originally included in the Contract and shall not be deemed to have given any representation of accuracy or completeness of any data or information. Any data or information received by the Contractor, from the Client or otherwise, shall not relieve the Contractor from its responsibility of completion of the Works.

(d) The Contractor has, prior to the execution of the Contract Agreement obtained all information and taken into consideration the restrictions imposed by the necessity to coordinate its activities for the New admin. & Engg. Block to be constructed and developed with the mutually agreed times.

15.2. **Local Conditions**

The Contractor represents that it is fully informed of all general and local conditions near the Site and other factors that may have an effect on the compliance of its obligations under the Contract. The Contractor cannot claim a Change under Clause 22 (Change in Contract Elements), an extension of time or an increase in the Contract Price as a result of such local conditions or factors.

15.3. **Site and the New admin. & Engg. Block**

(a) The Contractor represents and confirms that it has entered into the Contract Agreement on the basis of its proper examination of the Site by its checking or carrying out its own investigations as may be required, including the suitability and availability of the access routes thereto and that it is aware about the conditions of the Site and its surroundings and has satisfied itself as to all technical, commercial, social and general conditions of and all circumstances affecting the Site, including the nature of the ground and sub-soil, Site surroundings, environmental aspects, the form and nature of the Site and the exact location and condition, as may be required. In this regard, the Contractor has obtained for itself all information, as may be necessary or desirable for the compliance of its obligations under the Contract, including all necessary information as to the risks, contingencies, climatic, hydrological, natural conditions and all other circumstances which may influence or affect the Contract Price and/or its obligations under the Contract. Further, the Contractor agrees that if during the term of the Contract, any portion of the Site is rendered unsafe, on account of any reason whatsoever (including unfavourable weather), the Contractor shall restrict the completion of the Works, to such portion of the Site which is safe and not affected by the said contingency. The Contractor represents and confirms that by signing the Contract Agreement, the Contractor accepts total responsibility for having foreseen all difficulties and costs of successfully completing the Works and that the effect of all contingencies have been considered by the Contractor prior to entering into the Contract Agreement and that the Contractor shall not be entitled to extension of time or an increase in the Contract Price on account of the same.

(b) The Contractor represents and confirms that it has entered into the Contract on the basis of a proper examination of the data relating to the New admin. & Engg. Block on the basis of information that the Contractor could have obtained from a visual inspection of the Site and of other data readily available to it relating to the New admin. & Engg. Block. The Contractor acknowledges that any failure to verify and interpret any data and information in relation to the Site and/or the New admin. & Engg. Block shall not relieve it of its responsibility for properly estimating the difficulty or cost of successfully performing its obligations under the Contract.

16. SUB-CONTRACTORS

16.1. **Experience**

The Contractor represents that each Sub-Contractor has the requisite skill, expertise, experience, capacity, capability and has successfully executed works similar to the Works, in the immediately preceding [3 (three) years] from the Commencement Date.

16.2. **List of Sub-Contractors**

A list of all major items and the approved Sub-Contractors for each of such major items has been provided by the Contractor and incorporated in the Technical Specifications. The Client and the Contractor have agreed on a list of approved Sub-Contractors, from the list provided in the Technical Specifications, and the same is set out in **Schedule XV** (Approved List of Sub-Contractors) ("**Approved List**"). The Client, after due consultation and agreement with the

Contractor, shall have the right to add or delete from the Approved List, from time to time, and approve any successor or replacement of any person listed on the Approved List.

16.3. **Sub-Contracting**

With regard to major items, as specified in the Technical Specifications, the Contractor shall, subject to Clause 16.2, only contract with the Sub-Contractors provided in the Approved List. Further, any sub-contracting in terms of this Clause 16.3, shall not relieve or discharge the Contractor from any of its liabilities or obligations under the Contract and the Contractor shall be responsible for the acts, defaults and neglects of all Sub-Contractors and its agents, servants or workmen, or any of them, as fully, as if they were the acts, defaults or neglects of the Contractor under the terms of the Contract and the Client shall not be liable on account of the same. No acts or omissions on the part of any of the Sub-Contractors will allow the Contractor to claim an extension of time, an increase in the Contract Price, or any other dispensation pursuant to the Contract.

16.4. **Other Sub-Contractors**

If the Contractor intends on contracting with Sub-Contractors, other than those specified in the Approved List, the Contractor shall provide the Client with details in relation to the same. The Client shall, no later than 10 (ten) days from such additional details being provided by the Contractor, approve or disapprove the same. In the event the Client approves the additional Sub-Contractors in terms of this Clause 16.4, such additional Sub-Contractors shall be deemed to be included in the Approved List. The Client shall also have the right to propose a Sub-Contractor other than those specified in the Approved List and upon mutual agreement with the Contractor in this regard, require the Contractor to contract with such Sub-Contractor. In the event of such mutual agreement, the sub-contractor proposed by the Client shall be deemed to be included in the Approved List. Provided that, any agreement between the Parties in terms of this Clause 13.4 shall not relieve or discharge the Contractor from any of its liabilities or obligations under the Contract and the Contractor shall be responsible for the acts, defaults and neglects of all such Sub-Contractors and its agents, servants or workmen, or any of them, as fully, as if they were the acts, defaults or neglects of the Contractor under the terms of the Contract.

16.5. **Client's Consent**

The Contractor shall not sub-contract the whole of its obligations under the Contract. Notwithstanding the Client's consent to any Sub-Contractor, the Contractor shall at all times remain fully responsible to the Client for the proper performance of its obligations under the Contract. The Client shall, at no given point of time, be considered to have any duties or obligations towards any Sub-Contractor as a result of the Contract or by virtue of providing its consent to the Contractor with respect to a Sub-Contractor. The Contractor shall not be relieved of any obligation or responsibility under the Contract by subcontracting of any portion of the Works to a Sub-Contractor.

16.6. **Copies of Sub-Contracts**

The Contractor shall, upon request, provide to the Client copies of technical ordering specifications and principal commercial terms (un-priced) of the sub-contracts with regard to the major items as identified in the Technical Specifications, to be executed with the Sub-Contractors.

16.7. **Form of Sub-Contracts**

(a) The Contractor shall ensure that all contracts with its Sub-Contractors are made in writing. The Contractor shall also ensure that each Sub-Contractor includes provisions which will entitle the Contractor to discharge its obligations and liabilities to the Client in terms of the Contract. The Contractor shall further ensure that all contracts with the sub-contractors shall require each Sub-Contractor, to the extent of the Works to be performed by the Sub-Contractor, to be bound by the terms of the Contract and to assume toward the Contractor all the obligations and responsibilities which the Contractor, by the Contract, assumes toward the Client. Each contract with a Sub-Contractor shall preserve and protect the rights of the Client under the

Contract with respect to the Works being performed by the Sub-Contractor so that such sub-contracting does not prejudice the rights of the Client.

(b) Each instrument evidencing any contract with its Sub-Contractors shall provide that, pursuant to its terms, in form and substance satisfactory to the Client, the rights of the Contractor under such contract with its Sub-Contractors (including all warranties provided by the sub-contractor) are assignable to the Client. The Contractor shall assign to the Client, its successors and assigns, any such contract with its Sub-Contractors as may be required by the Client in its sole discretion, prior to the issuance of the Final Acceptance Certificate or following termination of the Contract, as the case may be.

16.8. **Client's Rights**

The Contractor warrants that no arrangement, agreement or understanding with any sub-contractor shall directly or indirectly interfere with, restrict or impede the Client in the exercise of any right or remedy under the Contract.

16.9. **Evidence of Payment**

(a) The Contractor shall promptly pay all amounts due to any Sub-Contractor. The Contractor shall, by an appropriate agreement with each Sub-Contractor, require each Sub-Contractor to make payments to its sub-contractors, if any, in a timely manner. The Client shall have no obligation to pay or to verify the payment of any monies to any sub-contractor. However, the Client may, at its discretion, verify the payments made by the Contractor to the Sub-Contractors.

(b) The Contractor shall provide to the Client documentary evidence that the Contractor has made or caused to be made all payments due to its Sub-Contractors and when final payment has been made to the Contractor under the Contract, that the Contractor has made final payment to its Sub-Contractors.

17. TRANSFER OF OWNERSHIP

17.1. **Ownership**

The ownership of the New admin. & Engg. Block shall, at all times vest with the Client. Without prejudice to this Clause 17.1, the Contractor shall, until the issuance of the Take Over Certificate, be responsible for the care of the New admin. & Engg. Block, together with the risk of damage thereto. After the issuance of the Take Over Certificate, the Client shall be responsible for the care of the New admin. & Engg. Block, provided that any damage to the New admin. & Engg. Block on account of reasons attributable to the Contractor, shall at all times during the term of the Contract and the expiry of the Defect Liability Period, be to the Contractor's account.

17.2. **Warranty as to Title**

The Contractor warrants that the Contractor's equipment and material shall remain free from defects in title including liens of any kind. The Contractor shall defend the title to the same against any third party and shall indemnify, defend and hold the Client harmless from and against any and all losses arising out of or otherwise resulting from any failure to comply with this Clause 17.2.

17.3. **Ownership of the Contractor's equipment & materials**

The ownership of the Contractor's Equipment, used by the Contractor or its Sub-Contractors, shall at all times remain with the Contractor**.**

17.4. **Excess Material**

The ownership of any Materials, in excess of the requirements for the New admin. & Engg. Block, as may be determined by the Client and Contractor, shall vest with the Contractor.

18. REPRESENTATIONS AND WARRANTIES

18.1. Contractor's Representations and Warranties

The Contractor makes the following representations and warranties to the Client, each of which is true and correct as on the date of issuance of Letter of Award which representations and warranties shall continue to be true and correct throughout the term of the Contract:

(a) it has been incorporated as a company under the Companies Act, [1956/2013], is validly existing and has the power and authority to carry on its business in India;

(b) it has the power to enter into the Contract and comply with its obligations under it;

(c) it has in full force and effect the authorizations necessary for it to enter into the Contract and the transactions contemplated under it;

(d) it has satisfied itself as to the correctness and sufficiency of the Contract Price, which shall, except as otherwise provided for in the Contract, cover all its obligations under the Contract; and

(e) it and its Sub-Contractors have the requisite knowledge, skill, experience, expertise, capacity and capability to execute the Works in a timely manner and to satisfy and fulfill all their respective obligations and responsibilities under the Contract.

18.2. Client's Representations and Warranties

The Client makes the following representations and warranties to the Contractor, each of which is true and correct as on the date of issuance of Letter of Award which representations and warranties shall continue to be true and correct throughout the term of the Contract:

(a) it has been incorporated as a company under the Companies Act, 2013, is validly existing and has the power and authority to carry on its business in India;

(b) it has the power to enter into the Contract and comply with its obligations under it;

(c) it has in full force and effect the authorizations necessary for it to enter into the Contract and the transactions contemplated under it; and

(d) it shall, with the necessary assistance of the Contractor, as and when required, acquire permits, approvals and/or licenses specified in the Technical Specifications.

19. WARRANTIES

19.1. Contractor's Warranties

The Contractor hereby warrants to the Client that the New admin. & Engg. Block has been and shall have been engineered, designed, tested and the Works shall be executed in a manner consistent with the terms of the Contract, in accordance with Prudent Industry Practices and Applicable Law,

(a) using the skill, care and diligence to be expected of appropriately qualified and experienced professionals with experience in ELECTRICAL AND ELV works of a type, nature and complexity similar to the ELECTRICAL AND ELV in the industry;

(b) in accordance with good modern engineering principles and of appropriate grade compatible with the intended purpose;

(c) using only Materials and goods for incorporation into the New admin. & Engg. Block which are new, and do not contain any refurbished components, are free of lien and encumbrances, are unused and the standards of all workmanship, manufacture and fabrication have conformed in all respects to the Technical Specifications, and shall be of such quality as is intended for the purpose for which it is intended;

(d) using the standards of all workmanship and fabrication which conform in all respects to the Codes and Standards and being of such quality as is intended for the purpose for which it is intended;

(e) conforming to the Technical Specifications and being free of defects and deficiencies. The engineering and design shall be such that the Works shall meet all safety and applicable criteria as specified in the Contract;

(f) being suitable for the use in accordance with the requirements necessary to meet the Performance Parameters;

(g) using means, methods and techniques required for the completion of the Works which are appropriate for the conditions and materials involved and in accordance with the current state of the art; and

(h) ensuring that the Works when completed will conform in all respects with the requirements of, and will be suitable for, the purpose of the Contract.

19.2. **Other Warranties**

The New admin. & Engg. Block shall:

(a) upon Final Completion, be in accordance with all requirements of the Contract unless otherwise agreed by the Client, or altered in accordance with a Change in accordance with Clause 22 (Change in Contract Elements) instructed by the Client;

(b) be capable of being operated in accordance with the requirements of the Contract and Prudent Industry Practices; and

(c) comply with Applicable Law in effect on the Final Completion Date.

20. INSURANCE

20.1. **Insurance Policies**

(a) All insurance policies, whether required to be obtained under this Clause 20 or otherwise, wherever possible shall be taken out in the joint names of the Client, the Contractor and Sub-Contractor, wherever applicable.

(b) All the insurance shall be arranged by Contractor from a reputable insurance company which can deal with all matters pertaining to the subject and is acceptable to the Client. The Client has reserved its right to nominate the insurance company or take the insurance policies under which the claims will be lodged by the Contractor.

(c) The Contractor must ensure that the policy amounts cover the Contract Price and adequately cover the maximum possible liability that may arise on the occurrence of the risks covered.

(d) The Contractor shall deposit the original insurance policy and the premium paid receipts with the Client on the date of issuance of the Letter of Award. If the Contractor fails to procure such policy or deposit the same and the premium receipts in original with the Client, the Client shall be entitled, but not obligated to procure

such policy and recover the payments thereon from the Contractor either by withholding the amounts payable to the Contractor or otherwise. Any deviation from the same shall be subject to the prior written approval of the Client. The Client shall be entitled to prosecute and/ or compromise or settle the claims under such policies in such manner as may be deemed fit without reference to the Contractor. The Contractor shall provide necessary assistance to the Client in this regard.

(e) The Client, however reserves the right to take all or some of the insurance policies on its own and thereafter the Contractor shall be required to process the claims if any for settlement under the policies so taken by the Client. The Client further reserves its right to nominate an insurance company with whom the Contractor will be required to obtain the policies, insurance of Works, etc.

(f) Without limiting its obligations and responsibilities, the Contractor shall insure in the joint names of the Client and the Contractor against all loss or damage from whatever cause arising, for which it is responsible under the terms of the Contract and in such manner that the Client and Contractor are covered for the period stipulated in hereof, and are also covered during the Defects Liability Period.

(g) Such insurance shall be effected with an insurer and in terms approved by the Client which approval shall not be unreasonably withheld, and the Contractor shall, whenever required produce to the Client or its representative the policy or policies of insurance and the receipts for payment of the current premiums.

(h) The Contractor shall take out a Contractor's all risk insurance policy for the full amount of the Contract Price valid till the expiry of the Defects Liability Period, within 10 (ten) days of the date of issuance of the Letter of Award jointly in the name of the Client and the Contractor and the original policy shall be deposited with the Client.

(i) The Contractor shall similarly indemnify the Client against all claims, which may be made upon the Client, whether under the Workman's Compensation Act, 1923 or any Applicable Law in force during the currency of the Contract or at common land in respect of any employee of the Contractor or any Sub-Contractor and shall at its own expense effect and maintain up to the Defect Liability Period, with an approved office, a policy of insurance in the joint names of the Client and the Contractor against such risks and deposit such policy or policies with the Client from time to time during the currency of the Contract.

20.2. **Third Party Insurance**

(a) Before commencing the Works, the Contractor shall insure against loss for any material or physical damage, loss or injury which may occur to any property, including that of the Client, or to any person, including any employee of the Client, the Project Manager, other contractors/ Sub-Contractor(s) or their respective employees, agents, representatives and visitors, by or arising out of the completion of the Works or in the carrying out of the Contract.

(b) The Contractor shall, whenever required, produce to the Client or its representative the policy or policies of insurance and the receipts for payment of the current premiums.

(c) The term of such insurance shall be up to the end/ expiry of the Defect Liability Period and shall include for any damage to the properties and/ or injury including death to the persons of the general/ public/ architects and anyone else deemed to be third party.

20.3. **Provisions to indemnify Client**

The terms of such insurance shall include a provision whereby, in the event of any claim in respect of which the Contractor would be entitled to receive and indemnify under the policy being bought or made against the Client, the insurer will indemnify the Client against such claims and any cost, charges and expenses in respect thereof and the

Contractor to indemnify the Client for any shortfall in the realization of the claims. The Client shall be entitled to set off any such amounts from the amounts due and payable by it to the Contractor under the terms of the Contract.

20.4. **Accident or Injury to workmen**

The Contractor shall be responsible and liable for or in respect of any damages or compensation payable at law in respect or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or any Sub-Contractor. The Client shall not be liable for or in respect of any damages or compensation payable by law in respect or in consequence of any accident or injury to any workman or other person in the employment of the Contractor or any person working under/with the Contractor. The Contractor shall fully indemnify and keep indemnified the Client against all such damages and compensation, against all claims, proceedings, costs, charges and expenses whatsoever in respect thereof or in relation thereto.

20.5. **Insurance against accident, etc., to workmen**

(a) The Contractor shall insure against such liability with an insurer approved by the Client, which approval shall not be unreasonably withheld, and shall continue such insurance during the whole of the time that any persons are employed by it on the Works and shall, when required, produce to the Client or its representative such policy of insurance and the receipt for payment of the current premium. Provided always that, in respect of any persons employed by any Sub-Contractor, the Contractor's obligation to insure as aforesaid under this sub-Clause shall be satisfied if the Sub-Contractor shall have issued against the liability in respect of such persons in such manner that the Client is indemnified under the policy, but the Contractor shall require such Sub-Contractor to produce to the Client or its representative, when required, such policy of insurance and the receipt for the payment of the current premium.

(b) Notwithstanding the requirements mentioned in the above, the Contractor shall at the minimum provide for Contractor’s all risk insurance policy to cover the following:

(i) entire Contract Price for the period of completion including Defect Liability Period;

(ii) third party insurance to cover for any damages to third party. This shall be up to the end of the Defect Liability Period and shall include for any damage to the properties and/ or injury including death to the persons of the general/ public/ architects and anyone else deemed to be third party;

(iii) policy to cover Contractor’s liability under Employee's Compensation Act 1923, Minimum Wages Act 1948, Contract Labour (Regulation and Abolition) Act 1970 and other Applicable Laws. This shall be for the period up to issue of the Final Acceptance Certificate, including the Defect Liability Period;

(iv) insurance cover against damage, theft or any other loss of all Materials and Contractor's Equipment brought to the Site; and

(v) the Contractor shall insure against all such liabilities and shall continue such insurance during the term of the Contract including Defect Liability Period. Premium for all insurance policies shall be paid and borne by the Contractor and shall not be reimbursable.

(c) These insurance certificates shall be executed and shall state that the policies cannot be surrendered for 10 (ten) days after written notice of the Client having consented to such surrender.

(d) The Contractor shall obtain written confirmation of similar certificates from all Sub-Contractors and thereby assume responsibility for any claims or losses to the Client resulting from failure of any of the Sub-Contractors to obtain adequate insurance protection in connection with the Works.

(e) If the Contractor fails to effect and keep in force the insurances referred to in Clause 20, or any other insurance which it may be required to effect under the terms of the Contract, then and in any such case the

Client may effect and keep in force any such insurance and pay such premiums as may be necessary for that purpose and from time to time deduct the amount so paid by the Client as aforesaid from any monies due or which may become due to the Contractor, or recover the same as a debt due from the Contractor.

20.6. **Insurance for Contractor's Equipment**

(a) The Contractor shall insure the Contractor's Equipment against all loss or damage. This insurance shall cover loss or damage from any cause in so far as such insurance is readily obtainable. Such insurance shall be for a limit of not less than the full replacement value (including delivery to the Site). Such insurance shall be in such a manner that each item of Contractor's Equipment is insured while it is being transported to and from the Site or the right of way and throughout the period it is on or near the Site or the right of way.

(b) The Client shall have no liability for the loss/ damage to the Contractor's Equipment unless such loss or damage are due to reasons attributable to the Client.

(c) Client shall deduct from any amount due to the Contractor under the Contract entire insurance premium and other costs that the Client shall have paid to the insurer or incurred or may otherwise recover such amount as a debt due from the Contractor.

20.7. **Insurance for Contractor's Personnel**

The Contractor shall effect and maintain insurance against liability for claims, Contractor's Personnel damages, losses and expenses (including legal fees and expenses) arising from the death, injury, sickness or disease to any person employed by the Contractor or any Sub-Contractor of all types. The Client and the Client's representatives shall also be indemnified under the policy of insurance, except that this insurance may exclude losses and claims to the extent that they arise from any act or neglect of the Client or of the Client's representative's personnel. For a Sub-Contractor's employees, such insurance may be effected by the Sub-Contractor, but the Contractor shall be responsible for compliance with this Clause.

20.8. **General Requirements for Insurance**

(a) The Contractor shall comply with the conditions stipulated in each of the insurance policies. The Contractor shall not make any adverse material alteration to the terms of any insurance without the prior approval of the Client.

(b) If the Contractor fails to effect and keep in force any of the insurance required wherever applicable under the Contract, or fails to provide satisfactory evidence policies and receipts in accordance with this sub-Clause, the Client may, without prejudice to any other right or remedy, effect insurance for the coverage relevant to such default, and pay the premiums due. Such payments shall be recoverable from the Party whose obligation it was to effect the insurance.

(c) Nothing in this Clause limits the obligations, liabilities or responsibilities of the Contractor, under the other terms of the Contract or otherwise. Any amounts not insured or not recovered from the insurers shall be borne by the Contractor in accordance with the Contract.

21. DEFECT LIABILITY PERIOD

21.1. **General** During the Defect Liability Period, the Contractor shall remain liable for any technical or other defects in the Works.

(a) The Defect Liability Period shall be [12 (twelve months)] from the issuance of the Take Over Certificate ("**Defect Liability Period**"). If the Contractor re-performs any of the Works or otherwise makes good the Works (as the Client shall, at its discretion, determine) a defect in terms of this Clause 21.2, then the Defect Liability Period with respect to any such re-performed Works, or Works which have been otherwise made good, shall be a period of [12 (twelve) months] from the date of re-performance of such Works, or the date when such Works, have otherwise been made good, as the case may be. Provided that, the Defect Liability Period pursuant to this Clause 21.2 shall be subject to a maximum period of [30 (thirty) months] from the issuance of the Take Over Certificate. Provided further that, if the Contract is terminated prior to the issuance of the Take Over Certificate, then, the provisions of this Clause 21.2 with respect to the Defect Liability Period for repair, replacement, or otherwise making good shall apply *mutatis mutandis*, and in such an event the Defect Liability Period shall be [12 (twelve) months] from the date of termination.

(b) If during the Defect Liability Period, any defect is found in the design, construction, or engineering being part of the Works, of the New admin. & Engg. Block, the Contractor shall promptly and in any event no later than [3 (three) days] from the receipt of the notice from the Client in terms of Clause 21.2, commence the correction of any errors, omissions, defects or deficiencies in the Works, re-perform any part of the Works, or repair, replace or otherwise make good (as the Client shall, at its discretion, determine) such defect, in addition to any damage to the New admin. & Engg. Block caused by such deficiency in Works, at the sole risk and expense of the Contractor. Provided that, the Contractor shall not be responsible for the repair, replacement or making good of any defect or of any damage to the New admin. & Engg. Block arising out of or resulting from normal wear and tear.

(c) The Contractor shall perform all remedial action and re-perform any part of the Works required in such a manner and at such time, and shall co-ordinate its activities in connection therewith as notified by the Client in this regard.

(d) The Contractor shall in re-performing the Works or undertaking any repair/ replacement under this Clause 21, which could affect the safe and effective use of the New admin. & Engg. Block or any part thereof, observe all requirement of the Client and the Project Manager with regard to safe and effective use or operation thereof.

(e) During the Defect Liability Period, any re-design, repair or replacement of any part of the New admin. & Engg. Block requiring the New admin. & Engg. Block to be shut-down, shall be undertaken in co-ordination with Client so as to minimize disruption of the ongoing operations of the New admin. & Engg. Block. Such re-design, repair or replacement may, at Client's option, require Works to be carried out at the Site by the Contractor's personnel, beyond the normal working hours, including weekends and public holidays. All costs required for the performance of such re-design, repair or replacement shall be to the account of the Contractor.

(f) During the performance of the re-design, repair or replacement of any part of the New admin. & Engg. Block as provided in Clause 21.6, the Contractor shall procure that the Contractor's personnel act in compliance with Applicable Law, the Site regulations, work rules, workmen's compensation requirements as well as safety procedures.

21.2. **Notice of Defect**

The Client shall provide the Contractor a notice stating the nature of any defect in the New admin. & Engg. Block and/or Works, together with all available evidence, promptly following the discovery of such defect. The Client shall afford all reasonable opportunity to the Contractor to inspect any such defect. The Contractor shall, within 3 (three) days of the notice from the Client in this regard, submit to the Client details of the proposed re-performance of the Works and/or the repairs or replacements, which it proposes to make, the estimated duration of the repairs or the duration required to effect the replacement Works, details or parts of the New admin. & Engg. Block considered

necessary to shut down and the proposed dates for such re-performance, repairs or replacements. All Works and repairs and replacements shall be carried out at a time and for periods agreed with the Client pursuant to Clause 21.

21.3. **Access**

With regard to repairs or re-performance of Works needed, the Client shall afford the Contractor, subject to its reasonable security restrictions, the necessary access to the New admin. & Engg. Block and the Site to enable the Contractor to perform its obligations under this Clause 21.

21.4. **Tests**

(a) The Contractor shall carry out the tests, in relation to the repaired part of the New admin. & Engg. Block and shall endeavor not to disrupt the New admin. & Engg. Block as a whole, to demonstrate that such defect has been removed and that the repaired part of the New admin. & Engg. Block is functioning in the manner in which it is required to function under the Contract. Such tests shall be conducted, solely at its cost and expenses and the Contractor shall provide all materials, manpower, tools and tackles etc., which are required for carrying out the said tests.

(b) In addition to the tests conducted under Clause 21.10(a), if the repair or making good is of such a nature that it may affect the efficiency of the New admin. & Engg. Block or any part thereof, the Client shall provide the Contractor a notice of [28 (twenty eight) days] requiring additional tests to be conducted on the defective part of the New admin. & Engg. Block and the Contractor shall promptly, at its own risk and cost, carry out any such additional tests.

(c) If any part of the New admin. & Engg. Block fails the tests as set forth in Clause 21.10.(a), the Contractor shall carry out further repair, replacement or making good, as the case may be, until that part of the New admin. & Engg. Block passes such tests. The tests, in character, in no event shall be inferior to what has been agreed upon by the Client and the Contractor.

21.5. **Failure to Remedy Defects**

(a) If the Contractor fails to commence repair of the defect or any damage to the New admin. & Engg. Block caused by such defect, within the time frame stipulated in Clause 21.3, following the notice from the Client in this regard, the Client may, by notice to the Contractor, proceed to repair such defect.

(b) In addition to the Client's rights pursuant to Clause 21, if, in the reasonable opinion of the Client, a defect in the New admin. & Engg. Block or part thereof, is expected to cause serious loss or damage which can be prevented by immediate action, such defect may be corrected by the Client or a third party designated by the Client. Upon intimation by the Client in this regard, the Contractor shall assist wherever possible in undertaking any necessary corrections. Notwithstanding anything to the contrary stated in the Contract, any action undertaken by the Client pursuant to this Clause 21.11.(b), shall not in any way relieve the Contractor of its responsibilities under the Contract and the warranties set forth in Clause 18 and Clause 19 (Warranties) shall not be reduced or affected on account of the Client undertaking such action.

(c) All costs incurred by the Client in terms of this Clause 21.11.(a), shall be paid to the Client by the Contractor and/or may be deducted by the Client from any monies due to the Contractor and/or claimed by invoking the Performance Bank Guarantee. For the avoidance of doubt, it is clarified that any action undertaken by the Client in terms of this Clause 21.11 shall not extinguish the Contractor's liabilities arising pursuant to the terms and conditions of the Contract.

(d) If the Contractor fails to remedy the defect or damage under Clause 21.11, the Client shall have the right to:

(i) terminate the Contract pursuant to Clause 34 as a whole or in respect to such major part which cannot be put to the intended use and without prejudice to any other rights, under the Contract or otherwise, the Client shall then be entitled to recover all sums paid for the Works or for such part (as the case may be), the cost of dismantling the same and clearing the Site; or

(ii) accept the deficient New admin. & Engg. Block and proportionately reduce the Contract Price to reflect the diminished value to the Client and such reduction shall be determined by the Client at its discretion.

21.6. **Latent Defect**

(a) If, any defect appearing in any part of the Works, is of a kind that would not have been apparent to the eye prior to the expiry of the Defect Liability Period (a "**Latent Defect**") and arises within a period of [5 (five) years] from the Completion Date, the same shall be made good by the Contractor by repair or replacement. The Client shall, upon discovery of Latent Defect, notify the Contractor. The Contractor shall commence repair on such Latent Defect no later than [3 (three) days], or such other mutually agreed time period, from the receipt of a notice from the Client in this regard.

(b) The Contractor shall have the right to investigate the cause of any problem or abnormality in the New admin. & Engg. Block, which the Client reasonably believes is due to a Latent Defect.

(c) If the Contractor fails to commence repair of any Latent Defect within the time specified in Clause 21.12(a), following receipt of a notice from the Client, the Client may cause such repairs to be affected at the Contractor's expense.

21.7. **Serial Defect**

(a) If, during the Defect Liability Period, more than [15% (fifteen percent)] of the Works contains the same defect ("**Serial Defect"**), then a Serial Defect shall be deemed to exist in all such parts of the Works.

(b) If a Serial Defect exists, then it shall be deemed to be a defect for the purposes of this Clause 21.13 and all provisions with regard to the rectification of defects as set out in this Clause 21.13 shall apply *mutatis mutandis* to the rectification of the Serial Defect.

(c) Without prejudice and in addition to Clause 21.13(b), if a Serial Defect exists, the Contractor shall:

(i) promptly perform a thorough investigation to ascertain the cause of the Serial Defect and provide a report to the Client detailing the cause and effect of the Serial Defect;

(ii) subject to Clause 21.6, remedy all Works which are deemed to be effected by the Serial Defect including carrying out any necessary alterations, additions, modifications, design modifications, repairs or replacements regardless of whether a defect has made itself apparent in such parts of the Works at the time that the threshold stated under Clause 21.13(a) is exceeded.

21.8. **Costs, Taxes and Duties**

The Contractor shall be responsible for payment of all costs, taxes (including all indirect taxes except excise duty, entry tax and octroi and duties incurred in the course of performance of its obligations under this Clause 21.

22. VARIATIONS AND CHANGE IN CONTRACT ELEMENTS

22.1. **Introducing a Change**

The Client shall have the right to propose and subsequently require the Contractor, from time to time, till the issuance of the Take Over Certificate, to make a Change in accordance with the procedure set out in Clause 22.3 ("**Change**"). The Contractor shall execute and be bound by a Change proposed by the Client, unless the Contractor promptly provides a notice to the Client (along with supporting documents) that, the Change:

(a) will have an adverse impact on the achievement of the Performance Parameters; or

(b) comprises the omission of any Works which are to be carried out by a third party.

22.2. **No Change for Default**

No variation made on account of any default of the Contractor in the performance of its obligations under the Contract shall be deemed to be a Change, and such variation shall not result in any adjustment of the Contract Price or the postponement of the Completion Date.

22.3. **Changes Originating from Client**

(a) If the Client proposes a Change pursuant to Clause 22.1, it shall send to the Contractor, a notice ("**Request for Change Proposal**") requiring the Contractor to prepare and provide to the Project Manager within [15 (fifteen) days] of the Request for Change Proposal, a proposal ("**Change Proposal**") which shall include the following:

(i) brief description of the Change, including a description of the proposed corrective activities and/or Works to be executed or modified, and a programme for its execution, together with supporting calculations containing a break down for the actual cost of supplies for any items required/Works to be executed to give effect to the Change;

(ii) effect on the Completion Date and the necessary modifications;

(iii) the effects of implementation of the Change, taking into account the omission of execution of a portion of the Works, if any;

(iv) the cumulative impact of effects resulting from the stated Change on all prior Works and any changes in the Works to be executed as scheduled; and

(v) estimated cost of the Change;

(vi) effect of the Change on the safety of the New admin. & Engg. Block, if any; and

(vii) effect on any other provisions of the Contract.

(b) In addition to the information specified in this Clause 22.3(b), the Change Proposal shall include such other information as the Client may reasonably request in connection with each Change, and shall include copies of all price quotations and other documents as may enable the Client to verify the Contractor's proposed costs or savings in respect of the Change. For the avoidance of doubt, it is clarified that Contractor shall bear all costs and expenses in relation to the Change Proposal, whether or not such proposal is ultimately implemented.

(c) The pricing of a Change shall, as far as practicable, be calculated in accordance with the rates and prices included in the Contract as set out in Bidding Documents. If the rates and prices of any Change are not available in the Contract, the Parties shall agree on specific rates for the valuation of the Change. If the

Contractor is instructed to proceed with a Change, prior to the determination of its value, the Contractor shall keep contemporary records of all labour hours, cost of Materials and Contractor's Equipment and any other cost related to undertaking the Change. Such records shall be provided to the Client upon request.

(d) If before or during the preparation of the Change Proposal, it becomes apparent that the aggregate effect of compliance with the Change and with previously issued Change Orders, would have the effect of increasing or decreasing the Contract Price as originally set forth by more than [15% (fifteen percent)], the Contractor shall provide a notice of objection prior to providing the Change Proposal. If the Client accepts the Contractor's objection, the Client and the Contractor shall agree on specific rates for the valuation of the Change and the Contractor shall submit the Change Proposal accordingly. If the Client does not accept the Contractor's objection, then the Client may cancel or vary the Request for Change Proposal, in which case, the Contractor shall submit the Change Proposal in accordance with the Client's revised Request for Change Proposal. However, in case of any Dispute in this regard, the matter may be resolved in terms of Clause 35 (Dispute Resolution).

(e) Upon receipt of the Change Proposal, the Client and the Contractor shall mutually agree upon all matters in the Change Proposal, including agreement on rates if such rates are not available in the Contract or if the limit of [15% (fifteen percent)] has been exceeded. Within 15 (fifteen) days of such agreement, the Client shall, if it intends to proceed with the Change, issue to the Contractor an order ("**Change Order**") whereby:

(i) the Client shall grant an extension of time, if necessary;

(ii) the agreed adjustments, if any, shall be made to the Contract Price and the Completion Date; and

(iii) such other changes may be ordered as may be required to give effect to the Change.

(f) The Client shall only instruct a Change under this Clause 22.3(f), upon mutual agreement with the Contractor on the quotation and the terms and conditions of the implementation of the Change.

(g) If the Client is unable to reach a decision within 15 (fifteen) days of the receipt of the Change Proposal, it shall notify the Contractor with details of the expected time by when the Contractor can expect a decision. For the avoidance of doubt, it is clarified that the Contractor shall continue to perform its obligations under the Contract, whilst awaiting a response from the Client in relation to the Change Proposal.

(h) If the Client decides not to proceed with the Change, for any reason whatsoever, it shall, within 30 (thirty) days from the receipt of the Change Proposal, or such later date indicated to the Contractor, notify the Contractor accordingly.

(i) If the Client and the Contractor cannot reach an agreement on:

(i) the price for the Change;

(ii) an equitable adjustment to the Completion Date; or

(iii) any other matters identified in the Change Proposal,

then, the Client has the right to instruct the Contractor to proceed with the Change by issuing an instruction in this regard ("**Pending Agreement Change Order**").

(j) Upon receipt of a Pending Agreement Change Order, the Contractor shall immediately proceed with effecting the Change under the Pending Agreement Change Order. The Parties shall thereafter attempt to reach an agreement on the outstanding issues under the Change Proposal. If the Parties cannot reach an agreement within 60 (sixty) days from the date of issuance of the Pending Agreement Change Order, then the matter may be resolved in terms of Clause 35 (Dispute Resolution).

22.4. **Changes Originating from Contractor**

(a) The Contractor shall have a right to propose a Change only, when in the Contractor's opinion, if adopted, such change would:

(i) accelerate Completion;

(ii) reduce the cost to the Client of constructing and developing the New admin. & Engg. Block;

(iii) improve the efficiency or value to the Client of the completed Works;

(iv) improve the quality, efficiency or safety of the New admin. & Engg. Block or any part thereof; or

(v) otherwise be of benefit to the Client,

in each instance, by submitting to the Client a written application in this regard, at its own cost and expense, giving reasons for the proposed Change and including the information stated in Clause 22.4 ("**Application for Change Proposal**").

(b) Without prejudice to the above, the Contractor shall, during the term of the Contract, have a continuing obligation to suggest to the Client for its consideration, Changes known to the Contractor, as may be necessary to incorporate significant new developments in technology which are applicable or appropriate for the New admin. & Engg. Block or any part thereof. If the Contractor proposes such a Change, it shall submit to the Client an Application for Change Proposal, *inter-alia*, identifying the benefits of such Change.

(c) Upon receipt of the Application for Change Proposal under this Clause 22.4., the provisions of Clauses 22.3(c) to 22.3(j) shall apply *mutatis mutandis*.

22.5. **Improvements**

The Client or the Contractor may propose changes in the Technical Specifications in respect of the New admin. & Engg. Block or quality thereof, which enhances the performance of the New admin. & Engg. Block. If the Parties agree upon any such changes, the same shall be given effect to in accordance with the procedure specified in this Clause 22.

22.6. **Exclusions**

(a) Notwithstanding anything to the contrary, no Change Order shall be granted if:

(i) the Contractor seeks any Change or variation in its obligations which is due to any fault in the Documents supplied by it or due to any misrepresentation relating to any warranties provided by the Contractor;

(ii) the Change is necessary in order for the Contractor to satisfy its responsibility to complete the Works and ensure that the New admin. & Engg. Block is capable of performing as contemplated under the Contract and as specified in the Technical Specifications; or

(iii) the Change relates to the re-performance of any of the Works due to the Contractor's failure to comply with the Technical Specifications.

(b) Notwithstanding any other provision of the Contract, none of the following shall:

(i) be considered under any circumstances as a Change;

(ii) be taken into account when calculating the effect upon the Contract Price; or

(iii) by itself, be considered the basis for any adjustment of the Contract Price:

(A) any escalation in the cost of materials or labour; or

(B) any normal design improvements effected by the Contractor.

23. CONTRACT PRICE AND INVOICING

23.1. Payment of Contract Price

(a) The Contract Price is exclusive of service tax and works contract tax and the applicable taxes and duties shall be payable in accordance with the provisions of Clause 21.14 (Taxes and Duties).

23.2. Mobilization Advance

(a) 10% of Contract Value against an irrevocable bank guarantee as prescribed in the tender form for equivalent value and recoverable 12.5% basis from 2nd RA bills however 100% mobilization will be recovered once the value of work done reached of 80% of contract value.

23.3. Escalation/Contract Price Variation

Subject to the provisions of Clause 22 (Variation and Change in Contract Elements) and Contract Price, the Contract Price shall be firm till the completion of the obligations of the Contractor under the Contract and there shall be no escalation whatsoever of the Contract Price.

23.4. Full and Complete Payment

a) The Contract Price shall be the full and complete payment for satisfactory discharge of the Contractor's performance of its obligations under the Contract and all things necessary for the proper execution and completion of the Works and the remedying of any defects and except as otherwise provided, includes all costs necessary for the completion of the Works and compliance with the terms and provisions of the Contract.

b) For the avoidance of doubt, it is clarified that the Contract Price includes all Direct Taxes, direct, indirect and ancillary charges, cess, costs and expenses of whatsoever nature, including for the Contractor's Equipment & Materials, license, royalty and fees, accessories, Intellectual Property licenses and Documents to be provided under the Contract. The applicable indirect taxes shall be paid in accordance with Taxation.

24. TERMS OF PAYMENT

24.1. General

The Contract Price shall be paid in accordance with this Clause 24.

24.2. **Effect of Payment**

No payment of the Contract Price made by the Client, shall be deemed to constitute acceptance by the Client of the Works or any part(s) thereof and shall not relieve the Contractor of any of its obligations under the Contract.

24.3. **Currency of Contract Price**

All payments of the Contract Price shall be made by the Client to the Contractor in INR (Indian Rupees).

24.4. **Terms and Procedure of Payments of the Contract Price**

(a) The Contractor shall submit an invoice to the Client [in triplicate] by the 1st week of each month providing details of the achievement, in the immediately preceding month. The Invoices shall be accompanied with relevant supporting documents (including work completion reports to be submitted by the Contractor) and any relevant documents required by the Client in this regard. The Contractor shall submit to the Client, for its approval, a copy of each Invoice to be submitted by the Contractor pursuant to this Clause 24. The approval of the Client shall be made within 30 (Thirty) Days, (10 days to the PMC + 20 days to the Client) from the submission of such Invoice in a manner satisfactory to the Client. The proforma of the Invoice and the documents and details to accompany it shall be mutually discussed and agreed to by the Parties, provided that, the Contractor shall at all times ensure that Invoices are raised in accordance with the relevant provisions of Applicable Law, so as to enable the Client to avail credit of the taxes indicated in the said Invoice.

For the avoidance of doubt, it is clarified that if an Invoice is not accompanied by the supporting documents, then such amounts of the Invoice shall not be due and payable by the Client, until the supporting documents have been provided by the Contractor. Further, the withholding of any amounts by the Client pursuant to this Clause 24, shall not constitute an event of default for non-payment, on the part of the Client.

(b) If an amount under an Invoice is disputed for any reason by the Client in terms of Clause 24, or if the Invoice is not raised in accordance with the relevant provisions of Applicable Law, then such amounts of the Invoice shall not be due and payable by the Client and the Client shall be entitled to withhold payment of the amounts under such Invoice, which shall only be released upon the resolution of the Dispute in terms of Clause 35, or upon receipt of a revised Invoice raised in accordance with the relevant provisions of Applicable Law, from the Contractor, as the case may be. Further, the withholding of any amounts by the Client pursuant to this Clause 24 shall not constitute an event of default for non-payment, on the part of the Client. The Contractor shall provide details concerning the description of the Works executed and any further substantiation as Client may reasonably require, including any other information or documentation relating to the performance of the obligations of the Contractor under the Contract, that the Client might reasonably need to present, from time to time, to a Government Instrumentality.

(c) The Client shall, subject to Clause 24.4.(b), make payments of undisputed amounts under an Invoice, within 30 (Thirty Days) days following the approval by the Client of the Invoice pursuant to Clause 24. The Client shall pay amounts under each Invoice directly to such bank account(s) of the Contractor, as may be instructed by the Contractor to the Client.

(d) 5% (five percent) retention of the value of Works certified by the Project Manager, shall be made in every Invoice by the Client.

(e) It is expressly clarified that the value of the Retention Money shall not exceed 5% (five percent) of the Contract Price in aggregate and shall be retained by the Client till the expiry of the Defect Liability Period.

(f) The Retention Money shall be released by the Client, subject to the following conditions being satisfied:

(i) the Contractor has achieved Final Completion;

(ii) the New admin. & Engg. Block has been handed over to the Client in terms of Clause 11.4;

(iii) the Contractor has executed all the Works to the sole satisfaction of the Client;

(iv) the Defect Liability Period has expired, and the Contractor has rectified all defects in terms of Clause 21;

(v) the Contractor has paid all liquidated damages, indemnity sums and other payments due from the Contractor under this Agreement.

(vi) the Contractor has assigned to the Client or provided Client with all warranties or guarantees that Contractor has received from Sub-Contractors to the extent Contractor is obligated to do so pursuant to this Agreement.

(vii) all Contractor's Materials and other supplies, equipment, surplus, waste, huts, wreckage, debris, rubbish, and temporary facilities to which Client does not, and is not entitled to hold title, have been removed from the Site, and the Site have been restored in accordance with the terms of this Agreement provided that, all activities in relation to clearing and disposal shall be conducted in accordance with all Applicable Laws;

(viii) all the Contractor's Personnel and the personnel of the Sub-Contractors and their personnel, have been removed from the Site;

(ix) all Sub-Contractors have been paid their dues by the Contractor and Contractor has delivered the final release and waiver of Liens and claims pursuant to this Agreement and has delivered such other documents and certificates as Client has reasonably requested to ensure compliance with all Applicable Laws; and

(x) all activities required as per Applicable Law on account of the completion of the Works have been completed by the Contractor.

Provided that the Retention Money may be released upon submission an unconditional and irrevocable bank guarantee from a reputable bank acceptable to the Client for an amount equivalent to the Retention Money. The Retention Money Bank Guarantee shall be valid up to the expiry of the Defect Liability Period and shall have a claim period of 3 (three) months from the date of its expiry. If requested by the Client, the Contractor undertakes to extend the validity period of the Retention Money Bank Guarantee.

(g) The Client shall withhold from payments to be made to the Contractor and pay to the Governmental Authority, any and all taxes required to be withheld pursuant to Applicable Law. The Client shall provide to the Contractor the tax deduction certificates, for such withheld amounts.

(h) All Invoices shall be endorsed with the contract number and title.

(i) Payments made by the Client against any Invoice shall not preclude the right of the Client to thereafter dispute any items invoiced and paid for.

(j) Except as provided in Clause 24, if any other amounts are due and payable from one Party to the other, including payments pursuant to Clause 10 (Liquidated Damages) and Clause 28 (Indemnity), then the Party to whom such amounts are owed shall provide to the other Party an invoice accompanied by/along with the calculations and with the relevant documentary proof showing the basis for the calculations substantiating the claimed payments. The Party liable to make payment under a Miscellaneous Invoice shall make payment against the same within 30 (thirty) days from the date of receipt of such Miscellaneous Invoice.

(k) Notwithstanding the provisions of this Clause 24, the Parties shall have the right to dispute, in good faith, any invoiced item. Where any amount, under an Invoice or a Miscellaneous Invoice, as the case may be, is disputed by a Party, then such Party shall, within 21 (twenty one) days of receipt of the Invoice or Miscellaneous Invoice, as the case may be, notify the other Party of such Dispute and the Parties shall seek to resolve the Dispute by mutual consultation. If the Parties fail to resolve the Dispute by mutual consultation within 15 (fifteen) days of the date of such notice then the disputing Party shall withhold payment of such disputed amount till the resolution of such Dispute pursuant to Clause 35 (Dispute Resolution). Provided that, the disputing Party shall duly make payment of the undisputed amount in accordance with this Clause 24 (Terms of Payment).

(l) The Client shall withhold sums equivalent to taxes at applicable rates on the amount payable to the Contractor by way of consideration under the Contract in accordance with the provisions of the Income Tax Act, 1961, as amended or modified and applicable. The Client shall not make such withholdings in the event that the Contractor produces a certificate from the appropriate authority constituted under the Indian Income Tax laws to the effect that no withholding taxes would be required on the payments received by the Contractor from the Client.

(m) The Contractor shall adhere to the directions of the Client, Project Manager and/or the Architect, as the case may be in terms of the provisions laid down in the Contract.

24.5. **Client's Claims**

(a) If the Client considers itself to be entitled to any payment under any Clause of the Contract or otherwise in connection with the Contract, and/or to any extension of the Defect Liability Period in accordance with Clause 21, it shall, as soon as practicable after becoming aware of its claim or circumstances giving rise to such claim, provide the Contractor with notice and particulars of such claim. A notice relating to any extension of the Defect Liability Period shall be given before the expiry of such period.

(b) The notice for claim shall specify the provisions of the Contract which the Client relies upon or other basis of the claim, and shall include substantiation of the amount and/or extension to which the Client considers itself to be entitled in connection with the Contract. The Client shall then proceed to agree or determine (i) the amount (if any) which the Client is entitled to be paid by the Contractor, and/or (ii) the extension (if any) of the Defect Liability Period in accordance with Clause 21.

(c) The Client may deduct the amount due to it pursuant to such a claim from the Contractor, from any monies due, or that become due, to the Contractor or may issue a Miscellaneous Invoice with regard to such amounts.

25. SITE OFFICES, SECURITY AND FACILITIES

25.1. The Contractor shall supply and erect a well-lit, temporary Site office for use by it at its own cost, if required. The layout of the Site office, Drawing shall be as approved by the Client in consultation with the Project Manager. The Site office shall contain wash rooms, seating arrangement with furniture and good ventilation.

25.2. A fully furnished Site office to be provided to the Client and the Project Manager for total 10 (TEN) members crew for a period of 90 days beyond actual project completion date. The Site office to contain workstations, meeting/conference room, manager cabin, air conditioning, grid ceiling, chairs, flooring, washrooms, maintenance of wash rooms/office, tea and drinking water facility, projector, projector screen, walky talky, fridge, dining area, safety PPE (safety helmet, google, shoes (with steel toes), reflective vest, public address system, for the Client and Project Manager and their visitors.

25.3. No photos/CCTV shall be installed by the Contractor without prior written permission from the Client.

25.4. The Contractor shall deploy Site security team for material storage as well as for manpower movement at Site till the Take Over Certificate is issued by the Client. The Contractor security team should work closely with the Client and the Project Manager for maintaining the Site logistics.

26. SAFETY REQUIREMENTS

26.1. The Contractor shall comply with the safety precautions, protective measures, housekeeping requirements, etc. as set out in **Section 10**. The Client shall have the right to stop the work at Site, if in its opinion, proceeding with the Works will lead to an unsafe and dangerous condition. The Contractor shall get the unsafe condition removed or provide protective equipment. The Contractor shall ensure that all workmen are aware about the nature of risk involved in their work and have adequate knowledge for carrying out their work safely.

26.2. The instructions issued by the Client and/or the Project Manager pursuant to the Contract are indicative and not exhaustive. Therefore, the Contractor shall be responsible to ensure that adequate safety measures are adopted in the course of execution of the Works in accordance with the Contract in accordance with safety standards / statutory regulations, as applicable.

26.3. In case of any non-compliance by the Contractor of any of the provisions of this Clause 26 above would, without prejudice to any other remedy that the Client may be entitled to under Applicable Law or in the Contract or otherwise, the Client shall be entitled to impose an amount as compensation in its sole discretion.

27. LIMITATION OF LIABILITY

27.1. The total liability of the Contractor to the Client under or in connection with the Contract, shall not exceed the Contract Price, provided that, this limitation shall not apply to any obligation of the Contractor to:

(a) pay liquidated damages to the Client in accordance with Clause 10;

(b) indemnify the Client in accordance with the provisions of the Contract;

(c) pay the indemnity amount that may be payable under Clause 28.2; or

(d) pay for losses caused due to the Contractor's gross negligence, fraud or willful misconduct.

27.2. **No Consequential Loss**

Notwithstanding anything to the contrary, except in cases of payment to be made pursuant to Clause 27.1., neither the Contractor nor the Client shall be liable to the other, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, provided that, this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Client.

28. INDEMNITY

28.1. **General:** The Contractor shall protect, defend, indemnify and hold the Client, and their directors, key managerial personnel, employees, agents and representatives harmless from and against:

(a) any and all losses, damages, costs, expenses (collectively "**Losses**") incurred by reason of the acts or omissions of the Contractor, its officers, directors, employees, in the performance of the Contract or execution of Works, including without limitation any and all Losses, arising directly or indirectly from or incurred by reason of any failure of the Contractor or any Sub-Contractor (i) to pay any taxes, duties, cesses etc. required to be paid by such person, (ii) to make any payments in respect of taxes, duties, cesses which are to be paid by such person in connection with the performance of its obligations relating to the Contract, (iii) any such Losses arising from injury to or death of third parties or damage to or loss of property of third parties;

(b) any and all Losses, incurred by reason of or arising from claims or sanctions or penalties imposed by any Governmental Authorities or others for any actual or asserted failure by the Contractor, Sub-Contractor(s) or any of their respective officers, directors, employees to comply with any Applicable Laws;

(c) any and all Losses, arising directly or indirectly from or incurred by reason of the Works being undertaken at the Site post Completion Date;

(d) any damage caused by the Contractor to the Site;

(e) all Contractor and/or Sub-Contractor employee claims, failure of Contractor or its Sub Contractors to comply with Applicable Law and Prudent Industry Practices and liability for any hazardous substances claims; and

(f) any and all Losses, arising directly or indirectly as a result of any violation of any patents, design rights, trademark or copyright, confidentiality and other protected rights arising in connection with the Contractor's Equipment or in the course of the completion of the Works; and

(g) any and all Losses, damages, costs, expenses, claims, demands, proceedings, or liability however arising against or incurred by the Client relating to the Project due to or arising from or contributed to by any act, omission or default on the part of the Contractor.

28.2. **Zero Fatality Rate at Site**

(a) The Contractor acknowledges that having a zero fatality rate at the Site is important for the Client and a material requirement of the Safety Requirement. If the Contractor does not take all safety precautions and/or fails to comply with the Safety requirement or the Applicable Laws for the safety at the Site while performing its obligations under the Contract, then without prejudice to the provisions of Clause 28.1 or any other obligation of the Contractor under the Contract, the Contractor shall pay to the Client:

(i) a sum of [INR 10,00,000 (Rupees ten lakh only)] in case of death of any workman/employee at the Site; and

(ii) a sum of [INR 2,50,000 (Rupees two lakh fifty thousand only)] in case of permanent disability of any workman/employee at the Site,

in each case occurring during the course of the Contract.

(b) The Contractor shall pay such amounts to the Client, immediately upon a demand being made for the same, but in no event later than the time period prescribed in Clause 24.4.(g) for payment of a Miscellaneous Invoice. The Parties agree that such amounts received by the Client from the Contractor shall be paid by the Client to the family of such deceased workman/employee or such disabled workman/employee. The compensation mentioned in this Clause 28.2. is in addition to the compensation payable to the workman under the relevant provisions of the Employee's Compensation Act, 1923 and rules framed there under or any other Applicable Law.

28.3. **Proceedings**

On receipt of any notice of any claim from any third Party, which would entitle any Party ("**Indemnified Party**") to claim indemnification from the other Party ("**Indemnifying Party**"), the Indemnified Party shall within a reasonable time provide a written notice of the same to the Indemnifying Party along with all the documents available with it in respect of the said claim specifying in detail the claim, the amount claimed by the third Party, the date on which the claim arose and the nature of the default to which such item is related (including a reference to the applicable provision of the Contract). The Indemnifying Party shall be entitled to but not obliged to participate in and control the defense of any such suit, action or proceeding at its own expense or direct the Indemnified Party to defend such claim, at the

cost of the Indemnifying Party. If the Indemnifying Party elects to control the defense of any such suit, action or proceeding, the Indemnified Party shall render all necessary assistance including grant of access to premises and personnel and to relevant documents and records that it possesses or controls to the extent required by the relevant adjudicatory authorities or is necessary for the purposes of investigating the matter and enabling the Indemnifying Party to take the action referred to in this clause. The Indemnifying Party may also request the Indemnified Party, at the cost of the Indemnifying Party to dispute, resist, appeal, compromise, defend, remedy or mitigate the matter or enforce against the Third Party the Indemnifying Party's rights in relation to the matter and in connection with proceedings related to the matter or use reputable advisers and lawyers chosen by the Indemnifying Party. The Indemnified Party shall not settle any such suit, action or proceeding without the prior written consent of the Indemnifying Party.

28.4. **Payment of Indemnities**

Where a Party is entitled to payment from the other Party pursuant to this Clause 28, such Party shall promptly notify the other Party of the same and issue a Miscellaneous Invoice. The other Party shall make payment of such Miscellaneous Invoice in accordance with Clause 24.4.(g).

29. CONFIDENTIAL INFORMATION

29.1. Each Party shall treat as confidential, the other Party's information consisting of specifications, designs, plans, drawings, software, data, prototypes, or other business and/or technical information, methodologies, know-how, processes, quotations, which such party discloses to the other party ("**Information"**).

29.2. Each Party agrees that for a confidentiality period beginning on the date of execution of the Contract and ending 2 (two) years from the termination of the Contract, the receiving Party shall use information only for the purpose of the Contract ("**Purpose**"), shall hold information in confidence using the same degree of care as it normally exercises to protect its own proprietary information, but not less than reasonable care, taking into account the nature of the information, and shall grant access to Information only to its employees who have a need to know, shall reproduce Information only to the extent essential to fulfilling the purpose, and shall prevent disclosure of information to third parties. The receiving Party may, however, disclose the Information to its consultants and contractors with a need to know; provided that by doing so, the receiving Party agrees to bind those consultants and contractors to terms at least as restrictive as those stated herein, advise them of their obligations, and indemnify the disclosing party for any breach of those obligations.

29.3. Upon the disclosing Party's request, the receiving Party shall either return to the disclosing Party all Information or shall certify to the disclosing Party that all media containing Information have been destroyed.

29.4. The foregoing restrictions on each Party's use or disclosure of Information shall not apply to information that the receiving Party can demonstrate:

(a) was independently developed by or for the receiving Party without reference to the information, or was received without restrictions; or

(b) has become generally available to the public without breach of confidentiality obligations of the receiving Party; or

(c) was in the receiving Party's possession without restriction or was known by the receiving party without restriction at the time of disclosure; or

(d) is required to be disclosed pursuant to legal or administrative requirement for disclosure; provided that the receiving Party has given the disclosing Party prompt notice of such demand for disclosure and the receiving Party reasonably cooperates with the disclosing Party's efforts to secure an appropriate protective order.

30. INTELLECTUAL PROPERTY RIGHTS

30.1. All designs, Drawings, specifications, data, Documents, reports, studies, manuals, programs, analyses and all other items produced by the Contractor or the Sub-Contractors or the suppliers in the performance of the Works (herein collectively referred to as the "**Work Product**"), shall become and remain the property of the Client, and the Contractor shall deliver the same (properly sorted and indexed) to the Client in accordance with the provisions of the Contract and in any event upon termination of the Contract. For the avoidance of doubt, the Parties acknowledge and agree that the Drawings and plans, and all ELECTRICAL AND ELV and construction plans and Drawings relating to the Project, are the Client's property.

30.2. The Contractor hereby irrevocably assigns to the Client any rights it may have or acquire in (and waives and will require each supplier, vendor and Sub-Contractor to waive all "moral rights" it may have with respect to) any and all such Work Product.

30.3. The Contractor shall save harmless and indemnify the Client from and against all claims and proceedings for or on account of infringement of any intellectual property rights including patent rights, designed trademark or name or other protected rights in respect of any constructional plant, technology, design, machine work, or Material used for or in connection with the Works or any of them and from and against all claims, proceedings, damages, cost, charges and expenses whatsoever in respect thereof or in relation thereto. Except where otherwise specified, the Contractor shall pay all tonnage and other royalties, rent and other payments or compensation, if any, for any document/materials required for the Works.

30.4. **Ownership of Documents**

All Documents and other documents prepared by the Contractor and used in the performance of the Works shall be the property (including all intellectual property rights vested in the documents prepared by the Contractor for the purposes of the development of the New admin. & Engg. Block) of the Client. The Contractor shall supply to the Client all such Documents and other documents, as well as any drawings, specifications, calculations, memoranda, data, notes and other materials at the earlier of Final Acceptance or termination of the Contract. The Client shall have the right to copy, use, transfer and communicate the documents for the purposes of completing, operating, maintaining, altering, adjusting, or repairing the New admin. & Engg. Block.

30.5. **Use of Drawings by Contractor**

The Contractor shall be entitled to retain a reproducible set of all Drawings and Documents and other documents delivered to the Client by the Contractor in accordance with the Contract. Provided that the Contractor shall not at any given point of time use the information provided in such documents or such documents for any purpose other than the completion of the Works.

30.6. **Royalties and License Fees**

The Contractor shall pay all required royalties and license fees with respect to proprietary rights, intellectual property licenses and agreements and shall procure (at its cost), as required, the appropriate proprietary rights, intellectual property licenses and agreements for materials, methods, processes and systems in accordance with the provisions of the Contract. The Contractor shall not incorporate any materials, methods, processes or systems that involve the use of any Confidential Information, intellectual property or proprietary rights that the Client does not have the right to use or that may result in claims or suits against the Client or the Contractor arising out of claims of infringement of any domestic or foreign patent rights, copyrights or other proprietary rights, or applications for any such rights, or use of Confidential Information.

31. FORCE MAJEURE

31.1. Except as otherwise specifically provided in the Contract, neither Party shall be liable to the other Party or be deemed to be in breach of the Contract by reason of any delay in performing or observing, or any failure to perform or observe, any of its obligations under the Contract, if the delay or failure was due to any event or circumstance which is not

within the reasonable control, of the Party, and with the exercise of due diligence, was not reasonably foreseeable and could not reasonably be prevented, avoided or removed by such party ("**Affected Party**") through the exercise of reasonable skill or care, and does not result from the Affected Party's negligence or the negligence of its agents, employees or Sub-Contractors, which causes the Affected Party to be delayed, in whole or in part, or unable to partially or wholly perform its obligations under the Contract ("**Force Majeure Event**"). Force Majeure Event shall include:

(a) acts of God, fire, flood, lightning, storm, typhoon, hurricane, tornado, earthquake, epidemics, or other natural disaster;

(b) act of Government Authority which makes the performance of obligations under the Contract to be impossible for either Party;

(c) event of war (whether declared or not), invasion, act of foreign enemy, hostilities, revolution, rebellion, terrorism, insurrection, military, usurped power, mutiny or civil war.

For the avoidance of doubt, it is clarified that insufficiency of finances or funds or any obligation for the payment of money or the Contract becoming onerous to perform shall not be a Force Majeure Event.

31.2. The Affected Party shall give notice to the other Parties of any Force Majeure Event as soon as practicable, but not later than 7 (seven) days after the date on which such Party becomes aware of the occurrence of the Force Majeure Event or should reasonably have known of the commencement of the Force Majeure Event. If an event of Force Majeure results in a breakdown of communications rendering it unreasonable to give notice within the applicable time limit specified herein, then the Affected Party shall give such notice as soon as reasonably practicable after reinstatement of communications, but not later than 1 (one) day after such reinstatement.

31.3. The notice of occurrence of a Force Majeure Event shall be a pre-condition to the Affected Party's entitlement to claim relief under the Contract. Such notice shall include full particulars of the event of Force Majeure, its effects on the Party claiming relief and the remedial measures proposed. The Affected Party shall give the other Party regular reports on the progress of those remedial measures and such other information as the other Party may reasonably request about the Force Majeure Event.

31.4. The Affected Party shall give notice to the other Parties of:

(a) the cessation of the relevant Force Majeure Event; or

(b) the cessation of the effects of such Force Majeure Event, on the performance of its obligations under the Contract.

31.5. To the extent not prevented by a Force Majeure Event pursuant to Clause 31, the Affected Party shall continue to perform its obligations under the Contract. The Affected Party shall use its reasonable efforts to mitigate the effect of any Force Majeure Event as soon as practicable.

31.6. Subject to Clause 31.3, the Affected Party shall not be responsible or liable for failure to perform its obligations under the Contract, if such failure is due to a continuing Force Majeure Event, provided that a Force Majeure Event shall not release the Affected Party of its obligations to perform the other obligations, which are unaffected by such Force Majeure Event.

31.7. For avoidance of doubt, no Party's obligation to make payments of money due or payable prior to occurrence of the Force Majeure Events under the Contract shall be suspended or excused due to the occurrence of a Force Majeure Event in respect of such Party.

32. CHANGE IN LAW

32.1. For the purpose of the Contract, the term "**Change in Law**" shall mean the occurrence of any of the following events after the Execution Date, resulting into any increase or decrease in the Contract Price:

(a) the enactment, coming into effect, adoption, promulgation, amendment, modification or repeal (without re-enactment or consolidation) in India, of any Applicable Law, including rules and regulations framed pursuant to such Applicable Law;

(b) a change in the interpretation of any Applicable Law by any Government Authority having the legal power to interpret or apply such Applicable Law;

(c) the imposition of a requirement, for obtaining any applicable approvals/licenses/ permits which were not required earlier;

(d) a change in the terms and conditions prescribed for obtaining any approvals/licenses/ permits required by a Party for the performance of its obligations under the Contract or the inclusion of any new terms or conditions for obtaining such approvals/licenses/ permits;

(e) any change in tax or introduction of any tax made applicable for performance of the Works as per the terms of the Contract.

For the avoidance of doubt, it is clarified that any revision to the Contract Price or the Completion Date would be restricted to direct transactions between the Parties.

32.2. If the Contractor is affected by an incident of Change in Law and considers itself eligible for relief for such Change in Law, then, it shall give notice to the Client and the Project Manager of such Change in Law, along with the documentary evidence, if any, establishing the impact of such Change in Law. The notice served pursuant to this Clause 32 shall provide, amongst other things, precise details of:

(a) the Change in Law;

(b) effect on the Contractor;

(c) adjustment required in the Contract Price.

32.3. If after the date of issuance of the Letter of Award, there is a Change in Law, due to which the Completion Date needs to be changed, the same shall be revised reasonably in accordance with Clause 7.2, to the extent that Contractor has thereby been affected in the performance of any of its obligations under the Contract.

32.4. If the Parties fail to agree upon a revision to the Contract Price, the matter shall be referred to an internationally recognized firm of auditors, mutually acceptable to the Parties. If the Parties cannot agree on a firm of auditors, then the Client shall appoint an internationally recognized firm of auditors. The said firm of auditors, shall within 10 (ten) days of such appointment, make a determination as to such proposed revision, which determination shall be binding on the Parties.

33. SUSPENSION

33.1. **Suspension of works:**

The Contractor confirms and acknowledges that the Client shall have the right to, by giving a 1 (one) day prior written notice to the Contractor, with the previous approval of the Client, direct the Contractor to suspend the progress of the Works or any part thereof for such time and in such manner as the Client may consider necessary and shall during such suspension require the Contractor to properly protect and secure the Works, so far as is necessary in the opinion of the Client. The extra cost incurred by the Contractor in giving effect to the instructions of the Client under this Clause shall be borne by the Client unless such suspension is:

(a) otherwise provided for in the Contract, or

(b) necessary by reason of some default on the part of the Contractor, or

(c) necessary by reason of climatic conditions on Site, or

(d) necessary for the proper completion of the Works or for the safety of the Works or any part thereof in so far as such necessity does not arise from any act or default by the Project Manager or the Client.

Provided that the Contractor shall not be entitled to recover any such extra cost unless it gives written notice of its intention to claim such costs to the Client and the Project Manager within 15 (fifteen) days of the order of the Client. The Client shall settle and determine any extra payment and/or extension of time under to be made to the Contractor in respect of such claim in accordance with the provisions of the Contract.

33.2. **Suspension of Work**

The Contractor shall, on the instructions of the Client and/or the Project Manager, suspend the progress of the Works or any part thereof for such time and in such manner as the Client and/or the Project Manager may consider necessary and shall, during such suspension, properly protect and secure the Works or such part thereof so far as is necessary in the opinion of the Client and/or the Project Manager.

33.3. The Project Manager shall after due consultation with the Client and the Contractor, determine any extension of time to which the Contractor is entitled on account of such suspension.

34. TERMINATION

34.1. The Contract may be terminated by the Client by issuing a written notice of 7 (seven) days to the other Parties upon occurrence of the any of the following events:

(a) any breach of the terms of the Contract and/or Applicable Law which breach has not been rectified by the Contractor within 7 (seven) days of issuance of notice by the Client; or

(b) if the Contractor fails to complete the Works by the Completion Date.

34.2. The Client shall have the right to terminate the Contract forthwith if the Contractor becomes insolvent or an order is made or a resolution passed for the liquidation, administration, winding-up, bankruptcy or dissolution of the other Party (otherwise than for the purposes of a solvent amalgamation or reconstruction) or an administrative or other receiver, manager, trustee, liquidator, administrator, insolvency resolution professional or similar officer is appointed over all or any substantial part of the assets of the Contractor or the Contractor enters into or proposes any composition or arrangement with its creditors generally or anything analogous to the foregoing occurs in any applicable jurisdiction.

34.3. Expiry or termination of the Contract shall not relieve the Parties of their obligations due up to the time of such expiry or termination, nor shall such expiry or termination prejudice any claim of either Party that has already accrued prior to such expiry or termination.

34.4. If the Client elects to terminate the Contract pursuant to Clause 34, the Client shall be entitled (but not obliged) to complete the remaining Works either by itself or by any other contractor on account of and at the risk and cost of the Contractor. If the Client decides to complete the remaining Works, it shall be entitled to recover the cost and other charges associated with such completion from the Contractor. In all cases, and irrespective of whether the Client decides to complete the remaining Works, the Client shall be entitled to recover all costs, expenses or losses flowing from the termination from the Contractor.

34.5. The Contractor shall, at Client's request and at Contractor's cost and expense, perform the following services in relation to the Works so affected:

(a) cease all further Works which is the subject of the termination, except such Works as Client may specify in the termination notice for the sole purpose of protecting that part of the Works already executed;

(b) assist the Client in preparing an inventory of all equipment in use or in storage at the Site;

(c) assign to the Client or to any replacement contractor designated by Client, without any right to compensation, title to all Works not already owned by Client, together will all subcontracts and other contractual arrangements (including warranties) as may be designated by Client, all of which subcontracts and contractual arrangement shall be so assignable and assign to Client;

(d) remove from the Site all such Contractor's equipment and materials and waste material as the Client may request; and

(e) deliver to Client all design and other information in the possession of the Contractor as may be requested by Client for the completion of the Works.

34.6. The Parties agree that in the event of termination of the Contract, the Client shall pay to the Contractor the Contract Price proportionate to the Works completed by the Contractor to the Client's satisfaction by the date of termination.

35. GOVERNING LAW AND DISPUTE RESOLUTION

35.1. The Contract including all questions concerning the construction, validity and interpretation of the Contract will be governed by the laws of India. Subject to Clause 35.2 below, the courts at Gautam Buddh Nagar, Uttar Pradesh, India shall have exclusive jurisdiction on any matter arising under the Contract.

35.2. The Parties shall amicably resolve by mutual discussions any and all controversy, claim, differences or disputes arising out of or in connection with the Contract including any question regarding its existence, validity, invalidity, breach or termination ("**Dispute**"), failing which the Disputes shall be settled by arbitration in accordance with provisions of the Indian Arbitration and Conciliation Act, 1996. The arbitral tribunal shall consist of 1 (one) arbitrator. The seat for arbitration shall be Gautam Buddh Nagar, Uttar Pradesh, India and the language for arbitration shall be English. Any arbitral award shall be final and binding on the Parties.

35.3. The Contract and the rights and obligations of the Parties contained in the Contract shall remain in full force and effect pending issuance of the award in such arbitration proceedings, which award, if appropriate, shall determine whether and when any termination shall become effective.

36. **MISCELLANEOUS**

36.1. **Notices**

Any notice and other communications provided for in the Contract shall be in writing and shall be transmitted by e-mail or registered post or courier service in the manner as elected by the Party giving such notice to the following addresses:

In the case of notices to the Client:
Attn: [__]
Add: [__]
Email: [__]

In the case of notices to the Project Manager:
Attn: [__]

Add: [__]
Email: [__]

In the case of notices to the Contractor:
Attn: [__]
Add: [__]
Email: [__]

Any Party may, from time to time, change its address or representative for receipt of notices provided for in the Contract by giving to the other prior written notice.

36.2. **Waiver**

Waiver by a Party of any default by the other Party(ies) in the observance and performance of any provision of or obligations under the Contract:

(a) shall not operate or be construed as a waiver of any other or subsequent default hereof or of other provisions or obligations under the Contract;

(b) shall not be effective unless it is in writing and executed by a duly authorised representative of such Party;

(c) shall not affect the validity or enforceability of the Contract in any manner.

Neither the failure by a Party to insist on any occasion upon the performance of the terms, conditions and provisions of the Contractor any obligation hereunder nor time or other indulgence granted by a Party to the other Party shall be treated or deemed as waiver/breach of any terms, conditions or provisions of the Contract.

36.3. **Survival**

Termination of the Contract (a) shall not relieve the Parties of any obligations already incurred hereunder which expressly or by implication survives termination hereof, and (b) shall not relieve a Party of any obligations or liabilities for loss or damage to the other Party(ies) arising out of or caused by acts or omissions of such Party prior to the effectiveness of such termination or arising out of such termination.

36.4. **Partial Invalidity**

If any provision of the Contract is held to be invalid or unenforceable to any extent, the remainder of the Contract shall not be affected thereby, and each provision of the Contract shall be valid and enforceable to the fullest extent permitted by applicable law. Any invalid or unenforceable provision of the Contract shall be replaced with a provision which is valid and enforceable and most nearly reflects the original intent of the unenforceable provision.

36.5. **Amendments**

Subject to the terms of the Contract, no modification or amendment to the Contract shall be valid or binding unless made in writing and duly executed by all the Parties.

36.6. **Cost**

Except as otherwise provided in the Contract, each Party will bear its own costs and expenses incurred in connection with the preparation and execution of the Contract and for performance of transactions contemplated hereunder including any accounting, tax, legal and other advisors' expenses and expenses.

36.7. **Further Assurances**

Each Party will, at its own respective cost and expense, execute and do (or procure to be executed and done by any other necessary party) all such deeds, documents, acts and things as may be required from time to time or as may be necessary to give full effect to the Contract or for performance of its obligations under the Contract or for compliance with the provisions of Applicable Law.

36.8. **No Partnerships**

Nothing contained or implied in the Contract shall constitute or be deemed to constitute a partnership or agency between the Parties and none of the Parties hereto will have any authority to bind, commit or make any representations on behalf of the other Party(ies).

36.9. **Anti-Corruption**

(a) The Parties shall not, and shall ensure that their respective Affiliates, officers, agents, directors and representatives shall not, in the course of conduct of performance of their obligations under the Contract: (i) the (Indian) Prevention of Corruption Act, 1988, or any other applicable anti-bribery or anti-corruption laws under any Applicable Law; or (ii) offer, pay, promise to pay, or authorize the payment of any money, or offer, give, promise to give, or authorize the giving of anything of value, to anyone, including Public Officials, either directly or indirectly, to improperly influence official action or obtain an improper advantage. This includes acting through a third party under circumstances where the Parties (or their respective Affiliates, officers, agents, directors and representatives) know, or are aware of circumstance that may cause a significant risk, that all or a portion of such money or thing of value would be offered, given or promised to anyone, including a Public Official, for the purpose of:

(i) improperly influencing any act or decision of such Public Official in his official capacity;

(ii) inducing such Public Official to do or omit to do any act in relation to his lawful duty;

(iii) securing any improper advantage; or

(iv) inducing such Public Official to influence or affect any act or decision of any Government Authority;

(v) (any such payment, a "**Prohibited Payment**"), provided that Clause 36.9 shall not apply to any payment that is permitted by Applicable Law.

(b) For the purposes of this Clause 36, the term "**Public Official**" means any officer or employee of a government, public entity or public international organization (including any department, or agency thereof or any government-owned or controlled entity including state-owned enterprises), or any person acting in an official capacity for or on behalf of a government or public international organization.

Each of the Parties shall, and shall procure that each of their respective Affiliates, officers, agents, directors and representatives shall, promptly report to the other Party any Prohibited Payment of which they obtain knowledge, become aware of, or which they have reasonable grounds to believe has occurred during the term of the Contract.

37. Priority of Documents

The documents forming the contract are to be taken as mutually explanatory of one another, for the purpose of interpretation, the priority of the documents shall be in accordance with the following sequence:

a. The contract Agreement
b. The Letter of Intent
c. The Letter of Tender
d. GCC

e. Schedule of quantities and rates
f. The specifications
g. The Drawings
h. The schedules and any other documents forming part of the Contract.

SECTION: 5

FISCAL ASPECTS

SCHEDULE OF FISCAL ASPECTS

Description	**Schedule of Fiscal Aspects.**
Location Of work	Engineering & Admin Block Project at Galgotias University, Yamuna Expressway, Greater Noida, Uttar Pradesh
Scope of Work	Main Scope: The detailed Scope for execution shall conform to the BOQ, Technical specification and drawings for the ELECTRICAL & ELV works. This Contract is re measurable Item rate contract and all the scope as per the drawings/tender/attached annexure shall be included. The quoted rates hold firm for the entire work plus the period up to the settlement of final bill. No escalation will be entertained towards labor, materials, petrol, diesel and or any such account.
Type of Contract	Item rate & Re-measurable type of contract.
Escalation	This is a fixed price contract with all rates being firm till completion of project and no escalation is admissible on any item, for any reason.
Date of Commencement	Immediate from the date of issuance of LOI/Work Order.
Contract Construction Period	Commencement of work: Immediate from the date of issuance of LOI. Total time for the completion of all works under the scope of this contract and handover shall be 10 (Ten) Calendar months form the date of issuance of LOI including final handing over and de-snagging. Contractor shall submit a detailed Construction programme in the form of bar-chart for major milestones along with resource loading.
Mobilization Advance	10% of Contract Value against an irrevocable bank guarantee as prescribed in the tender form for equivalent value and recoverable 12.5% basis from 2nd RA bills however 100% mobilization will be recovered once the value of work done reached of 80% of contract value.
Payment cycle	The owner, after submission of bill from Contractor and recommendation from the Project Manager, shall pay 100% of the bill amount to the Contractor. This payment shall be released within 30 (Thirty) working days (10 days for PMC + 20 Days for client) from the date of application for payment from Contractor; if the Project Manager disputes any items shown on the application for payment or the Owner disputes on the certificate for payment, the Project Manager shall bring the disputed items to the attention of the

	Contractor, and within said time period, the Owner shall pay the amount of such application for payment that is not in dispute.
Payment terms	The Terms of payment shall be as follows: - 10% against submission of shop drawings on Pro-rata basis 50% against supply on Pro-rata basis 15% against installation on pro-rata basis 15% against testing and commissioning at site on pro-rata basis 10% after handing over the work.
Amount of Liquidated Damage	Time is the essence of the contract. If the works are not completed within 10 months' time, liquidated damages of 1% of the Contract Value per week will be deducted, subject to a maximum of 5% of the contract value, after which the contract can be terminated at the option of M/s. Galgotias University, Plot No 2, Sector 17A, Yamuna Expressway, Opp Budha International Circuit, Greater Noida, Uttar Pradesh – 203201.
Defects Liability Period	12 months from the date of issuance of Final Completion Certificate.
Performance Guarantee	5% of the Accepted Contract Amount, within 7 days of issue of Agreement, and shall be released upon successful completion of Defect Liability Period.
Performance Bonus	If works completed within 10 (Ten) calendar months form the date of issuance of LOI, bonus of 1% of the contract value will give to the contractor
Percentage of retention	5% from each certified or an unconditional, irrevocable and divisible bank guarantee from any nationalized bank of the equal amount. 50% retention money shall be released upon the issuance of final completion certificate against unconditional, irrevocable and divisible bank guarantee from any nationalized bank of the same amount and balance 50% shall be released at the end of Defect Liability Period.
Bank Guarantees	The bank guarantees required to be submitted by the successful contractor shall be as per the forms and formats provided by Client. Only bank guarantees drawn from nationalized banks shall be accepted
Insurance	The contractor will take Contractors All Risk Insurance (CAR) Policy in our joint name for the full contract value together with the value of material supplied by M/s. Galgotias University, Plot No 2, Sector 17A, Yamuna Expressway, Opp. Budha International Circuit, Greater Noida, Uttar Pradesh – 203201 In addition to the above you should also take • Workmen Compensation Insurance for your direct workmen and your subcontractor's Labour. • Group Personnel Accident Insurance to your staff. • Third party liability insurance.

	Personal Injury: You will take insurance policy for a value as may be required subject to an individual limit of Rs.1.00 lakh per person per incident
Price for Extra Items	The accepted rates in the schedule of quantities will apply for the entire project. Any item of work which is not covered in the schedule of quantities shall be paid as per the actual cost of materials, Labour, 2% (will be towards tools, cartage, power, and water) and 15% (towards all overheads and profits), provided the same cannot be derived from quoted rates from similar comparable items. It is to be clearly understood that claims for extras of any nature will not be entertained unless such extras are duly authorized by project manager in advance
Taxes & Duties	The rate shall include all customs duties and Excise Duties, taxes, like sales tax any other direct or indirect taxes (if applicable) works contract tax, GST, entry tax etc. There shall be no extras on any account whatsoever, excluding the statutory variations after award of contract.
ESI and PF	The accepted rates are inclusive of ESI and PF as applicable
Statutory Compliance of State & Central Government and Local Municipal Authorities	Following Statutory compliance obligations shall be performed during the entire Contract period without any failure. I. Labour License II. Provident Fund & ESI III.GST VI. Other compliances changes from time to time as per State and Central Government.
Construction Related Statutory Compliances	Shall be arranged by the Contractor at no additional cost to the Client.
Construction Water	Construction Water will be provided by the client free of cost at one point, the contractor must make his own arrangements for distribution at the site at his own cost.
Construction Electricity	There will be a charge for electricity provided by the client, and the contractor will install a sub-meter to measure the amount of electricity consumed. The contractor is responsible for making his own arrangements for the supply and distribution of electricity as part of the work that he is undertaking. The Contractor shall be responsible for ensuring that uninterrupted power supply is provided for their works by installing silent DG sets at their own expense as required.
Safety, Health, and Environment	Contractor shall adhere to all Health and Safety standards as issued by the Bureau of Indian Standards, National Building Code, 1983 as required by Project Management Consultant / Owner regulations of local Authorities.
Labour	Adequate number of persons to the satisfaction of the Project Manger shall be provided. Statutory requirements of EPF, ESIC and all other applicable Labour legislations to be complied with; and monthly certification to that effect to be submitted.

	Duty allocation and Roaster control shall be contractor's responsibility
Sanitary	The Contractor shall make all arrangements till completion of Project for sanitary and storm sewer arrangements as required and shall make all necessary payments directly to appropriate departments. The Contractor shall arrange to provide the Contractor's subcontractor, these facilities at no additional cost to the owner.
Contractors Conditions	Apart from those stated in the above provisions, no other conditions of the Contractors shall be acceptable
Storage, Safe Custody & Protection of Finished items	Rent free space will be provided at the site. The cost of construction of store, security etc. will have to be arranged by the contractor
RA Bills	The RA bill in triplicate shall be submitted by 1st week of every month to the Project Manager along with all supporting documents. Only one bill per 30 days shall be admitted. Bill/Invoice submitted by the contractor shall be strictly as per the format prescribed by the Project Manager. Bills will not be accepted/ received by the Project Managers if bills are not in the correct format as prescribed by the Project Managers or are not presented along with material invoices/ delivery challans, measurement sheets, rate analysis etc. The final bill shall be accompanied with all necessary and relevant handover/closure documents.
Final Bill	Within 45 days of Final completion of works and submission of handing over documents duly signed by the Architect/Project Manager/Client.
Correctness of Measurement.	In case measurements submitted with bills are found to contain incorrect information, the bill would be returned and would be admissible only with the next bill after correction of all measurements. The correct information shall be as per defined norms of measurement or generally accepted practices; any queries shall be discussed and clarified during project pre-Commencement meeting.
Weekly meetings/Monthly Meeting	The Project Manager will hold and preside over weekly progress meetings at the site. The scheduling of such meetings will be arranged by the Project Manager in advance or set up on a regular basis at a set time. Senior Management of Contractor shall be part of Monthly meeting arranged by Project Manager.
Billing Address/Shipping Address	M/s. Galgotias University, Plot No 2, Sector 17A, Yamuna Expressway, Opp Budha International Circuit, Greater Noida, Uttar Pradesh – 203201

SECTION: 6
SPECIAL CONDITIONS OF CONTRACTS

SPECIAL CONDITIONS OF CONTRACT FOR ELECTRICAL WORKS

1. GENERAL:

These special conditions are meant to amplify the specifications and General Conditions of Contract. If any discrepancy is noted among these Special Conditions, General Conditions of Contract, Specifications, Schedule of Quantities and Drawings, the most stringent of the above shall apply, should there by any ambiguity or inconsistency, the contractor should report the same to the Architect/ Project Manager/ Owner and obtain clarification before submitting the tender. Contractor to collect General Conditions of Contract and Schedule of Fiscal Aspects from the Owner/ project manager/ architect.

2. SCOPE OF WORK:

The work to be carried out under this contract comprises of internal and external electrical installation of the project as called in the tender documents. The Electrical Contractor shall include for the supply of the whole of the materials in accordance with the Specifications and the whole of the work of fixing necessary for the complete installation as set out in these Specifications and with the accompanying schedule and drawings, commencing from the supply authority's terminals. This also include any material, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and Customary to make the installation complete in all respects. In general the work to be performed under this contract shall comprise supply, installation, testing & commissioning of the following:-

a. All conduit work including junction boxes, outlet boxes, wiring & earthing for lighting & power.
b. All conduit work including junction boxes, outlet boxes & wiring for LV systems such as voice, data, fire alarm, paging, CCTV, Access control & MATV etc.
c. Switches, plug sockets, cover plates and wiring accessories.
d. Emergency lighting, wiring, Inverter/UPS.
e. Substation, HT Switchgear and HT Cabling.
f. Mains and sub-mains between various distribution boards, cables, submain wiring, cable trays, Rising Mains & Bus Ducts.
g. Distribution Boards, Panels, meter boards & final DB's.
h. Earthing system.
i. Lighting Fixtures and Fans.
j. Lightning Arrestor System
k. External lighting, cabling, lighting fixtures and poles.
l. Center Battery System
m. Solar PV System
n. Training of owner's staff/representative.
o. Preparation of "As Built Drawings & Documents".

Note:- Some items may be supplied free of cost by the owners for installation, testing & commissioning. The entire work is to be carried out with the direction of & to the satisfaction of the owner /Project Manager/ Architect.

3. STANDARD OF WORK:

The work shall be carried out to the satisfaction of the Architect/Consultant/ Project Manager /Owner and in accordance with the latest regulations of the Local Electricity Supply Authority, Local chief Electrical Inspectorate, The Fire Insurance Company, insuring the building, Indian Electricity Rules and Regulations, National Building code, National Electrical code and the enclosed Specifications.

4. ABBREVIATIONS:

The following abbreviations have been used in the accompanying specifications, drawings and schedule of quantities:

RCCB stands for Residual Current Circuit Breaker
ELCB stands for Earth Leakage circuit Breaker
HRC stands for High Rupturing Capacity
G stands for gauge
GI stands for Galvanized Iron
MS stands for Mild Steel
AL stands for Aluminum
CU stands for Copper
CI stands for Cast Iron
PVC stands for Polyvinyl Chloride
A or Amp stands for Amperes.
V stands for Volts
KWH stands for Kilowatt hour
KV stands for Kilo Volts
LV stands for Low Voltage
LT stands for Low tension
HT stands for High tension
VCB stands for Vacuum Circuit Breaker
OCB stands for Oil Circuit Breaker
CSS stands for Compact Substation
VPI stands for Vacuum Pressure Impregnated
SLD stands for single line drawing/ diagram.
IEE stands for Institution of Electrical Engineers – London
IR stands for Insulation Resistance
IC stands for Iron Clad
IP stands for Ingress Protection
MCB stands for Miniature Circuit Breaker
MCCB stands for Moulded Case Circuit Breaker
MPCB stands for Motor Protection Circuit Breaker
ACB stands for Air circuit Breaker
CT stands for Current Transformer
PT stands for Potential Transformer
O/L stands for Over Load Relay
S/C stands for Short Circuit
SPP stands for Single Phasing Preventor
MV stands for Medium Voltage
SP stands for Single Pole
DP stands for Double Pole
TP stands for Triple Pole
TPN stands for Triple Pole and Neutral
FP stands for Four Pole

MDB stands for Main Distribution Board
DB stands for Distribution Board
SDB stands for Sub-Distribution Board
FDB stands for Final Distribution Board
MCC stands for Motor Control Centre
PCC stands for Power Control Centre
IS stands for Indian Standards
BIS stands for Bureau of Indian Standards
NEC stands for National Electrical Code
NBC stands for National Building Code of India
ECBC stands for Energy Conservation Building Code of India
BMS Building Management System
HVAC stands for Heating, Ventilation & Air Conditioning
NFPA stands for National Fire Protection Association of USA
PMC stands for Project Manager
SWG stands for Standard Wire Gauge
VFD stands for Variable Frequency Drive
PLC stands for Programmable Logic Controller
ATS stands for Automatic Transfer Switch
OLTC stands for On Load Tap Charger
EDO Electrically Operated Draw Out
MDO Manually Operated Draw Out
CPCB Stands for Central Pollution Control Board
BOQ Stands for Bill of Quantities (Schedule of Quantities)

5. FEES AND PERMITS:

The contractor shall obtain and pay for all fees and permits required for the installation and approval of the complete Electrical Installation. On completion of the work, the contractor shall obtain and deliver to the Architect/ Consultant/ Project Manager/ Owner, certificates of final inspection and approval by the Local Chief Electrical Inspectorate. All receipted amount shall however, be payable by the Owner on production of proof of payment.

6. SPECIFICATIONS AND SCHEDULE OF QUANTITIES:

The Specification and Schedule of quantities shall be considered as part of this contract and any work or materials shown in schedule and not called for in the specifications or vice versa, shall be executed as if specially called for in both.

7. TENDER DRAWINGS:

The tender drawings if enclosed with the tender documents are only for the purpose of guidance to the contractor. The exact level, location etc.is to be governed by the Architecture/ interior layouts. The data/ information provided in the tender drawings and documents are as exact as it could be secured, but its complete accuracy can not be guaranteed. The drawings indicate the general arrangement and broadly suggest the extent of work and route etc. Any change required to Co-ordinate this installation with other trades will have to be made without any extra cost to the owners. The contractor will have to assume and include every thing from supply of material to its execution, testing & commissioning to make the job safe & complete in all respects as per rules & regulations, building codes & govt. approving agencies.

8. GOOD FOR CONSTRUCTION DRAWINGS (GFC's):

The details and data provided in **"GFC"** drawings is as exact and correct as it could be possible but its complete accuracy and correctness is not guaranteed. Every effort is made to make the drawings as per site conditions and the requirement of building codes but the electrical contractor has to check the accuracy and adequacy of **"GFC"** drawings before start of work. The contractor must study site conditions, understand Owner's requirement and also cross-check that the GFC drawings issued meet electrical codes, electrical safety and all govt. requirements or not. Contractor must also check the electrical earthing & lightning arrestor scheme for correctness and safety. Contractor must also check electrical SLD and calculate and cross-check load balancing on the Main LT Panel's different sections, switch

gear rating and all the cable sizes. The electrical equipment layout plans must be checked for electrical safety and spacings as per electrical codes & requirement.

Any short coming noted in the design & GFC drawings and any variance from National Building codes, National Electrical code, Rules & Regulations of State Chief Electrical Inspectorate & Electrical supply company must be brought to the notice of the Architect/ Consultants/ Project Manager/ Owner in writing before the start of the work. The very purpose of preparation of shop drawings by contractor is to eliminate any error/ shortcoming in the design and the GFC's drawings prepared by the consultant.

9. SHOP DRAWINGS & FINAL WORKING DRAWINGS:

The Contractor after studying the Owner's requirement, site situation & constraints, specifications, schedule of quantities, tender drawings and good for construction drawings (if available or other wise) shall prepare and submit to Architects/ Project Manager/ Owner for comments/ approval on all the shop drawings & final working drawings required for completion of full job as per National Building Code, National Electrical Code, IEEE, requirement of Local Chief Electrical Inspectorate and the local electrical supply company including Owner's requirement. The contractor shall finally be responsible and accountable to Owner for correctness, accuracy, adequacy and safety of the complete electrical installation. The process of completing "The shop drawings & Final Drawings" shall be completed quickly with in the time frame of the project without causing any delay and before starting the actual execution work. No claims for extension of time shall be acceptable due to contractor's failure to produce right shop drawings at the right time in accordance with the approved programme of deliverables. All shop drawings to be prepared on the latest Architectural / Structural / Interior layouts, which are to be collected by the electrical contractor from the office of the Architect/Project Manager / Owner.

Following Shop Drawings & Final Working Drawings necessarily need to be prepared and submitted by the contractor:

a. LIGHTING & POWER CONDUITING LAYOUTS & DB CHARTS:

Lighting & Power Conduiting layout showing route with details on number, run & size of conduits, number of wires/ circuits to be carried thru conduits, location of junction boxes & pull boxes, circuit numbers, phase & load balancing of circuits, wire/ circuit/ point wire size sub main size. Complete DB Chart is to be submitted for each area/ Zone.

b. LV CONDUITING LAYOUTS:

Conduiting layout of LV systems such as voice/ data/ intercom, MATV, CCTV Fire detection & alarm, Paging, public address, music and access control etc. showing route, layout, size of conduits, number of wires to be carried thru conduits, location of junction boxes & pull boxes etc. to be submitted.

c. PANEL/ DISTRIBUTION BOARDS SHOP DRAWINGS:

Shop drawings/ GA drawings of all the panels/ distribution boards/ switch boards/ cabinets with SLD's and complete control wiring, power wiring and inter locking schemes and logics to be submitted.

d. HT & LT EQUIPMENT LAYOUT:

Layout plans with dimensions, clearances for Panel rooms, Substation & DG set area, Electrical rooms and LT Panel room areas.

e. BUS DUCTING LAYOUT:

Layouts of Bus ducting, its route with details of bends, fittings, supports and its co-ordination with other services.

f. RISING MAINS LAYOUT:

Layouts of Rising Mains, route with details of bends, fittings, supports and its co-ordination with other services.

g. CABLE TRAY/ TRENCH LAYOUT

Cable tray/ trench layouts with sizes of cable trays/ trenches, details on number/ run of various cables to be Laid on trays/ in trenches. Calculations showing cable tray sizing/ spacing need to be submitted with the cable tray/ trench layouts including cable tray supporting details. Complete cable schedule is also to be submitted.

h. EARTHING LAYOUT

Earthing Layout of the complete installation showing all the earth details like size of earth tapes/ wires & materials for each equipment & routing of earth tapes/wires. Also layout of earth pits is to be submitted.

i. LIGHTNING ARRESTOR LAYOUT

Lightning Arrestor Layout showing network of horizontal & vertical conductors, down takes, test boxes & earth pits location/ layout and sizing of earth tapes etc.

j. CONTROL SCHEMES AND INTER LOCKAING

Control Schemes and Inter Lockings for linkages with other systems such as BMS, HVAC & Fire Alarm / Paging Systems.

Drawings shall not be limited to the above only. All necessary drawings/ details required for satisfactorily execution of the job need to be included.

Electrical Contractor shall also to be Co-ordinating its drawings with other MEP Services & Site Plans before submitting to Owners/PMC.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

10. PRODUCT SAMPLES

Samples of the materials like conduits, accessories, switches, Sockets, wires & cables, light fixtures etc. shall be submitted to the Owners/ PMC prior to procurement. These will be submitted in two sets for approval and retention by Owners and shall be kept in their site office for reference and verification till the completion of the project.

11. MANUFACTURER'S CATALOGUES & DRAWINGS

Manufacturer's drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material to allow Architect/Consultant ample time for scrutiny.

12. TEST CERTIFICATES & TECHNICAL SUBMITTALS

Contractor shall submit to owners/Project manager, test certificates & technical data sheets of all the items covered in the scope of work before supply of the item.

13. MANUFACTURERS INSTRUCTIONS:

Where manufacturers have furnished specific instructions, relating to the materials used in this job and covering points not specifically mentioned in specifications & schedule of quantities, manufacturer's instructions shall be followed.

14. MATERIALS AND EQUIPMENT:

All materials and equipment shall be of the approved make and design. Unless otherwise called for only the best quality materials and equipment shall be used. The materials and equipment shall conform to relevant Indian standards. The contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Architect / Consultant/ Project Manager / Owner's within 15 days of he award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical data giving sizes, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitute the contractor shall state substitution be approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from the Architect/Consultants/ Project Manager / Owner's.

15. TOOLS AND TACKLES

The Contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, all transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Owner/PMC.

16. SAFETY OF MATERIALS:

The contractor shall provide proper and adequate storage facilities to protect all the materials and equipment, including those issued by the owner against damage from any cause whatsoever.

17. CO-ORDINATION

Contractor shall fully Co-ordinate & render all necessary support and assistance to other contractors for completion of all MEP & Civil/Interior works to satisfaction & safety. This work will involve close Co-ordination with HVAC, BMS, Plumbing & Fire Fighting contractor including Civil contractor. Electrical contractor to ensure necessary safety linkages with AHU fire dampers & fire detection systems. Electrical contractor shall be fully responsible & accountable for these life safety linkages. Nothing extra can be claimed for this co-ordination support.

18. COMPLETION & AS BUILT DRAWINGS & DOCUMENTS:

On the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Architect/ Project Manager/ Owners/ Consultant five sets of **"AS BUILT DRAWINGS & DOCUMENTS"** drawn at approved scale.

- Contractor to submit a complete write-up of the electrical and LV system installed along with interlocking and safety schemes.
- All the shop drawings & final working drawings need to be converted into "AS BUILT" drawings based on actual executed conditions.
- Technical documents will also have the test certificates, test reports **& IR results** for all the electrical equipment/ material used in the installation, which will need to be submitted in proper folders. All the final DB charts shall also be included in the completion documents.
- Technical catalogues, operation & maintenance manuals of the all the products & equipment used in installation also to be submitted in proper folders. List of recommended spares is also to be furnished along with schedule of preventive maintenance is to be submitted as part of completion documents.
- All the "AS BUILT" drawings, test reports, test certificates & DB Charts must be signed and stamped by the contractors Engineer-in -Charge and the supervisor, who was responsible for the execution, testing & commissioning of the installation.
- Contractor shall be responsible for the correctness of the **"AS BUILT DRAWINGS & DOCUMENTS"** and shall sign & stamp them.

19. GUARANTEE:

At the close of the work and before issue of final certificate of virtual completion, the contractor shall furnish written guarantee indemnifying the owners against defective materials and workmanship for a period of one year after testing & commissioning of the installation. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to owner the following:

a. Any defective work or material supplied by the Contractor.
b. Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

20. PERFORMANCE GUARANTEE

The contractor shall carry out the work in accordance with the Drawings, Specifications and other documents forming part of the contract.

The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required end result.

The contractor shall guarantee that the electrical system as installed shall perform to complete satisfaction of Owner's.

The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

21. CONTACTOR'S ENGINEER-IN-CHARGE & OTHER STAFF:

- The contractor shall employ competent, fully qualified, trained & experienced full time electrical engineer/ Engineer-In-Charge/ Site Engineer/ Project Engineer to direct the work of electrical installation in accordance with drawings and specifications. The engineer shall be available at all times on the site to receive instructions from the consultant / Owner / Architect/ Project Manager / Owner in the day-to-day activities throughout the duration of the contract. The Engineer shall correlate the progress of the work in conjunction with all relevant requirements of the supply authorities.
- The Contractor shall employ only qualified, trained, experienced and licensed Project Engineer, Supervisor, foremen, wiremen and electricians.
- At the start of project, contractor shall furnish a list of employees i.e. Project Engineer, Supervisor, Foremen, Wiremen, and Electricians to be posted on the site, clearly specifying their qualification, experience and along with copies of qualification and trade certificates and licenses to establish / prove the furnished data.
- These details / certificates / copies of licenses of employees to be posted at site must be submitted to Project Manager / Architect/ Owner.

22. CONTRACTOR'S LICENCE:

Contractor shall be in possession of a valid Electrical contractor's license (to be issued by state's chief electrical inspectorate) for carrying out electrical works of the nature specified in the schedule of quantities and scope of works.

Contactor must furnish / submit a copy of the license to Project Manager/ Architect / Owner before start of the work.

23. TESTS & TEST REPORTS

On completion of complete installation, contractor shall submit to PMC/ Owner a signed copy of test report of complete installation and assume full responsibility of its soundness and safety.

Contractor shall physically inspect every material before installation and shall also carryout all necessary electrical tests such as:

a. IR values of Panels, DB's, Boards, cabling, sub mains, circuit and point wiring.
b. Checking and recording earth continuity, earth values of earthing pits and earthing conductor and entire earthing system and lightning arrestor system. Contractor shall be responsible for the adequacy of the earthing and lightning arrestor system and shall consider the changes in the BOQ as may be required but with the approval of the owners / PMC / site in-charge before execution.
c. Testing of all the relays and testing of transformers, HT switchgear and DG set alternator.
d. Checking all the terminations at panels, DB's and at lighting fixtures and socket outlets for tightness.

e. It is to be ensured by the contractor and its staff that all wire connections / cable connections / lighting and socket connections are with proper sized lugs / thimbles.

f. Contractor and its staff must follow good engineering practices.

g. A complete log of all the tests shall be maintained for review of Project Manager / Owner / Consultant.

h. Contractor shall assume full responsibility of correctness and validation of all the tests.

i. Any equipments / wire / cabling found faulty during testing carried out by contractor will be removed / replaced by healthy system / equipment by the contractor at its own cost.

p. Contractor shall assume full responsibility of safety of installation and shall be liable to owners for any loss / damage due to faulty equipment selection/ undersized equipment/ wrong design/ faulty installation / poor work-man-ship / poor quality.

k. It is contractor's responsibility to cross-check all the design and drawings before execution and assumes full responsibility for the correctness and adequacy of all the designs and drawings and shall be responsible and accountable to Owner for any deficiency and shortcomings in the system design/ product design.

24. COMPLETION CERTIFICATE:

On completion of the electrical installation a certificates shall be furnished by the contractor countersigned by Contractor's licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electrical inspectorate / National Building Code. The contractor shall be responsible for getting the electrical installation inspected and approved by the local authorities concerned.

LIST OF INDIAN STANDARDS (BIS)

IS: 374 – 1979	Ceiling fans and regulators (3rd revision)
IS: 694 – 1990	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS: 732 – 1989	Code of practice for electrical wiring and installation
IS: 1255 – 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS: 1258 – 1987	Bayonet lamp holders (Third revision)
IS: 1293 – 1988	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS: 1554 - 1988 (Part - I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS: 1646 – 1982	Electrical installation fire safety of buildings (general) Code of practice.
IS: 1885 – 1971	Glossary of items for electrical cables and conductors.
IS: 1913 - 1978	General and safety requirements for fluorescent lamps luminaries Tubular.
IS: 2026 - 1977 to 81 (Part I to IV)	Power Transformers
IS: 2071 - 1974 – 76	Methods of high voltage testing
IS: 2309 – 1989	Protection of building and allied structures against lightning
IS: 2551-1982	Danger notice plate.
IS: 3043 – 1987	Code of practice for earthing.
IS: 3480 – 1966	Flexible steel conduits for electrical wiring.
IS: 3837 – 1976	Accessories for rigid steel conduit for electrical wiring.
IS: 4146 - 1983	Application guide for voltage transformers
IS: 4615 – 1968	Switch socket outlets.
IS: 5133 - 1969 (Part -I)	Boxes for the enclosure of electrical accessories.
IS: 5216 - 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS: 5424 – 1969	Rubber mats for electrical purposes.
IS: 5578 &	Marking and arrangement of bus bars

11353-1985

IS: 7098 – 1985 (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS: 8130 – 1984	Conductors for insulated electric cables and flexible cords
IS: 8623 -1977 (Part -I)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS: 8623 – 1980 (Part -II)	Bus Bar trunking system
IS: 8828 – 1996	Miniature Circuit Breakers
IS: 9537 – 1981	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS: 10810 – 1988	Methods of test for cables.
IS: 12640 – 1988	Earth Leakage Circuit Breakers
IS: 13947-1993 (Part-II)	Air Circuit Breakers
IS: 13947-1989	Moulded Case Circuit Breakers
IS: 13947 – 1993	Degree of protection provided by enclosures for LV switchgear and control gear.
IS: 13947 – 1993	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS: 1651 & 1652 1991	Stationary cells and batteries lead acid type.
IS: 13779	Digital measuring instrument and testing accessories.
IS: 7098 (Part 1)	XLPE Insulated HR PVC Sheathed Aluminum Conductor Armoured./ UnArmoured Cable.
IS: 3854 - 1997	Switch Modules
IS: 1293 - 1998	Socket Modules

Note:-

1. Follow relevant (amended upto date) Indian Standards in case the listed above are found not to belatest/uptodate.

2. If codes of any/some of items are not written above, it is essential that relevant BIS Codes for these items are to be referred to.

GUARANTEE PROFORMA

GUARANTEE FOR ELECTRICAL INSTALLATION

We hereby guarantee the year round Electrical System which we have installed in the Complex described below :

Building –

Location –

For a period of ONE YEAR from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner's, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize the Owner's to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation upon completion and ensure that all systems are functioning satisfactorily.

SIGNATURE OF TENDERER
For ELECTRICAL INSTALLATION

DATE :

SEAL

SPECIAL CONDITIONS OF CONTRACT FOR ELV WORKS

5. GENERAL:

These special conditions are meant to amplify the specifications and General Conditions of Contract. If any discrepancy is noted among these Special Conditions, General Conditions of Contract, Specifications, Schedule of Quantities and Drawings, the most stringent of the above shall apply, should there by any ambiguity or inconsistency, the contractor should report the same to the Architect/ Project Manager/ Owner and obtain clarification before submitting the tender. Contractor to collect General Conditions of Contract and Schedule of Fiscal Aspects from the Owner/ project manager/ architect.

6. SCOPE OF WORK:

The work to be carried out under this contract comprises of internal and external electrical installation of the project as called in the tender documents. The Electrical Contractor shall include for the supply of the whole of the materials in accordance with the Specifications and the whole of the work of fixing necessary for the complete installation as set out in these Specifications and with the accompanying schedule and drawings, commencing from the supply authority's terminals. This also include any material, appliances, equipment not specifically mentioned herein or noted on the drawings as being furnished or installed but which are necessary and Customary to make the installation complete in all respects. In general the work to be performed under this contract shall comprise supply, installation, testing & commissioning of the following:-

q. All conduit work including junction boxes, outlet boxes, wiring & earthing for ELV System.
r. All conduit work including junction boxes, outlet boxes, wiring & cabling for LV systems such as fire alarm, paging, CCTV, Access control etc.
s. Analog Addressable Fire Detection & Alarm System with Integrated Digital Voice Evacuation & Digital 2 Way Fire Fighters communications
t. IP Based CCTV System
u. Access Control System
v. Boom Barrier / Flap Barrier / RFID
w. Building Management System
x. IO Summary for BMS
y. Training of owner's staff/representative.
z. Preparation of "As Built Drawings & Documents".

Note: Some items may be supplied free of cost by the owners for installation, testing & commissioning. The entire work is to be carried out with the direction of & to the satisfaction of the owner /Project Manager/ Architect.

7. STANDARD OF WORK:

The work shall be carried out to the satisfaction of the Architect/Consultant/ Project Manager /Owner and in accordance with the latest regulations of the Local Electricity Supply Authority, Local chief Electrical Inspectorate, The Fire Insurance Company, insuring the building, Indian Electricity Rules and Regulations, National Building code, National Electrical code and the enclosed Specifications.

8. FEES AND PERMITS:

The contractor shall obtain and pay for all fees and permits required for the installation and approval of the complete Electrical Installation. On completion of the work, the contractor shall obtain and deliver to the Architect/ Consultant/ Project Manager/ Owner, certificates of final inspection and approval by the Local Chief Electrical Inspectorate. All receipted amount shall however, be payable by the Owner on production of proof of payment.

9. SPECIFICATIONS AND SCHEDULE OF QUANTITIES:

The Specification and Schedule of quantities shall be considered as part of this contract and any work or materials shown in schedule and not called for in the specifications or vice versa, shall be executed as if specially called for in both.

10. TENDER DRAWINGS:

The tender drawings if enclosed with the tender documents are only for the purpose of guidance to the contractor. The exact level, location etc.is to be governed by the Architecture/ interior layouts. The data/ information provided in the tender drawings and documents are as exact as it could be secured, but its complete accuracy can not be guaranteed. The drawings indicate the general arrangement and broadly suggest the extent of work and route etc. Any change required to Co-ordinate this installation with other trades will have to be made without any extra cost to the owners. The contractor will have to assume and include every thing from supply of material to its execution, testing & commissioning to make the job safe & complete in all respects as per rules & regulations, building codes & govt. approving agencies.

11. GOOD FOR CONSTRUCTION DRAWINGS (GFC's):

The details and data provided in **"GFC"** drawings is as exact and correct as it could be possible but its complete accuracy and correctness is not guaranteed. Every effort is made to make the drawings as per site conditions and the requirement of building codes but the electrical contractor has to check the accuracy and adequacy of **"GFC"** drawings before start of work. The contractor must study site conditions, understand Owner's requirement and also cross-check that the GFC drawings issued meet electrical codes, electrical safety and all govt. requirements or not. Contractor must also check the electrical earthing & lightning arrestor scheme for correctness and safety. Contractor must also check electrical SLD and calculate and cross-check load balancing on the Main LT Panel's different sections, switch gear rating and all the cable sizes. The electrical equipment layout plans must be checked for electrical safety and spacings as per electrical codes & requirement.

Any short coming noted in the design & GFC drawings and any variance from National Building codes, National Electrical code, Rules & Regulations of State Chief Electrical Inspectorate & Electrical supply company must be brought to the notice of the Architect/ Consultants/ Project Manager/ Owner in writing before the start of the work. The very purpose of preparation of shop drawings by contractor is to eliminate any error/ shortcoming in the design and the GFC's drawings prepared by the consultant.

12. SHOP DRAWINGS & FINAL WORKING DRAWINGS:

The Contractor after studying the Owner's requirement, site situation & constraints, specifications, schedule of quantities, tender drawings and good for construction drawings (if available or other wise) shall prepare and submit to Architects/ Project Manager/ Owner for comments/ approval on all the shop drawings & final working drawings required for completion of full job as per National Building Code, National Electrical Code, IEEE, requirement of Local Chief Electrical Inspectorate and the local electrical supply company including Owner's requirement. The contractor shall finally be responsible and accountable to Owner for correctness, accuracy, adequacy and safety of the complete electrical installation. The process of completing "The shop drawings & Final Drawings" shall be completed quickly with in the time frame of the project without causing any delay and before starting the actual execution work. No claims for extension of time shall be acceptable due to contractor's failure to produce right shop drawings at the right time in accordance with the approved programme of deliverables. All shop drawings to be prepared on the latest Architectural / Structural / Interior layouts, which are to be collected by the electrical contractor from the office of the Architect/Project Manager / Owner.

Following Shop Drawings & Final Working Drawings necessarily need to be prepared and submitted by the contractor:

a. Fire Detection & Alarm Layouts
b. Fire Detection & Alarm Risers
c. CCTV Layouts
d. CCTV Risers
e. Access Control Layouts
f. Access Control Risers
g. Boom Barriers / Flap Barriers

Drawings shall not be limited to the above only. All necessary drawings/ details required for satisfactorily execution of the job need to be included.

Electrical Contractor shall also to be Co-ordinating its drawings with other MEP Services & Site Plans before submitting to Owners/PMC.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supersede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

13. PRODUCT SAMPLES

Samples of the materials like conduits, accessories, switches, Sockets, wires & cables, light fixtures etc. shall be submitted to the Owners/ PMC prior to procurement. These will be submitted in two sets for approval and retention by Owners and shall be kept in their site office for reference and verification till the completion of the project.

14. MANUFACTURER'S CATALOGUES & DRAWINGS

Manufacturer's drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material to allow Architect/Consultant ample time for scrutiny.

15. TEST CERTIFICATES & TECHNICAL SUBMITTALS

Contractor shall submit to owners/Project manager, test certificates & technical data sheets of all the items covered in the scope of work before supply of the item.

16. MANUFACTURERS INSTRUCTIONS:

Where manufacturers have furnished specific instructions, relating to the materials used in this job and covering points not specifically mentioned in specifications & schedule of quantities, manufacturer's instructions shall be followed.

17. MATERIALS AND EQUIPMENT:

All materials and equipment shall be of the approved make and design. Unless otherwise called for only the best quality materials and equipment shall be used. The materials and equipment shall conform to relevant Indian standards. The contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Architect / Consultant/ Project Manager / Owner's within 15 days of he award of the contract. Any item which is proposed as a substitute, shall be accompanied by all technical data giving sizes, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitute the contractor shall state substitution be approved, all changes and substitutions shall be requested in writing and approvals obtained in writing from the Architect/Consultants/ Project Manager / Owner's.

18. TOOLS AND TACKLES

The Contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, all transport for labour and materials and plant necessary for the proper execution and completion of the work to the satisfaction of the Owner/PMC.

19. SAFETY OF MATERIALS:

The contractor shall provide proper and adequate storage facilities to protect all the materials and equipment, including those issued by the owner against damage from any cause whatsoever.

20. CO-ORDINATION

Contractor shall fully Co-ordinate & render all necessary support and assistance to other contractors for completion of all MEP & Civil/Interior works to satisfaction & safety. This work will involve close Co-ordination with HVAC, BMS, Plumbing & Fire Fighting contractor including Civil contractor. Electrical contractor to ensure necessary safety linkages with AHU fire dampers & fire detection systems. Electrical contractor shall be fully responsible & accountable for these life safety linkages. Nothing extra can be claimed for this co-ordination support.

21. COMPLETION & AS BUILT DRAWINGS & DOCUMENTS:

On the completion of the work and before issuance of certificate of virtual completion, the contractor shall submit to the Architect/ Project Manager/ Owners/ Consultant five sets of **"AS BUILT DRAWINGS & DOCUMENTS"** drawn at approved scale.

- Contractor to submit a complete write-up of the electrical and LV system installed along with interlocking and safety schemes.
- All the shop drawings & final working drawings need to be converted into "AS BUILT" drawings based on actual executed conditions.
- Technical documents will also have the test certificates, test reports **& IR results** for all the electrical equipment/ material used in the installation, which will need to be submitted in proper folders. All the final DB charts shall also be included in the completion documents.
- Technical catalogues, operation & maintenance manuals of the all the products & equipment used in installation also to be submitted in proper folders. List of recommended spares is also to be furnished along with schedule of preventive maintenance is to be submitted as part of completion documents.
- All the "AS BUILT" drawings, test reports, test certificates & DB Charts must be signed and stamped by the contractors Engineer-in -Charge and the supervisor, who was responsible for the execution, testing & commissioning of the installation.
- Contractor shall be responsible for the correctness of the **"AS BUILT DRAWINGS & DOCUMENTS"** and shall sign & stamp them.

22. GUARANTEE:

At the close of the work and before issue of final certificate of virtual completion, the contractor shall furnish written guarantee indemnifying the owners against defective materials and workmanship for a period of one year after testing & commissioning of the installation. The contractor shall hold himself fully responsible for reinstallation or replacement, free of cost to owner the following:

c. Any defective work or material supplied by the Contractor.

d. Any material or equipment damaged or destroyed as a result of defective workmanship by the contractor.

23. PERFORMANCE GUARANTEE

The contractor shall carry out the work in accordance with the Drawings, Specifications and other documents forming part of the contract.

The contractor shall be fully responsible for the performance of the selected equipment (installed by him) at the specified parameters and for the efficiency of the installation to deliver the required end result.

The contractor shall guarantee that the electrical system as installed shall perform to complete satisfaction of Owner's.

The contractor shall also guarantee that the performance of various equipment individually, shall not be less than the quoted capacity also actual power consumption shall not exceed the quoted rating, during testing and commissioning, handing over and guarantee period.

24. CONTACTOR'S ENGINEER-IN-CHARGE & OTHER STAFF:

- The contractor shall employ competent, fully qualified, trained & experienced full time electrical engineer/ Engineer-In-Charge/ Site Engineer/ Project Engineer to direct the work of electrical installation in accordance with drawings and specifications. The engineer shall be available at all times on the site to receive instructions from the consultant / Owner / Architect/ Project Manager / Owner in the day-to-day activities throughout the duration of the contract. The Engineer shall correlate the progress of the work in conjunction with all relevant requirements of the supply authorities.
- The Contractor shall employ only qualified, trained, experienced and licensed Project Engineer, Supervisor, foremen, wiremen and electricians.
- At the start of project, contractor shall furnish a list of employees i.e. Project Engineer, Supervisor, Foremen, Wiremen, and Electricians to be posted on the site, clearly specifying their qualification, experience and along with copies of qualification and trade certificates and licenses to establish / prove the furnished data.

- These details / certificates / copies of licenses of employees to be posted at site must be submitted to Project Manager / Architect/ Owner.

25. CONTRACTOR'S LICENCE:

Contractor shall be in possession of a valid ELV contractor's license (to be issued by Govt. Body) for carrying out Complete ELV works of the nature specified in the schedule of quantities and scope of works.

Contactor must furnish / submit a copy of the license to Project Manager/ Architect / Owner before start of the work.

26. TESTS & TEST REPORTS

On completion of complete installation, contractor shall submit to PMC/ Owner a signed copy of test report of complete installation and assume full responsibility of its soundness and safety.

Contractor shall physically inspect every material before installation and shall also carryout all necessary tests with the approval of the owners / PMC / site in-charge.

Contractor and its staff must follow good engineering practices.

A complete log of all the tests shall be maintained for review of Project Manager / Owner / Consultant.

Contractor shall assume full responsibility of correctness and validation of all the tests.

Any equipments / wire / cabling found faulty during testing carried out by contractor will be removed / replaced by healthy system / equipment by the contractor at its own cost.

Contractor shall assume full responsibility of safety of installation and shall be liable to owners for any loss / damage due to faulty equipment selection/ undersized equipment/ wrong design/ faulty installation / poor work-man-ship / poor quality.

It is contractor's responsibility to cross-check all the design and drawings before execution and assumes full responsibility for the correctness and adequacy of all the designs and drawings and shall be responsible and accountable to Owner for any deficiency and shortcomings in the system design/ product design.

27. COMPLETION CERTIFICATE:

On completion of the ELV installation a certificates shall be furnished by the contractor countersigned by Contractor's licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electrical inspectorate / National Building Code. The contractor shall be responsible for getting the electrical installation inspected and approved by the local authorities concerned.

LIST OF INDIAN STANDARDS (BIS)

IS: 374 – 1979	Ceiling fans and regulators (3rd revision)
IS: 694 – 1990	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS: 732 – 1989	Code of practice for electrical wiring and installation
IS: 1255 – 1983	Code of Practice for installation and maintenance of Power Cables upto and including 33 KV rating (Second Revision)
IS: 1258 – 1987	Bayonet lamp holders (Third revision)
IS: 1293 – 1988	Three pin plugs and sockets outlets rated voltage upto and including 250 volts and rated current upto and including 160 amps.
IS: 1554 - 1988 (Part - I)	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS: 1646 – 1982	Electrical installation fire safety of buildings (general) Code of practice.
IS: 1885 – 1971	Glossary of items for electrical cables and conductors.
IS: 1913 - 1978	General and safety requirements for fluorescent lamps luminaries Tubular.
IS: 2026 - 1977 to 81 (Part I to IV)	Power Transformers
IS: 2071 - 1974 – 76	Methods of high voltage testing
IS: 2309 – 1989	Protection of building and allied structures against lightning
IS: 2551-1982	Danger notice plate.
IS: 3043 – 1987	Code of practice for earthing.
IS: 3480 – 1966	Flexible steel conduits for electrical wiring.
IS: 3837 – 1976	Accessories for rigid steel conduit for electrical wiring.
IS: 4146 - 1983	Application guide for voltage transformers
IS: 4615 – 1968	Switch socket outlets.
IS: 5133 - 1969 (Part -I)	Boxes for the enclosure of electrical accessories.
IS: 5216 - 1982 (Part-I)	Guide for safety procedures and practices in electrical work.
IS: 5424 – 1969	Rubber mats for electrical purposes.
IS: 5578 & 11353-1985	Marking and arrangement of bus bars
IS: 7098 – 1985 (Part - II)	Cross linked polyethylene insulated PVC sheathed cables. For working voltages from 3.3 KV upto and including 33 KV
IS: 8130 – 1984	Conductors for insulated electric cables and flexible cords
IS: 8623 -1977 (Part -I)	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS: 8623 – 1980 (Part -II)	Bus Bar trunking system
IS: 8828 – 1996	Miniature Circuit Breakers
IS: 9537 – 1981	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS: 10810 – 1988	Methods of test for cables.
IS: 12640 – 1988	Earth Leakage Circuit Breakers
IS: 13947-1993 (Part-II)	Air Circuit Breakers
IS: 13947-1989	Moulded Case Circuit Breakers
IS: 13947 – 1993	Degree of protection provided by enclosures for LV switchgear and control gear.
IS: 13947 – 1993	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.
IS: 1651 & 1652 1991	Stationary cells and batteries lead acid type.
IS: 13779	Digital measuring instrument and testing accessories.
IS: 7098 (Part 1)	XLPE Insulated HR PVC Sheathed Aluminum Conductor Armoured./ UnArmoured Cable.

IS: 3854 - 1997	**Switch Modules**
IS: 1293 - 1998	**Socket Modules**

Note:- 1. Follow relevant (amended upto date) Indian Standards in case the listed above are found not to be latest/upto date.

2. If codes of any/some of items are not written above, it is essential that relevant BIS Codes for these items are to be referred to.

GUARANTEE PROFORMA

GUARANTEE FOR LOW VOLTAGE INSTALLATION

We hereby guarantee the year round Low Voltage System which we have installed in the Complex described below :

Building –

Location –

For a period of ONE YEAR from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner's, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorize the Owner's to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation upon completion and ensure that all systems are functioning satisfactorily.

SIGNATURE OF TENDERER
For LOW VOLTAGE INSTALLATION

DATE :

SEAL

SECTION: 7
TECHNICAL SPECIFICATIONS ELE & ELV WORKS

TECHNICAL SPECIFICATIONS ELE WORKS

INDEX

TECHNICAL SPECIFICATIONS

SUBHEAD-A. CONDUIT, ACCESSORIES & FIXING ARRANGEMENT

1. RIGID PVC CONDUIT & ACCESSORIES

PVC conduits shall be high impact, rigid, FRLS PVC, heavy-duty type and shall comply with relevant Indian Standards.

Plain conduits shall be jointed by slip type of couplers with approved sealing cement. All conduit entries to outlet boxes are to be made with adaptors female thread and screwed male bushes. Conduit fittings and accessories such as inspection boxes, draw boxes and junction boxes shall be of heavy duty rigid PVC installed in such a manner that they can remain accessible for existing wires or for the installation of the additional wires. Fan hook box shall be of M.S. Inspection boxes shall be covered with suitable covers.

Conduit runs shall be so arranged that the cables connected to separate main circuits shall be enclosed in separate conduits and that all lead and return wires of each circuit shall be run with the same circuit.

PVC conduits shall be smooth in bore, true in size and all ends where conduits are cut shall be made carefully smooth. Sharp edges shall be trimmed. All joints between lengths of conduits or between conduits and fittings and boxes shall be held firmly together and glued properly. All joints shall be fully water tight. All jointing of PVC conduits shall be by means of adhesive jointing.

2. RIGID MS CONDUIT/GI CONDUIT & ACCESSORIES

Rigid MS conduits shall conform to relevant Indian Standards. MS ERW conduits protected inside & outside by black stove enamel shall be used as called for in the schedule of quantities.

Conduit upto 32mm dia shall be of 16 G and above that shall be of 14 G.

Joints between conduits and accessories shall be securely made, to ensure earth continuity (screwed joints). All joints shall be fully watertight. Threads and Sockets shall be free from grease and oil.

Conduit fittings and accessories such as inspection boxes, draw boxes and junction boxes shall be of C.I. for concealed conduiting and shall be of M.S. for surface conduiting. Fan hook box shall be of M.S. Inspection boxes shall be covered with 16 G GI covers. All conduit accessories shall be threaded type only.

Conduit runs shall be so arranged that the cables connected to separate main circuits shall be enclosed in separate conduits and that all lead and return wires of each circuit shall be run with the same circuit.

MS conduits shall be smooth in bore, true in size and all ends where conduits are cut shall be made carefully smooth. Sharp edges shall be trimmed. All joints between lengths of conduits or between conduits and fittings and boxes shall be held firmly together and screwed properly. Connection between screwed conduit and sheet

metal boxes shall be by means a brass / GI hexagonal check nut fixed from inside the box and another check nut from outside the box. Smooth PVC bushes from inside the box to be used to avoid damage to wires.

GI conduits if called for in the schedule of quantities shall conform to relevant Indian Standards. These conduits shall be protected by hot dip galvanized coating both inside and outside.

3. FLEXIBLE CONDUITS

Flexible conduits shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip to have interlocking to avoid opening up.

4. LAYING / FIXING OF CONDUITS.

Conduits shall be installed so as to avoid steam and hot water pipes. Conduits for LV systems shall be at least 150mm away from the electrical conduits.

Wires shall not be drawn into conduits until the conduits are erected, firmly fixed and cleaned out. Not more than two right angle bends or the equivalent shall be permitted between draw or junction boxes. Bending radius shall not be less than 2.5 times the outer diameter of the conduit.

Conduits concealed in the ceiling slab shall run parallel to walls and beams and conduit concealed in the walls shall be vertical or horizontal.

The chase in the walls required for the recessed conduit system shall be neatly made and shall be of ample dimensions to permit the conduits to be fixed in the manner desired. Conduits in chase shall be held by steel clamps of approved design. The chase shall be filled up neatly after erection of conduits and brought to the original finish of the wall with cement plaster/cement concrete. The spacing between each clamp shall be 60 cm center to center.

Surface conduits shall be fixed by means of spacer bar saddles at intervals of not more than 500 mm from both sides of fittings/accessories. The saddles shall be of 3mm x 19mm galvanized M.S. flat properly treated, primed and painted securely fixed to support by means of nuts & bolts / raw plugs and brass machine screws.

Where conduits cross expansion joints in the buildings, adequate expansion fittings shall be used to take care of any relative movement.

Separate conduits shall be laid for the following systems:

a) Normal light, Fan and 6 A socket outlets.
b) Power points.
c) TV outlets.
d) PA/ Paging system.
e) Telephone points and Data Points
f) Fire alarm system.
g) UPS points.

h) CCTV System
i) Access Control System
j) Emergency Lighting

Contractor shall submit the conduiting layout to PMC / Owners for approval before start of work. While laying conduiting, care should be taken that water, mortar and dirt etc. do not enter the conduits and boxes.

Conduiting system should be such that it shall facilitate easy drawing of new wires/additional wires at any stage. All junction boxes/pull boxes/ draw boxes shall be completely accessible for inspection, maintenance or for future expansion. While drawing of wires, care shall be taken to avoid damage to the wire insulation.

All joints in the wiring shall be made only at switches, distribution boards, socket outlets, lighting outlets and switch boxes only. No joint shall be made in conduits and junction boxes.

5. FAN HOOK BOX:

- Recessed Fan hook box shall be fabricated from 16G 'MS' sheet Anodized.
- Fan hook box shall be Hexagonal in shape with 75mm depth & 150mm diameter.
- The fan fixing rod shall be 'U' shaped, 12mm dia 'MS' Anodised, welded to the box with minimum 150mm projection on either side.

SUBHEAD-B. WIRING AND WIRING ACCESSORIES

1. GENERAL

- All the internal wiring shall be with 600/1100 V grade, single core FRLS(H), Special PVC insulated, unsheathed multi-stranded electrolytic grade annealed bare copper conductor wires confirming to BIS: 694 (Latest Edition) amended & revised to date and wiring installation should conform to IS: 732.
- Multicore flexible cables shall be 600/1100V, multicore, PVC insulated, FRLS(H) PVC Sheathed, multi-stranded, electrolytic grade annealed bare copper conductor flexible cables conforming to BIS:694 (Latest Edition) .

2. COLOUR CODING

Colour coding of wiring shall be done as per IS specifications, for identification of different circuits and phases.

All wiring shall be in concealed or surface conduits as called for.

In three phase feeder circuit, three phase wire, with or without neutral wire, shall be taken through any single conduit. In lighting and power socket outlets wiring, in no case two lives wires of different phases shall be drawn through the same conduit.

3. SWITCH

All switches shall be connected to live wire and neutral of each circuit shall be continuous everywhere having no fuse or switch installed in the line except at the main switch board.

4. INSTALLATION

The conduits and wiring installation are to be installed such that modifications or repairs can be carried out in future without disturbing the building fabric in any way.

For wiring accessories partly recessed in wall, special care must be taken to ensure that the final position of all switch\ socket plates are set symmetrical with the pattern of the wall finish as required by the architect. All switch socket-mounting plates shall be set square to the vertical and horizontal axis.

5. FISH WIRE

GI Fish wire / Pull wire of 14G shall be provided in the recessed conduiting to facilitate pulling of wires through conduits.

6. INSPECTION BOXES

Inspection boxes / Pull boxes shall be provided as required and approved by the Architect / Consultant for pulling of wires through c``onduiting network. Rigid PVC boxes shall be used for the PVC conduiting and G.I. boxes of suitable size and depth shall be used for MS / GI conduiting.

7. JOINTS

Only looping system of wiring shall be used. Wires shall not be jointed/ taped. All joints shall be made at switches, sockets outlets, distribution boards and lighting points. No joints shall be made inside conduits and in junction boxes. Suitable sizes connectors to be used at light fixtures. No reduction of strands is permitted at terminations. Before connections, copper conductor wire ends shall be properly soldered (at least 20-mm length). Terminals shall have adequate cross-sectional area to take all strands. No wire smaller than 1.5 sq.mm shall be used.

8. IDENTIFICATION

Identification ferrules indicating the circuit and D.B. number shall be used for sub mains and sub-circuit wiring. The Ferrules shall be provided at both ends of each sub-main and sub-circuit.

9. CIRCUITS OF DIFFERENT PHASES & DIFFERENT DB's

Where single-phase circuits are supplied from a three phase and neutral distribution board, no conduit shall contain the wiring of different phases. Circuits fed from distinct sources of supply \ from different distribution boards or MCB's shall not be bunched in one conduit.

10. LOAD BALANCING, CONTROL & EARTH WIRE

Load Balancing of circuits in three-phase installation shall be arranged before installation is taken up.. The earth continuity green FRLS PVC insulated copper wire for individual circuits of light / power / UPS should be laid. From D.B. each circuit will have separate earth wire. Earth wire shall be run inside the conduit to earth the third pin of socket outlets, earth terminal of light fixtures & fans etc. & earth terminals of outlet box as required. Light points shall be either of single control, twin control & multiple points controlled by a single switch / MCB as per schedule of works. Insulated copper wire for earthing as specified in the item of work shall be provided with each circuit and terminated in the earth bar of DB's / Switch boxes with proper lugs, as required.

11. CONDUIT FILL

Number of wires in each conduit shall be drawn as per chart given below:

MAXIMUM PERMISSIBLE NUMBER OF 600/1100 V GRADE FRLS PVC INSULATED COPPER CONDUCTOR WIRES THAT CAN BE DRAWN INTO METALLIC AND NON METALLIC CONDUITS AS PER BIS CODES TABLES 6 & 7 AS GIVEN BELOW:

TABLE 6 MAXIMUM PERMISSIBLE NUMBER OF 250 V GRADE SINGLE-CORE CABLES THAT CAN BE DRAWN INTO RIGID STEEL CONDUITS

(*Clauses* B-3.7, B-4.9 *and* B-5.1.1)

Size of Cable		Size of Conduit, mm													
Nominal Cross-Sectional Area, mm²	Number and Diameter of Wires, mm	16		20		25		32		40		50		63	
		Number of Cables, Max													
		S	B	S	B	S	B	S	B	S	B	S	B	S	B
1·0	1/1·12*	5	4	7	5	13	10	20	14	—	—	—	—	—	—
1·5	1/1·40	4	3	7	5	12	10	20	14	—	—	—	—	—	—
2·5	1/1·80 3/1·06*	3	2	0	5	10	8	18	12	—	—	—	—	—	—
4	1/2·24 7/0·85*	3	2	4	3	7	8	12	10	—	—	—	—	—	—
6	1/2·80 7/1·06*	2	—	3	2	6	5	10	8	—	—	—	—	—	—
10	11/3·55† 7/1·40*	— —	— —	2 2	— —	5 4	4 3	8 6	7 5	— 8	— 6	— —	— —	— —	— —
16	7/1·70	—	—	—	—	2	—	4	3	7	6	—	—	—	—
25	7/2·24	—	—	—	—	—	—	3	2	5	4	8	6	9	7
35	7/2·50	—	—	—	—	—	—	2	—	4	3	7	5	8	6
50	7/3·00† 19/1·80	—	—	—	—	—	—	—	—	2	—	5	4	6	5

NOTE 1 — The table shows the maximum capacity of conduits for the simultaneouly drawing of cables. The columns headed *S* apply to runs of conduit which have distance not exceeding 4·25 m between drawn-in boxes, and which do not deflect from the straight by an angle of more than 15°. The columns headed *B* apply to runs of conduit which deflect from the straight by an angle of more than 15°.

NOTE 2 — In case an inspection type draw-in box has been provided and if the cable in first drawn through one straight conduit, then through the draw-in box, and then through the second straight conduit, such systems may be considered as that of a straight conduit even if the conduit deflects through the straight by more than 15°.

*For copper conductors only.
†For aluminium conductors only.

TABLE 7 MAXIMUM PERMISSIBLE NUMBER OF 250 VOLTS GRADE SINGLE-CORE CABLES THAT MAY BE DRAWN INTO RIGID NON-METALLIC CONDUITS

(*Clauses* B-3.7, B-4.9 *and* B-5.3.2)

Size of Cable		Size of Conduit (mm)					
Nominal Cross-Sectional Area mm²	Number and Diameter (in mm) of Wires	16	20	25	32	40	50
		Number of Cables, *Max*					
1·0	1/1·12*	5	7	13	20	—	—
1·5	1/1·40	4	6	10	14	—	—
2·5	(1/1·80) (3/1·06*)	3	5	10	14	—	—
4	(1/2·24) (7/0·85*)	2	3	6	10	14	—
6	(1/2·80) (7/1·40*)	—	2	5	9	11	—
10	(1/3·55†) (7/1·40*)	—	—	4	7	9	—
16	7/1·70	—	—	2	4	5	12
25	7/2·24	—	—	—	2	2	6
35	7/2·50	—	—	—	—	2	5
50	7/3·00†	—	—	—	—	2	5
	19/1·80	—	—	—	—	2	3

*For copper conductors only.
†For aluminium conductors only.

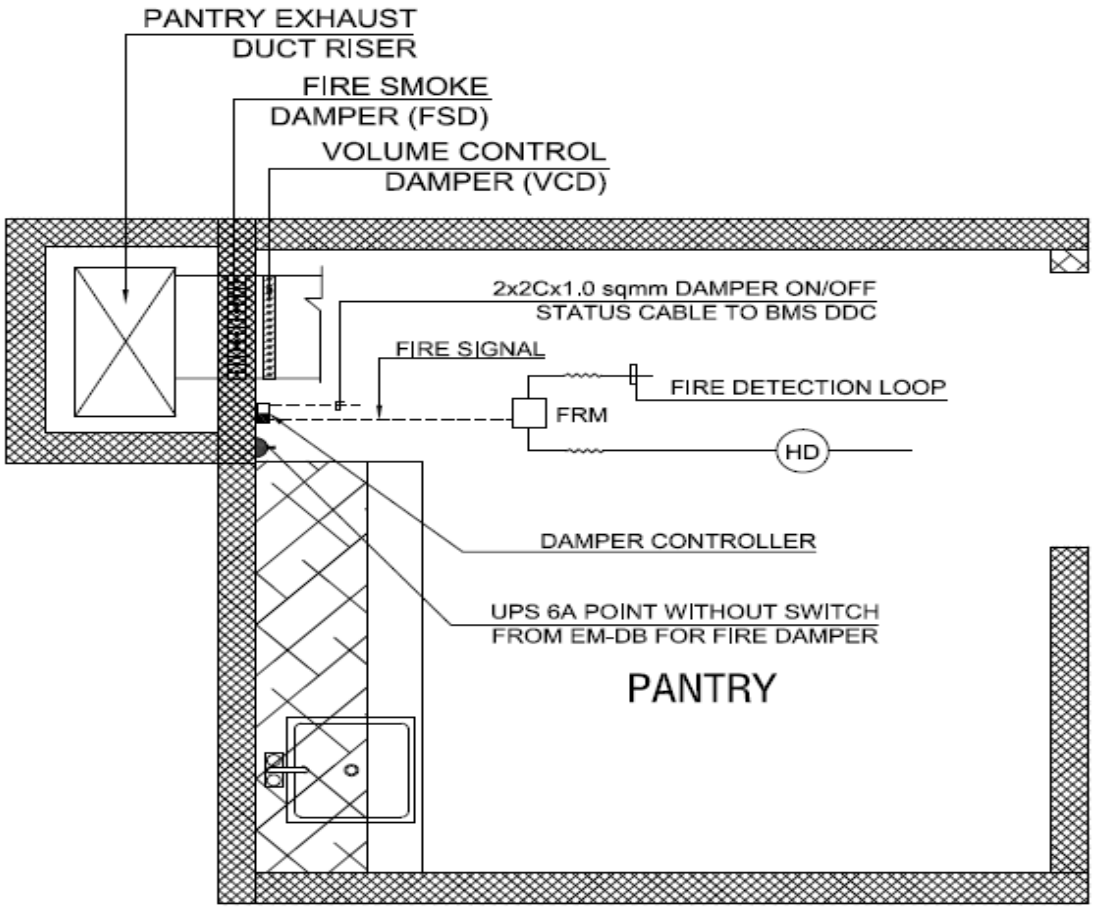
12. WIRING AND EARTHING NORMS

Light Points, 6 A sockets and fans points may be wired on a common circuit. Not more than 10 light points, 6 A sockets and fan points and a load not exceeding 800 W be connected on a lighting circuit unless it is specified otherwise on the drawings/ in the schedule of quantities. It will however, be preferred to have separate circuits of 6A sockets as may be required by the consultant. Size of the earth wire shall be of the same size as that of the live / phase conductor unless specified otherwise. It shall however, be ensured that in one switchboard, only one circuit is terminated. For different circuits, separate switch boards shall be used. Each power circuit shall be wired as specified in drawings/schedule of quantities. Not more than two power points 6A/16A sockets shall be connected on one power circuits unless specified differently in the drawings/schedule of quantities.

UPS circuits shall start from the UPS DB's. UPS points will have two insulated green earth wires, one for the earthing of the 3rd pin of the socket and other for the earthing of the outlet box/furniture.

The smallest copper conductor to be used for lighting circuits shall be of 1.5/2.5 sq. mm (as specified in the schedule of quantities) and for power circuit 4 sq. mm respectively. Wiring shall be done in the looping system. Phase or live conductor shall be looped at the switch box and neutral conductor can be looped from the light, fan or socket outlet. Neutral conductor and earth continuity wire shall be brought to each switchboard situated in rooms/ halls. These shall be terminated inside the switchboards with suitable connectors.

PROVISION AND WIRING DETAILS FOR FIRE DAMPERS, MOTORIZED DAMPERS AND AHU'S FOR TRIPPING / OPERATION LINKED WITH FIRE DETECTION SYSTEM AND BMS



TYPICAL PANTRY / KITCHEN ON FLOOR

NOTES ;

HVAC Drawings / Tender to show:

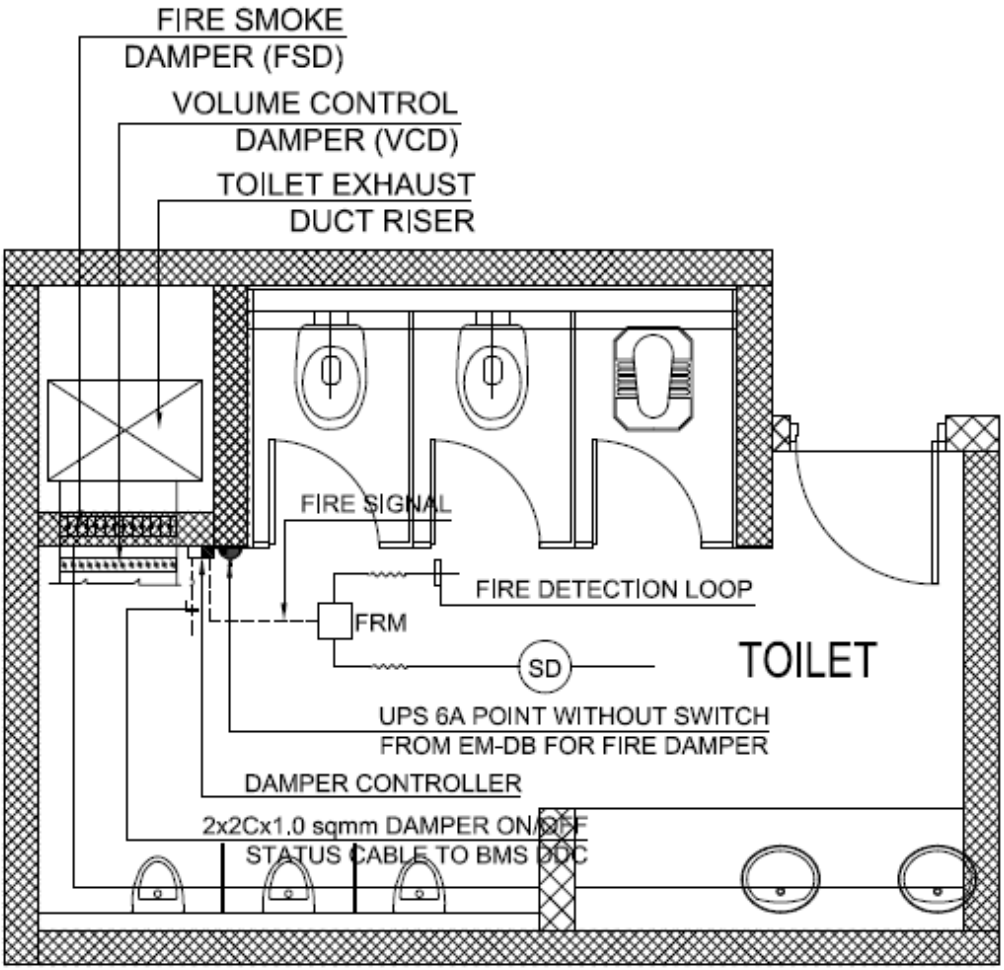
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL TOILET ON FLOOR

NOTES :

HVAC Drawings / Tender to show:

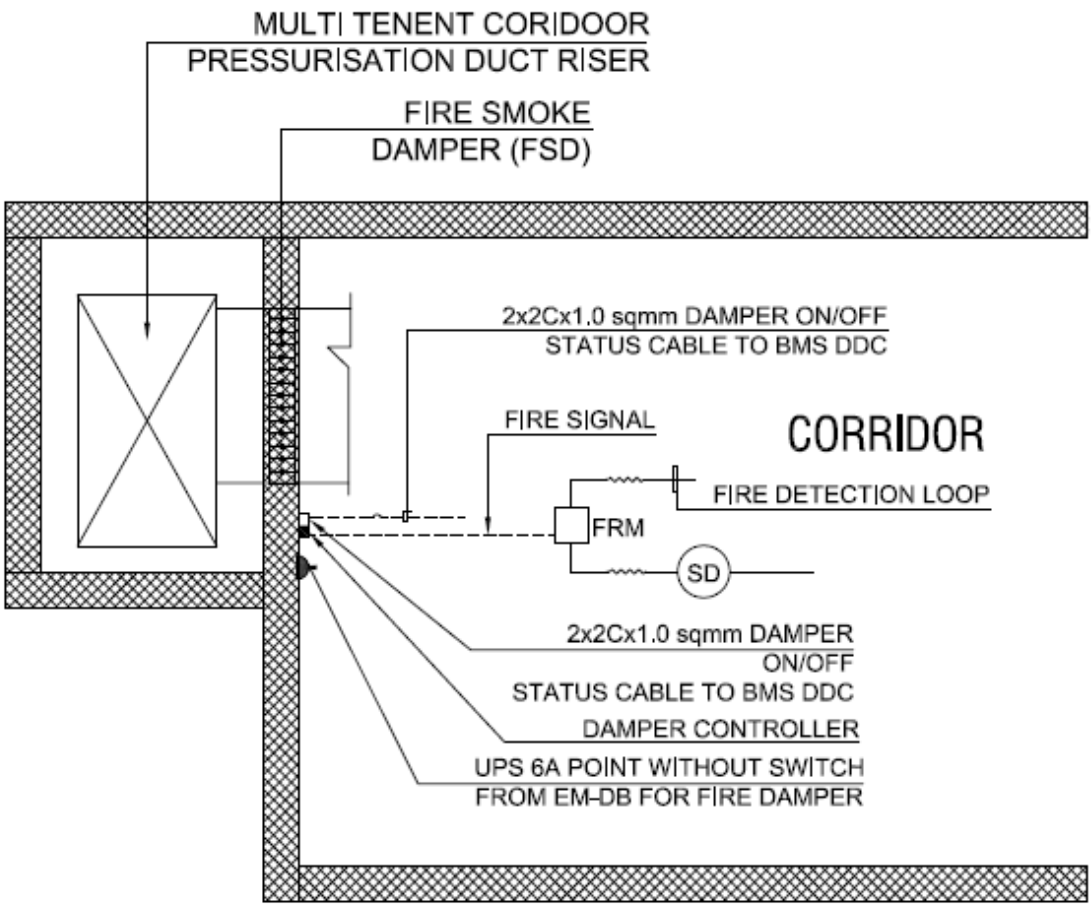
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL MULTI TENENT CORIDOOR PRESSURISATION

NOTES :

HVAC Drawings / Tender to show:

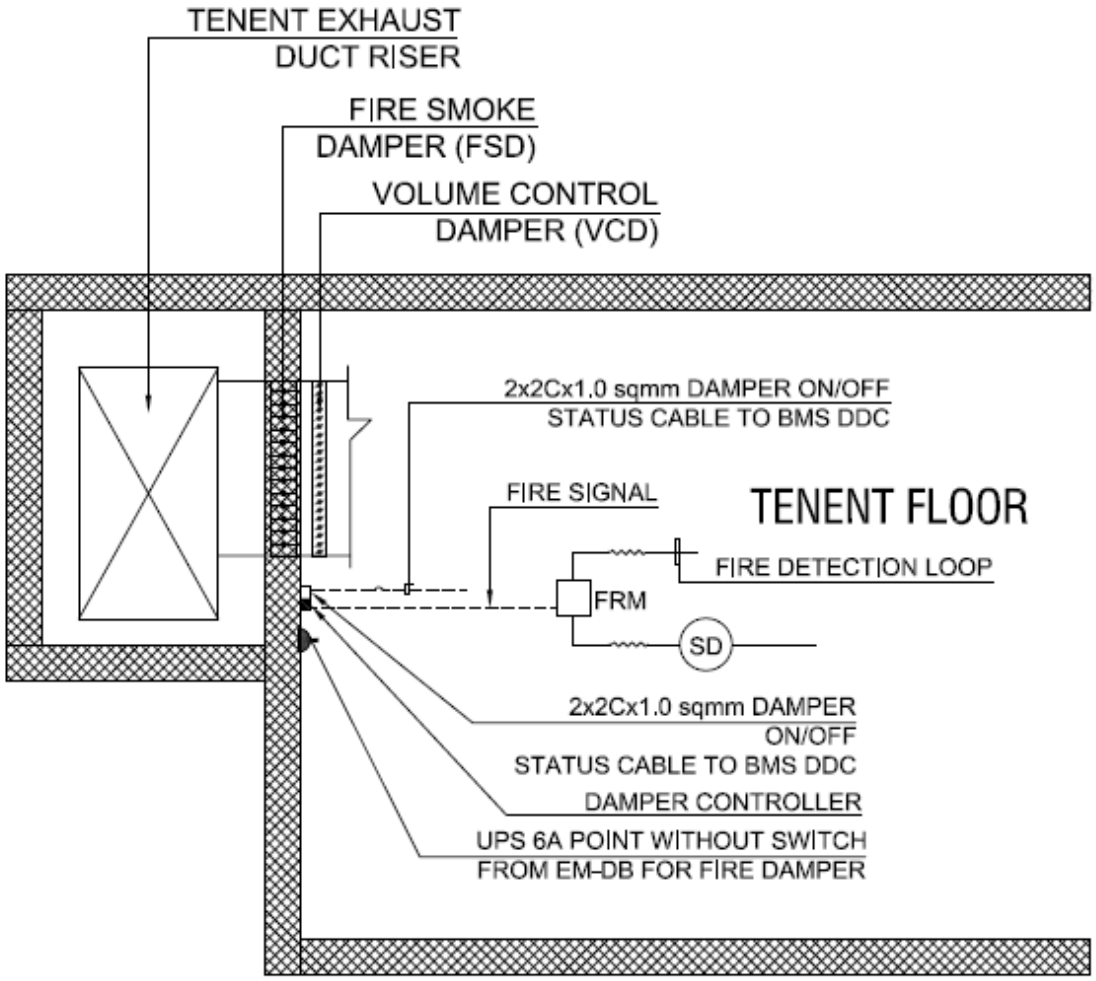
- Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL DUCT TENENT EXHAUST

NOTES :

HVAC Drawings / Tender to show:

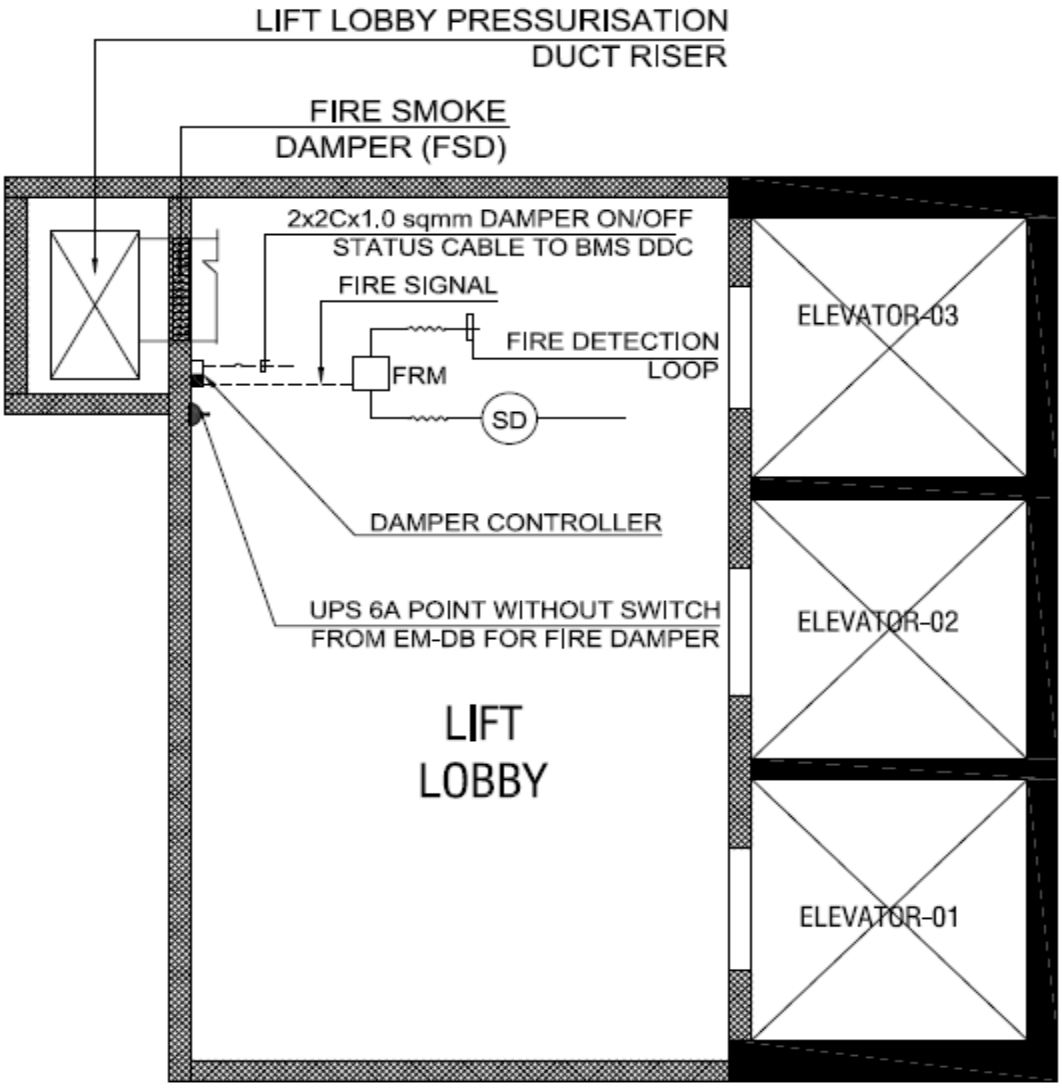
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL LIFT LOBBY PRESSURISATION DUCT ON FLOOR

NOTES :

HVAC Drawings / Tender to show:

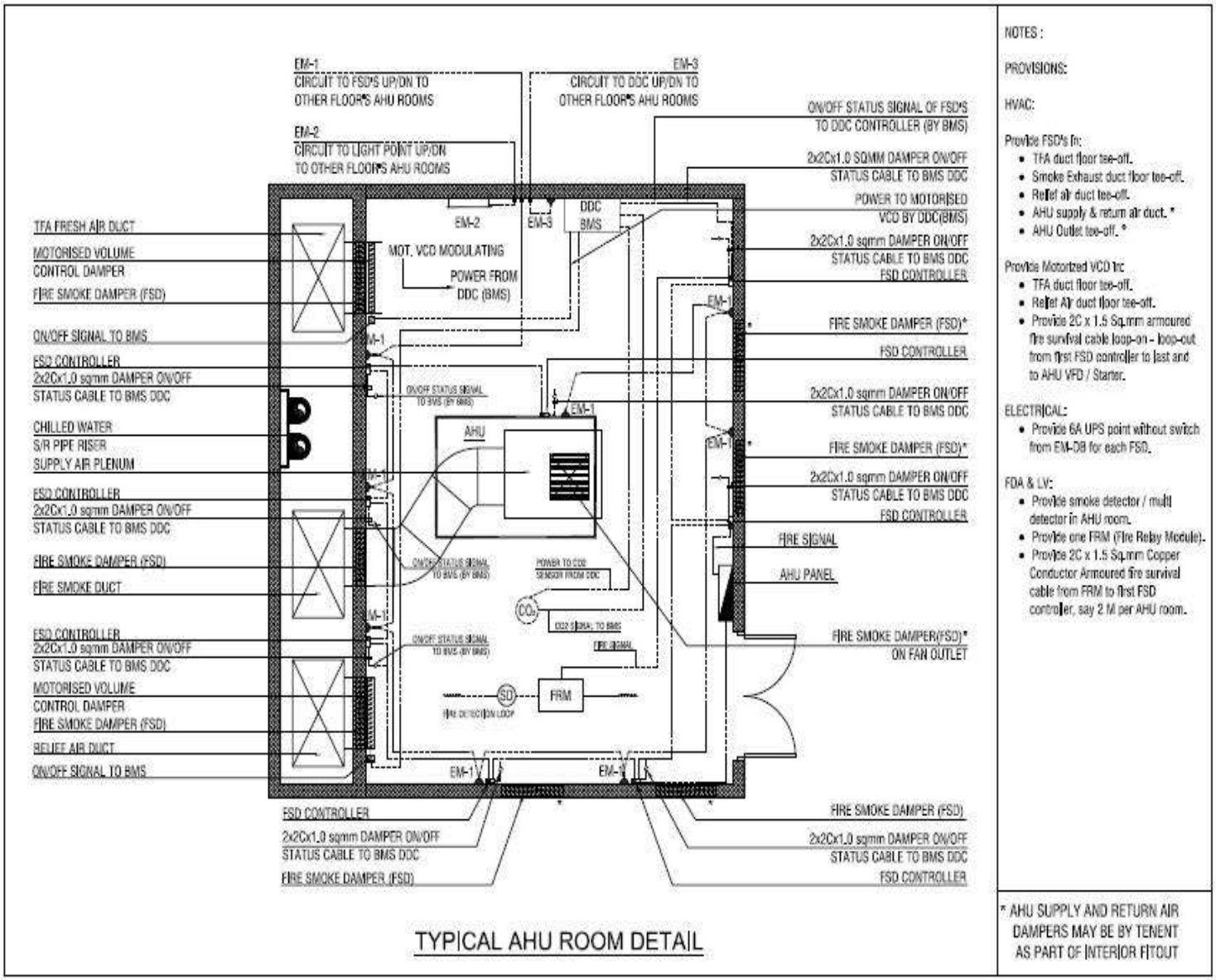
- Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



NOTES :

PROVISIONS:

HVAC:

Provide FSD's in:

- TFA duct floor tee-off.
- Smoke Exhaust duct floor tee-off.
- Relief air duct tee-off.
- AHU supply & return air duct. *
- AHU Outlet tee-off. *

Provide Motorized VCD inc

- TFA duct floor tee-off.
- Relief Air duct floor tee-off.
- Provide 2C x 1.5 Sq.mm armoured fire survival cable loop-on - loop-out from first FSD controller to last and to AHU VFD / Starter.

ELECTRICAL:

- Provide 6A UPS point without switch from EM-DB for each FSD.

FDA & LV:

- Provide smoke detector / multi detector in AHU room.
- Provide one FRM (Fire Relay Module).
- Provide 2C x 1.5 Sq.mm Copper Conductor Armoured fire survival cable from FRM to first FSD controller, say 2 M per AHU room.

* AHU SUPPLY AND RETURN AIR DAMPERS MAY BE BY TENENT AS PART OF INTERIOR FITOUT

SUBHEAD-C. SWITCHES, SOCKETS & ACCESSORIES

1. MODULAR GRID SWITCHES & PLATES

All 6 Amps, 16 Amps & 13 Amps switches shall be clip in switch modules. Switches shall be with positive action rockers clipped on to modular front plates and shall be suitable for 230 / 250 volts AC. Switches & plates shall be made out of Fire retardant UV stabilized Engineering thermo plastic (grade poly carbonate). All modular plates shall be fixed to the switch boxes with brass screws, leaving ample space at the back and sides for accommodating wires. Switches and Sockets shall have Silver Cadmium contacts for long life. Live terminals should be shrouded for finger protection. All switches shall conform to IS: 3854 amended and revised to date. Switches controlling the lights shall be connected to the phase wire of the circuit. Switches & Plates shall confirm to IP: 20

2. MODULAR GRID SOCKET OUTLETS

All 6 Amps, 16 Amps & 13 Amps socket outlets shall be clip in modules, clipped on to modular front plates and shall be 3/5/6/ multi pin round or flat pin or international or multi pin type as called for in the Schedule of Quantities. Socket outlets and plates shall be made out of Fire retardant UV stabilized Engineering thermo plastic (grade poly carbonate). GI outlet box shall have an earth terminal. The earth terminal of the socket shall be connected to the earth terminal provided inside the box.

Switches and Sockets shall have Silver Cadmium contacts for long life. Live terminals should be shrouded for finger protection.

All 3 pin / 5pin / 6 pin / international / multi pin socket outlets shall be with child resistant shuttered system.

All socket outlets shall be suitable for 230V / 250V AC AC supply.

Each socket outlet shall be controlled by a switch. The switch controlling socket outlet shall be on live side/phase wire of the circuit. All switches shall confirm to IS: 3854 and socket outlets to IS: 1293 amended and revised to date. Sockets shall confirm to IP: 20

3. MODULAR GRID FAN REGULATORS & DIMMERS

Fan regulator shall be clip in modular type suitable for 230V / 250V AC. The minimum rated power shall be 120W. The regulator shall be totally hum free. The fan regulator shall have “Off” position. The fan regulator shall be clipped on to modular front face plate.

The dimmer shall be clip in modular type suitable for 230V / 250V AC. The minimum rated power shall be 400W. The dimmer shall have “Off” position. The dimmer shall be clipped on to modular front face plates.

These shall be made of Fire retardant, UV Stabilized, and engineering thermo plastic. Dimmers and fan regulators operation should not interfere with radio & TV signal. Diameter & fan regulator shall confirm to IP:20.

4. MODULAR GRID COMMUNICATION OUTLETS

TV, Tele & Data outlets shall be modular type clipped on to suitable modular front plates on suitable outlet boxes. These are made of engineering thermo plastics. TV outlet shall be Co-axial, Sliver plated for minimal signal loss.

Tele Jack, (RJ-11) shall accept minimum 2 lines, gold plated contacts for better voice clarity and with spring loaded shutter for dust protection. Data outlet (RJ 45) shall be able to accept Cat 6 cable, gold plated contacts for better data transfer efficiency and spring loaded shutter for dust protection.

5. METAL OUTLET BOXES

1 MM thick pre-galvanized sheet outlet boxes of suitable size as per the requirement of modular front plate shall be used. The outlet box shall be of minimum depth of 50mm unless otherwise specified differently. GI outlet box shall have a brass earth terminal.

6. PLASTIC OUTLET BOXES

Plastic enclosures / outlet boxes where ever required shall be of suitable size as required for the switch / socket front face plates and shall be made of UV stabilized engineering plastics.

7. TYPE OF MODULAR GRID SOCKET OUTLETS (to be used as specified in the B.O.Q.)

a. 6 Amps. 3 Pin, Round Pin
b. 6 Amps. 5 Pin, Round Pin
c. 16 Amps. 3 Pin, Round Pin
d. 6A/16 Amp. Combined, Round Pin
e. 13 Amps. 3 Pin, Flat Pin
f. 13 Amps. Multi-standard, International / Intel Socket

7a. USB PORT & TYPE C PORT

Type C charger output 5 V, 2.1A , Input 230V, 50 Hz, 0.3A,

USB Port charger output 5 V, 2.1A , Input 230V, 50 Hz, 0.3A,

- Input operating voltage range is 100-300V AC.
- It can withstand surge up to 3kV.
- Protection against electric shock.
- Safe operate during charging.
- UL approved PCB.
- Flame retardant plastic material.

8. INDUSTRIAL PLUGS & SOCKETS & MOBILE PLUG & SOCKETS

Industrial plug & sockets & mobile plug & socket shall be:

- 3 Pin, 230V / 250V (P,N,E), Round (Single phase + Neutral + Earth).
- 4 Pin, 415V (3P,E), Round (Three phase + Earth).
- 5 Pin, 415V (3P,N,E), Round (Three phase +Neutral + Earth).

As called for in the schedule of quantities.

Industrial plug & sockets mobile plug & sockets shall be 16A, 20A, 32A, 63A & 125A 1 Phase & 3 Phase rating.

Industrial plug & sockets shall be suitable for recessed and surface mounting.

Plug & sockets shall be made of high quality engineering thermoplastics (high quality polycarbonate).

The housing shall be either powder coated sheet steel enclosure of 14G or of the same material as high quality polycarbonate as called for in the schedule of quantities.

IP Rating of Plug, Socket & Enclosure:

IP rating of complete assembly i.e. plug & socket unit enclose shall be:

- Plastic Plug & socket in metal enclosure: Plastic P&S IP 44 & metal enclosure IP 30.
- Plastic Plug & socket in polycarbonate enclosure: IP 66 or IP 67 as called for in the BOQ.
- Plastic Plug & socket assembly with protection shall be complete with a DIN channel for mounting of DP MCB / 4P MCB / DP RCBO / 4P RCBO as shall have required rating of MCB's / RCBO's as called for in the schedule of quantities.
- Plastic Plug & socket without MCB / RCBO, shall be with rotary ON / OFF switch as called for in the schedule of quantities.

Note: All external area / all wet are shall have minimum IP66 or IP67 rating plug, socket & enclosure as complete assembly.

9. MOULDED PLUG & SOCKET OUTLETS FOR KITCHEN & LAUNDRY, IN HOTELS, HOSPITALS, FOOD COURT'S KITCHENS / DISPLAYS, MALLS, RESTAURANTS & FINE DINNING'S KITCHENS AND OTHER SIMILAR AREAS FOR INDOOR APPLICATIONS AND ALSO FOR OUTDOOR APPLICATIONS OF ALL TYPES:

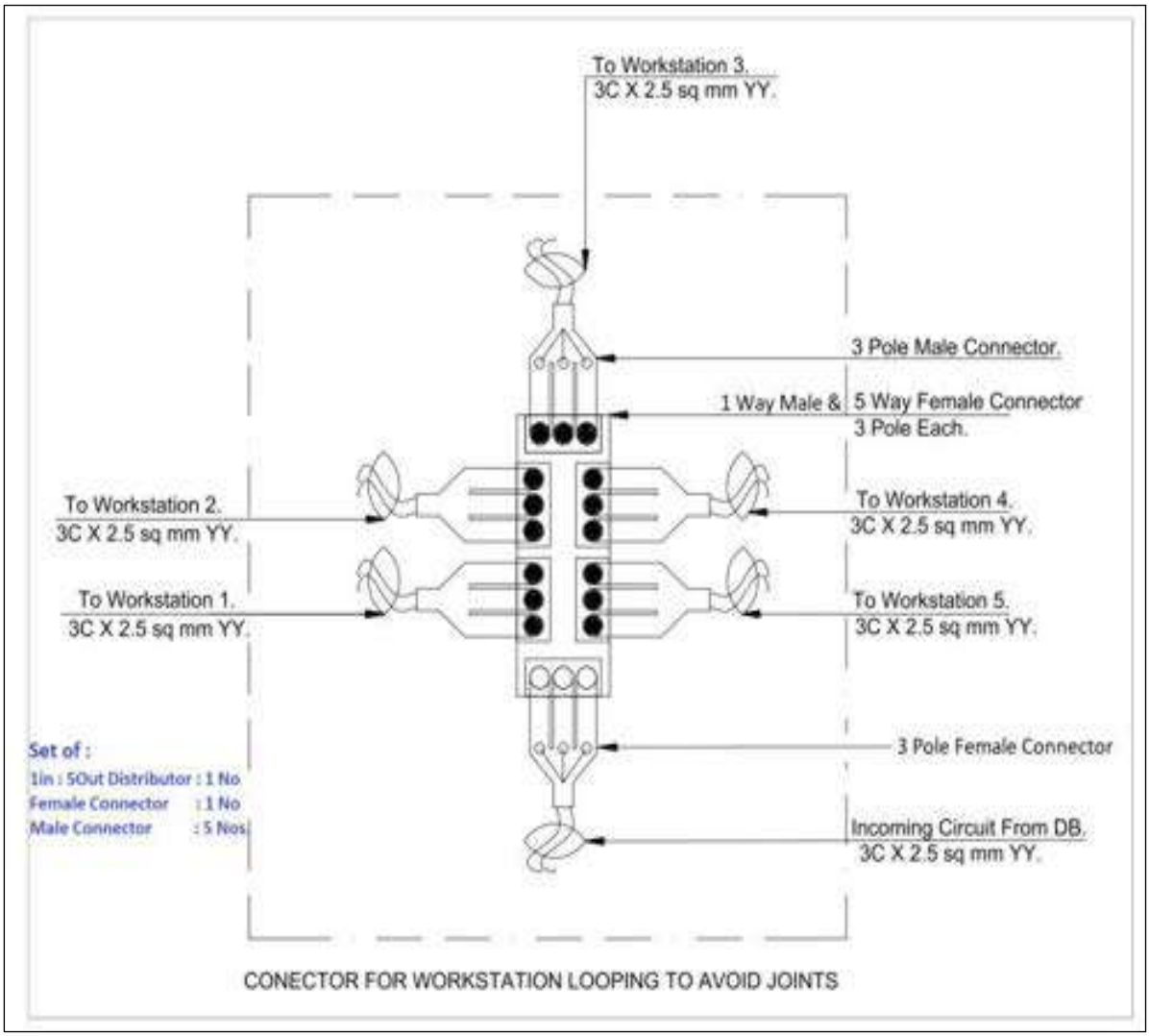
- Only IP67 Moulded plug & socket outlets with 30mA, DP RCBO / 30mA, 4P RCBO are to be used for human safety.
- Standard available ratings are:

a. 16A, 2P+PE, IP67

b. 32A, 2P+PE, IP67
c. 16A, 3P+N+PE, IP67
d. 32A, 3P+N+PE, IP67
e. 63A, 3P+N+PE, IP67

GALGOTIAS UNIVERSITY

WORK STATION UPS / RAW POWER WIRING DIAGRAM FOR REFERENCE



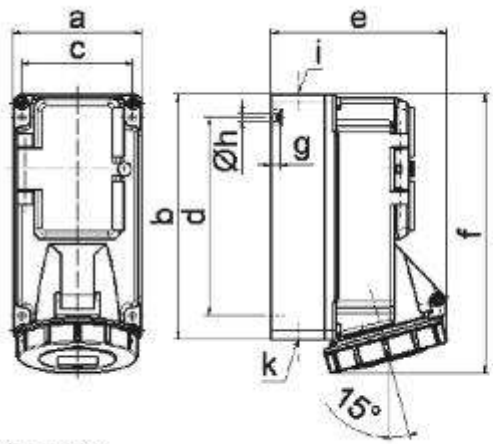
WALL MOUNTING SOCKET OUTLET, FUSED - HOUSING DIMENSION 170X90, WITH MOUNTING RAIL

Product Descritpions:

Product category	:	TE wall mounting socket outlet, fused
Current	:	16A
Number of poles	:	3P 2P+PE
Position of earth contact	:	6 h
Voltage	:	200 up to 250V
Frequency	:	50 and 60Hz
Protection degree	:	IP67
Colour code	:	Blue RAL 5015
Colour of appliance	:	Operating window smoky topaz, Hinged lid blue, Bayonet ring grey, Housing bottom grey, Housing top grey
Connection design	:	Screw-less spring terminals as cage clamp with Kontext-contact

Maximum conductor size	:	4,0 qmm
Cable entry	:	Top entry M20, bottom entry M25/20
Height	:	195mm
Width	:	90mm
Depth	:	109mm
Dimension of enclosure	:	170x90 mm (HxW)
Material of enclosure	:	Polycarbonate
Contact	:	The contact carrier is made of high temperature resistant material, the contacts are brass nickel plated
Additional technical information	:	The cable entry is one at top open and two at bottom closed Lower part of housing rotatable by 180° With mounting rail for 5 modules, vertical, with mounting rail, Protective cover for fuses with stamping
Logistics data		
Weight/pcs	:	0.513 kg / Piece
Packaging	:	Carton
Content amount	:	1 ST
Length	:	205 mm
Width	:	102 mm

Height	:	134 mm
Weight	:	0.573 kg
Volume	:	2,118.48 ccm



14 MB 6

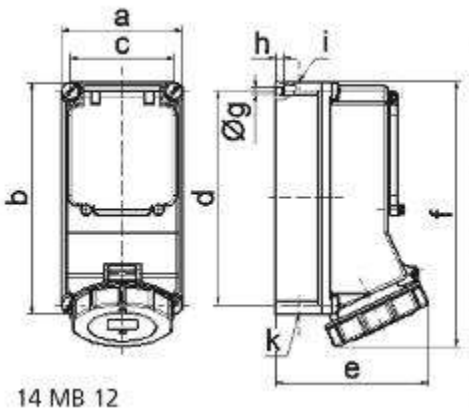
Ampere Polzahl	16 3	16 4	16 5
a	90,0	90,0	90,0
b	170,0	170,0	170,0
c	77,0	77,0	77,0
d	137,5	137,5	137,5
e	108,0	115,0	121,0
f	191,5	191,5	191,5
g	6,0	6,0	6,0
h ø	5,5	5,5	5,5
i	M20	M20	M20
k	M20/25	M20/25	M20/25

WALL MOUNTING SOCKET OUTLET, FUSED - HOUSING DIMENSION 225X118, WITH MOUNTING RAIL

Product Descritpions:		
		
Product category (PG)	:	Quick-Connect wall mounting socket outlet, fused
Current (A)	:	32A
Number of poles	:	3P 2P+PE
Position of earth contact (H)	:	6 h
Voltage (V)	:	200 up to 250V
Frequency	:	50 and 60Hz
Protection degree (SA)	:	IP67

Colour code 1 (KF1)	:	Blue RAL 5015
Colour of appliance	:	Operating window smoky topaz, Hinged lid blue, Bayonet ring grey, Housing screws grey, Housing bottom grey, Housing top grey
Connection design	:	Screwless spring terminals as cage clamp with Kontext-contact
Maximum conductor size	:	10,0 qmm
Cable entry	:	Top entry M25/M25 bottom entry M25
Height	:	260mm
Width	:	118mm
Depth	:	144mm
Dimension of enclosure	:	225x118 mm (HxW)
Material of enclosure	:	Polycarbonate
Contact	:	The contact carrier is made of high temperature resistant material, the contacts are brass nickel plated
Additional technical information	:	The cable entry is one at top open, one at top is closed, and two at bottom are closed With mounting rail, Protective cover for fuses with stamping, With mounting rail for 5 modules, vertical
Logistics data		
Weight/pcs	:	0.924 kg / Piece
Packaging	:	Carton

Content amount	:	1 ST
Length	:	275 mm
Width	:	175 mm
Height	:	137 mm
Weight	:	1.049 kg
Volume	:	5,737.5 ccm



14 MB 12

Ampere	16	16	32	32	32
Polzahl	4	5	3	4	5
a	118,0	118,0	118,0	118,0	118,0
b	225,0	225,0	225,0	225,0	225,0
c	101,0	101,0	101,0	101,0	101,0
d	208,0	208,0	208,0	208,0	208,0
e	127,0	134,0	143,0	143,0	149,0
f	245,0	245,0	255,0	255,0	255,0
g ø	6,5	6,5	6,5	6,5	6,5
h	8,0	8,0	8,0	8,0	8,0
i	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25
k	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25

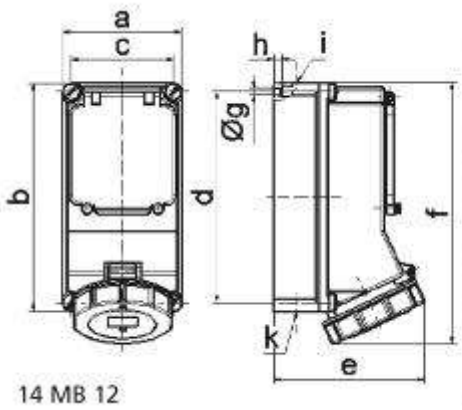
WALL MOUNTING SOCKET OUTLET, FUSED - HOUSING DIMENSION 225X118, WITH MOUNTING RAIL

Product Descritpions:

Product category	:	TE wall mounting socket outlet, fused
Current	:	16A
Number of poles	:	5P 3P+N+PE
Position of earth contact	:	6 h
Voltage	:	200/346 up to 240/415V
Frequency	:	50 and 60Hz
Protection degree	:	IP67
Colour code	:	Red RAL 3000

Colour of appliance	:	Operating window smoky topaz, Hinged lid red, Bayonet ring grey, Housing screws grey, Housing bottom grey, Housing top grey
Connection design	:	Screw-less spring terminals as cage clamp with Kontext-contact
Maximum conductor size	:	4,0 qmm
Cable entry	:	Top entry M25/M25 bottom entry M25
Height	:	250mm
Width	:	118mm
Depth	:	134mm
Dimension of enclosure	:	225x118 mm (HxW)
Material of enclosure	:	Polycarbonate
Contact	:	The contact carrier is made of high temperature resistant material, the contacts are brass nickel plated
Additional Technical Information	:	The cable entry is one at top open, one at top is closed, and two at bottom are closed With mounting rail, Protective cover for fuses with stamping, With mounting rail for 5 modules, vertical
Logistics data		
Weight/pcs	:	0.875 kg / Piece
Packaging	:	Carton
Content amount	:	1 ST
Length	:	275 mm

Width	:	175 mm
Height	:	137 mm
Weight	:	1 kg
Volume	:	5,737.5 ccm



14 MB 12

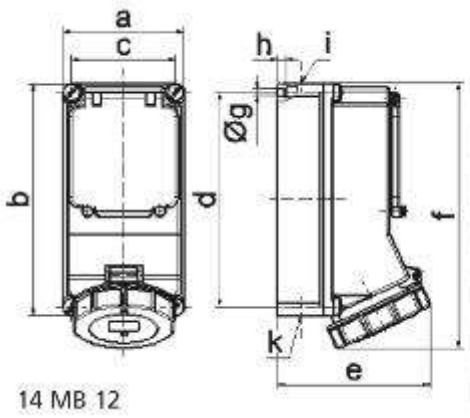
Ampere	16	16	32	32	32
Polzahl	4	5	3	4	5
a	118,0	118,0	118,0	118,0	118,0
b	225,0	225,0	225,0	225,0	225,0
c	101,0	101,0	101,0	101,0	101,0
d	208,0	208,0	208,0	208,0	208,0
e	127,0	134,0	143,0	143,0	149,0
f	245,0	245,0	255,0	255,0	255,0
g ø	6,5	6,5	6,5	6,5	6,5
h	8,0	8,0	8,0	8,0	8,0
i	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25
k	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25

WALL MOUNTING SOCKET OUTLET, FUSED - HOUSING DIMENSION 225X118, WITH MOUNTING RAIL

Product Descritpions:		
		
Product category	:	TE wall mounting socket outlet, fused
Current	:	32A
Number of poles	:	5P 3P+N+PE
Position of earth contact	:	6 h
Voltage	:	200/346 up to 240/415V

Frequency	:	50 and 60Hz
Protection degree	:	IP67
Colour code	:	Red RAL 3000
Colour of appliance	:	Operating window smoky topaz, Hinged lid red, Bayonet ring grey, Housing screws grey, Housing bottom grey, Housing top grey
Connection design	:	Screw-less spring terminals as cage clamp with Kontext-contact
Maximum conductor size	:	10,0 qmm
Cable entry	:	Top entry M25/M25 bottom entry M25
Height	:	260mm
Width	:	118mm
Depth	:	150mm
Dimension of enclosure	:	225x118 mm (HxW)
Material of enclosure	:	Polycarbonate
Contact	:	The contact carrier is made of high temperature resistant material, the contacts are brass nickel plated
Additional technical information	:	The cable entry is one at top open, one at top is closed, and two at bottom are closed With mounting rail, Protective cover for fuses with stamping, With mounting rail for 5 modules, vertical
Logistics data		
Weight/pcs	:	0.96 kg / Piece

Packaging	:	Carton
Content amount	:	1 ST
Length	:	275 mm
Width	:	175 mm
Height	:	137 mm
Weight	:	1.085 kg
Volume	:	5,737.5 ccm



14 MB 12

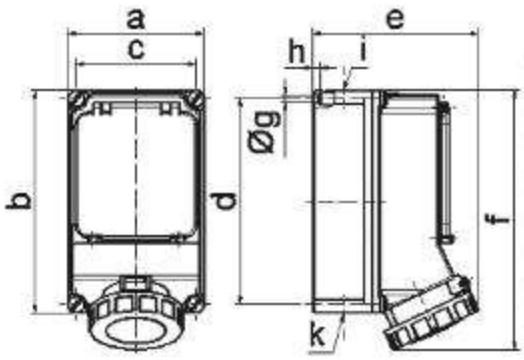
Ampere	16	16	32	32	32
Polzahl	4	5	3	4	5
a	118,0	118,0	118,0	118,0	118,0
b	225,0	225,0	225,0	225,0	225,0
c	101,0	101,0	101,0	101,0	101,0
d	208,0	208,0	208,0	208,0	208,0
e	127,0	134,0	143,0	143,0	149,0
f	245,0	245,0	255,0	255,0	255,0
g ø	6,5	6,5	6,5	6,5	6,5
h	8,0	8,0	8,0	8,0	8,0
i	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25
k	2 x M25	2 x M25	2 x M25	2 x M25	2 x M25

WALL MOUNTING SOCKET OUTLET, FUSED - HOUSING DIMENSIONS 260X160 WITH MOUNTING RAIL

Product Descritpions:		
		
Product category	:	TE wall mounting socket outlet, fused
Current	:	63A
Number of poles	:	5P 3P+N+PE
Position of earth contact	:	6h
Voltage	:	200/346 up to 240/415V
Frequency	:	50 and 60Hz
Protection degree	:	IP67
Colour code	:	Red RAL 3000
Colour of appliance	:	Operating window smoky topaz, Hinged lid red, Bayonet ring grey, Housing screws grey, Housing bottom grey, Housing top grey

Connection design	:	Screw terminal as box terminal with Kontex-contact
Maximum conductor size	:	25.0 qmm
Cable entry	:	Top entry M40, bottom entry M40/M32
Height	:	304mm
Width	:	160mm
Depth	:	195mm
Dimension of enclosure	:	260x160 mm (HxW)
Material of enclosure	:	Polycarbonate
Contact	:	The contact carrier is made of high temperature resistant material, the contacts are brass nickel plated
Additional technical information	:	The cable entry is one at top and two at bottom open
		With mounting rail, Protective cover for fuses with stamping, With mounting rail for 7 modules, vertical
Logistics data		
Weight/pcs	:	2.06 kg / Piece
Packaging	:	Carton
Content amount	:	1ST
Length	:	325 mm
Width	:	217 mm

Height	:	210 mm
Weight	:	2.276 kg
Volume	:	13,588.4 ccm



14 MB 11

Ampere Polzahl	32 4	32 5	63 4	63 5
a	160,0	160,0	160,0	160,0
b	260,0	260,0	260,0	260,0
c	140,0	140,0	140,0	140,0
d	240,0	240,0	240,0	240,0
e	172,0	174,0	195,0	195,0
f	293,0	294,0	304,0	304,0
g ø	8,1	8,1	8,1	8,1
h	10,0	10,0	10,0	10,0
i	M40	M40	M40	M40
k	M32/40	M32/40	M32/40	M32/40

SUBHEAD-D. LT CABLES - 1.1 KV GRADE & CABLE TRAYS

1. GENERAL

The cables shall be supplied, inspected, laid, tested and commissioned in accordance with drawings, Specifications, relevant Indian Standard and cable manufacturer's instruction.

2. MATERIAL

2.1 XLPE INSULATED, FRLS(H) PVC SHEATHED (IS: 7098 PART-1) CABLES

Specification of 1.1KV grade Single / Multicore XLPE insulated, **FRLS(H)** PVC sheathed Aluminium / Copper conductor Armoured / Unarmoured cables shall be as per IS: 7098 Part-1:

i. Conductor:

- Material : Aluminium / Copper : Electrolytic grade
- Shape : Aluminium conductor : 6 & 10 sqmm. Solid circular
  : 16 sqmm. & above stranded compacted shaped
  : Copper conductor : 4 & 6 sqmm. stranded non compacted circular
  : 10 sqmm. stranded compacted circular
  : 16 sqmm. & above stranded compacted shaped

ii. Insulation Material : Cross linked polyethylene XLPE (Red, Yellow, Blue & Black)

iii. Inner Sheath : Extruded inner FRLS(H) PVC sheath type ST-2.

iv. Armouring : Single layer of galvanized steel round wires / flat strips.

v. Outer sheath : FRLS(H) PVC Sheath type ST-2.

vi. Colour of sheath : Black.

Note: Single core armoured cables shall be with "Non-magnetic" type armouring.

2.2 PVC INSULATED, FRLS(H) PVC SHEATHED (IS:1554) CABLES

Specification of 1.1KV grade Single / Multicore PVC insulated, PVC sheathed Copper conductor Armoured / Unarmoured cables shall be as per IS: 1554:

i. Conductor:

- Material : Copper : Electrolytic grade
- Shape : Copper conductor : 1.5, 2.5, 4 & 6 sqmm. stranded non compacted circular
  : 10 sqmm. stranded compacted circular

ii. Insulation Material : PVC (Red, Yellow, Blue & Black)

iii. Inner Sheath : Extruded inner FRLS(H) PVC sheath type ST-1.

iv. Armouring : Single layer of galvanized steel round wires / flat strips / Non-magnetic armouring for single core cables.

v. Outer sheath : FRLS(H) PVC Sheath type ST-1.

vi. Colour of sheath : Black.

Note: Single core armoured cables shall be with "Non-magnetic" type armouring.

3. FIRE SURVIVAL CABLES(CIRCUIT INTEGRITY CABLES)

i. Voltage Grade: Up to 1000 V
ii. Designed as per : BS 7846
iii. Cable Size: Up to 1 to 4 Cores, 1.5 sq. mm. to 400 Sq.mm. copper.
iv. Conductor Type: Stranded Circular Copper.
v. Construction: Class 2
vi. Insulation Material: Glass Mica tape as flame barrier + XLPE Insulation
vii. Sheathing Material: Special Low Smoke Zero Halogen Compound
viii. Armour: Galvanized Steel
ix. Colour Codes: As per customer's requirement
x. Fire test as per : BS 8491/ BS 8434-2/ BS EN 50200 , CWZ tests (all three tests on one cable)
xi. Low Smoke Emission: Light Transmittance > 60 % as per IEC 61034
xii. Flame Retardant: As per IEC 60332
xiii. Halogen Free: Acid Gas Less than 0.5 % as per IEC 60754
xiv. Min. Bending Radius: 12 x O.D.
xv. Suitable for 950°C for 3 hrs duty operation.

Fire Survival / Resistance circuit integrity armoured cable of 600/1000V rated with Copper Circular conductors having Glass Mica (Fire barrier) tape covered by crosslinked poly Ethylene insulation (XLPE) and LSZH as inner & outer sheaths. Basic design as per BS 7846 for copper cables, Should retain circuit integrity as per Category-3 of BS:8419 when tested in accordance to BS 8491 for power cables having overall diameter of 20mm and above & BS EN 50200 PH-120 for control cables having overall diameter less than 20mm. Type test reports of each lot from 3rd party inspection agency required prior to despatch. (Should be LPCB /TUV/BRE-Global certificate to be submitted)

The cables should meet circuit integrity at 1000 volts with simultaneous action of Fire, Impact & water on single sample when tested in accordance to BS 8491 & BS EN 50200 PH-120.

The cables should not emit toxic gases in case of fire. The toxicity index should be less than 3 (refer NES 713).

The cables should comply with the requirements of IEC-61034 Part 1&2 (Measurement of Smoke density of cables burning under defined conditions).

The cables should comply with the requirements of BS EN 60754 (Determination for amount of halogen acid gas content which shall not be greater than 0.5%)

Fire & type test reports of each lot from 3rd party inspection agency required prior to despatch.

3A. APPLICATION OF FIRE SURVIVAL CABLES

Note: Contractor to use such cables as specified in the application table for all the application listed in the table irrespective of the fact if the same cables are not shown seperately in the BOQ of cable / in the electrical SLD. Contractor to ensure this point and bring it to the notice of PMC / Client / Consultant if any deviation in the BOQ and SLD is found.

ANNEX A

(Foreword)

APPLICATION OF FS CABLE

Sl No.	System Description	Cable Fire Rating Required (°C)	Time for which System Should Withstand (Minutes)
(1)	(2)	(3)	(4)
i)	Fire pumps	FS (950/FWS)	180
ii)	Pressurization	FS (950/FWS)	180
iii)	Smoke venting including its ancillary systems, such as dampers and actuators	950	60
iv)	Fire fighting shaft (staircase, lift, lift lobby)	FS (950/FWS)	180
v)	Fireman's lifts (including all lifts)	FS (950/FWS)	180
vi)	Exit signage lighting	950	120
vii)	Emergency lighting	950	120
viii)	Fire alarm system		
	a) Conventional (zone based system)	650	60
	b) Intelligent addressable system	650	60
ix)	Public address (PA)system (related to emergency voice evacuation and annunciation)	650	60
x)	Magnetic door hold open devices	650	60
xi)	Lighting in fire command centre and security room	FS (950/FWS)	180

3.5 Fire Survival Categories — Following categories of fire survival cable shall be applicable:

a)	*Resistance to fire alone*	950 °C for 3 h	Symbol F
b)	*Resistance to fire and water*	650 °C for 15 min followed by 5 bursts for water	Symbol W
c)	*Resistance to fire and mechanical shock*	950 °C for 15 min along with 03 mechanical impact	Symbol S
d)	*Resistance to fire, water and shock*	Category F3/ F30/F60/F120 as below	Symbol FWS

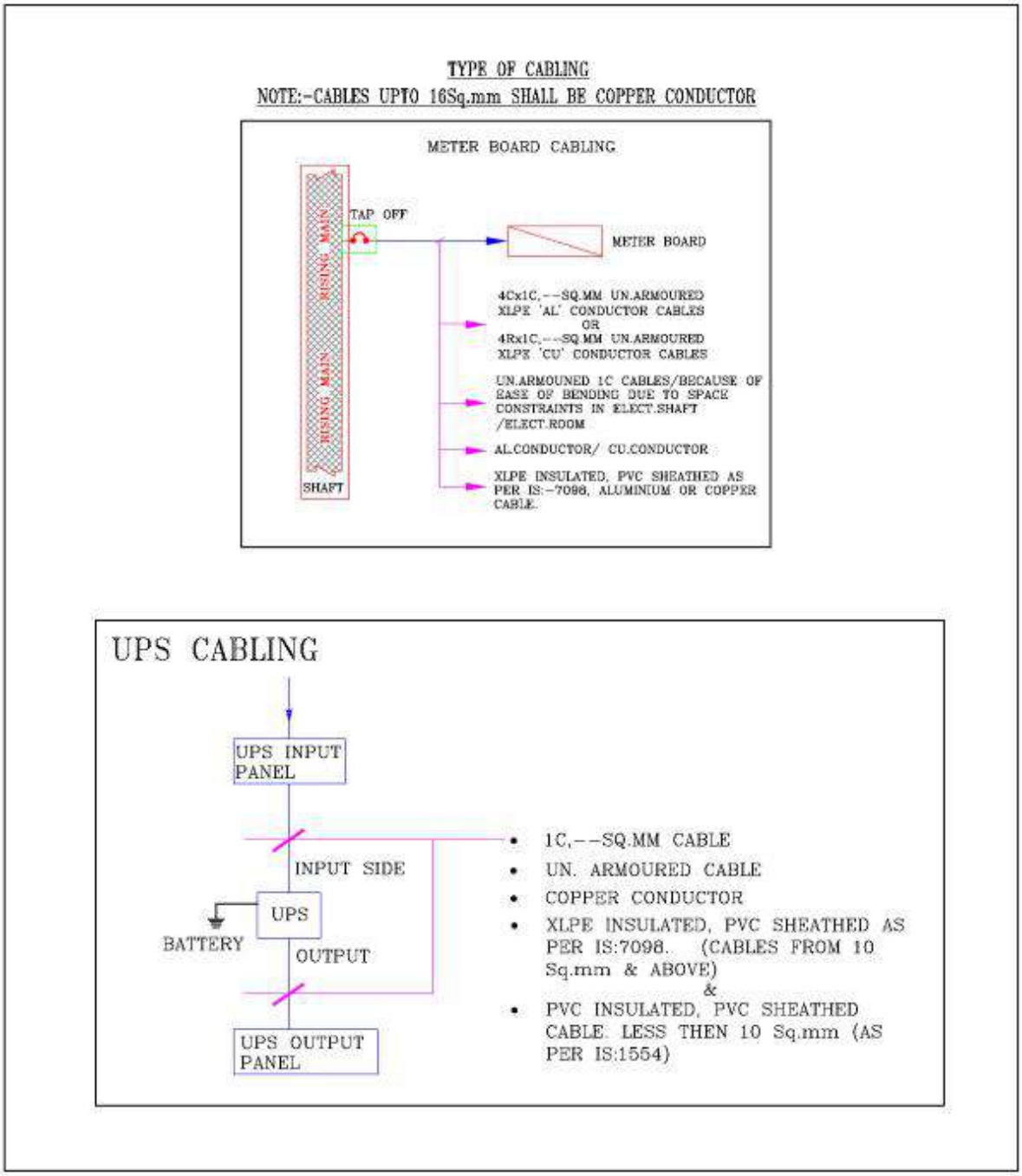
Category F 3: Resistance to fire, resistance to fire with water, resistance to fire with mechanical shock, assessed separately when tested in accordance to **E-7.3**, **E-7.4** and **E-7.5** respectively.

Category F 30: Resistance to fire with direct mechanical impact and water jet assessed in combination, when tested in accordance to Annex E for 30 min

Category F60: Resistance to fire with direct mechanical impact and water jet assessed in combination, when tested in accordance to Annex E for 60 min

Category F120: Resistance to fire with direct mechanical impact and water jet assessed in combination, when tested in accordance to Annex E for 120 min

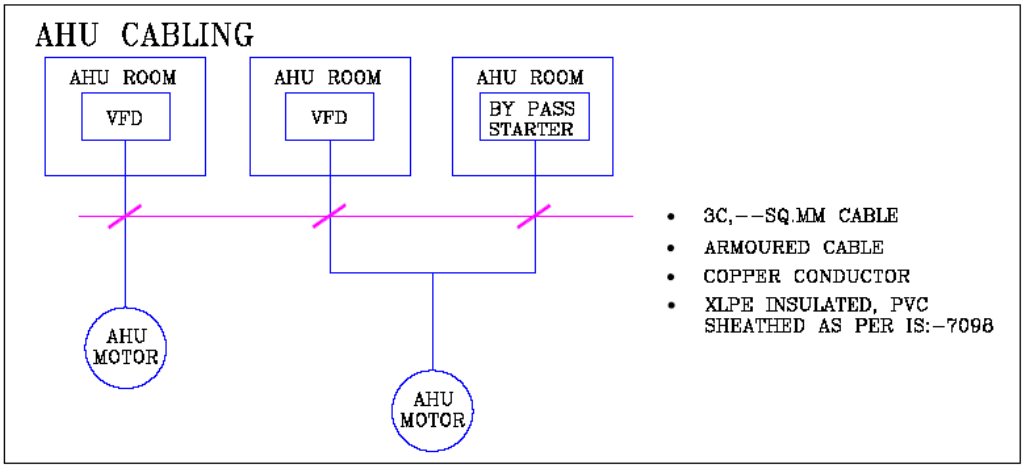
4. TYPE OF CABLES TO BE USED FOR DIFFERENT APPLICATIONS



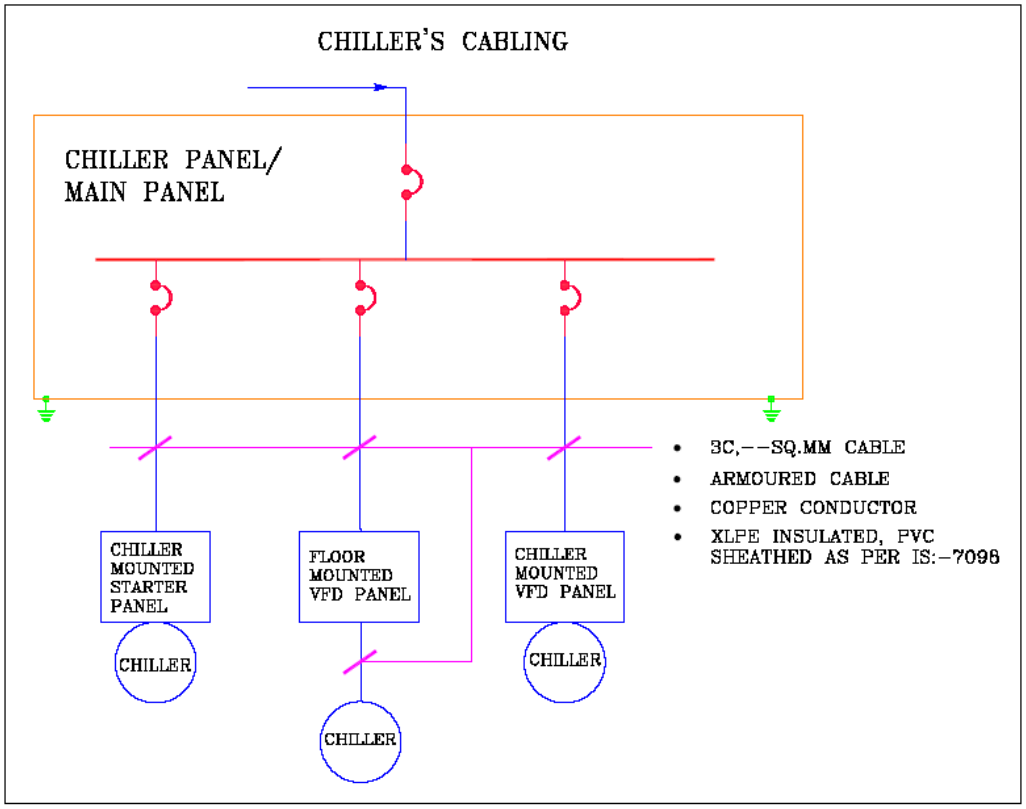
TYPE OF CABLING

NOTE:-CABLES UPTO 16Sq.mm SHALL BE COPPER CONDUCTOR

AHU CABLING



CHILLER'S CABLING



5. CABLE LAYING AND HANDLING

It should be ensured that both ends of the cable are properly sealed to prevent ingress / absorption of moisture.

6. CABLE HANDLING

When cable drums have to be moved over short distance, they should be rolled in the direction of the arrow marked on the drum.

While removing cables, the drums shall be properly mounted on jacks or on a cable wheels or any other suitable means, making sure the spindle, jack etc. are strong enough to take the weight of the drum.

The cables shall not be given a sharp bend to a small radius. The minimum safe bending radius for all types of PVC/XLPE cables shall be taken as 12 times the overall diameter of the cable. Wherever practicable, larger radius should be adopted. At joints and terminations, the bending radius of individual cores of a multicore cable shall not be less than 15 times its overall diameter.

Cable with kinks and straightened kinks, or with similar apparent defects like defective armoring etc. shall not be installed / laid.

Cables of different voltages as well as power and control cables should be kept in different trenches/racks with adequate separation. Where available space is restricted, LV/MV cable shall be laid above HV cables.

Where cables cross over cannot be avoided, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

Installation of cables including jointing shall be carried out as per IS: 1255 amended and revised to date.

Power and communication cables shall, as far as possible cross at right angles. Where power cables are laid in proximity to communication cables, the horizontal and vertical clearances shall not normally be less than 60 cm.

Cables shall be laid direct in ground, in pipes / closed ducts, in open ducts or on surface depending on environmental conditions, and as required in schedule of quantities.

During the preliminary stages of laying the cable, consideration should be given to proper location of the joint position so that when the cable is actually laid, the joints are made in the most suitable places and as approved by Consultant. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks, etc. shall be avoided.

The cable shall not in any circumstances be bent so as to form an abrupt right angle but must be rounded off at the corners to a radius not less than 12 times the overall diameter of the cable.

In case, where there are chances of any damage to the wiring/cables, such wiring/cables shall be covered with a sheet metal protective covering (not less than 16 SWG), the base of the covering being flush with the plaster

or brickwork as the case may be, or the wiring /cables shall be drawn through a heavy gauge metal conduit pipe by complying with all the requirements of conduit wiring system.

Such protective covering shall, in all cases, be fitted on all down drops within 1.5 m from the floor or from floor level upto the switch board, whichever is less.

While cutting and stripping of the outer sheathing of the cable, care shall be taken that the sharp edge of the cutting instrument does not touch the inner insulation of the conductors. The protective outer covering of the cable shall be stripped off near connecting terminal and this protective covering shall be maintained upto close proximity of connecting terminals. The cables laid near junction boxes shall be made moisture proof with a plastic compound.

7. CABLE JOINTING & TERMINATION

Jointing shall be as per the manufacturer's recommendations using standard kits. Cable joints shall be made in suitable, approved cable joint boxes, jointing of cables in the joint boxes and filling of compound shall be done as per manufacturer's recommendations. Heat shrinkable joints shall be made.

Cables shall be terminated onto the terminals of switchgear through crimping lugs of proper size and of heavy duty. Cable lugs shall be fitted onto the cable by crimping or compression jointing.

Continuity of cable armouring is to be maintained. Double compression glands to be used. Proper crimping tools to be used.

7a. CABLE GLANDS:

Heavy duty Brass-Nickel plated Double compression glands to be employed for cable termination into the panels & boards.

See photos of glands as below:

i. Single compression gland, IP-68 rated, shall be used for flexible un-armoured copper cables.
ii. Double compression glands, weatherproof IP-67 rated, shall be used for all the armoured / un-armoured cables.
iii. Double compression flame proof glands, IP-66 rated, shall be used for fire rated / fire survival cables.

7b. CABLE LUGS & THIMBLES:

Heavy duty lugs & thimbles to be employed for making cable & wire connections.

- Aluminium cables connection with aluminium bus bars shall be made with aluminium lugs / thimbles.
- Copper cables / copper wire connections with copper bus bars or with tinned copper witch gear terminations or with silver plated switchgear terminals shall be made with tinned copper lugs / thimbles.
- Copper cables / copper wire connections with aluminium bus bars shall be made with tinned copper lugs / thimbles or with bi-metal lugs / thimbles i.e. aluminium alloy lugs / thimbles with copper plating & then tinning.

- Hardware for cabling connections to panel's bus bars, to switch gear, to DB's and motors etc.: High tensile MS Alloy grade 8.8, Zinc coated (minimum 10microns coating). (Trivalent Plating CR3+).

Bolts, nuts & washers for cabling connections shall be:

1.	Steel Hardware		
	Salt mist spray withstand	:	120 Hours
	Bolt and nuts		
	Hardware quality	:	8.8
	According to	:	EN 20898, EN ISO 3506-1, 4759-1 (=S=FT30860)
	Contact Washers		
	Washer quality	:	8.8
	Class	:	160 HV
	According to	:	EN 20898, EN ISO 3506-1, 4759-1

Note : double washers to be employed. (plain and spring washers).

8. TRENCHING & CABLE LAYING

The minimum width of trench shall be 45 cm and depth shall be 75cm for laying of cable. Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the minimum gap between the cables is one diameter of the cable unless specified otherwise.

The clearance between axis of the end cables and the sides of the trench shall be minimum 1.5 D (diameter) of the end cable.

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided.

Where gradients and changes in depth are unavoidable, these shall be gradual.

The bottom of the trenches shall be level and free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 9 cm in depth.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 20 cms. above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before second tier is laid. If additional tiers are formed, each of the subsequent tiers shall have a sand cushion of 30 cms as stated above. The top-most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm x 10 cm x 10 cm (nominal size) as per CPWD building specification, or protection covers placed on top of the sand, (brick to be laid breadth wise) for the full length of the cable to satisfaction of the owner. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5 cm over the sides of and cables.

The trenches shall be then back filled with excavated earth free from stone or other sharp-edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm. Unless otherwise specified, a crown of earth not less than 50 mm in the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth, however, should not exceed 10 cms.

Where road bends or lawns have been cut or kerb stones displaced, the same shall be repaired to the satisfaction of the architect and all surplus earth or rock removed to places as specified.

In locations such as road crossing, entry to building in paved areas etc. cables shall be laid in pipes or closed ducts.

All cable entry/exit points into the building through pipe sleeves shall be properly sealed with water and fire safe sealants in an approved manner to avoid any seepage of water into the building.

Manholes of adequate size, as decided by the Architect, shall be provided to facilitate of adequate strength feeding/drawing in of cables and to provide working space for persons. Suitable manhole covers with frame of proper design shall cover Manholes.

CABLE LOOPS: Sufficient cable loop length shall be left at both ends.

9. CABLES ON HANGERS OR RACKS / TRAYS

The contractor shall provide and install all iron hangers racks, or racks with die-cast cleat, with fixing rag bolts or girder clamps or other specialist fixing as required.

Where hangers or racks are to be fixed to wall sides ceiling and other concrete structures, the contractor shall be responsible for cutting away, fixing and grouting in rag bolts and making good the damages as required.

The hangers or racks shall be designed to leave at least 25 mm clearance between the cables and the face to which it fixed. Multiple hangers shall have two or more fixing holes. All cables shall be saddled at not more than 500 mm intervals. These shall be designed to keep provision of some spare capacity for future development. Minimum spacing between the cables shall be one diameter of the cable or as specified.

Cable Clamps , saddles and screws :

Cable fixing clamps, saddles & screws on trays / walls / slabs		Indoor Application: • Aluminium • Readymade type clamps or Made from 20mm x 3mm aluminium sheet / strips. • 8mm SS-304 Screws for cable size 90mm² and above. • 6mm SS-304 Screws for cable size less than 90mm². Outdoor Application: • SS-304 • Clamps Made from 20x1.8mm SS-304 sheet / strips. • 8mm SS-304 Screws for cable size 90mm² and above. • 6mm SS-304 Screws for cable size less than 90mm².
Clamps spacing		• 600mm C/C in vertical fashion in shaft on vertical trays. • 1000mm C/C on horizontal tray or cable racks.

10. TESTING OF CABLES

The Megger value in normal dry weather shall be 50 mega ohm for 1.1 KV grade cable. Cables shall be tested at works for the following tests before being dispatched to site by the project team:

a. Insulation Resistance Test.
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.(in armoured cables)

e. Hi Pot Test.

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 Owner's site representative:

a. Insulation Resistance Test(Sectional and overall)
b. Continuity resistance test.
c. Sheathing continuity test.
d. Earth test.

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 PMC / Owner representative.

11. CABLE TAGS

Cable tags shall be made out of 2mm thick aluminum sheets. Each tag shall be 2" in dia or 3" x 3" square with one hole of 2.5mm dia, 6 mm below the periphery, or as approved by Consultant. Cable designations are to be punched with letters / number punches and the tags are to be tied to cables with piano wires of approve quality & size. Tags shall be tied inside the panels beyond the glanding as well as above the glands at cable entries. Along trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters.

Cables shall be secured to cable trays with 3mm thick x 25mm wide aluminum strips/suitable GI clamp, or as approved by Consultant, at 1000 mm intervals and screwed by means of rust proof screws, washers and bolts, of adequate but not excessive lengths. Cable trays for horizontal runs suspended from the ceiling will be supported with mild steel straps or brackets, at 1000 mm intervals and the overall tray arrangement shall be of a rigid construction. External cabling route marker with GI plate marked with "DANGER 1.1 kV CABLE" with 1 meter long GI angle iron grouting bracket including 1:3:6 ratio cement concrete base block of minimum size 200 x 200 x 350 mm to be provided or as approved by Elect. Supply Company.

12. CABLE TRAY

a) The MS cable trays should have undergone rigorous rust proofing process, which should comprise of alkaline, degreasing, descaling in diluted sulpharic acid and a recognized phosphating process. The sheet work shall then be given two coats of oxide primer before two coats of final painting. Cable trays & tray supports shall be either painted (Stove enameled) pre-galvanized or hot dip galvanized as called for in the schedule of quantities.

b) Cable trays shall be complete with bends, joints, coupler plates and accessories as may be required for joining the cable trays.

c) Cable trays shall be either perforated or ladder type as called for in the schedule of quantities.

13. PERFORATED CABLE TRAYS

Standard Technical details of perforated cable tray shall be as follows:

S. No.	SIZE OF TRAY (Width)	THICKNESS & COLLAR HEIGHT
1.	150mm to 450mm width	2mm thick & 50mm collar
2.	600mm to 750mm width	2mm thick & 50mm collar
3.	900mm to 1200mm width	3mm thick & 50mm collar

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray.

14. LADDER TYPE CABLE TRAYS

Standard technical details of ladder type cable trays shall be as follows:

S. No.	SIZE OF TRAY	SIZE OF MAIN CHANNEL OR RUNNER	SIZE OF RUNG & SPACING	CABLE TRAY SUPPORT
1.	900mm to 1500mm	25 x 100 x 25 x 2.5mm	20 x 50 x 20 x 2.5mm @ 250 C/C	50 x 50x 5mm angle @ 1000mm spacing.
2.	450mm to 750mm	20 x 75 x 20 x 2.0mm	20 x 50 x 20 x 2mm @ 250 C/C	40 x 40 x 5mm angle @ 1250mm spacing.
3.	150mm to 300mm	20 x 75 x 20 x 2.0mm	15 x 35 x 15 x 2mm @ 250 C/C	40 x 40 x 3mm angle @ 1500mm spacing.

Hangers shall be minimum 10mm dia GI Round bar.

Fixing /supporting arrangement shall be as approved by the Consultant / Owner / PMC

Hardware to be used in cable tray system shall be hot dip galvanized.

Note: Supports shall not be charged extra. It shall be considered to be included in the rate of the tray. All structural steel shall be according to the latest revision of IS: 226 & 808.

a. Quality of Zinc

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

b. Coating Requirement

Minimum weight of zinc coating for mild steel flats with thickness upto 6 mm in accordance with IS:6745-1972 shall be 400 g/sqm.

The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs; rust stains bulky white deposits, blisters.
Mild steel flats / wires shall undergo a process of degreasing, pickling in acid, cold rinsing and then galvanizing.

15. CABLE TRAY SUPPORT / INSTALLATION SYSTEM:

15.1 FACTORY FABRICATED MODULAR SUPPORTING SYSTEM:

a. Cable tray support from RCC Slab/PEB Structure:
Wire Hangers shall be used to suspend all static Electrical services.

Wire Hangers should consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings, these include a ferruled loop, permanently fixed threaded M6 (or M8, M10,M12) stud/eyebolt, permanently fixed nipple end with toggle, at one end or hook or eyelet, cladding hook, barrel, wedge anchor, eyebolt anchor or any other end fixture type or size as per manufacturers recommendation and design. The end fixings and the wire must be of the same manufacturer with several options available. The system should be secured and tensioned with a Hanger self-locking lock (double channel wedge type lock) at the other end. Once the lock is engaged, for safety purpose, unlocking should only be done by using a separate setting key and should not be an integral part of the self-locking lock. In case unlocking arrangement is an integral part ie. button/pin type, the button/pin shall be hidden under a separate housing cover made of same material as of housing. To guard against accidental unlocking, the unlocking button/pin should be accessible if and only if the housing cover is removed. Only wire and/or supports supplied and/or approved, shall be used with the system.

a. Wire Hangers should have been independently tested by Lloyds Register. APAVE, TUV, CSA, ADCAS, Intertek, ECA, UL (Electrical) and SMACNA, approved by CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope should be manufactured to BSEN 12385: 2002 standards. UL (Electrical) certificate should be for the complete wire rope hanger (including the wire, lock and end fittings). If product is not certified by SMACNA and manufacturer is giving compliance to SMACNA then the wire dia. Selection shall be as mentioned in SMACNA Chapter 5, Tables 5-1, 5-1M, 5-2 and 5-2M.

- Wire Hangers shall be independently tested by reputed third party testing organization to sustain safe working load for 120min at elevated temperature of 175 deg. C or above.

- The contractor shall select the correct specification of wire hanger to use for supporting each particular service. Each size should be designated with a maximum safe working load limit (which incorporates a 5:1 safety factor).

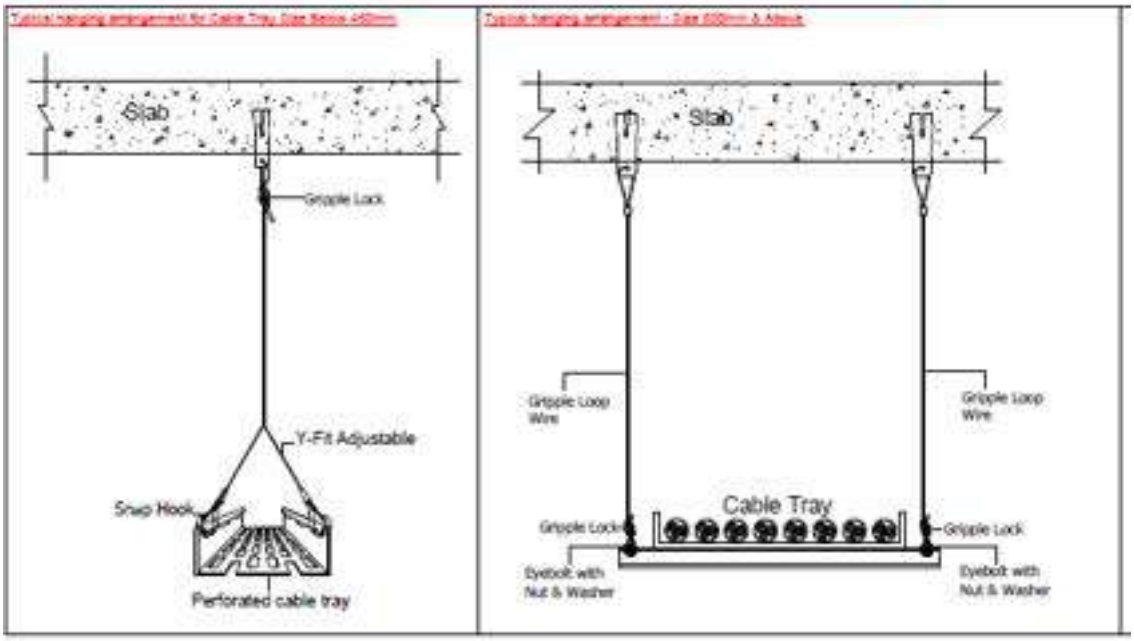
The correct specification of wire hanger required should be determined using the following formula or as per manufacturer's recommendation, whichever is stringent.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Hanger suspension point (kg).

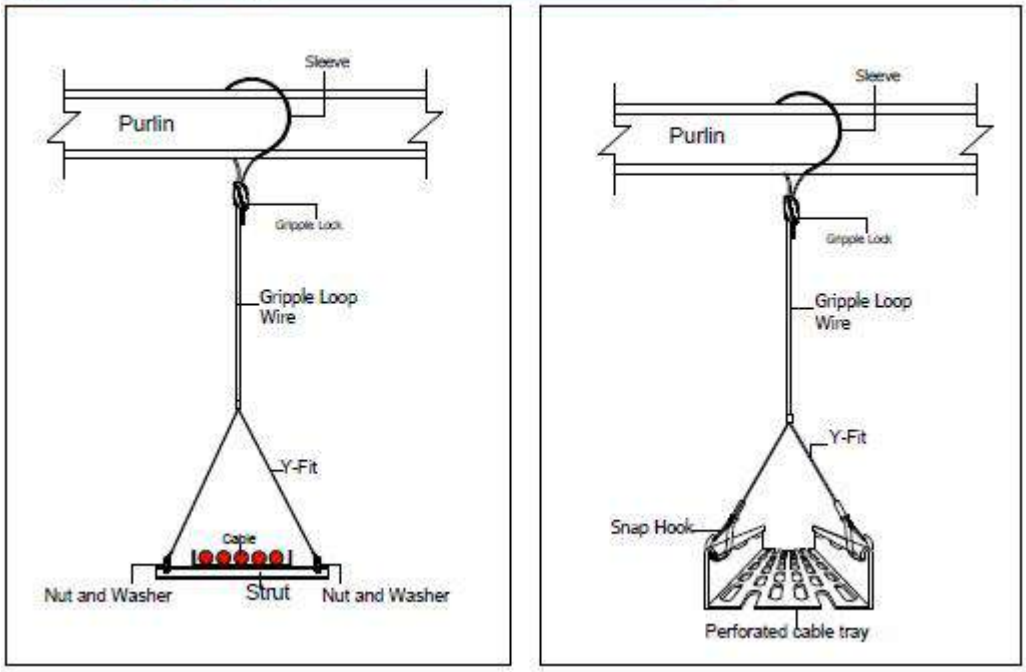
Where the installed wire rope is not vertical then the working load limit shall be reduced in accordance with the recommendations give in the manufacturer's handbook. The contractor shall select the correct length of wire rope required to support the service. No in–line joints should be made in the rope.

The standard range of Hanger Kits should contain galvanized high tensile steel wire rope or stainless steel wire rope as per the application, the minimum specification is as above and should be manufactured to BS 302, BSEN12385. **Comply with manufacturer's load ratings and recommended installation procedures.** The testing shall be done to the minimum breaking load of the wire thus giving a minimum safety factor of 5: 1.

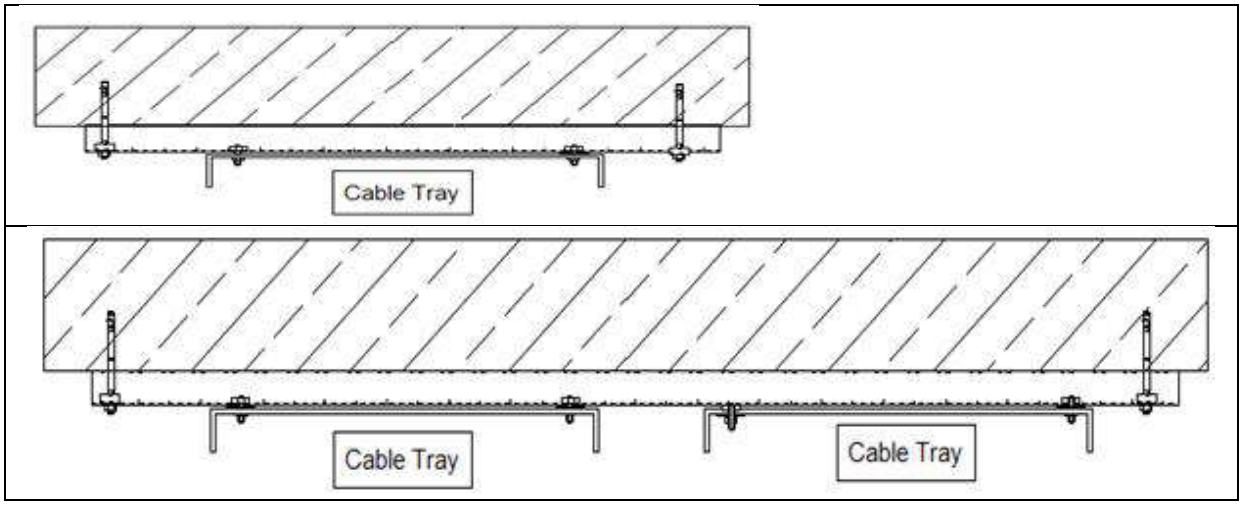
Typical hanging arrangement of Cable Tray for Slab Area



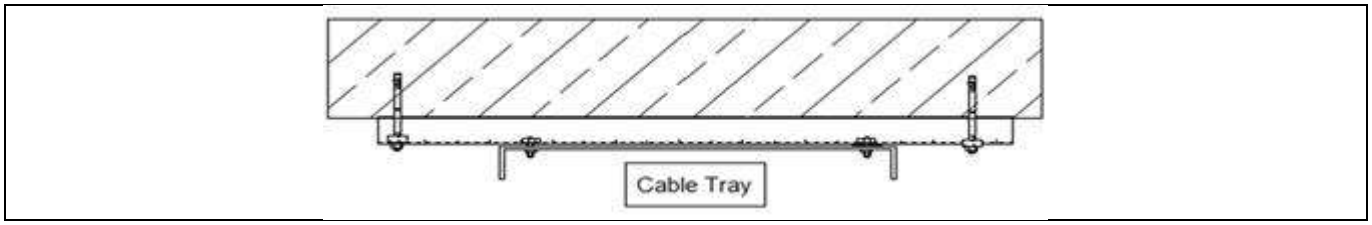
Typical hanging arrangement for Cable Tray Size Below 450mm

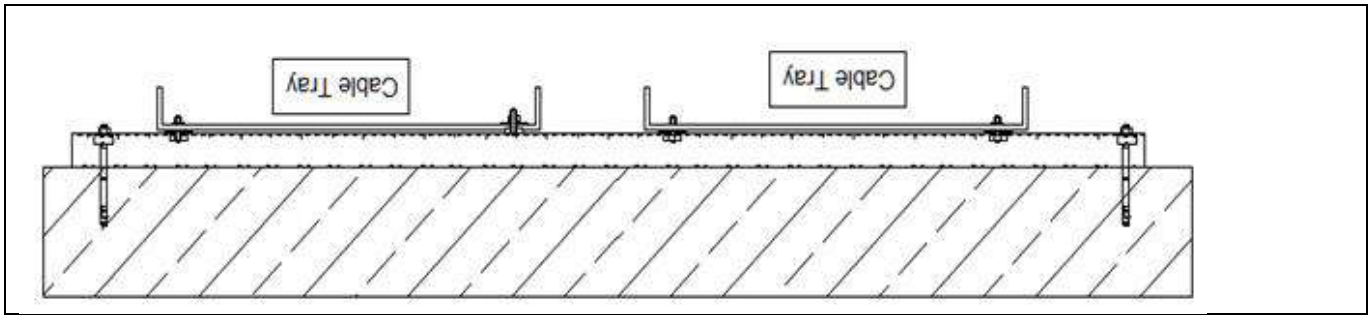


Typical Arrangement for cable tray support from building shaft



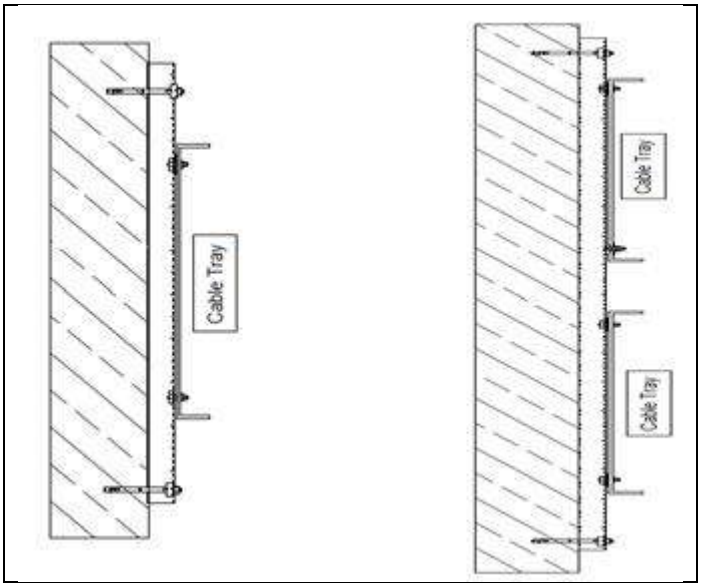
Typical Arrangement for cable tray support from building terrace





Foot based supports can also be used as an alternative to the above mentioned support system.

Typical Arrangement for Cable tray support from Building shaft



Supports can be provided for: Busbar, Cable Ladder, Cable Tray, Cable Basket, Channel, Trunking, Light Rafts, Luminaires, Secondary Supports, Safety Lines, High Bay/Low Bay Lights, Electrical Cables, CCTV and Catenary Supports: Y-Fit solution shall be used to a maximum width of 500mm Cable Tray. For Tray over 500mm cradle support method or independent supports must be taken as appropriate based on load. Any other solution can be used based on manufacturer's recommendation on site conditions after prior approval.

Special Supports: Refer to manufacturer's recommendations on Catenary supports, special care should be taken with tensioning of the wire and angles at which the installation of services are made**.**

Stainless Steel Supports should be available for food, chemical and High Corrosion areas near coastlines.

Refer to manufacturers catalogue and installation guide for further technical information. **Comply with manufacturer's load ratings and recommended installation procedures.**

The struts/channels used shall be made of pre-galvanized sheet as per IS standards. Contractor shall submit load calculation sheet and stress analysis of all struts/channels, brackets etc which shall be carried out by using a reputed third party modeling/analysis software.

Note: Contractor shall be fully responsible & accountable for the structural stability of the hanging / supporting system of duct work. The above data furnished about supports is only for guidance. The ducting contractor to hire a specialist agency / vendor to design the supporting system of duct work and submit a design & certificate along with supporting marked drawings with typical supporting arrangements.

All the supporting system shall be supplied from same manufacturer. And a structural stability certificate to be issued by the duct installation /HVAC contractor to the client along with the design.

15.2 SEISMIC RESTRAINTS & SEISMIC ISOLATION FOR ELECTRICAL SERVICES & EQUIPMENTS:

15.2.1 INTRODUCTION:

This specification is intended to provide general guidelines for the Seismic Analysis of Non-Structural components ie. MEP & FF distribution & equipments

15.2.2 SCOPE:

Seismic Analysis/Calculations should be carried out based on IS16700:2017. References from IS16700:2017 should be taken for seismic forces. Exceptions for Seismic supports as stated in ASCE7, SMACNA seismic restraint manual should be considered. For Fire-fighting distribution components & equipment sway bracing design and exceptions mentioned in NFPA 13 will supersede exceptions mentioned in ASCE 7.

15.2.3 **DESIGN LOADS:**

a. DEAD LOADS

The dead load is assessed based on the weight of the equipment/distribution system.

b. SUPERIMPOSED DEAD LOAD

The super imposed dead load is assessed based on the weight of the equipment / distribution system. For pipes containing water, weight of the water filled pipe is included in this load case.

c. EARTHQUAKE LOAD

Earthquake load should be calculated as per IS16700:2017, appropriate references from ASCE 7-10 should be considered considered

As per IS16700:2017/NBC 2016, following parameters should be considered

1. Seismic zone should as per NBC 2106 Part 6 Section 1 or as per building design seismic zone factor.
2. Seismic zone factor, Z – 0.24 (ZONE IV-Delhi NCR Region), as per NBC 2016 Part 6 Section 1 Table 42 Clause 5.3.4.2.
3. Seismic Design Force is calculated as IS16700:2017, as follows

$Fp = Z * (1+x/h) (ap * Ip/Rp) Wp \geq 0.10 Wp$ (As per IS16700:2017)

where,

Z = seismic zone factor given in NBC 2016 Table 42 (Clause 5.3.4.2) should be considered.

a.) Zone factor for some important towns are given at NBC 2016 Part 6 Section 1 Annexure K or as per building design seismic zone factor = 0.24 (Zone IV)

b.) Response Reduction Factor should be taken as per IS16700:2017.

c.) Amplification factor (as per IS16700:2017)

d.) Importance factor, Ip (as per IS16700:2017)
e.) z - Height in structure of point of attachment of component with respect to the base.
f.) h - Average roof height of structure with respect to the base

Linear static analysis is considered for gravity loads. Equivalent static method is considered for Earthquake loads.

d. WIND LOAD ANALYSIS:

Calculate static and dynamic loading due to wind forces required to select/design vibration isolators, bases and seismic & wind restraints for outdoor & roof top equipments/services. The calculation of wind load shall be as per IS:875(Part 3)/NBC 2016 Part 6 Section 1. Worst case between Seismic Loads and Wind Loads has to be considered for supporting and vibration isolation.

15.2.4 ANALYSIS METHOD

Linear static analysis is considered for gravity loads. Equivalent static method is considered for Earthquake loads.

15.2.5 DESIGN METHODOLOGY

The supporting structural steel system shall be designed according to Limit state method as specified in IS: 800-2007. Appropriate loads and its combinations, as per relevant clauses in IS codes should be chosen for design. Based on selection location and type of seismic support for the same shall be provided in the shop drawings.

15.2.6 LOAD COMBINATION

The various loads are combined in accordance with the stipulations in NBC2016. Load combinations considered in design are as follows,

Type	Load Case	Load Details
Primary	1	Dead Load-DL
Primary	2	Superimposed dead Load at Terrace- SIDL
Primary	3	Earthquake Load along X-Direction EQ(+X)
Primary	4	Earthquake Load along Z-Direction EQ(+Z)
Primary	5	Earthquake Load along Y-Direction EQ(+Y)

LOAD FACTOR FOR LOAD AND RESISTANCE FACTORED DESIGN (LRFD):

0.9 DL ± 1.5 (Eqx ± 0.3 Eqy) …… NBC2016 5.3.3.4

15.2.7 MATERIALS:

a. Structural Steel:

Materials	Standards
Hot-Rolled Members	
ISMC Channels	IS:2062
Angles	IS: 2062
Bolts & Nuts	Grade 4.6
Anchor fasteners	Grade 8.8
Cold-Formed Members	IS:811

b. Seismic Wire Rope Kit:

Wire based seismic restraint kits shall consist of Break strength certified, pre-stretched seismic cable with a permanently fixed 45 degree eyelet or ferruled copper/copper plated loop fixed to single, double or retrofit seismic bracket, or any other end fixture type or size as per manufacturers recommendation and design. The end fixing, bracket and wire must be of the same manufacturer. The system should be secured and tensioned with a Seismic rated self-locking grip at the other end. For ease of installation, flexibility, and workmanship only wire based seismic restraint system shall be used to restraint/brace all services.

Wire seismic restraints supplied and/or approved, shall be used with the system, the wire rope should not have color coding applied to it and should only be supplied with separate color coded tags. Bracing elements shall be seismic certified/tested by third party accredited lab as per ASHRAE standard 171, Method of Testing for Rating Seismic and Wind Restraints.

Cables shall have color coded size identifiers as per seismic requirements and must be pre-stretched. Cables shall be suspended 45 degrees (+/- 15 degrees Engineers allowances). Once the grip is locked for safety purpose unlocking should only be done by using a separate setting key and unlocking button should not be an integral part of the self-locking grip for safety purpose.

At the point of the seismic restraint installation, a rigid support is required (threaded rod + rod stiffener or appropriate as approved by a qualified engineer). The location of all the seismic restraint points shall be determined by a qualified engineer.

When attaching the seismic restraints to the slab/structure seismic rated anchor shall be used. The connection of channel/ stiffener to the concrete should be done using anchors with ETA C2 approval for seismic loads. The design of anchors should be done as per ETA-TR 045 guidelines for seismic anchor design.

The seismic product to be used shall be determined by a qualified engineer, based on data supplied by the manufacturer.

The contractor shall select the seismic bracket for the attachment to the 'service' as either a standard or retrofit bracket. All parts and materials shall have been fully tested to conform to local/ state/provincial requirements and codes. The same manufacturer shall supply all parts and materials

The designer/contractor shall select the correct specification of wire based seismic restraints to use for restraining/bracing particular service mentioned in this specification; approved concrete anchors must be used by the designer/contractor. Refer to Table 1 below.

The Seismic engineer shall select the correct length of wire rope required to restrain/brace the various services & applications. No in–line joints should be made in the rope.

Table 1:

Wire based seismic restraint Safe Working Loads	
Kit Type	**Design Strength (LRFD) (kg)**
Type 2	239
Type 3	522
Type 4	1261

All Seismic restraints must comply with manufacturer's load ratings and recommended installation procedures.

c. Threaded Rod:

Size	Threaded Rod Diameter (mm)	Allowable Working Load (kN)	Allowable Working Load (kgs)	Max Unbraced Rod Length (mm) Table 7-5 ASHRAE Seismic Manual
M10	10	2.7	275.23	457
M12	12	5	509.68	635
M 16	16	8	815.5	584
M 20	20	12	1223.24	610
M 22	22	16.7	1702.34	660

d. Rod Stiffeners:

Rod stiffener consisting of steel channel and attachment clips capable of bracing vertical suspension rods or made out of Polypropylene to avoid potential buckling due to vertical compression forces should be used. Braces shall be selected to be of sufficient strength to prevent support rod buckling. Brace shall be attached to the vertical suspension rod by a series of attachment clips.

e. Riser Guides:

Risers shall be restrained against excessive lateral movement during service/earthquake. Riser guides must allow axial motion of the pipe and provide lateral restraint against static, hydrostatic & earthquake loads. The guides should include a neoprene bushing. This bushing allows some flexibility and prevents short-circuiting of vibration isolated device. The neoprene bushing also allows seismic loads to be cushioned and distributed to several guides.

f. Riser Anchors:

Straight solid risers can be rigidly anchored at one point provided the load is not concentrated on one floor. Riser anchors must be able to restraint against static, hydrostatic & earthquake loads. Riser anchor should restraint against excessive movement during services and earthquake thrusts by the use of 3-axis resilient anchors designed to withstand the required installation, operating and earthquake loads. Anchors shall be of steel construction and shall be attached to the riser with either a heavy-duty riser clamp or a welded support bracket in a manner consistent with anticipated design load. Snubbers shall limit lateral and vertical riser movements at each anchor location to a maximum of ¼" (6mm) in any direction. Anchors shall include a minimum of ½" (13mm) thick resilient neoprene pad to cushion any impact and avoid any potential metal-to-metal contact. Anchors shall be capable of withstanding an externally applied force of up to their rated capacity in any direction.

g. Riser Clamps

Riser clamps should be two-piece heavy-duty clamps bolted together and have a load rating based on clamping capacity. Riser clamps reinforce the pipe and distribute forces evenly to minimize pipe wall stress concentrations that would otherwise develop with welded lugs or brackets. The clamp must be sized for two times the dead load and there must be a positive means of engagement between the clamp and riser.

h. All Directional Seismic Restraint Spring Mounts

Spring isolators shall be single or multiple coil spring elements which have all of the characteristics of free-standing coil spring, incorporating lateral and vertically restrained seismic housing assemblies. Restraint housing shall be sized to meet or exceed the force requirements of the application and shall have the capability of accepting coil springs of various sizes, capacities, and deflections as required to meet the required isolation criteria. All spring forces shall be contained within the coil/housing assembly, and the restraint anchoring hardware shall not be exposed to spring generated forces under conditions of no seismic force. Spring element should have built-in levelling adjustment and shall be accessible from above and suitable for use with a conventional, pneumatic or electric impact wrench. Restraint element shall

incorporate a steel housing with elastomeric elements at all dynamic contact points. Elastomeric elements shall be replaceable. Restraint shall allow ¼" (6 mm) free motion in any direction from the neutral position. Isolators should have a min. operating Kx/Ky ratio of 1.0, springs should have 50% additional travel to solid beyond rated load. Isolators should be selected in the range of -30% to +25% of rated load. All isolators certified to withstand minimum 1.0 G force. Seismic 'G' ratings for all seismic restraint products should be 3rd party certified and should be part of relevant submittal. Spring elements should be color-coded for easy field verification and should be capable handling high deflection and should have a low natural frequency.

i. Modular Support Components:

C-channel vertical suspension shall be selected to be of sufficient strength to prevent support buckling. Wire rope brace shall be attached to the connector connecting vertical suspension C-channel/threaded rod/stiffener with horizontal C-channel by a suitable connector capable of taking seismic loads. Stress analysis calculation should be submitted for the worst-case length of the C-Channel/Strut members used. Stress analysis should be done for tensile, compressive and combined stresses.

The connection of wire rope bracing /channel/ threaded rod to the concrete should be done using anchors with ETA C2 approval for seismic loads. The design of anchors should be done as per ETA-TR 045 guidelines for seismic anchor design.

j. Flexible Connections/bellows for accommodation of differential seismic motion:

Install flexible metal hose loops in piping which crosses building seismic joints, sized for the anticipated amount of movement. Install flexible connectors where adjacent sections or branches are supported/connected by different structural/non-structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural/non-structural element from the one supporting the connections as they approach equipment. All installed bellows and flexible connections shall be designed to accommodate for seismic motion and deflection.

15.2.8 SERVICABILITY REQUIREMENTS:

a. Deflection:

Deflection Limitations shall be as per 5.6.1 Table 6 of IS800:2007

15.2.9 SEISMIC BRACING DESIGN:

Seismic Supporting system shall be analyzed for seismic forces as per IS 16700 Cl. 10.2 and design intent of SMACNA seismic restraint manual - Guidelines for Mechanical system; ASCE 7-10 Chapter 13 and ASHRAE Practical Guide to Seismic Restraint shall be used as a reference for design basis & exceptions. The load calculations, stress calculations, design basis and exceptions considered shall be part of submittal for approval.

a. Project Design Criteria:

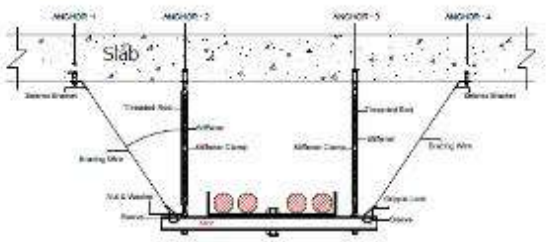
To be mentioned in the submittal documents:

Description	Standard
Seismic Zone	IS16700:2017
Seismic Zone factor	NBC 2016 Table 42 (Clause 5.3.4.2) or as per building seismic zone factor.
Soil Site class	as per site location
Importance Factor (Ip)	IS16700:2017
Component amplication factor (ap)	IS16700:2017
Component response modification factor (Rp)	IS16700:2017
Component response modification factor (Rp) for base isolation	IS16700:2017
Height in structure of point of attachment of component with respect to the base (z)	As per level of attachment of component
Average roof height of structure with respect to the base (h)	As per level of attachment at the roof/slab/peb level
z/h	ratio based on above parameters

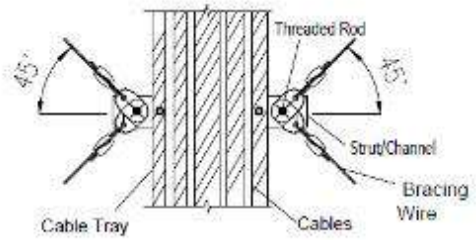
b. For Calculations:

Description	Formula & Values
Seismic Design force In horizontal direction (Fp')	to be part of submittal
Vertical seismic force (Eqy')	to be part of submittal

Typical Arrangement for Cable Tray

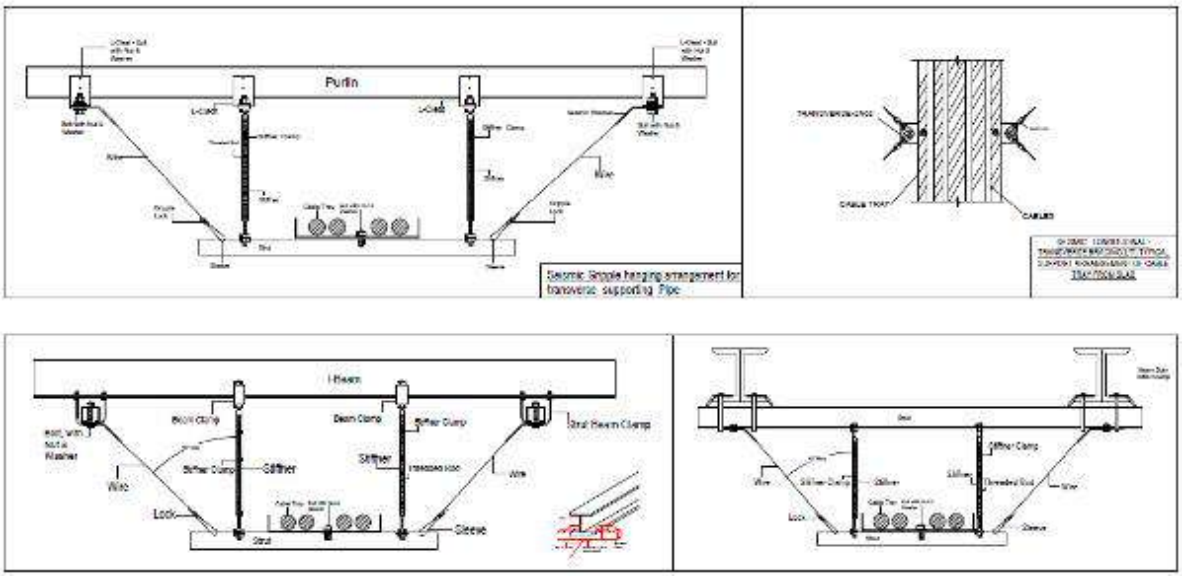


Seismic Gripple hanging arrangement for transverse supporting-Cable Tray



Seismic Gripple hanging arrangement for longitudinal supporting-Cable tray

Typical Hanging Arrangement for Cable Tray



Supporting distance between seismic transverse supports shall not be more than 30 feet and supporting distance between longitudinal supports shall not be more than 60 feet.

NOTE: CABLE TRAY SUPPORTING SYSTEM TO BE DESIGNED BY A COMPETENT AGENCY TO ENSURE SAFETY OF THE INSTALLATION, BUILDING AND THE PERSONS. CONTRACTOR TO HIRE A SPECIALISED AGENCY FOR DESIGN AND INSTALLATION OF THE CABLE TRAY SUPPORT SYSTEM AND ASSUME COMPLETE RESPONSIBILTY ON ADEQUACY OF THE SUPPORT SYSTEM. CONTRACTOR TO SUBMIT A CERTICATE FROM THE STRUCTUAL CONSULTANT ALONG WITH THE DESIGN AND DRAWINGS SUBMITTED TO THE CLIENT/PMC. SIGN AND DRAWINGS SUBMITTED TO THE CLIENT/PMC.

SUBHEAD-E. EARTHING

1. SYSTEM OF EARTHING

The system shall be TNS with 4 wires supply system (R, Y, B, N and 2 Nos. E) brought from the main LT Panel.

All non-current carrying metal parts of the electrical installation shall be earthed as per IS: 3043 – 2018 with latest amendment. All metal conduits, cable sheath, switchgear, DB's, light fixture, equipment and all other parts made of metal shall be bonded together and connected to earth electrodes. Earthing shall be in conformity with provisions of rules 32, 61, 62, 67 and 68 of Indian Electricity Rules, 1956.

All earthing conductors shall be of high conductivity copper or GI, as specified in the schedule of quantities & shall have protection against mechanical damage. The cross-sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor.

Main earthing conductors shall be taken from the earth connections at the main L T panel to an earth electrode with which the connection is to be made. All joints in tapes shall be with S.S. Straight through or cross connectors or copper brazing in case of copper tapes and by Exothermic welding or bolting or S.S. connectors (straight through or cross connectors) in case of GI tapes. Wires shall be connected with suitable crimping lugs, all bolts shall have plain and spring washers spring washers. Sub- mains earthing conductors shall run from the main distribution panel to the sub distribution panel. Final distribution panel earthing conductors shall run from sub-distribution panel.

Circuit earthing conductor shall run from the exposed metal of equipment and shall be connected to any point on the main earthing conductor, or its distribution panel. Metal conduits, cable sheathing and armouring shall be earthed at the ends adjacent to distribution panel at which they originate, or otherwise at the commencement of the run by an earthing conductor in effective electrical contact with cable sheathing. Where equipment is connected by flexible cord, all exposed metal parts of the equipment shall be earthed by means of an earthing conductor enclosed with the current carrying conductors within the flexible cord. Switches, accessories, lighting fitting etc. which are rigidly secured in effective electrical contact with a run of metallic conduit shall not be considered as a part of the earthing conductor for earthing purposes, even though the run of metallic conduit is earthed.

a. All Lighting fixtures, sockets outlets, fans, switch boxes and junction boxes etc. shall be earthed with copper wire as specified in schedule of quantities. The earth wire ends shall be connected with solderless/bottle type copper lugs.

b. All the earth wires in switch boxes, sockets outlets, DB's and light fixtures shall be of green Colour (PVC insulated).

c. Main earth bus shall be taken from the L.T. switch board to earth electrodes. The electrical resistance of earthing conductors shall be low enough to permit passage of fault current necessary to operate fuse or circuit breaker, and it shall not exceed 1 ohm.

2. SIZING OF EARTHING CONDUCTORS

The cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits upto 15 amps shall be earthed with FRLS PVC insulated copper wire.

All 3 phase switches and distribution panels upto 60 amps rating shall be earthed with 2 Nos. distinct and independent 4 mm dia copper / GI wires. All 3 phase switches and distribution panels upto 100 amps rating shall be earthed with 2 Nos. distinct and independent 6 mm dia copper / GI wires. All switches, bus bar, ducts and distribution panels of rating 200 amps and above shall be earthed with minimum of 2 nos separate and independent 25 mm x 3 mm copper / GI tape.
Earthing details given in Table – A & B shall be referred to as a general guidance. Exact sizes to be worked out by the contractor as per relevant IS Codes.

TABLE - A

Approximate Sizes of earth leads

(a) For Transformer/Generator Neutral Point Earthing:

Transformer/ DG Set Rating in KVA		Electrolytic Bare copper Conductor Wire or strip		Galvanized Iron Conductor wire or strip
50KVA & below		4mm dia		25mm x 6.0mm
75 KVA		25mm x 3.0mm		25mm x 6.0mm
100 KVA		25mm x 6.0mm		32mm x 6.0mm
150 KVA		25mm x 6.0mm		40mm x 6.0mm
200 KVA		25mm x 6.0mm		40mm x 6.0mm
250 KVA		25mm x 6.0mm		40mm x 6.0mm
300 KVA		25mm x 6.0mm		40mm x 6.0mm

500 KVA		40mm x 6.0mm		50mm x 6.0mm
750 KVA		40mm x 6.0mm		50mm x 6.0mm
1000 KVA		40mm x 6.0mm		50mm x 6.0mm
1250 KVA		50mm x 6.0mm		50mm x 6.0mm
1500 KVA		50mm x 6.0mm		75mm x 6.0mm
2000 KVA		50mm x 6.0mm		75mm x 6.0mm

NOTE: - EXACT SIZE OF EARTH LEAD TO BE DETERMINED BY CONTRACTOR AS PER LATEST IS CODES AND APPROVAL TO BE TAKEN FROM CONSULTANT.

TABLE – B

(b) Approximate sizes of Earth leads for Equipment Earthing (Applicable to Transformer, Generators, Switchgears, Panels, DB's, Motors etc.)

Rating of 400-V, 3ph 50 cy. Equipment In KVA		Bare Electrolytic Copper conductor Wire / Strip	Galvanised Iron Wire / Strip
Upto 5KVA	7A	2mm dia	2mm dia (14 SWG)
6 KVA to 15 KVA	Upto 20A	3mm dia	3mm dia (10 SWG)
16 KVA to 30 KVA	Upto 42A	4mm dia	4mm dia (8 SWG)
31 KVA to 50 KVA	Upto 70A	6mm dia	6mm dia
51 KVA to 100 KVA	Upto 140A	25mm x 3.0mm	25mm x 6.0mm
101 KVA to 125 KVA	Upto 175A	25mm x 3.0mm	32mm x 6.0mm
126 KVA to 150 KVA	Upto 200A	25mm x 3.0mm	32mm x 6.0mm
151 KVA to 200 KVA	Upto 300A	25mm x 6.0mm	40mm x 6.0mm
201 KVA to 300 KVA	Upto 400A	25mm x 6.0mm	50mm x 6.0mm
301 KVA to 500 KVA	Upto 700A	32mm x 6.0mm	50mm x 6.0mm
501 KVA to 800 KVA	Upto 1100A	40mm x 6.0mm	50mm x 6.0mm
Above 800 KVA	Above 1100A	50mm x 6.0mm	50mm x 6.0mm

NOTE: EXACT SIZE OF EARTH LEAD TO BE DETERMINED BY CONTRACTOR AS PER LATEST IS CODES AND APPROVAL TO BE TAKEN FROM CONSULTANT.

NOTE: ALL THREE PHASE EQUIPMENT SHALL BE DOUBLE EARTHED

3. SUGGESTED EARTH SIZES FOR DB'S FOR BODY & 3RD PIN DEDICATED EARTH LINK (FOR UPS DB'S ONLY) (SUBJECT TO FINAL FAULT CALCULATION AND EARTH SIZE BY CONTRACTOR)

a. 3 Phase LDB's, PDB's, UPS DB's, Pr. AC's (Body Earth):

Cu. Ar. / Al. Ar. Power Cables	Suggested Size of 'GI' Earth Wire
4C x 10 Sq.mm	2 R x 4 mm dia
4C x 16 Sq.mm	2 R x 5 mm dia
4C x 25 Sq.mm	2 R x 5 mm dia
3.5C x 35 Sq.mm	2 R x 5 mm dia

b. 3rd Pin / Dedicated Earthing Link Wiring of UPS DB's / PDU's:
3 Phase Cu. Ar. / Al. AR. Power Cables to UPS DB's / PDU

Cu. Ar. / Al. Ar. Power Cables	Suggested Insulated Earth wire 'Cu' XLPE Insulated for Dedicated Earth Wire
4C x 10 Sq.mm	2C x 6 Sq.mm Cu. Conductor XLPE Insulated Un. Ar. Cable
4C x 16 Sq.mm	2C x 10 Sq.mm Cu. Conductor XLPE Insulated Un. Ar. Cable
4C x 25 Sq.mm	2C x 10 Sq.mm Cu. Conductor XLPE Insulated Un. Ar. Cable

Note: For higher sizes of cables to PDU's take not less than half the size of phase conductor / cable size.

c. Server Room / Hub Room Rack Body & Raised Floor Earthing:

• 1C x 6 Sq.mm FRLS(H) PVC insulated, unsheathed, 600/1100 Volts grade stranded copper conductor single core wire as per IS:694
• 1C x 10 Sq.mm FRLS(H) PVC insulated, unsheathed, 600/1100 Volts grade stranded copper conductor single core wire as per IS:694

d. Modular Workstation Earthing:

• 2.5 Sq.mm FRLS(H) PVC insulated, unsheathed, 600/1100 Volts grade stranded copper conductor single core wire as per IS:694
• 4 Sq.mm FRLS(H) PVC insulated, unsheathed, 600/ 1100 Volts grade stranded copper conductor single core wire as per IS:694

4. PROHIBITED CONNECTIONS

Neutral conductor, sprinkler pipes, or pipes conveying gas, water, or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lighting protection system conductors shall not be used as an earthing conductor.

5. CONNECTION/JOINTS

A. GI Earth Tape Jointing shall be:

a. <u>Bolted Joints for all exposed GI earth tape joints on cable trays:</u>

Tape to tape bolted connections are to be made by sufficiently over lapping two tapes, one above the other and then making connection by not less than two sets of Nuts, bolts & washers. Washers shall be used at both sides. Overlapped joint with 2 sets of bolting arrangement per joint.

Zinc passivated / coated high tensile alloy MS grade 5.6 Hardware shall be used for making joint. (See attached sketches with the specifications).

High grade S.S. hard ware shall be used in coastal areas.

b. <u>Fixing of GI Earth tape on cable tray:</u>

Earth tape bolting on to GI cable trays shall be made by nuts, bolts & washers of same quality as mentioned earlier but at any fixing location on the tray, a small piece of GI tape shall be over lapped on the main earth tape so as to compensate for the area loss due to hole for fixing.

c. Exo Thermic welding of GI earth tape for tape joints buried in ground or clamped on wall, floor, slab:

'UL' listed exothermic welding to be employed for such joints.

d. S.S. Cross / Straight through connectors for GI tape joints clamped on wall, floor, slab:

Cross or straight through connectors may be used for making such joints.

B. Copper Earth Tape Jointing shall be:

a. S.S. Cross or straight through connectors to be used for making such joints.
b. By copper Brazing.
c. S.S. 304 nuts, bolts, plain and spring washers. Overlapped joint with 2 sets of bolting arrangement per joint.

6. EARTHING

The following must always be ensured in earthing system:

- All earth pits should be at equi - potential. Main equipotential bonding conductors shall be provided.
- Extraneous conductive parts such as gas pipes, other service pipes and ducting risers and pipes of fire protection equipment and exposed metallic parts of the building structure shall be bonded to earth.
- 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.

7. RESISTANCE TO EARTH

The resistance of earthing system shall be less than 1 ohm.

SPECIFICATION FOR HOT DIP GALVANIZING PROCESS FOR MILD STEEL USED FOR EARTHING FOR ELECTRICAL INSTALLATION

8. GENERAL REQUIREMENTS

a. **Quality of Zinc**

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992 (refer latest codes).

b. **Coating Requirement**

Minimum weight of zinc coating for mild steel flats shall be in accordance with latest IS:6745-1972 (refer revised code) but shall not be less than 500 gsm & 70 microns coating.

The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.
The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs; rust stains bulky white deposits, blisters.

Recycled steel is not be used for making earth tapes.
Mild steel flats / wires shall undergo a process of degreasing, pickling in acid, cold rinsing and then galvanizing.

Wooden mallet to be used for straightening of GI tapes so that galvinsed coating is not damaged.

9. MAINTENANCE FREE CHEMICAL EARTHING:

Maintenance Free Chemical Earthing shall be done strictly as per manufacturer's recommendations. It shall be completely maintenance free, long life close to 25 years, environmentally safe, non corrosive & electrically conductive. The earth resistance results shall be less than one ohm.

Maintenance Free Earthing System consisting of 1 Nos. CPRI tested 'UL' Listed copper bonded carbon steel core electrode of 25 / 20 mm dia Electrode tested according to IEC 62561-2 and as specified in the BOQ, each with a minimum coating thickness of 250 microns and length of 3 meters. 25 kgs/Electrode of earth enhancing compound needs to be considered to fill the 100mm augered hole surrounding to the electrode.

SS Universal Clamp of Size 175X50X3 mm for Connection Terminal to be used..

Earth enhancing compound(OEC) tested as per IEC 62561-7 (miminum 25 kg or more as per requirement) to be used.

Poly Propiline Heavy duty Pit cover to be employed.

10. Galvanic Corrosion between dissimilar materials:

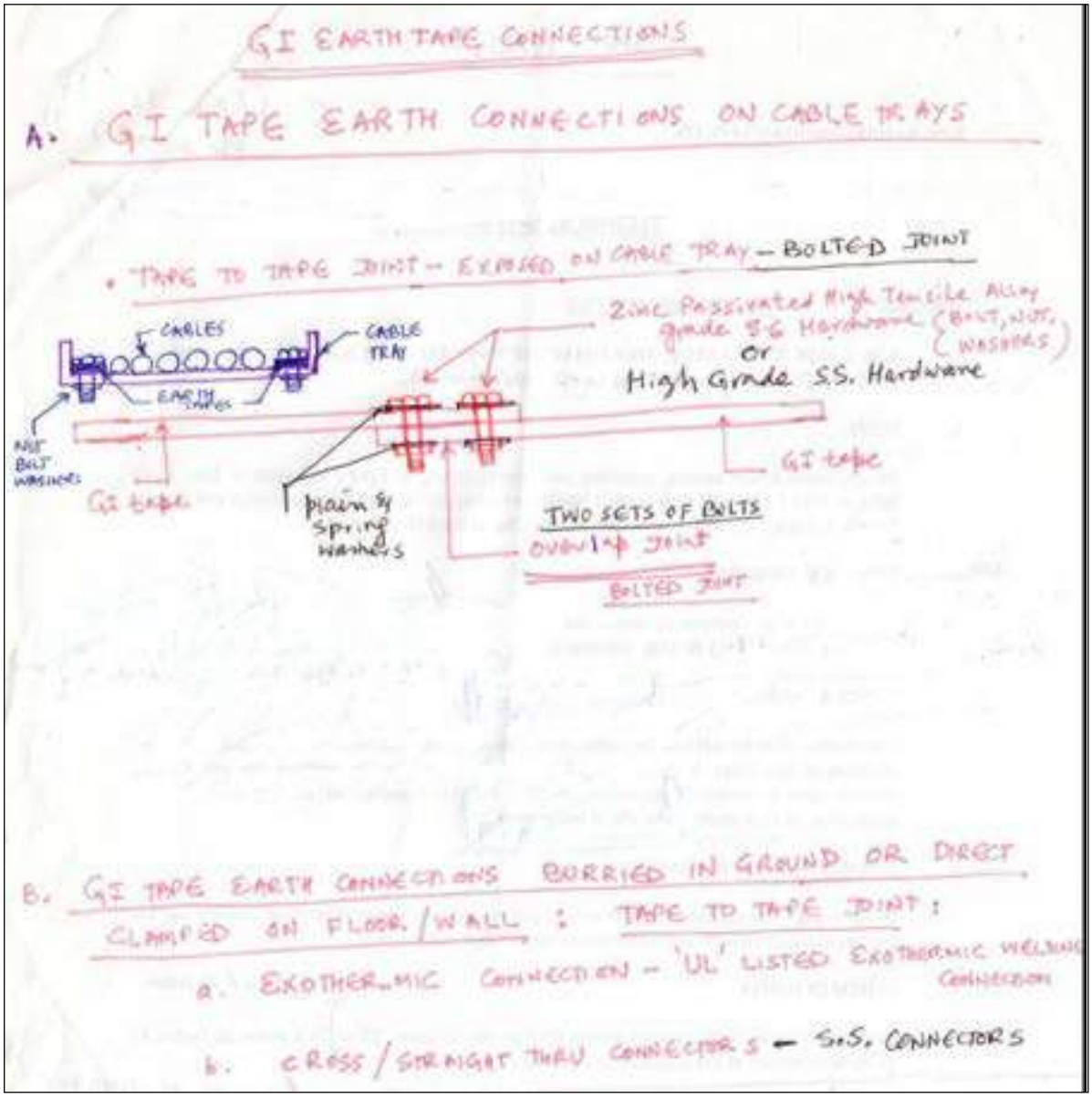
CONNECTIONS WITHOUT RISK OF GALVANIC CORROSION

Material combinations without increased risk of corrosion

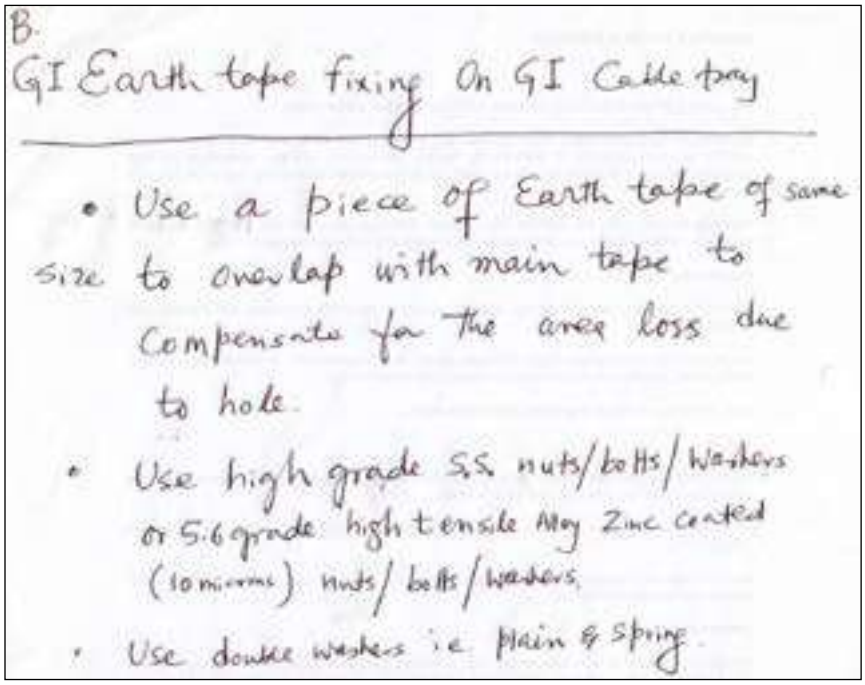
	Steel, galvanised	Aluminium	Copper	Stainless steel	Titanium	Tin
Steel, galvanised (S I)	Yes	Yes	No	Yes	Yes	Yes
Aluminium	Yes	Yes	No	Yes	Yes	Yes
Copper	No	No	Yes	Yes	No	Yes
Stainless steel	Yes	Yes	Yes	Yes	Yes	Yes
Titanium	Yes	Yes	No	Yes	Yes	Yes
Tin	Yes	Yes	Yes	Yes	Yes	Yes

11 GI EARTH TAPE CONNECTIONS

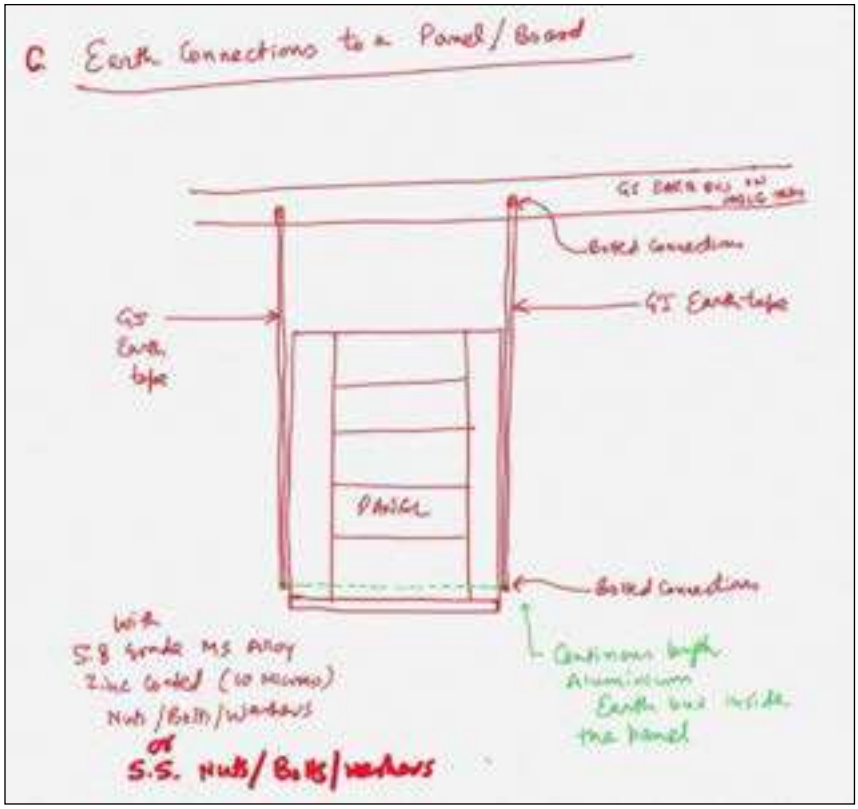
A. GI Tape Earth Connection on Cable Trays:



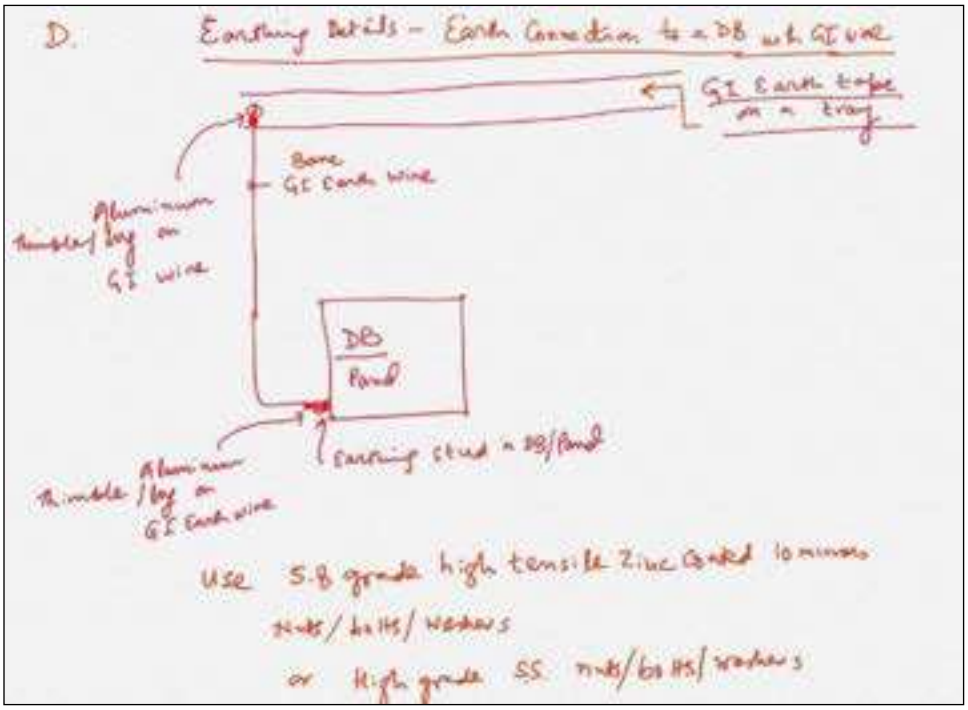
B. GI Earth Tape Fixing on GI Cable Tray:



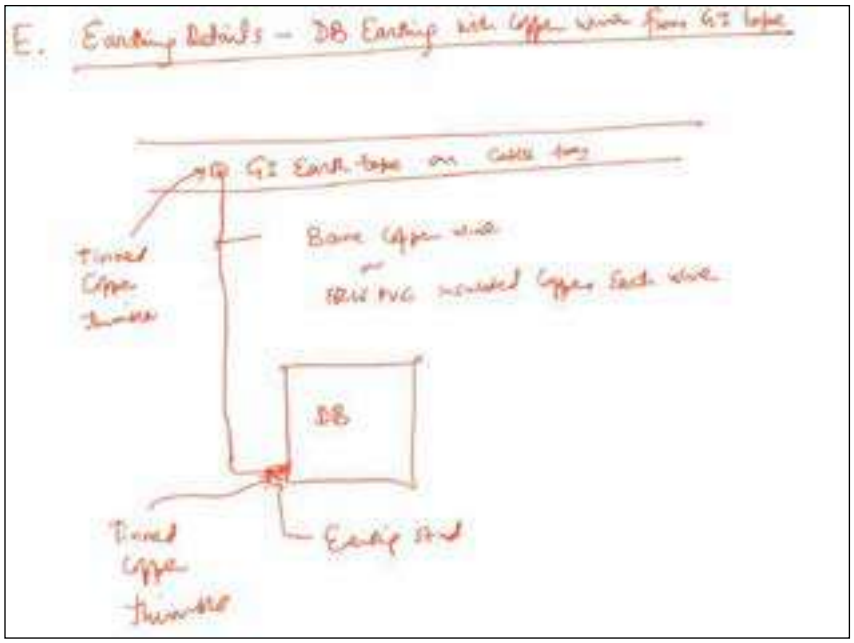
C. Earth Connection to a Panel / Board:



D. Earthing Details – Earth Connection to a DB with GI Wire:



E. Earthing Details – DB Earthing with Copper Wire from GI Tape:



SUBHEAD-F. DISTRIBUTION BOARDS (FDB's)

Final Distribution Boards (FDBs) shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, neutral grounded at transformer. The DB shall be minimum di-electric strength of 2.5 KV for 1 Sec. All Distribution Boards shall manufactured by a manufacturer listed in approved makes of material.

FDB's shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS: 13947-1993.

1. CONSTRUCTIONAL FEATURES

FDB's shall be constructed with 1.2 mm thick pre-treated and powder coated sheet steel used in the construction of FDB shall be folded and braced as necessary to provide a rigid support for all component. FDB shall be suitable for indoor / outdoor installation as the case may be, wall mounting or free-standing type as per requirement, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sqm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions / site conditions. 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: 8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

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 FDBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

2. FINAL DISTRIBUTION BOARDS SHALL COMPRISE OF THE FOLLOWING:

2.1 A Din Channel for mounting, where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

2.2 Installation accessories shall be part of the DB for fixing conductor and rails/ Din Channels for mounting MCB's and RCCB's etc. phase bus bars, neutral bus bars & earthing bus bars as required. All bus bars shall be of tinned copper. MCB's / ELCB's shall be simply snapped fitted on to a Din Channel and screwed to the bus bar. The arrangement should be such that any MCB can be taken out of without disturbing the other MCB's.

2.3 Service cable /entry connection shall be part of the Distribution Boards.

2.4 The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

2.5 Degree of protection shall be **IP-52 for indoor application, IP-54 for kitchen, laundry, basements/garages and IP-55 for outdoor application**.

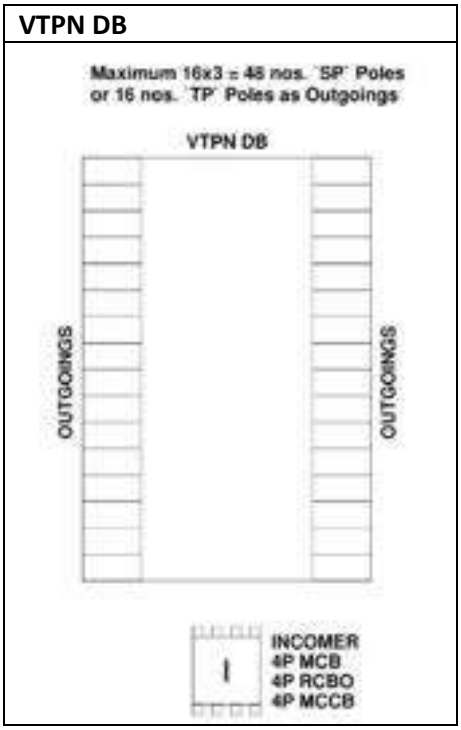
2.6 All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

2.7 Phase segregation to be maintained in all three phase distribution boards.
2.8 Earthing shall be provided in each FDB's.
2.9 Where in 3 Phase FDB's, if each phase is controlled by a DP ELCB/ DP RCCB, then a separate neutral link / bar is to be provided per phase. These will be in addition to the main neutral link / bar.
2.10 All internal wiring within the FDB shall be with flexible PVC insulated copper conductor wires of adequate size.
2.11 All bus bars including neutral bar / link shall not be less than 100 Amp, 415 V.
2.12 Main neutral bar / link and separate neutral link / bar per phase shall also be of 100 Amp.
2.13 All connections with wires shall be with adequately sized thimbles.
2.14 UPS DB's will have two earth buses i.e. one for body earthing and another for third pin earthing of UPS socket. Dedicated earth bus shall be fixed on the insulated supports.

3. VTPN DB

- It can have only SP MCB's, TP MCB's or a combination of SP & TP MCB's as out goings.
- It cannot have DP MCB's / DB RCBO's or 4P MCB's / 4P RCBO's as out goings.
- It does not have a separate Neutral per phase as we plan in Flexi-DB's.
- Maximum number of Single Pole MCB ways it can accommodate is 16 Ways x 3 Phase = 48 Nos. SP MCB's or 16 Nos. TP MCB's or a combination of SP MCB's & TP MCB's totaling to 16 poles per phase.
- Incomer can be 4P MCB, 4P RCBO or a 4P, MCCB, upto 250A.

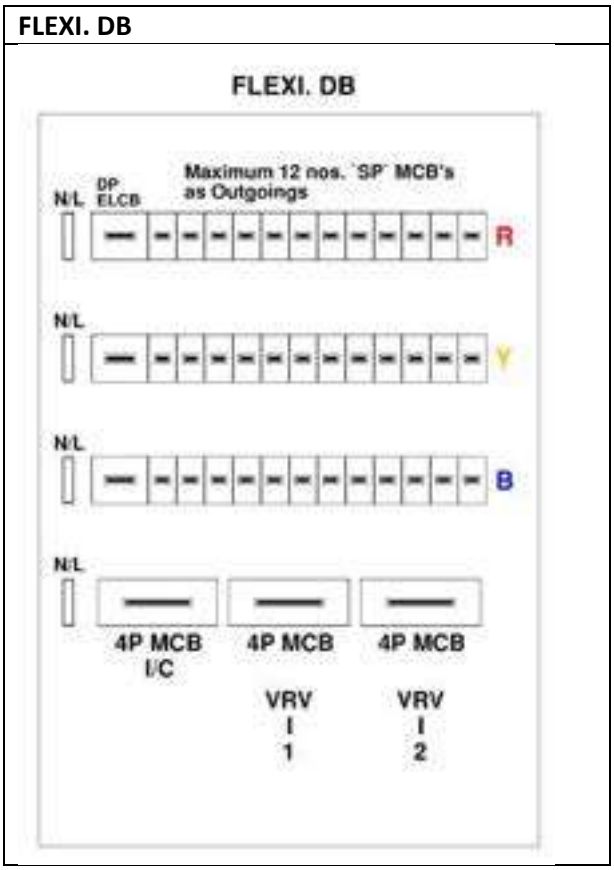
VTPN DB



4. FLEXI. DB – VERTICAL

- It has four bars / four din channels.
- Each Bar / Row can accommodate 14 Nos., SP Poles.
- Normally top three Din-channels are used for 'R','Y'& 'B' outgoing circuits MCB poles.
- So for each Bar, 2 poles as DP ELCB, so balance 12 MCB's as outgoing circuits per phase. So total 36 Nos. SP MCB outgoing circuits.
- For each bar a separate sub-neutral link is to be planned.
- Bottom most bar / Din-channel is used for incomer 4P MCB & additionally 2 Nos., 4P MCB's / 4P RCBO's can be used for 3 Phase loads like VRV units.

FLEXI. DB



5. MCB's 'KA' RATINGS:

- MCB's are available in standard 10 KA fault withstand rating indigenously produced (Indian Range).
- Imported range is 15KA, 25KA, 36KA & 50 KA fault ratings are also available.
- In the same cost 4P MCCB will come, but its space requirement will be more than compared to 4P MCB of 36KA.
- For 25KA & 36KA MCB rating wherever required, MCCB / MPCB may be opted for cost & delivery reasons.

Use of MCB's shall be application based i.e.: (Even if it not mentioned specifically in the BOQ)

For computers / IT equipment / Servers	:	Type 'D' characteristics
For motors, inductive loads and Discharge Lamps	:	Type 'C' characteristics
For lighting & small power	:	Type 'B' characteristics

6. EARTHING

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

7. PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of FDB inside/outside shall be of Siemens gray paint shade no. RAL-7032 of IS Code No.5 or as per Owner / Architect / PMC's requirement.

8. LABELS

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.

9. TESTING

Testing of FDB's shall be as per following codes:

a. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

b. IS: 13947: 1993 for Degree of protection

10. WIRING

In wiring a FDB, it shall be ensured that total load of various circuits is divided evenly between the phases and number of ways as per Consultants approval.

GALGOTIAS UNIVERSITY

11. Pre-commissioning Test for Final Distribution Boards

PROJECT :
LOCATION :
ARCHITECTS :
PROJECT MANAGERS :
ELECTRICAL CONSULTANTS :
ELECTRICAL CONTRACTORS :

D.B. No..Name : Location :
D.B. Size :
Incomer Cable Size :
3 Phase Incomer MCB/MCCB :
Phase Incomer DP ELCB :

S.No.	Ckt.No.	Wire Size	MCB Rating	I.R. Value (M.Ohm) P-N	P-E	N-E	Polarity Test	Visual Check	Remarks

Particular of Meggar : Meger Sl.No.
Range
Make
Voltage

Name & Designation of Testing Engineer _____

Signature of Testing Engineer _____

Date _____

Note:- Each Final DB to be tested and a Pre-commissioning report to be generated in the format given above.

SUBHEAD-G. PANEL & DISTRIBUTION BOARD, LT SWITCH GEAR, VFD'S, STARTERS, IMPORTANT NOTES ON STARTERS, CONSTRUCTION FEATURES AND GENERAL NOTES ON PANELS / DISTRIBUTION BOARDS

1. AIR CIRCUIT BREAKERS (ACB)

- The ACB shall confirm to IEC/IS – 60947-2. The ACB shall have a rated service short circuit breaking capacity (Ics) as specified in SLD's and BOQ "Technical parameters" at rated operational voltage(Ue) at 415V, frequency at 50 Hz. The ultimate breaking capacity (Icu) shall be equal to Service breaking capacity (Ics) and Short Ckt Withstand capacity (Ics=Icu=Icw for 1 see) rated Impulse withstand voltage(Uimp) shall be 12kv and rated insulation voltage (Ui) at 1000V. The ACB release should have true RMS sensing. ACB should have single frame size up to 4000A and shall be suitable for "Switch Disconnect" function (AC 23 utilization category). The construction of circuit breakers shall be as per **pollution degree 3**.
- Circuit breakers shall be three / four pole, air break, horizontal drawout / fixed type as indicated in SLD/BOQ.
- Drawout type Circuit breakers alongwith its operating mechanism shall be provided with suitable arrangement for easy withdrawal. Suitable guides shall be provided to minimize misalignment of the breaker.
- There shall be "SERVICE", "TEST" and "FULLY WITHDRAWN" positions for the breakers. In "TEST" position the circuit breaker shall be capable of being tested for operation without energizing the power circuits i.e. the power contacts shall be disconnected, while the control circuits shall remain undisturbed. Locking facilities shall be provided so as to prevent movement of the circuit breaker from the "SERVICE", "TEST" or "FULLY WITHDRAWN" position. Safety interlock must be provided to prevent the ACB from falling out in a fully withdrawn position. It shall be possible to close the door in "TEST" position.
- Suitable mechanical indications shall be provided on all circuit breakers to show "OPEN", "CLOSE", "SERVICE", "TEST", and "SPRING CHARGED" positions.
- All ACBs should be provided with Microprocessor based release as specified in BOQ / SLD's should be provided on circuit breaker for short circuit, over current and earth fault protection with adjustable settings with intentional delay. Specific LED indications should be provided for short circuit, over current and earth fault operation for faster fault diagnosis and reduced down time. All ACBs should be provided with "Auto Protection" facility. Opening and closing time of ACB should be <40 m Sec and <70 m sec respectively. All Incomer ACB Release should be provided with display for current and voltage parameters (for each phase & Ground Fault). Control unit shall have fault history data & store **last 10 trip causes**.

  The Circuit Breaker shall have minimum **mechanical life of 10000** operations **without maintenance**.

  The electrical life of circuit breaker upto 2000 Amps shall not be less than 5000 operations and beyond 2000 Amps shall be greater than 1000 operations.

  ACB releases shall be EMI / EMC compatible. In case of Four Pale ACB , Fully rated Neutral with protection against O/L & S/C with settings at 50%-100%- OFF. ACBs should comply with RoHS.

Microprocessor releases shall be provided with integral LCD Display of load current and individual loading of all the three phases. Microprocessor release shall also be suitable for zone selective interlocking (ZSI) . Microprocessor releases shall also have I^2t ON/OFF time delay protection for short circuit and Earth fault.
All ACBs release shall have in-built thermal memory before and after the fault. ACB release should be provided with Rotary Dial for release setting. Separate LEDs should be provided on release itself for fault differentiation.

- Relays should be CT operated through shunt trip, under voltage trip for short circuit and earth fault protection.
- Wherever microprocessor earth fault release is asked for. Additional CT shall be provided on the neutral bus link. This CT shall have characteristics matching to the CT's installed in the ACB for the purpose. It should be possible to change the setting of release in "ON" condition.
- All circuit breakers shall be provided with "4 NO" and " 4NC" potential free auxiliary contacts. These contacts shall be in addition to those required for internal mechanism of the breaker and should be directly operated from breaker operating mechanism.
- All circuit breakers shall be provided with the following interlocks :

- Movement of a circuit breaker between "SERVICE" and "TEST" position shall not be possible unless it is in open position. Attempted withdrawal of a closed circuit breaker shall preferably not trip the circuit breaker. In cases the offered circuit breaker trips on attempted withdrawal as a standard interlock, it shall be ensured that sufficient contact exist between the fixed and drawout contact at the time of breaker trip, so that no arcing takes place even with the breaker carrying it's full rated current.

- Closing of a circuit breaker shall not be possible unless it is in "SERVICE" position, "TEST" position or in "FULLY WITHDRAWN" position.

All ACB's shall have **door interlock**

- Circuit-breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage, to cover the stationary isolated contacts when the breaker is withdrawn. It shall however be possible to open the shutters intentionally against pressure for testing purposes.

ACBs shall be provided with a flexibility to rotate power terminals by 90 degree to suite stringent site requirements.

- A breaker of particular rating shall be prevented from insertion in a cubicle of a different rating.

- There should be a provision of positive earth connection between fixed and moving portion of the ACB either through connector plug or sliding solid earth mechanism. Earthing bolts must be provided on the cradle or body of fixed ACB.
- It should be possible to bolt the drawout frame not only in CONNECTED position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

- Circuit barkers shall provide with castle key / electrical interlocking devices, as specified in "Bill Of Quantity".

- Mechanical tripping shall be possible by means of front mounted Red "trip" push-button. In case of electrically operated breakers these push buttons shall be shrouded to prevent accidental operation.

  The **racking handle shall be stored on the air circuit breaker** in such a manner as to be accessible without defeating the door interlocking

- Alternatively Means shall be provided to slowly close the circuit breaker in "withdrawn position", if required, for inspection and setting of contacts. In "service position" slow closing shall not be possible.

- All accessories like shunt release, undervoltage, motorized mechanism etc. shall be front mounted, requiring no adjustments and can be fitted at site.

- The manufacturer shall provide details of opening time and duration with temperature to ensure discrimination and proper selection for feeder protections. All ACB's of 4000A and above shall be a single ACB unit. The manufacturer shall also indicate the mechanical and electrical life of circuit breaker.

- Circuit breaker shall be provided with either of the following mechanisms as specified in "Bill Of Quantity".

  The trip unit shall have following protection settings, based on the type of trip unit.
  - Adjustable over load current (Ir) settings from 40% to 100% of rating of ACB (In).
  - Over load time setting (tr) from 0.5s, 1s, 2s, 4s…….24s as field selectable curves
  - Short circuit setting (Isd) from 1.5 to 10 times of Ir setting
  - Short circuit time delay adjustable from 0 to 400 msec.
  - Instantaneous (Ii) protection with an adjustable pick-up and an OFF position.
  - Earth fault setting adjustable in absolute Ampere with time delay settings from 0 to 400 ms.

1.01 Manually Operated Mechanism

- Manually operated mechanism shall be of manual spring charging stored energy type.

- The circuit breaker shall have a spring charging handle and push-button for closing the breaker mechanically after the spring has been charged. However, closing by spring charging handle after the spring has been fully charged shall also be acceptable, provided the movement of contacts does not take place with the movement of handle and the contacts operate only when the spring stored energy is released. Overcharging of spring shall not be possible.

- The closing action of the circuit breaker shall charge the tripping spring, thus making it ready for tripping.

- The circuit breaker shall be provided with the interlocks so that it shall not close unless the spring is fully charged.

- The mechanism shall be suitable for addition of motor mechanism at site if required for future upgrade without the need of any special accessories.

1.02 Power Operated Mechanism

- Power operated mechanism shall be provided with a universal motor suitable for operation on 240 AC / DC Control supply, with voltage variation from 90% to 110% rated voltage. Motor insulation shall be class "E" or better.

  All ACBs should be provided with "Ready to Close" Contact

- The motor shall be such that it requires not more than 30 seconds for fully charging the closing spring at minimum available control voltage.

- Once the closing springs are discharged, after one closing operation of circuit breaker, it shall automatically initiate recharging of the spring.

- The mechanism shall be such that as long as power is available to the motor, a continuous sequence of closing and opening operation shall be possible. After failure of power supply at least one open-close-open operation shall be possible.

- Provision shall be made for emergency manual charging and as soon as this manual charging handle is coupled, the motor shall automatically get mechanically decoupled.
- All circuit breakers shall be provided with closing and trip coils (Shunt release + Under voltage release). The closing coil shall operate correctly at all values of voltage between 85% to 110% of rated control voltage. The trip coil shall operate satisfactorily at all values of voltage between 70% to 110% of rated control voltage and shall have continuous rating.
- Provision for mechanical closing of the breaker only in "TEST" and "WITHDRAWN" positions shall be made. Alternately, the mechanical closing facility shall be normally made inaccessible; accessibility being rendered only after deliberate removal of shrouds.

2.00 **MOULDED CASE CIRCUIT BREAKERS (MCCB'S)**

- The Moulded case circuit Breaker (MCCB) shall confirm to the latest IEC 60947-2 and IEC 947-3-1989. MCCB's shall be suitable for rated operation voltage upto 415 VAC & rated insulation voltage upto 690 VAC.

- MCCB's in AC circuits shall be of triple pole / four pole construction as per enclosed BOQ. Operating mechanism shall be quick-make, quick-break and trip-free type (Roto-Active design) . The "ON", "OFF" and "TRIP" positions of the MCCB's shall be clearly indicated and visible to the operator when mounted as in service. Front of door operating handle shall be provided with pad lock and door interlock. Front of door operating handle shall be provided with door interlock defeat mechanism to facilitate inspection of the MCCB during 'ON' position. MCCB shall be suitable for Positive isolation / disconnection according to IEC 60947-1 & 2 for optimum user safety.

- The Service short circuit Breaking capacity (Ics at 415 VAC) of all MCCB's shall be as specified in SLD / BOQ and shall have (Ics=Icu=100%).

All MCCB should have “Class-II” front facia as per IEC 60664.

Electrical life of MCCB’s shall not be less than 10000 operations and mechanical life shall not be less than 20000 operations.

- The MCCB shall be current limiting type. MCCB shall have Arc extinguishing device contained in a compact, high strength, heat resistance, flame retardant, halogen free insulating moulded case with high withstand capability against thermal and mechanical stresses.

- MCCB’s shall be either with Thermal-magnetic releases for over load and short circuit or with microprocessor based releases for over load and short circuit as mentioned in the Electrical Single Line Diagram (SLD) / SLD Notes and / or in the BOQ.

Load indication LED shall be integral part of electronic releases. All electronic releases shall be EMI / EMC compatible.

- Wherever microprocessor earth fault add on earth fault Module is asked for, additional CBCT shall be provided.

It should not be possible to by pass / switch off the S/C, E/F protection in MCCB. The E/F setting should be provided with 10% to 60% with time delay of 0.3 to 3 seconds. LED Indication should be provided in case of earth Fault. E/F Module should have Test Push Button for self diagnostic features without tripping the ckt breaker. Also Over current and earth fault differentiation should be provided.

- The trip command of releases in MCCB shall over ride all the other commands. The MCCB shall employ maintenance free double break contact system to minimize the set through energies and capable of achieving Total Discrimination up to the full short circuit capacity of the downstream MCCB. The MCCB shall not be restricted to line / load connections. MCCB shall be provided with test trip Push Button to check the proper function of tripping mechanism. MCCB shall comply with RoHS & WEEE norms

- Where Earth fault protection are indicated in drawings / BOQ they shall be thru Add on Module MCCB’s and have adjustability from 10% to 60% of rated current with adjustable time delays to aid discrimination on earth faults. The system shall be immunized against nuisance tripping as per IEC 61000-4 standards.
-
- MCCB’s shall be capable of withstanding the thermal stresses caused by overloads and locked rotor currents of values associated with protective relay settings of the motor starting equipment and the mechanical stress caused by the peak short-circuit current of value associated with the switchgear rating. The maximum tripping time under short circuit shall not exceed 8 milliseconds.

- MCCB terminals shall be shrouded and designed to receive Bus Bar Links /cable lugs for cable sizes relevant to circuit ratings.
- The MCCB shall have common field fittable snap-on auxiliaries common for entire range. The remote tripping coil should be of continuous duty cycle.

- Where mechanical interlocking is called-for between two Incomer and Bus Coupler or between two Incomers without Bus Couplers, proper arrangement for built-in Ronis / Coded key interlocking shall be provided.

- MCCB's shall be with bus bar spreaders. (Spreaders shall be of the same make of MCCB i.e. spreaders shall come along with the MCCB, to be supplied by the MCCB manufacturer).
  MCCB's shall be with direct / extended Rotary Handle.
  ARRANGEMENT OF PAD LOCKING & FOOL PROOF LOTO (LOCKOUT & TAG OUT) TO BE AVAILABLE WITH ALL MCCB'S FOR MAINTENANCE SAFETY REASONS ON MOTORS / EQUIPMENT.

3.00 ATS SPECIFICATIONS

Type-1 Equivalent to 'ASCO' make Series 7000 for above 1200Amps and Series 300 below 1200 Amps ATS as per UL 1008A	• ATS (ATS & Controller) 100% overlapping neutral as per IEEE 446 for unbalanced system • In phase monitoring is possible i.e. same phase angle transition. • Phase Angle monitoring • DG Supply to Main Supply transition time: 50 ms • RS485 communication • Solenoid operated • Upto 5000A rating Fault withstand: • 85 KA for 0.3 Sec • 50KA to 0.5 Sec • Utilization category – AC 33A • Controller with AMF function	<u>Usage:</u> • Main LT Panel • Fire Emergency Panel • DG Set Aux. Panel
Type-2 Equivalent to 'ASCO' make Series 300 ATS as per UL 1008A	(ATS & Controller) (Switch is same as 7000 series but control is different) • 100% overlapping neutral as per IEEE 446 for unbalanced system • In phase monitoring Not possible. • Transition on same phase angle not possible. • Solenoid operated • No communication Fault withstand: • 85 KA for 0.3 Sec • 50 KA to 0.5 Sec • Utilization category – AC 33A	<u>Usage:</u> • UPS Input Panel • Lift Panel

	• Controller with AMF function	
Type-3 Equivalent to 'ASCO' make Series 230 As per IEC 60947-6-1	• ATS with motorized operation with inbuilt controller • No overlapping neutral • No communication • Utilization category – AC 33B	

4. MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14. The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947- 4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the "isolated" position.

The motor circuit breakers shall be equipped with a "PUSH TO TRIP" device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C).

MPCB shall be with bus bar spreaders. (Spreaders shall be of the same make of MPCB i.e. spreaders shall come along with the MPCB, to be supplied by the MPCB manufacturer). MPCB'S shall be with direct / extended rotary handles.

ARRANGEMENT OF PAD LOCKING & FOOL PROOF LOTO (LOCKOUT & TAG OUT) TO BE AVAILABLE WITH ALL MPCB'S FOR MAINTENANCE SAFETY REASONS ON MOTORS / EQUIPMENT.

MPCB's shall be with microprocessor-based releases. MPCB's shall be two of types as called for in the bill of quantities as follows:

a) MPCB's shall be with thermal & magnetic releases with adjustable thermal setting.
b) MPCB's with magnetic release only shall be with fixed magnetic setting.

5. MINIATURE CIRCUIT BREAKER (MCB)

- Miniature Circuit Breaker shall comply with IS 8828 – 1996 / IEC 898 – 1995.
- Miniature Circuit Breaker shall be quick make and break type for 230 / 415 V AC and 50 Hz application. The housing of MCB's shall be heat resistant and having a high impact strength. The breaking current of MCB's shall not be less than 10000 Amps, at 230 V / 415 V. The MCB's shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical 'ON' and 'OFF' indications. MCB's shall be suitable for isolation function and line load reversibility.
- MCB's shall be current limiting type class – 3. MCB's shall be classified as B, C, and D as per standard Ref. IS as per the Tripping characteristics curves defined by all the manufactures. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS / IEC and the manufactures shall publish the value.
- MCB's shall be calibrated at an ambient temperature of 40 degree.
- The MCB contacts shall be silver nickel alloy and contact tip coated with silver. Proper arc chutes shall be provided to quench the arc immediately. MCB's shall be provided with magnetic coil releases for short circuit protection and thermal release for over load protection. The over load or short circuit devices shall have a common trip bar in the case of DP, TP, TPN and FP Miniature Circuit Breakers and shall have 20000 electrical operations upto 63A. The terminals shall be protected against finger contact to IP 20 Degree of protection.
- MCB's shall have a facility to accommodate accessories like auxiliary contacts, trip alarm contact, shunt trip and under voltage add-on blocks.

Use of MCB's shall be application based i.e.: (Even if it not mentioned specifically in the BOQ)

For computers / IT equipment / Servers	:	Type 'D' characteristics
For motors, inductive loads and Discharge Lamps	:	Type 'C' characteristics
For lighting & small power	:	Type 'B' characteristics

MCB's 'KA' RATINGS:

- MCB's are available in standard 10 KA fault with stand rating indigenously produced.
- Imported MCB's in 16KA, 25KA & 36 KA fault ratings are also available.
- 16KA fault rating may be 15% more expansive than 10 KA rating.
- For 25KA & 36KA MCB rating wherever required, MCCB / MPCB may be opted for cost & delivery reasons.

6. RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

- The RCCB / ELCB should comply with IEC 1008 and shall be suitable for use with pure AC/AC with DC off set, for frequency range of 50 Hz to 400 Hz. The RCCB / ELCB shall be protected against nuisance tripping by a protective device, limiting such tripping to a peak value of 250 A according to the 8/20 wave for instantaneous devices. RCCB's / ELCB's shall be suitable for isolation function and line load reversibility.

- EL + MCB / RCCB shall have Earth leakage, over load and short circuit protection where as ELCB shall have Earth leakage protection only. RCBO / RCCB wherever provided in Computer systems / IT equipment's shall be super immunized / equivalent, even if it is not specifically mentioned in the BOQ, it needs to be provided for such circuits.

- EL + MCB / RCCB / ELCB shall be quick make and break type. The housing shall be heat insulated and having a high impact strength. The moving contacts of the Phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism for closing / opening of all the three phases simultaneously. The neutral moving contact shall be so mounted on the common bridge that at the time of closing, the neutral makes contact first before the phases and at the time of opening, the neutral breaks last after allowing the phases to open first.

- The core balance transformer ensures positive detection of earth leakage currents. The incoming current shall pass through the torroidal core transformer. As long as the current in the phase and the neutral shall be the same, no electromotive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which will cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. The device shall be current operated independent of the line voltage, current sensitivity of 30mA/100mA/300mA at 240 / 415V AC as called for in the BOQ.

- EL + MCB / RCCB / ELCB shall have trip free nature of mechanism ensuring that it cannot be closed when an earth leakage fault persists.
- Test device shall be there to check the integrity of earth leakage detection system and the tripping mechanism. It shall have box type terminals and capture screws ensuring easy connection of cables and protected against finger contact to IP 20 Degree of Protection.

7. METERS

a. All voltmeters / multi-function meters and indicating lamps shall be protected through MCB's / MPCB's depending upon fault level.
b. Meters and indicating instruments shall be flush type.
c. All CT's connection for meters shall be through Test Terminal Block (TTB).
d. CT ratio and burdens shall be as specified on the Single line diagram/ in the BOQ/ as required for the application.

8. CURRENT TRANSFORMERS (CT'S) & VOLTAGE / POTENTIAL TRANSFORMERS (PT'S)

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondary's for operation of associated metering.

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 metering CTs shall be of accuracy class I.

Accuracy class and VA burden shall be as per the application as required as per metering / protection needs.

PT shall be Class-1 accuracy for metering.
PT shall be cast resin type.
PT shall be of suitable burden (VA).

9. INDICATING PANEL

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted digital type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per required fault level. Indicating Lamps shall be of LED type. All digital instruments shall have shrouded terminals and suitable for 0°C to 50°C temperature range and shall with stand 1.2 time over loading. Accuracy class and VA burdens shall be as per the requirement. Meters shall be with RS 485 port wherever called for in the BOQ's for communication.

10. SELECTOR SWITCH

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

11. CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with a 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.

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".

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. Contactors shall be of 3P / 4P design as required.

12. THERMAL OVERLOAD RELAY

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.

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.

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 capacities.

13. TIME DELAY RELAYS

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.

14. TOGGLE SWITCH

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

15. PUSH BUTTON STATIONS

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.

16. Coordination Study In LV Network

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB &** MCB for all Incoming and outgoing devices for all Panels/ DB`s as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of downstream circuit Breakers.

17. CAPACITORS:

17.1 Power Factor Improvement Capacitors:

- The power factor improvement capacitors shall be heavy duty Dry type MPP (metalized poly propelene type).
- The MPP type capacitors shall be made with impregnation technology. The capacitor shall be made using three capacitor elements wound wired internally in a delta connection with PPMh and positioned inside a metal case. Impregnation shall be Dry resin filled.
- The capacitors shall be meant for continuous duty.

- Capacitors shall be rated for 525V for harmonics environment with 14% De -tuned reactors per bank where non liner IT loads, VFD’s UPS & other similar loads are present like in IT buildings, Office buildings, Data Centres, Hotels, Malls/Retail ,Hospitals, Airports, factories, Industrial Installation, Corporate offices, Universities and Schools/Colleges and High and Medium End Housings/Apartment Buildings . Normal housings/Apartments shall have 480V rated capacitors with 7% De-tuned reactors per bank.
- The operating voltage of normal application shall be 415V / 440V.
- Dielectric losses shall less than or equal to 0.2W /Watt / KVAR.

- Capacitance tolerance shall be within the range of – 5 to + 10%.
- The rated frequency shall be 50 Hz ±3%.
- Life expantancy shall be equal to or more than 170000 hours.
- The reference standard for capacitors shall be IEC 831-1/2.
- Capacitors should have high over load capabilities with good thermal & mechanical protections.
- Capacitors should be selected / sized in such a way that actual required capacitance is available at 415V. That means more capacitance need to be provided while using 525V /480 V rated capacitors as the case may be to meet the required capacitance in terms of KVAR.

17.2 Harmonic circuit filter reactors 7% & 14%:

- Harmonic circuit filters shall be strip / wire wound, copper type construction.
- These shall be designed for low loss. The losses shall be less than 5W / KVAR.
- It shall be vacuum impregnated.
- The class of insulation shall be H class, 180 deg C.
- The reactors are made out of an iron core and air gap.
- It shall have low temperature rise & lower flux density so that it operate in worst conditions of ambient & harmonic loads.
- These should offer good degree of linearity and low losses.
- The filter reactors shall have filtering factor of 7% and 14% as called for in the BOQ.
- These filters are designed for protection of capacitors against Harmonics.

Note: Make: Schneider Electric, Siemens, ABB

17.3 Automatic power factor correction relay:

- The relay shall be an intelligent relay which should measure, monitor and control reactive energy. Relay shall be 3 Phase type.
- It shall automatically monitor the power factor, monitor all the connected capacitor steps with real time power in KVAR.
- The relay shall be communicable with RS 485 modbus protocol.

17.4 Capacitor Duty Contactors:

- Contactors shall be suitable for 415V / 440V supply & shall be suitable for capacitor duty.

18. VARIABLE FREQUENCY DRIVE (VFD'S)

18.1 SCOPE

This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works, delivery at site, installation, testing, commissioning and carrying out performance test at site of Variable Frequency Drives.

18.2 CODES and STANDARDS

The design, materials, construction features, manufacturer, inspection, testing and performance of variable frequency drives shall comply with all currently applicable statues, regulations, codes and standards in the locality where the system is to be installed. Nothing in this specification shall be construed to relieve the Contractor of this responsibility. In particular, the air distribution system shall conform to the latest edition of following standards.

18.3 GENERAL REQUIREMENTS

- ✓ This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.
  - ✓ The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered design.
- ✓ The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.
- ✓ The VFD shall be tested to UL 508C. The appropriate UL label shall be applied. VFD shall be manufactured in ISO 9000, 2000 certified facilities.
- ✓ The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.
- ✓ The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.
- ✓ The manufacturer shall have been engaged in the production of this type of equipment for a minimum of thirty years.
  - ✓ The frequency converter shall be supported locally by the manufacturer who will provide full technical support, spares holding and troubleshooting capability from their own local facility. A training course shall be provided by the manufacturer to the consultant / contractor / maintenance engineers.
- ✓ To ensure adequate technical and factory support, VFDs manufactured by others and brand labeled shall not be acceptable.

18.4 TECHNICAL REQUIREMENTS

The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable.

VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters.

The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

The VFD must be able to produce full torque at low speed to operate direct driven fans.

Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current

surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

18.5 PROTECTIVE FEATURES

A minimum of Class 20 I^2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

Protect VFD from input phase loss : The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

Protect from under voltage : The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.
The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

Protection from output switching: The VFD shall be fully protected from switching a contactor / isolator at the output without causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

18.6 INTERFACE FEATURES

Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

There shall be an “Info” key on the keypad. The Info key shall include “on-line” context sensitive assistance for programming and troubleshooting.

The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD’s keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

A three-feedback PID controller to control the speed of the VFD shall be standard.

This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

The VFD shall be able to apply individual scaling to each feedback signal.

For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD. A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run request" signal to indicate to the external equipment that the VFD has received a request to run.

VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in ^{0}C , return air temperature in ^{0}C , supply air temperature in ^{0}C, CO_2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

<u>Standard Control and Monitoring Inputs and Outputs</u>

Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

Each relay shall have an adjustable on delay / off delay time.

Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

Each shall be independently selectable to be used with either an analog voltage or current signal.

The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting, One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

It shall be possible to command all digital and analog output through the serial communication bus.

Optional Control and Monitoring Inputs and Outputs It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

These modules shall use rigid connectors to plug into the VFD's control card.

The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

Modules may include adequate number of such items as may be required as follow:
Additional digital outputs
Additional digital inputs
Additional analog outputs
Additional analog inputs, including Ni or Pt temperature sensor inputs
Additional relay outputs (minimum 2 NO + 2 NC) suitable for 230 V, AC.

It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Fire mode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

A real-time clock shall be an integral part of the VFD.
It shall be possible to use this to display the current date and time on the VFD's display.

Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

All VFD faults shall be time stamped to aid troubleshooting.
It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.
The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.
The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
Comparators for comparing VFD analog values to programmed trigger values
Logic operators to combine up to three logic expressions using Boolean algebra
Delay timers
A 20-step programmable structure

The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

18.7 SERIAL COMMUNICATIONS

The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
Metasys N2
Modbus RTU
VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

18.8 ADJUSTMENTS

The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

Four independent setups shall be provided.

Four preset speeds per setup shall be provided for a total of 16.

Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time ***between attempts shall be adjustable from 0 through 600 seconds.***

An automatic "start delay" may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

18.9 OPTIONAL FEATURES

All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

18.10 SERVICE CONDITIONS

Ambient temperature at full speed, full load operation with continuous drive rated output current:

-10°C to 45°C for ratings upto 90 kW without derating

-10°C to 40°C for ratings 110 kW and higher without derating

Relative Humidity : 0 to 95%, non-condensing.

Elevation : Up to 3,300 feet without derating.

AC line voltage variation : ± 10% of nominal with full output.

VFD Enclosure protection : IP 20 with Mains Disconnect switch, integral, with no additional cabinets. – Not applicable. Protection shall be for Indoor installation.

Side Clearances : No side clearance shall be required for cooling.

All power and control wiring shall be done from the bottom.

All VFDs shall be plenum rated.

All the contacts mounted on each VFD should be brought to the terminal blocks of each starter in order to enable BMS vendor to do termination of his cables. None of the terminations of the BMS cables be done directly to the VFD.

18.11 QUALITY ASSURANCE

To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

All optional features shall be functionally tested at the factory for proper operation.

18.12 SUBMITTALS

This specification lists the minimum VFD performance requirements for this project. Each supplier shall list any exceptions to the specification. If no departures from the specification are identified, the supplier shall be bound by the specification.

18.13 ADDITIONAL NOTES

- VFD's should have inbuilt DC choke.
- THDI on current side shall be limited to 35% to 40% (Total harmonics distortion).
- VFD's shall be complete with RFI & EMC filters as may be required for type of building/installation/project to limit the interference .
- VFD's to work with input voltage variation of 415V ± 10%
- IP 20 for installation inside panels.
- In open : IP 55

18.14 IMPORTANT NOTES:

A. HARMONIC FILTERATION

i. VFD'S FOR CHILLER

- Chiller VFD shall have passive harmonic filters comprising LC circuit with inductance and capacitance to achieve THDI not more than 25%.
- Passive filtration shall be part of / inclusive in VFD enclosure / VFD Panel.

ii. VFD FOR AHU'S, FAN'S AND PUMPS:

- VFD's for AHU's, Ventilation and Pressurization fans & pumps shall have DC Chokes to achieve THDI not more than 40%.
- DC chokes shall be part of / inclusive in VFD enclosure.

B. EMC & RFI FILTRATION

VFD's for sensitive installations where life critical data communications are of importance ,like:

- Hospitals
- Airports
- Electronic Industry
- Data centres
- Communication centres

These installations Must have 'C1' category of RFI & EMC filters for 50 meters of cable length. These are applicable to all the VFD's of AHU's, fans, blowers, pumps, cooling towers & chillers.

For these above mentioned critical applications, if chiller motors and pump motors are more than 90Kw, then 'C2' category of filters to be used if 'C1' is not available.

VFD's for normal buildings and others similar installations shall have 'C3' category of RFI & EMC filter for AHU's, fans, blowers, pumps, cooling towers & Chillers.

C. METERING DISPLAY OF VFD'S

The following parameters shall be available on display in the VFD:
A, V, Hz, PF, KW, KWH, KVA, KVARH, KVAH

D. PROTECTION OFFERED BY VFD

It must offer, overload, short circuit, over & under voltage, single phasing and earth fault protections to motors.

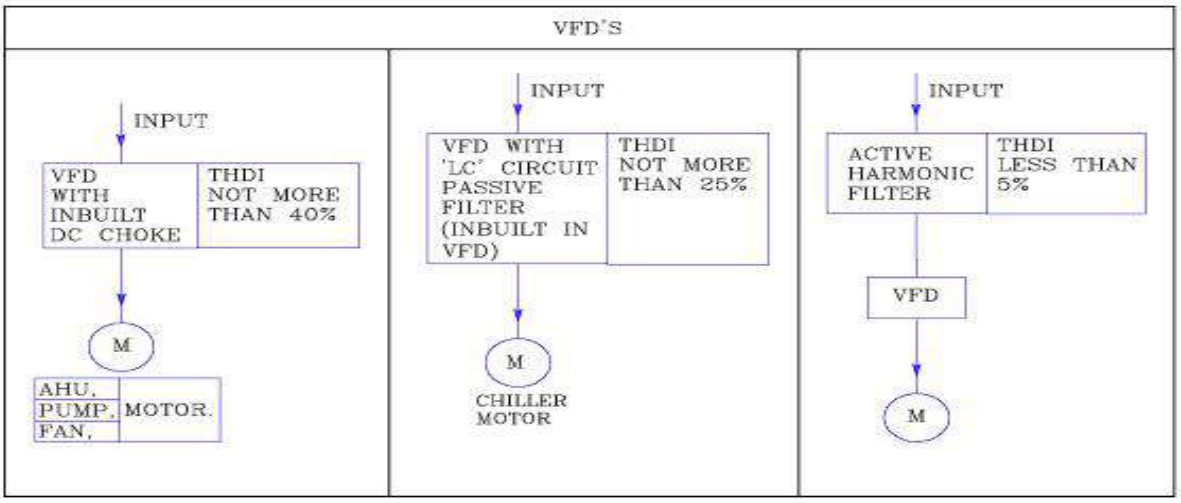
E. VFD STATUS:

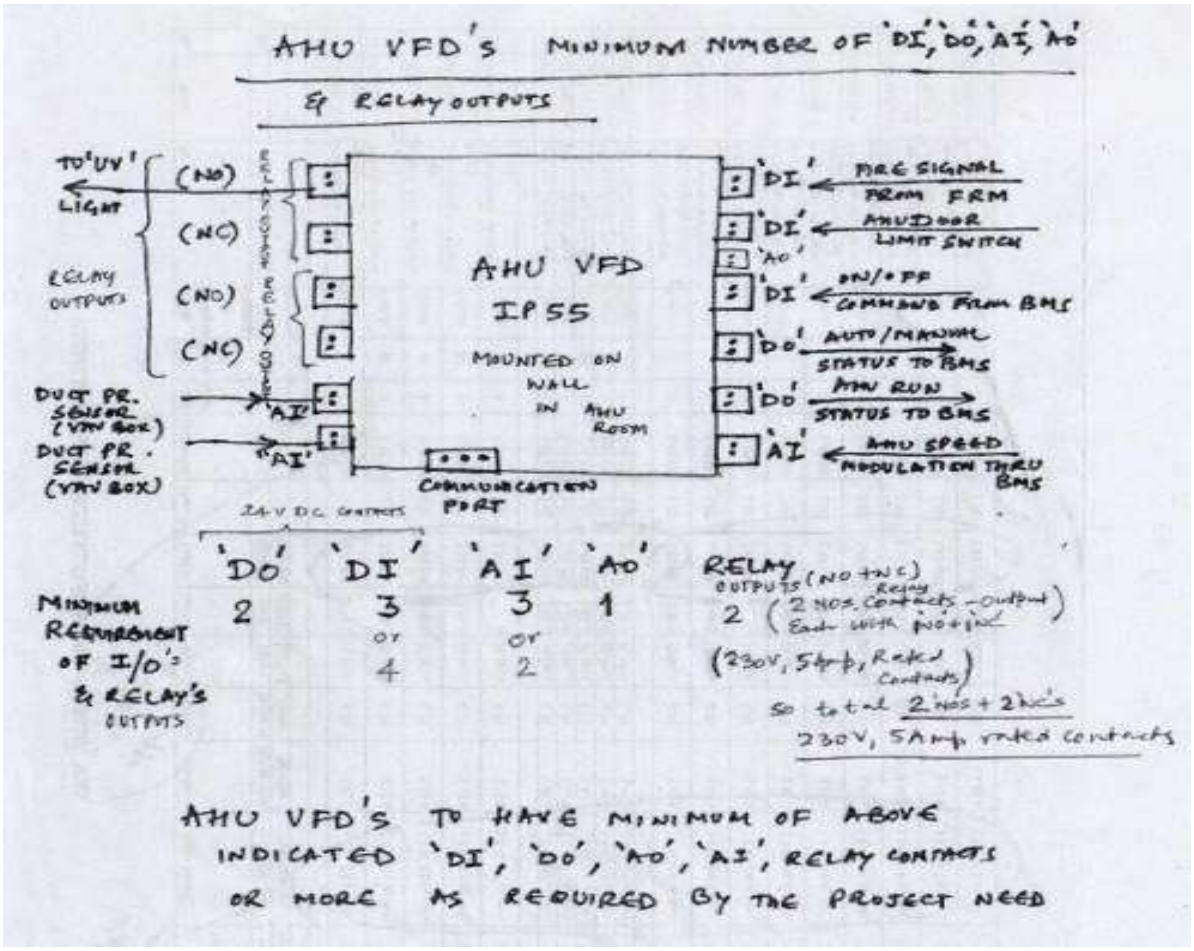
VFD display screen will display faults like:

- Over current i.e. over load.
- Phase loss i.e. single phasing & will trip.
- A small light will start blinking on the screen also and this will go off only when a fault is removed and drive is 'RESET'.
- These status details will also be available at BMS.
  VFD Front Display & Buttons:

AUTO 'ON' / 'OFF'	(Means remotely through BMS)
HAND 'ON'	(Means 'ON' from drive itself)
RESET	If trip on fault or on fire signal & can be 'Reset' from the Drive only after fault is cleared.

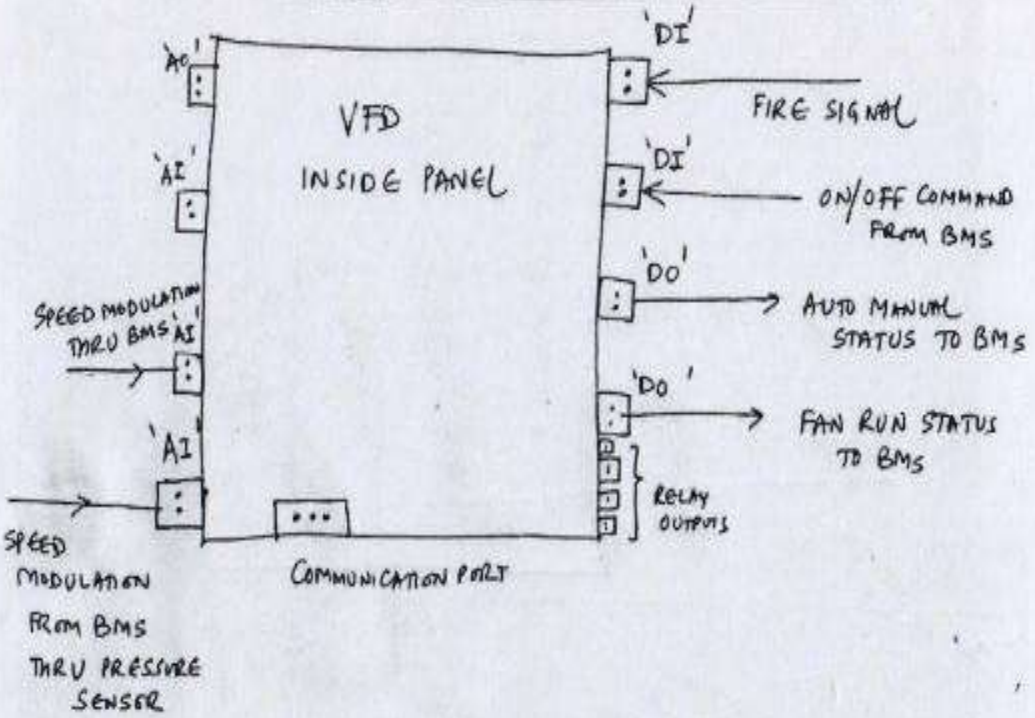
F. SKETCHES



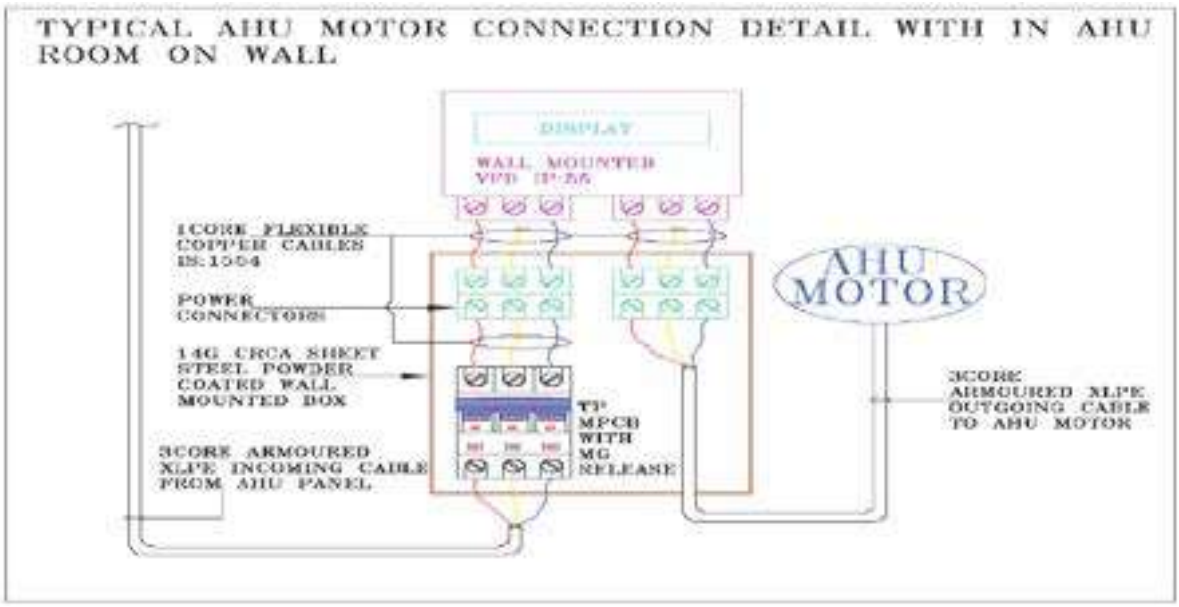

AHU VFD'S MINIMUM NUMBER OF 'DI', 'DO', 'AI', 'AO'
& RELAY OUTPUTS
TO 'UV' LIGHT
(NO)
(NC)
(NO)
(NC)
RELAY OUTPUTS
RELAY CONTACTS
DUCT PR. SENSOR (VAV BOX)
DUCT PR. SENSOR (VAV BOX)
'AI'
'AI'
AHU VFD
IP55
MOUNTED ON WALL IN AHU ROOM
COMMUNICATION PORT
24 V D.C. CONTROL
'DI' FIRE SIGNAL FROM FAM
'DI' AHU DOOR LIMIT SWITCH
'AO'
'DI' ON/OFF COMMAND FROM BMS
'DO' AUTO/MANUAL STATUS TO BMS
'DO' AHU RUN STATUS TO BMS
'AI' AHU SPEED MODULATION THRU BMS
'DO' 'DI' 'AI' 'AO'
MINIMUM REQUIREMENT OF I/O'S & RELAY'S OUTPUTS
2 3 OR 4 3 OR 2 1
RELAY OUTPUTS (NO + NC)
2 (2 NOS. CONTACTS - OUTPUT Relay Each with NO + NC)
(230V, 5Amp, Rated Contacts)
So total 2 NOS + 2 NC's
230V, 5Amp, rated contacts
AHU VFD'S TO HAVE MINIMUM OF ABOVE INDICATED 'DI', 'DO', 'AO', 'AI', RELAY CONTACTS OR MORE AS REQUIRED BY THE PROJECT NEED

VFD FOR PRESSURISATION FANS

MINIMUM NUMBER OF 'DI', 'DO', 'AI', 'AO' & RELAY OUTPUTS



	'DO'	'DI'	'AO'	AI	RELAY OUTPUT (NO+NC)
MINIMUM REQUIREMENT OF I/O's & RELAY OUTPUTS	2	2	1	3	4 (2NO + 2NC) 230V, 5Amp rated Contacts



19. **MOTOR STARTER AND VARIABLE FREQUENCY DRIVE FEEDERS WITH IN MCC's (Motor Control Centre)- SPECIFICATIONS**

Type of Motor Starters:

- DOL starters upto 10HP / 7.5 KW motors.
- Star-Delta starters from 12.5HP / 9.3 KW and above.
- VFD's for motors, wherever specified.
- Soft starters / VFD's for fire pumps.

All Starter feeders for **DOL, Star-Delta, VFD and Soft Starter** shall be complete with and inclusive of the following:

DOL starter feeder **upto 7.5 KW / 10HP Motor** shall be complete with and inclusive of the following, but refer specifications for details:

- 3P MPCB with in built Thermal & Magnetic releases.
- MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.
- 3 Pole Contactor (110 V contactor coil voltage).
- A/M selector switch- 2pole/2way (for BMS connectivity)
- ON / OFF Push buttons
- ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts & trip indication from MPCB Aux. contact) with additional trip contact multiplier for BMS.
- Digital Ammeter with inbuilt selector switch and with metering class CT's (Upto 10 HP, only one CT in one of the phases)
- Internal wiring
- Type-II coordination

Star Delta starter feeder **from 9.3KW / 12.5HP and upto 30 KW / 40 HP Motor** shall be complete with and inclusive of the following, but refer specifications for details:

- 3P MPCB with in built Thermal & Magnetic releases.
- MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.

- 3 Pole Contactors (110 V contactor coil voltage). Star, Delta & Main Contactors.
- Timers
- A/M selector switch- 2pole/2way (for BMS connectivity)
- ON / OFF Push buttons
- ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts & trip indication from MPCB Aux. contact) with additional trip contact multiplier for BMS.
- Digital Ammeter with inbuilt selector switch and with metering class CT's (one per phase) (Three CT's)
- Internal wiring
- Type-II coordination

Star Delta starter feeder **from 37 KW / 50HP and upto 110 KW / 150 HP Motor** shall be complete with and inclusive of the following, but refer specifications for details:

- 3P Motor Duty MCCB with inbuilt Fixed Magnetic release.
- 3 Pole Contactors (110 V contactor coil voltage). Star, Delta & Main Contactors.
- Timers
- External Digital Motor protection relay, CT operated (3 Nos. protection class CT's). Motor protection relay to offer protection against thermal O/L, O/C, Under correct, SPP, Locked rotor and earth leakage. Motor Protection relay shall be with current display. Motor protection relay with additional trip contract multiplier for BMS
- A/M selector switch- 2pole/2way (for BMS connectivity)
- ON / OFF Push buttons
- ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts).
- Internal wiring
- Type-II coordination

Star Delta starter feeder **for motors above 110 KW / 150 HP Motor** shall be complete with and inclusive of the following, but refer specifications for details:

- 3P Motor Duty MCCB with inbuilt Microprocessor based release.
- 3 Pole Contactors (110 V contactor coil voltage). Star, Delta & Main Contactors.
- Timers
- External Digital Motor protection relay, CT operated (3 Nos. protection class CT's). Motor protection relay to offer protection against thermal O/L, O/C, Under correct, SPP, Locked rotor and earth leakage. Motor Protection relay shall be with current display. Motor protection relay with additional trip contract multiplier for BMS
- A/M selector switch- 2pole/2way (for BMS connectivity)
- ON / OFF Push buttons
- ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts).
- Internal wiring
- Type-II coordination

All **VFD feeders** shall be complete with and inclusive of the following, but refer specifications for details :

- For Motor Upto 30 KW / 40 HP, 3P MPCB with.
- MPCB'S above 63A shall be with Microprocessor based release.
- For Motor from 37 KW / 50 HP and upto 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Fixed Magnetic release.
- For Motor for above 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Microprocessor based release.
- VFD as per specifications.

- VFD cooling fan (110V)
- Type-II coordination

All **VFD feeders with by-pass starter** shall be complete with and inclusive of the following, but refer specifications for details:

- For Motor Upto 30 KW / 40 HP, 3P MPCB with inbuilt Magnetic release.
- MPCB'S above 63A shall be with Microprocessor based release.
- For Motor from 37 KW / 50 HP and upto 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Fixed Magnetic release.
- For Motor for above 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Microprocessor based release.
- VFD as per specifications.
- VFD cooling fan (110V)
- Bypass starter if called for as described in above starter paragraphs (110V contactor coil voltage). DOL or Star Delta depending upon Motor HP.
- Internal wiring
- Type-II coordination

Soft Starter feeders shall be complete with and inclusive of the following, but refer specifications for details:

- For Motor Upto 30 KW / 40 HP, 3P MPCB with inbuilt Magnatic release.
- MPCB'S above 63A shall be with Microprocessor based release.
- For Motor from 37 KW / 50 HP and upto 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Fixed Magnetic release.
- For Motor for above 110 KW / 150 HP, 3P Motor Duty MCCB with inbuilt Microprocessor based release.
- Thyristar circuit with inbuilt O/L and SPP feature (in case of fire pumps no O/L & SPP protection)
- Bypass contactor to Thyristar circuit (110 V contactor coil voltage)
- A/M selector switch- 2pole/2way (for BMS connectivity)
- ON /OFF push buttons
- Necessary 'DO' & 'DI' ports
- Modbus communication port
- ON /OFF / Trip indications (110V)
- Digital Ammeter with inbuilt selector switch and with metering class CT's (one per phase) (3CT's)
- Internal wiring
- Type-II coordination

Notes:

1. **Soft starter** for fire pumps shall be without O/L relay feature.
2. Soft Starter shall be complete with inbuilt bypass Contactor.

Following motor control centres / panels shall have:

- 3 Pole incomer switch i.e. MCCB or ACB & 3P bus bars
  a. AHU Panel
  b. Basement / podium ventilation panel
  c. Staircase & lift well pressurization fan panel
  d. Smoke venting panel
  e. Chillers auxiliary panel
  f. Chiller plant panel
  g. Plumbing panel
  h. Fire pump panel
  i. Sump pump panel

j. DG set auxiliary panel

20. MOTOR STARTERS AND VARIABLE FREQUENCY DRIVES IN STANDALONE, INSIDE AHU ROOMS FOR AHU MOTORS & OTHER MOTORS FOR PUMPS & FANS, NEAR MOTORS BUT NOT INSIDE MCC & PANELS

Note: Only 3 Phase supply without neutral shall be available at starter incomer / VFD disconnect switch.

Type of Motor Starters:

- DOL starters upto 10HP / 7.5 KW motors.
- Star-Delta starters from 12.5HP / 9.3 KW and above.
- VFD's for motors, wherever specified.
- Soft starters / VFD's for fire pumps.

a. DOL Starters for motors above upto 10HP / 7.5 KW shall have:

14G CRCA powder coated sheet steel enclosure, wall mount type to house switchgear.

Type-II Co-ordination
MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.
3 Pole Contactor (110 V contactor coil voltage)
A/M selector switch- 2pole/2way (for BMS connectivity)
ON / OFF Push buttons
ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts & trip indication from MPCB Aux. contact) with additional trip contact multiplier for BMS

R,Y,B LED Indications (63.5V)

1 No. cast resin metering Class-1 accuracy CT's of adequate burden & ratio, in one of the phases.

Digital KWH meter + Ammeter – communicable type (110V)
PT for metering & indication lamps:
415V / √3 / 110V / √3 PT for metering and indication lamps.
PT shall be Class-1 accuracy.
PT shall be cast resin type.
• PT shall be of suitable burden (VA) to cater to load of R,Y,B indication lamps (63.5V) at incomer, KWH meter (110V), contactor coils (110V) & ON / OFF / Trip Indications lamps (110V).

Protection for metering PT:

TP MPCB /TP MCB of suitable rating & fault withstand capacity on primary side of PT.

TP MCB of suitable rating on secondary side of PT.

ADDITIONAL FEATURES (FOR AHU MOTORS):

• Cast Resin Copper wound step down transformer, 415V, 3Ph / 230V, 1Ph of suitable 'VA' for AHU's marine light, 'UV' light if asked for and ultrasonic humidifier if asked for in the AHU BOQ.

Transformer to have TPMCB/MPCB & DP MCB at primary & secondary for protection.

DP MCB's for protection of 230V, 1Ph. AC marine light & 'UV' light & ultrasonic humidifier within AHU.
230V, AC Door Relay with 2 NO + 2NC contacts for AHU Door with DP MCB for protection. Relay for control of lights through door limit switch.

b. Star-Delta Starter from 12.5HP / 9.3 KW to 40HP / 30 KW shall have:

14G CRCA powder coated sheet steel enclosure, wall mount type to house switchgear.

Type-II Co-ordination
MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.
3 Pole Contactors (110 V contactor coil voltage). Star, Delta & Main Contactors.
Timers
A/M selector switch- 2pole/2way (for BMS connectivity)
ON / OFF Push buttons
ON /OFF / Trip indications (110V) (ON /OFF Indication from contactor's 2NO / 2NC Aux. Contacts & trip indication from MPCB Aux. contact) with additional trip contact multiplier for BMS.

R,Y,B LED Indications (63.5V)

3 Nos. cast resin metering Class-1 accuracy CT's of adequate burden & ratio, one in each phase.

Digital KWH meter + Ammeter – communicable type (110V)
PT for metering & indication lamps:
415V / √3 / 110V / √3 PT for metering and indication lamps.
PT shall be Class-1 accuracy.
PT shall be cast resin type.
• PT shall be of suitable burden (VA) to cater to load of R,Y,B indication lamps (63.5V) at incomer, KWH meter (110V), contactor coils (110V) & ON / OFF / Trip Indications lamps (110V).

Protection for metering PT:
3P MPCB of suitable rating & fault withstand capacity on primary side of PT.
3P MCB of suitable rating on secondary side of PT.

ADDITIONAL FEATURES (FOR AHU MOTORS):
Cast Resin Copper wound step down transformer, 415V, 3Ph / 230V, 1Ph of suitable 'VA' **for AHU's Marine light, UV light & ESP filter if asked for.**

Transformer to have TPMCB/MPCB & DP MCB at primary & secondary for protection.

DP MCB's for protection of 230V, 1Ph. AC Marine light, **'UV' light & ESP filter if asked for.**

230V, AC Door Relay with 2 NO + 2NC contacts for AHU Door with DP MCB for protection. Relay for control of lights through door limit switch.

c. VFD for motors upto 40HP / 30 KW shall have:

For Motor Upto 30 KW / 40 HP, 3P MPCB with inbuilt Magnetic release.
MPCB'S above 63A shall be with Microprocessor based release.
MPCB in 14G CRCA powder coated sheet steel enclosure, wall mount type to house switchgear & input / output power connectors.
Input / Output cable terminals of suitable rating.
Suitable rated IP55 VFD, Wall Mounted, outside the enclosure.

ADDITIONAL FEATURES (FOR AHU MOTORS):

• Cast Resin Copper wound step down transformer, 415V, 3Ph / 230V, 1Ph of suitable 'VA' for AHU's marine light, 'UV' light if asked for and ultrasonic humidifier if asked for in the AHU BOQ.

Transformer to have TPMCB/MPCB & DP MCB at primary & secondary for protection.

• DP MCB's for protection of 230V, 1Ph. AC marine light & 'UV' light & ultrasonic humidifier within AHU.
230V, AC Door Relay with 2 NO + 2NC contacts for AHU Door with DP MCB for protection. Relay for control of lights through door limit switch.
Interconnecting FRLSH Copper cabling as per IS 694 between MPCB output terminal to VFD & from VFD output terminals to output terminal block as per motor HP.

All these items in the same enclosure along with 3P MPCB.

d. VFD with bypass DOL Starter (110V contactor coil voltage):

14G CRCA powder coated sheet steel enclosure, wall mount type to house switchgear & VFD.

All items as listed in DOL Starter for motors for the applicable motor HP as specified in earlier paragraphs along with VFD & by pass scheme of contactors (Two isolation contractors + DOL starter (Contactor) complete in all respects as per specifications. VFD shall be IP20

ADDITIONAL FEATURES (FOR AHU MOTORS):

• Cast Resin Copper wound step down transformer, 415V, 3Ph / 230V, 1Ph of suitable 'VA' for AHU's marine light, 'UV' light if asked for and ultrasonic humidifier if asked for in the AHU BOQ.

Transformer to have TPMCB/MPCB & DP MCB at primary & secondary for protection.

• DP MCB's for protection of 230V, 1Ph. AC marine light & 'UV' light & ultrasonic humidifier within AHU.
230V, AC Door Relay with 2 NO + 2NC contacts for AHU Door with DP MCB for protection. Relay for control of lights through door limit switch.

e. VFD with bypass Star Delta Starter (110V contactor coil voltage):

14G CRCA powder coated sheet steel enclosure, wall mount type to house switchgear & VFD.

All items as listed in Star Delta Starter for motors for the applicable motor HP as specified in earlier paragraphs along with VFD & by pass scheme of contactors (Three isolation contractors + Main, star & Delta (Contactors) complete in all respects as per specifications. VFD shall be IP20.

ADDITIONAL FEATURES (FOR AHU MOTORS):

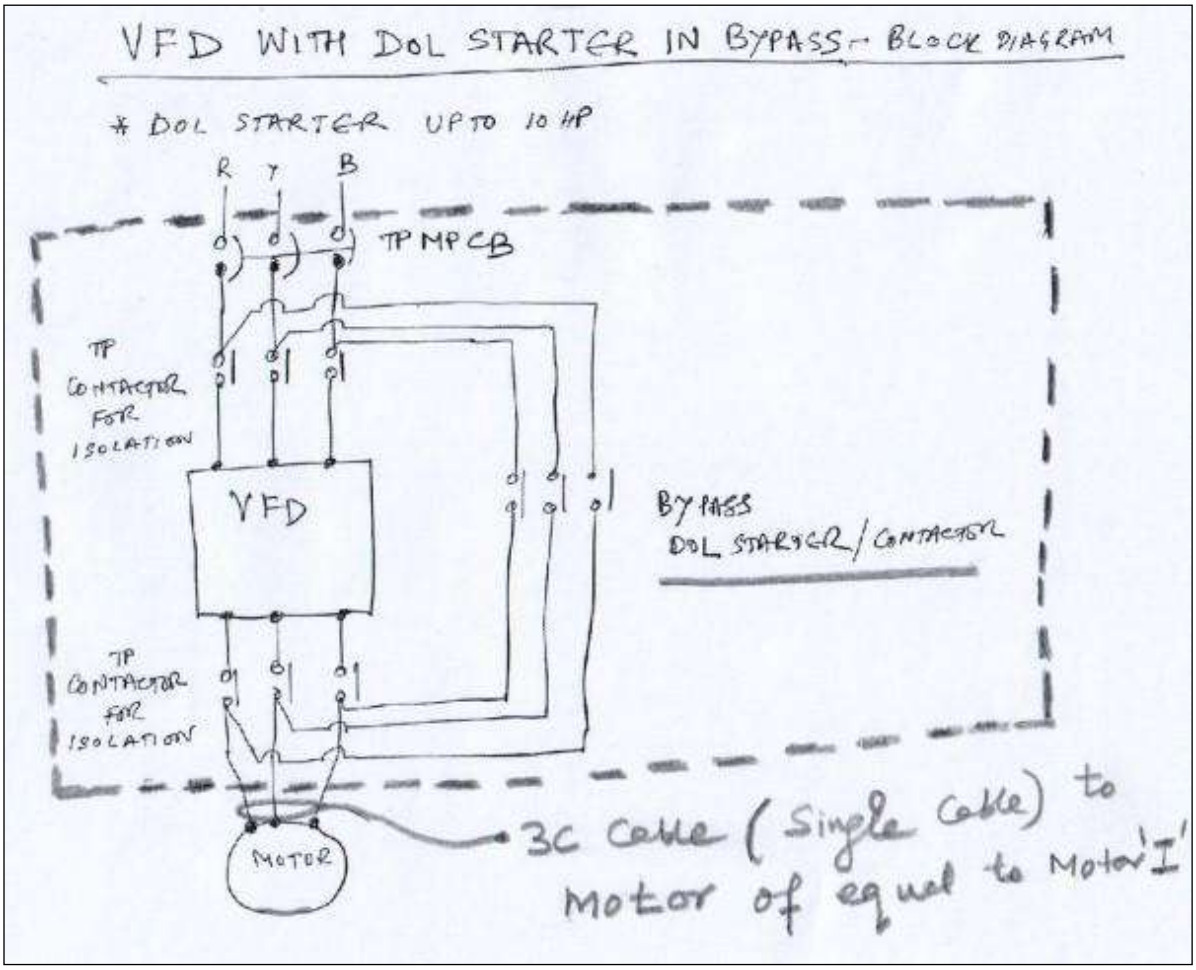
• Cast Resin Copper wound step down transformer, 415V, 3Ph / 230V, 1Ph of suitable 'VA' for AHU's marine light, 'UV' light if asked for and ultrasonic humidifier if asked for in the AHU BOQ.

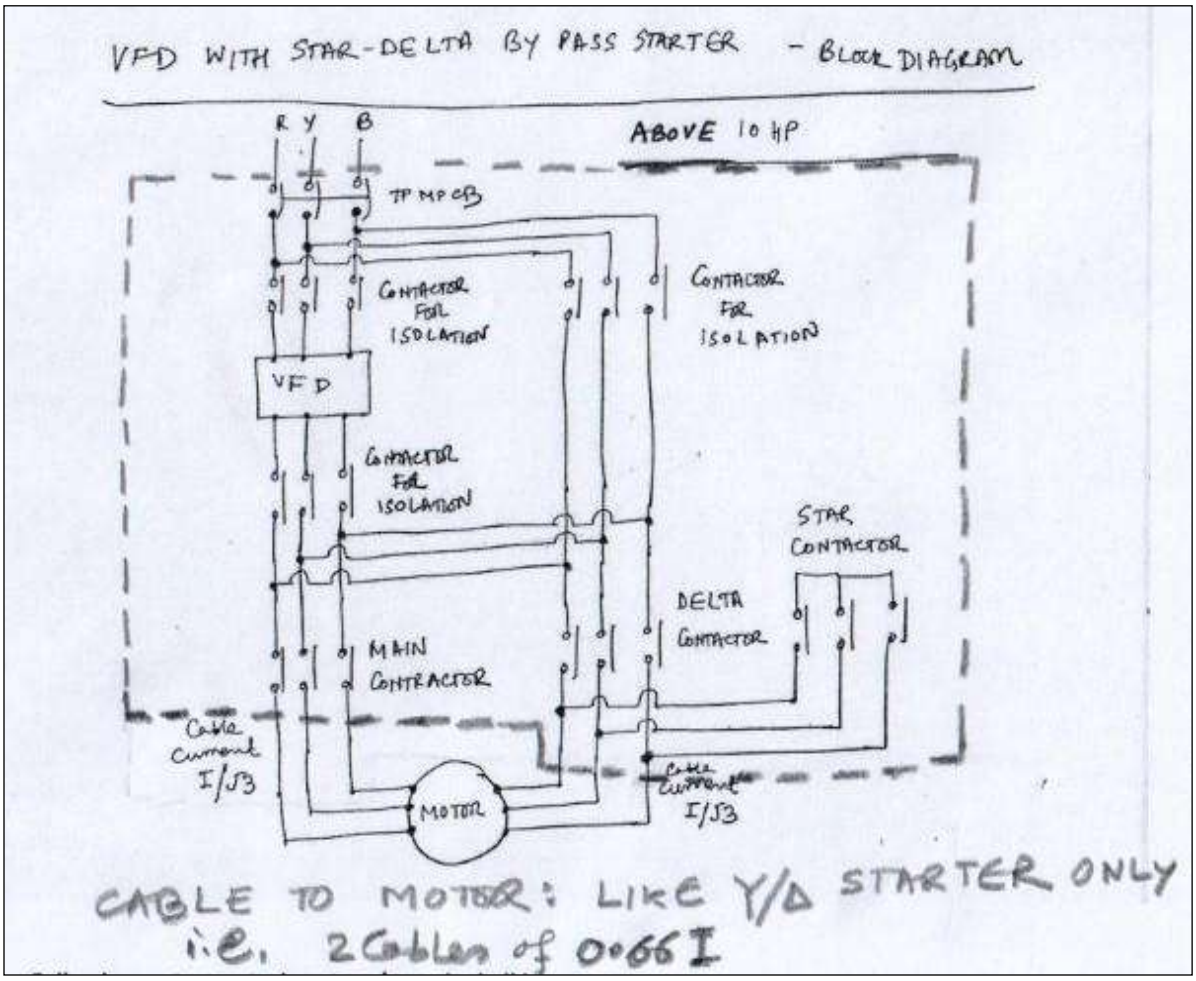
Transformer to have TPMCB/MPCB & DP MCB at primary & secondary for protection.

• DP MCB's for protection of 230V, 1Ph. AC marine light & 'UV' light & ultrasonic humidifier within AHU.

230V, AC Door Relay with 2 NO + 2NC contacts for AHU Door with DP MCB for protection. Relay for control of lights through door limit switch.

Note:- Please refer Block diagram sketches of VFD with by pass starter.





Following motor control centres / panels shall have:

- 3 Pole incomer switch i.e. MCCB or ACB & 3P bus bars
  a. AHU Panel
  b. Basement / podium ventilation panel
  c. Staircase & lift well pressurization fan panel
  d. Smoke venting panel
  e. Chillers auxiliary panel
  f. Chiller plant panel
  g. Plumbing panel
  h. Fire pump panel
  i. Sump pump panel

21. SOFT STARTER:

- Soft starter shall be used to limit the starting inrush current of motors.
- Soft starter shall have Thyristor to limit the starting current.
- As the motor attains its full speed, the motor running is shifted to a by-pass contactor, which is part of the soft starter assembly.
- Soft starter will have inbuilt overload and single phasing protection.
- Soft starter shall have RS485 (Modbus) communication port.
- Soft starter shall also have programmable DO & DI (Digital Output & Input) ports, as required.
- Soft starter shall be complete with motor duty MPCB or MCCB as incomer or HRC Fuses for short circuit protection and isolation purposes to attain Type-2 coordination.
- Soft starter shall be complete with local ON / OFF push buttons and A/M selector switch.
- For fire pumps, if soft starters are used, then it's overload / over current feature will be kept disabled.
- Soft starter shall have panel door mounted display unit for display of Electrical parameters & ON / OFF / Run status.
- Soft starter shall be integrated with fire alarm system and BMS system.

22. <u>IMPORTANT NOTES FOR ELECTRICAL PANELS, SWITCHGEAR & MOTOR CONTROL CENTRES</u>

- SWITCHGEAR OF ONLY ONE MAKE / MANUFACTURER TO BE USED.
- TYPE-2 CO-ORDINATION TO BE FOLLOWED.
- ICS = ICU = 100% FOR THE MCCB'S, MPCB'S & ACB'S

- **415V/√3/ 110V / √3 POTENTIAL TRANSFORMER FOR INCOMER METERING & R,Y,B PHASE INDICATION LAMPS:-**
  - ❖ For Panels/ MCC's (Motor Control Centre's) / PCC's (Power control center) incomer metering & Phase indication R,Y,B lamps, **<u>415V/√3/ 110V / √3 Cast resin PT's shall be used.</u>**
  - ❖ Entire metering / MFM's / KWH meters / VAF meters etc, 110V, 3 Phase input.
  - ❖ R,Y,B Phase indication lamps shall be 110V/√3 = 63.5V.

- **415V/110V CONTROL TRANSFORMER FOR CONTACTOR COILS & ON/OFF/TRIP INDICATION LAMPS:-**
  - ❖ For MCC's (Motor Control Center's), **<u>415 V / 110V Cast resin control Transformers</u>** shall be used for **<u>Control Supply to Contactor Coils and ON/OFF/TRIP indication Lamps</u>**.
  - ❖ Contactor Coils of Motor Starters shall be of 110V. **<u>A 110V Control BUS shall be run throughout MCC</u>** to Power 110 V control Transformer of Contactors / Starters.
  - ❖ CRITICAL PANELS / MCC's SUCH AS BASEMENT & PODIUM VENTILATION PANEL, PRESSURIZATION FAN PANEL, SMOKE VENTING PANEL & FIRE PUMP PANELS SHALL HAVE TWO CONTROL TRANSFORMERS OF 415V / 110V (ONE TO ACT AS STAND BY) FOR WORKING & STANDBY 110V CONTROL BUS AS REDUNDANCY.

- MOTORISED (EDO) ACB'S SHALL HAVE CLOSING COIL, SHUNT TRIP COIL & UNDER VOLTAGE RELEASE.
- MANUAL (MDO) ACB'S SHALL HAVE SHUNT TRIP COIL.
- ACB'S UPTO 4000A SHALL BE SINGLE FRAME TYPE.
- ALL ACB's OF ALL RATINGS, MANUAL & MOTORISED SHALL BE OF DRAW OUT TYPE.
- MCCB'S WITH FIXED THERMAL & MAGNETIC RELEASES, WHEREVER CALLED FOR, CAN ALSO BE WITH ADJUTABLE THERMAL & FIXED MAGNETIC, IF THIS COMES AS A STANDARD FEATURE OF THE PRODUCT.
- MCCB's UPTO 250A SHALL BE WITH FIXED RELEASES & ABOVE 250A SHALL BE WITH MICRO PROCESSOR BASED RELEASES.
- MOTOR DUTY MPCB'S & MCCB'S TO BE SELECTED AS PER SWITCHGEAR MANUFACTURER'S RECOMMENDATION / CHARTS.

- IN CASE OF ANY DISCREPANCY BETWEEN SPECIFICATIONS, BOQ & DRAWING (SLD), THE BEST OF THE THREE TO BE CONSIDERED OR CLARIFICATION TO BE SOUGHT FROM THE CONSULTANT / CLIENT / PMC.
- TEMPERATURE DERATION OF SWITCHGEAR TO BE TAKEN INTO ACCOUNT WHILE SELECTING IT EVEN IF IT IS NOT ACCOUNTED FOR IN THE BOQ / DRAWING (SLD).
- MOTOR DUTY MCCB'S ARE AVAILABLE IN 50KA FAULT WITHSTAND CAPACITY, EVEN IF IT IS SPECIFIED OTHERWISE IN BOQ / DRAWINGS (SLD).
- MPCB'S LESS THAN 36KA FAULT WITHSTAND CAPACITY NOT TO BE USED, EVEN IF IT HAS BEEN SPECIFIED OTHERWISE.
- STANDARD RANGE OF MCCB'S IS:
  16A, 25A, 32A, 40A, 50A, 63A, 80A, 100A, 125A, 160A, 225A, 250A, 320A, 400A, 500A, 630A
- STANDARD FAULT WITHSTAND RATINGS OF MCCB'S ARE:
  16KA, 25KA, 35KA/36KA, 50KA, 65KA/70KA, 100KA
  STANDARD MPCB'S FAULT WITHSTAND RATINGS ARE:
  25KA, 36KA, 50KA, 100KA, 150KA
- MPCB'S UPTO 63A SHALL BE THERMAL-MAGNETIC TYPE WITH ADJUSTABLE O/L TRIP SETTING AND ABOVE 63A SHALL BE WITH MICROPROCESSOR BASED RELEASE.
- ALL MCCB'S & MPCB'S SHALL BE WITH DIRECT / EXTENDED ROTARY HANDLES.
- ARRANGEMENT OF PAD LOCKING & FOOL PROOF LOTO (LOCKOUT & TAG OUT) TO BE AVAILABLE WITH ALL MCCB'S & MPCB'S FOR MAINTENANCE, SERVICING, REPAIRS AND INSPECTION FOR SAFETY REASONS ON MOTORS / EQUIPMENT. ALSO, DOOR INTERLOCK DEFEAT FUNCTION SHOULD NOT BE PROVIDED.
- CLIENT's MAINTENANCE TEAM TO UTILIZE LOTO FEATURE BEFORE INITIATING ANY REPAIR / MAINTENANCE ON ALL ELECTRICAL EQUIPMENT / PUMPS / MOTORS / FANS / BLOWERS ETC.

- **ATS**

  For Main LT Panel, Fire Emergency Panel & DG Set Aux. Panel:
  - ATS shall be ASCO Make Series 7000 for above 1200Amps and Series 300 below 1200 Amps or equivalent.
  - Main LT Panel & Fire Emergency Panel shall have 4P ATS.
  - DG Set Aux. Panel shall have 3P ATS.
  - ATS with controller, controller will AMF function.
  - ATS with 100% overlapping neutral.
  - ATS: Solenoid operated, RS485 Communication.
  - Utilization category: AC 33A.
  - Same phase angle transition & in phase monitoring.
  - 85KA for 0.3 sec (fault withstand)

  For Lift Panel & UPS Input Panel:
  - ATS shall be ASCO Make Series 300 or equivalent
  - 4P ATS
  - ATS with 100% overlapping neutral.
  - ATS: Solenoid operated.
  - 85KA for 0.3 sec (fault withstand).

- CHILLER AUX. PANEL, AC PLANT / CHILLER PLANT PANEL, PRIMARY / SECONDARY PUMP VFD PANEL, PLUMBING PANEL, STP PANEL, FIRE PUMP PANEL, AHU PANEL, BASEMENT VENTILATION PANEL, SMOKING VENTING PANEL, AIR WASHER PANEL, SCRUBBER PANEL, JET VENT PANEL, PRESSURIZATION FAN PANELS AND ALL MOTOR CONTROL CENTRES WILL NOT HAVE ANY NEUTRAL BUS BAR AND ONLY 3C CABLE SHALL BE TERMINATED IN MOTOR CONTROL CENTRES.

- ALL METERING, PROTECTION, INDICATION LAMPS ETC. SHALL BE OF 110V i.e. 230V SUPPLY SHALL NOT BE USED FOR THESE PURPOSES & PANEL DOOR WILL NOT HAVE 230V METERING & LAMPS ETC.
- CONTACTOR'S COIL SHALL BE 110V, AC. NECESSARY PT'S TO BE USED.
- SWITCHGEAR SELECTION SHOULD ACHIEVE DISCRIMINATION EVEN IF IT IS NOT SHOWN IN BOQ / DRAWING (SLD).
- BURDEN CALCULATIONS FOR CT'S, PT'S AND CONTROL TRANSFORMERS TO BE SUMITTED ALONG WITH SHOP DRWINGS.
- INCOMER SWITCHGEAR, BUS BARS, SUPPORTS AND OUTGOING SWITCHGEAR SHALL BE OF SAME FAULT LEVEL WITHSTAND CAPACITY AS MENTIONED FOR THE PANEL.
- SUGGESTED "MCCB" SELECTION FOR CAPACITOR APPLICATION WITH DETUNED FILTERS:

5 KVAR	16A TP MCCB (TH + MG) – F
10 KVAR	25A TP MCCB (TH + MG) – F
15 KVAR	40A TP MCCB (TH + MG) – F
20 KVAR	50A TP MCCB (TH + MG) – F
25 KVAR	63A TP MCCB (TH + MG) – F
50 KVAR	125A TP MCCB (TH + MG) – F

- CAPACITORS SHALL BE HEAVY DUTY MPP CONSTRUCTION.
- 7% & 14% DETUNED REACTORS SHALL BE COPPER WOUND, CLASS H INSULATION.
- **DEDICATED COPPER EARTHING LINK OF SUITABLE SIZE ON INSULATED SUPPORTS FOR:**
  ALL UPS DB'S, PDU'S, UPS OUTPUT PANELS & FLOOR UPS PANELS/ SDB - UPS PANELS WILL HAVE A DEDICATED COPPER EARTH LINK OF ADEQUATE SIZE SUPPORTED ON INSULATED SUPPORTS FOR 3RD PIN EARTHING (ISOLATED GROUND).
  THE GROUNDING EARTH LINK SHALL ALSO BE PROVIDED IN ADDITION TO DEDICATED EARTH BUS.

MOTOR FEEDERS

A. MOTOR FEEDERS WITH STARTERS:-

1. Upto 10 HP / 7.5 KW Motor

- 3P MPCB – TH + MG (Thermal Magnetic Release with adjustable O/L trip class).
- MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.
- DOL

2. From 12.5 HP / 9.3 KW to 40 HP / 30 KW Motors

- 3P MPCB – TH + MG (Thermal Magnetic Release with adjustable O/L trip class).
- MPCB'S upto 63A shall be Thermal-Magnetic type with adjustable O/L trip setting and above 63A shall be with Microprocessor based release.
- Star Delta

3. From 50 HP / 37 KW to 150 HP / 110 KW

- 3P MCCB – M (F) (Motor Duty – Fixed Release)
- Star Delta
- External Electronic O/L Relay with SPP

4. Above 150 HP / 110 KW Motors

- 3P MCCB – MP (Motor Duty – Micro Processor Base Release)
- Star Delta
- External Electronic O/L Relay with SPP

B. MOTOR FEEDERS WITH VFD's

1. Upto 40 HP / 30 KW Motors

- 3P MPCB –MG (Magnetic Release)
- MPCB'S upto 63A shall be Magnetic release and above 63A shall be with Microprocessor based release.
- VFD

2. From 50 HP / 37 KW to 150 HP / 110 KW Motors

- 3P MCCB –M(F) (Motor Duty - Fixed Release)
- VFD

3. Above 150 HP / 110 KW Motors

- 3P MCCB – M (MP) (Motor Duty – Micro Processor Base Release)
- VFD

C. MOTOR FEEDERS WITH SOFT STARTERS

1. Upto 40 HP / 30 KW Motor

- 3P MPCB – MG (Magnetic Release)
- MPCB'S upto 63A shall be Magnetic release and above 63A shall be with Microprocessor based release.
- Soft Starter with inbuilt Bypass Contactor

2. From 50 HP/ 37 KW to 150 HP / 110 KW Motor

- 3P MCCB – M(F) (Motor Duty - Fixed Release)
- Soft Starter with inbuilt Bypass Contactor

3. Above 150 HP / 110 KW Motor

- 3P MCCB – M (MP) (Motor Duty – Micro Processor Base Release)
- Soft Starter with inbuilt Bypass Contactor

D. JET FAN 2 STAGE STARTER

- 3P MPCB – MG (Magnetic Release)
- 2 Stage Starter
- Overload Relay & SPP

IMPORTANT NOTE: - *VENDORS TO SUBMIT SWITCHGEAR SELECTION/ RATINGS FOR ALL THE PANELS ALONG WITH THE BID.*

23. CONSTRUCTION FEATURES & GENERAL NOTES OF LOW VOLTAGE MAIN AND SUB DISTRIBUTION BOARDS / PANELS/SWITCH BOARDS/ METER BOARDS/ACB ISOLATOR PANELS / MOTOR CONTROLS CENTRES (MCC)

GENERAL SPECIFICATIONS

Main & Sub Distribution Boards shall be classified as per IEC: 61439 of Cubicle type, Sheet steel clad, Totally enclosed, Dust & Vermin proof, Indoor type/ out door type, Rigid, Free standing, Floor mounted compartmentalized, Single front for use on 415 volts, 3 phase, 50 cycles, AC system with a fault level withstand capacity as per B.O.Q. /as required, RMS Symmetrical. Complete with busbars interconnections, power, control/auxiliary circuits/ wiring & earthing, with switchgear as per B.O.Q of approved makes as specified.

ALL PANELS / DISTRIBUTION BOARDS EXCEPT FEEDER PILLERS, WALL MOUNT PANELS AND OUT DOOR PANELS SHALL BE AS PER IEC: 61439 TESTED (TOTAL ASSEMBLY). IT SHALL MEAN BLOCKSET WITH SCHNEIDER SWITCHGEAR, R2K WITH ABB SWITCHGEAR, C-PAN WITH SIEMENS SWITCHGREAR AND TIA / TERA FOR L&T SWICHGEAR IF SPECIFIED.

BASE FRAME: 3MM
Normal Indoor Application: CRCA WITH POWDER COATING (minimum 60 micron coating).
Outdoor Application: ALUZINC WITH POWDER COATING (minimum 80 micron coating).
CRCA Sheet Type: PN02/ Equivalent as approved.
CRCA Sheet Make: TISCO/ Equivalent as approved.
ALUZINC Sheet Type: Grade CS Type A.
ALUZINC Sheet Make: Dongbu Steel South Korea.

STRUCTURE, COVER BACK & FRONT DOOR: 2MM
Normal Indoor Application: CRCA WITH POWDER COATING (minimum 60 micron coating).
Outdoor Application: ALUZINC WITH POWDER COATING (minimum 80 micron coating).
CRCA Sheet Type: PN02/ Equivalent as approved
CRCA Sheet Make: TISCO/ Equivalent as approved
ALUZINC Sheet Type: Grade CS Type A.
ALUZINC Sheet Make: Dongbu Steel South Korea.

INTERNAL PARTITIONS: 1.6MM
Normal Indoor Application: ALUZINC
Outdoor Application: ALUZINC
ALUZINC Sheet Type: Grade CS Type A.
ALUZINC Sheet Make: Dongbu Steel South Korea.

CABLE GLAND PLATES: 3MM
Multi Core Cables: ALUZINC
Single Core Cables: Aluminum

INTERNAL SWITCHGEAR MOUNTING PLATES: 2MM
Normal Indoor Application: ALUZINC
Outdoor Application: ALUZINC
ALUZINC Sheet Type: Grade CS Type A.
ALUZINC Sheet Make: Dongbu Steel South Korea.

CONSTRUCTION

- Completely modular & compartmentalized, form 3B separation. Separate adequately spaced Unit Chamber, Bus bar & cable compartments.
- IP20 ingress protection to be ensured compartment to compartment inside the panel.

EXTENSIBILITY
Readily extensible on both ends.
Panels should be made in easily transportable sections.

DIMENSIONS

Operating height	1800mm max. 300mm min.
Overall height	2400mm max.
Compartment size HXW	225mm x 500mm min
Cable chamber	300mm min.

DEGREE OF PROTECTION

IP: 42 for totally Indoor application.

- Panels in Substation area, Electrical Rooms, LT Panel Rooms & DG Set Room
- MDB L+P Panel
- Tower Panel, Tower LT Panel (individual housing tower or office tower panel)
- EWS Panel
- Meter Boards (In Electrical Rooms)
- Lift Panel (In Lift Machine Room)
- AHU Panel
- Basement Ventilation Panel
- Staircase & Liftwell Pressurization Fan Panel (If Indoors)
- Plumbing Panel
- Fire Pump Panel
- STP Panel
- AC / Chiller Panel
- Chiller Auxiliary Panel
- DG Set Auxiliary Panel

- **IP: 54 for Indoor Application**
- Laundry Panel
- Kitchen Panel
- Sump pump panel

IP: 55 for Outdoor Application.

- Feeder Pillar
- Outdoor Junction boxes
- Outdoor boards / panels/Outdoor DG Panel
- ACB/MCCB Isolators (outdoors)

All outdoor IP 55 panels shall be:

a. Double door design
b. With canopy
c. Panel shall have forced ventilation mechanism with Rital fan & filter section, to avoid temperature rise and at the same time maintaining IP 55 integrity.
d. Complete ALUZINC Powder coated construction. 80 microns powder coating.

DOOR HINGES

Concealed, Powder Painted

DOOR LOCKS

Zinc alloy powder painted with provision for pad locking.

GASKET

Neoprene / PE foam of suitable profile to provide desired degree of protection.

LIFTING ARRANGEMENT

Eye bolt of removable design, when removed these shall not leave any opening in the boards.

PAINTING

Pre-treatment eight tank process on CRCA sheets or on-line automatic spray system with oven for drying after Pre-treatment as per IS: 101-1988 effective temperature and concentration control. Powder coating of desired shade as per requirement. Paint thickness min. 60 micron

CORROSSION RESISTANCE

Withstand 500 hrs of Salt Spray as per IS: 101-1988

BUS BARS MAIN

Aluminum E-91E grade, min. 53% IACS
Copper min 99% IACS (Tinned copper)
Configuration: Interleaved 2000A & above

Minimum clearances shall be:

Phase to Phase	32mm
Phase to Neutral	25mm
Phase to earth	25mm
Neutral to earth	25mm

BUS BARS EARTH

As per material of main busbar of size suitable to withstand fault level specified / as required. Continues length of earth bus to be provided.

UPS Output Panels shall have two earth bars of tinned copper of suitable rating. One of the earth buses shall be dedicated i.e. mounted on insulated supports.

BUS BAR TEMP. RISE

Ambient 45^{o}C
Maximum bus bar temperature rise 40^{o} C over ambient
No deration of Switchgear & Panels upto 45^{0}C

BUS BAR SIZING / CROSS-SECTION

Bus bars to be sized to carry the full rated load current without exceeding maximum temperature rise as limited above. Bus bar size calculations to be submitted with shop drawings. Busbars to withstand the maximum short circuit current as specified / as per requirement.

BUS BAR SUPPORTS

Non Hygroscopic Epoxy/SMC/Nylon 6.6 supports at suitable distance to withstand forces of short circuit as per requirement.

BUS BAR INSULATION

Black heat shrinkable, fire retardant, self extinguishing type sleeves suitable to withstand 110^{o}C
Colour coding to be followed as per IS codes. Phase sequences and polarity to be followed as per IS codes.

SHROUDING

All live parts should be shrouded with IP2 protection Fire Retardant, Non Inflammable, Non Hygroscopic e.g. Polycarbonate, FRP.

BUS BAR SLEEVING

Heat shrinkable sleeves rated for minimum 110 deg C for one hour.

HARDWARE

A. For Internal Connections of switch gear, bus bars & cables etc.

- High Tensile MS Alloy, Zinc coated, Grade 8.8 (Minimum 10 micron coating thickness). (Trivalent Plating CR3+).
- Salt Mist spray test with stand: 120 Hours duration.

1.	Steel Hardware		
	Salt mist spray withstand	:	120 Hours
	Bolt and nuts		
	Hardware quality	:	8.8
	According to	:	EN 20898, EN ISO 3506-1, 4759-1 (=S=FT30860)
	Contact Washers		
	Washer quality	:	8.8
	Class	:	160 HV
	According to	:	EN 20898, EN ISO 3506-1, 4759-1

Note: Contact washer to be fixed on both sides (Plain Washer & Spring Washer).

B. For External Body & Enclosure Construction: High Tensile MS Alloy, Zinc Coated Grade 8.8 (minimum 10 micron coating thickness). (Trivalent Plating CR3+).

PANEL COOLING / VENTILATION:

110V 1phase, heavy duty/ sturdy, panel ventilation fans to be employed, which shall be controlled by a thermostat. Or in VFD motor modules, module ventilation fan to be linked with VFD operation i.e. "On" operation of fan through relay contacts of the VFD , so that ventilation fan for VFD will be "On "only when the particular VFD is "On". Relay contacts of any VFD are suitable for 230V, so 110V will not be any problem.

PANEL SPACE HEATING /CONDENSATION CONTROL:

230V or 415V space heaters with humidistat to be employed for moisture condensation control.

WIRING

1100V Fire retardant, virgin PVC color coded flexible wire

Voltage circuit	1.5 sq mm
Current circuit	2.5 sq mm
Earth circuit	2.5 sq mm

As per IS: 694

WIRING IDENTIFICATION

Computerized ferrule on both ends as per IS: 375

TERMINAL BLOCK

Power - Melamine stud type.
Control - Polyimide color coded screw less clamp fit type.
Not more than one wire connected to one terminal block.
Plug in type terminal block at each transport section.

COMPONENT LEGEND

Computerized labels for all control component & terminal block

FEEDER DESCRIPTION PLATES

Powder coated Al. Plate with computerized printing, size:
MDB = 150 x 50 min
S/DB = 100 x 40 min

SPARE FEEDERS

It shall be as per B.O.Q. / SLD. If B.O.Q / SLD does not specify anything, than an average of 20% of a mix of various ratings / feeders to be provided as spare feeders in each board / panel. Spare feeders must include a minimum one biggest and a minimum of one smallest rated feeders as spares along with other spares.

CABLING

Provision for top/ bottom/ top & bottom entry of cables, as per requirement / as per site. Adequately sized cable chambers. Easy and safe termination & maintenance facility.

BUS TRUNKING TERMINATION

Wherever specified in B.O.Q power connection arrangement at top suitable for bus trunking.

SWITCHGEAR

As per specification & Makes specified. IS: 13947 I- IV, 1993

Only one make of switchgear to be used in a board/panel. The switchgear selection shall be as per manufacturer's co-ordination tables. Type 2 coordination to be achieved as a minimum.

CONTROL MCB'S / MPCB'S
For control and metering circuit/wiring, these shall be of fault level as required.

CONTROL COMPONENTS
As per specification & Makes specified. IS: 13947 I - IV, 1993

INDICATING INSTRUMENTS
Analog/Digital as per specifications, notes, B.O.Q. & Makes specified. IS: 13779

BMS compatible multifunction meters shall be complete with communication card, shall be net-workable and shall be wired on to common RS 485 Bus and information from these meters to BMS to be released at one point.

INDICATING INSTRUMENTS ACCESSORIES
CT/PT-Cast resin as per specifications & make specified. IS: 2705, 1992

SPACE HEATER
All ACB Incomer & bus couplers shall be provided with Space Heater & Thermostat & 11 watt panel illumination. Heaters shall be controlled by a 6A MCB / MPCB as per the required fault level.

PLC'S FOR LOAD MANAGEMENT & INTERLOCKING OF BREAKERS:
Use separate PLC's for Load management and for separate for interlocking of breakers and bus couplers and closing of bus couplers.

SHOP DRAWINGS
Notes, General arrangement, Elevations, Single line diagram, Bill of material, Control and inter locking scheme to be submitted for approval prior to manufacturing and approval taken from PMC / Consultant / Owner.

TESTING & PRE-DISPATCH QUALITY CONTROL

A. Fabrication, Pre-treatment, painting, assembly and wiring.

B. **Tests**:

- Physical, Electrical, and Operational tests of all Breakers / Switches.
- Operational check of all meters and relays.
- Dielectric strength test for insulation at 2.5kV for 1 sec.
- Insulation resistance test at 1000V megger,
- Protective measures and continuity of circuits, as per IS: 8623-I, 1993.
- Testing of protection relays by secondary injection kit before commissioning.
- Interlocking Function Test.
- Earth continuity test between various Non-current carryings parts of equipment steel work etc. & the earth bus provided in the panel.

INSPECTION
To be offered at works to PMC / Owner.

TEST CERTIFICATE TYPE AND ROUTINE

Test results for routine tests conducted at works should be submitted. Type tests as per IS: 61439.

PACKING

Wooden Crates/ Wooden Cases/ Polythene & Water proof paper to be used.

AS MANUFACTURED DRAWINGS

To be submitted in CD format with catalogues and test certificates of switchgear, controlgear and other components used within MDB & PDB.

AFTER SALES SERVICE

Manufacturer to have an Independent department to render after sales support for Installation, commissioning & trouble shooting during and after warranty period.

OPERATING CONDITIONS:

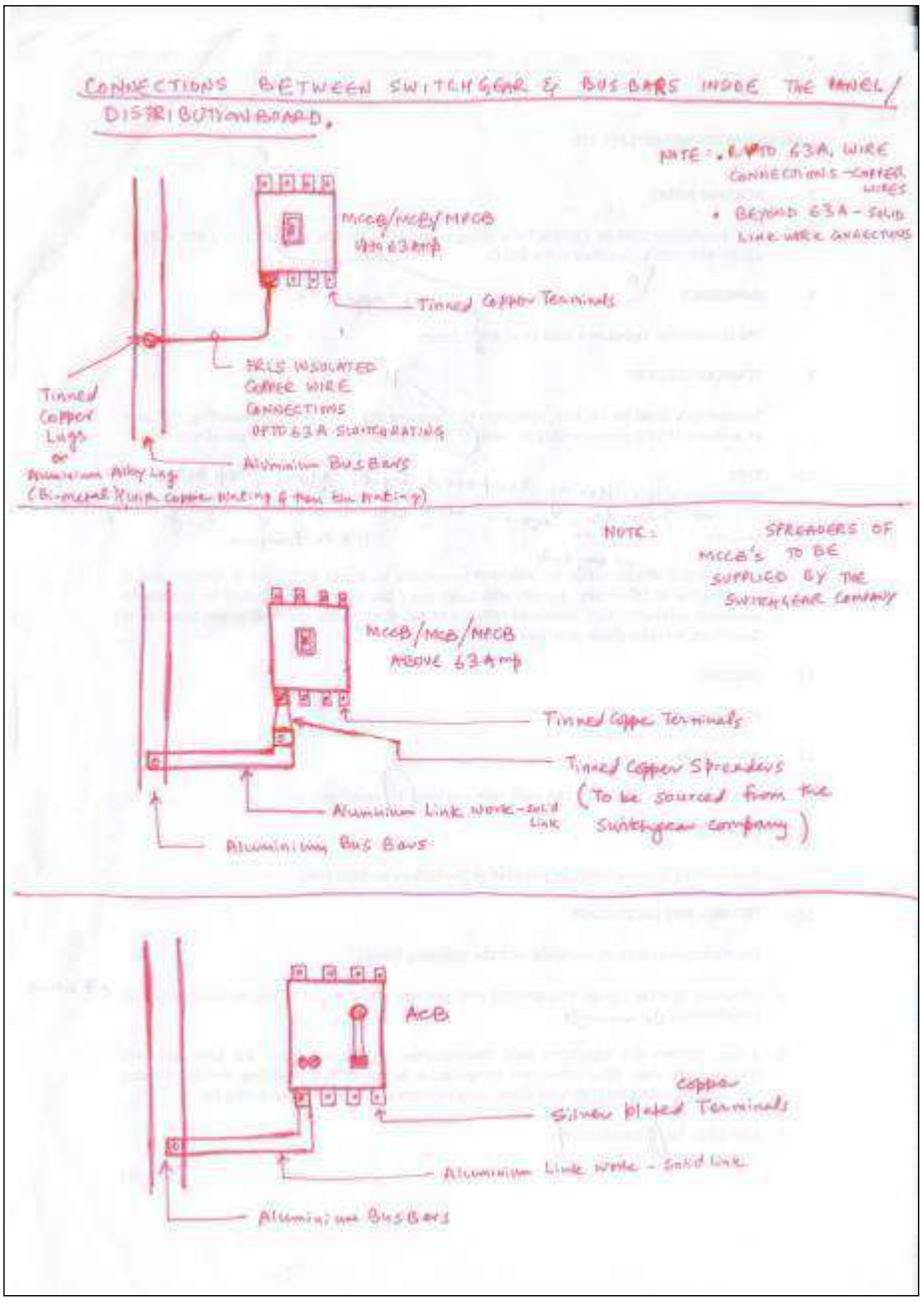
- No De-ration of panels, Switchgear/Equipment & Busbars upto 45 Deg. C & Altitude of 1000M above MSL for indoor panels**.**
- No De-ration of panels, Switchgear/Equipment & Busbars upto 50 Deg. C & Altitude of 1000M above MSL for outdoor panels / feeder pillars.

CONNECTION BETWEEN BUSBARS & SWITCHGEAR

- Upto 63Amp Switch rating with 1.1 KV grade FRLS PVC insulated flexible single core copper cables. Tinned copper or silver plated copper lugs shall be used on copper wires.
- Above 63Amp Switch rating, with solid aluminium / copper busbar links, to be used.
- Neutral Bus bars for four pole feeders shall be of the same size as phase.
  Neutral Bus bars for triple pole feeders shall be of 50% size of phase.
  Neutral Bus bars for UPS panels shall be of 200% size of phase.

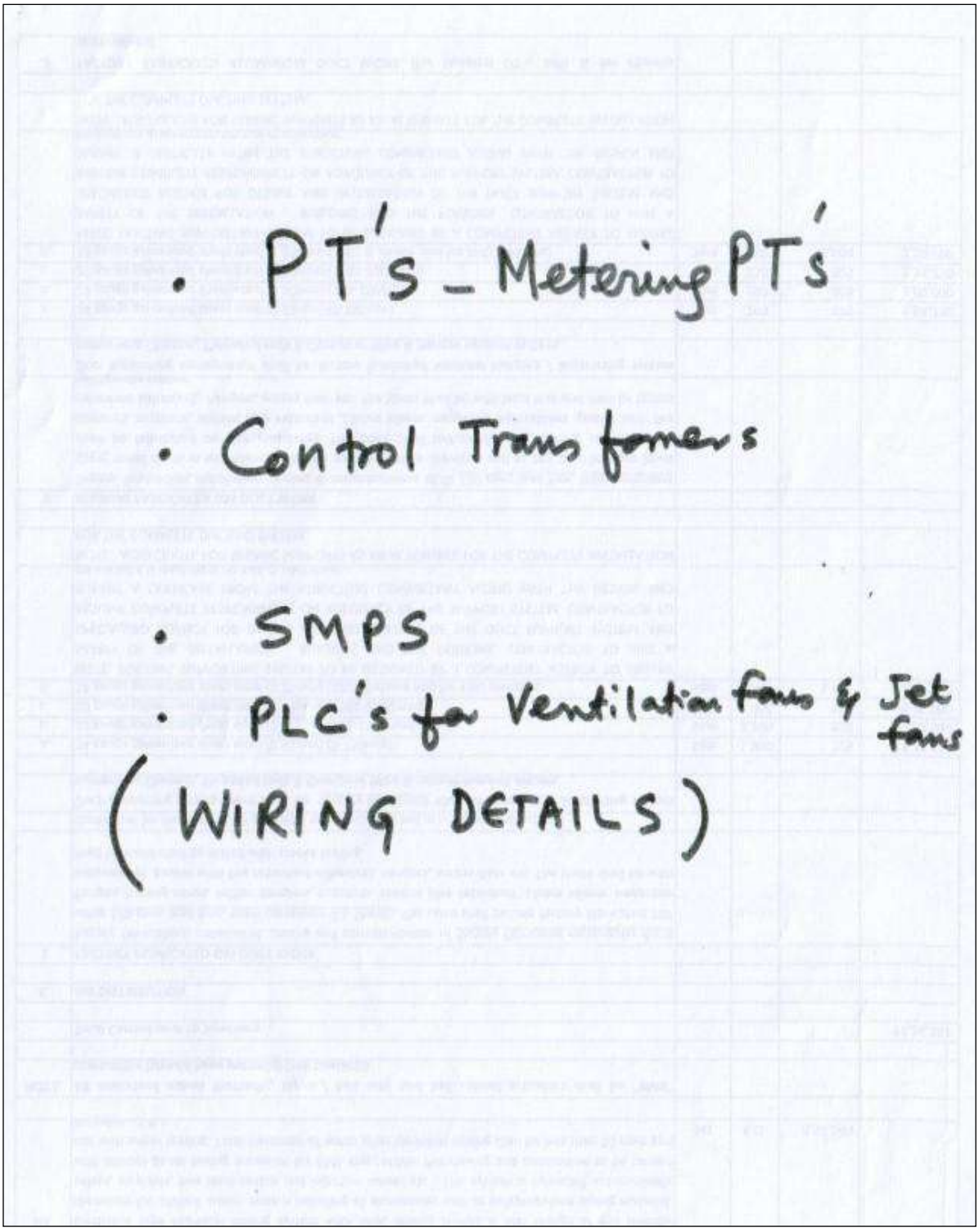
ROTARY HANDLES & LOTO FEATURES IN MCCB'S & MPCB'S:

- ALL MCCB'S & MPCB'S SHALL BE WITH DIRECT / EXTENDED ROTARY HANDLES.
- ARRANGEMENT OF PAD LOCKING & FOOL PROOF LOTO (LOCKOUT & TAG OUT) TO BE AVAILABLE WITH ALL MCCB'S & MPCB'S FOR MAINTENANCE SAFETY REASONS ON MOTORS / EQUIPMENT.
- MAINTENANCE TEAM TO UTILIZE LOTO FEATURE BEFORE INITIATING ANY REPAIR / MAINTENANCE ON ALL ELECTRICAL EQUIPMENT / PUMPS / MOTORS / FANS / BLOWERS ETC.



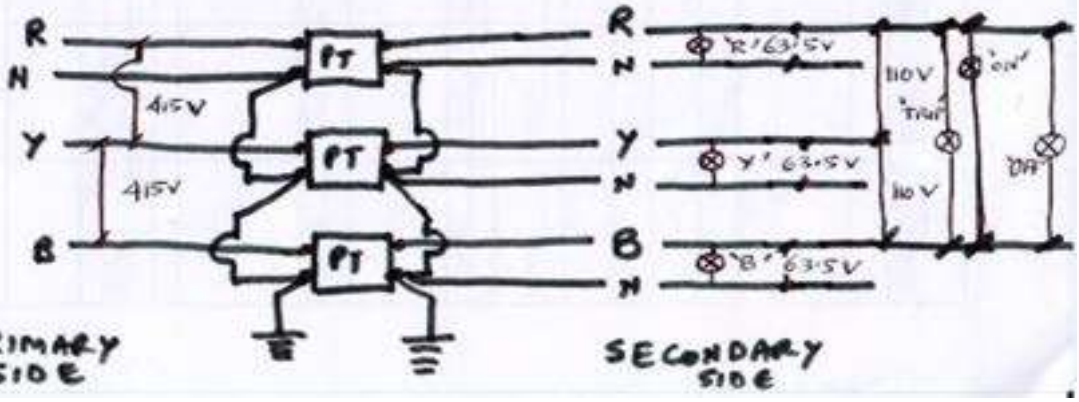
23a. Construction Typology: Block set of Schneider /R2K of ABB if called for in the BOQ specifically.

23b.


• PT's - Metering PTs
• Control Transformers
• SMPS
• PLC's for Ventilation fans & Jet fans
(WIRING DETAILS)

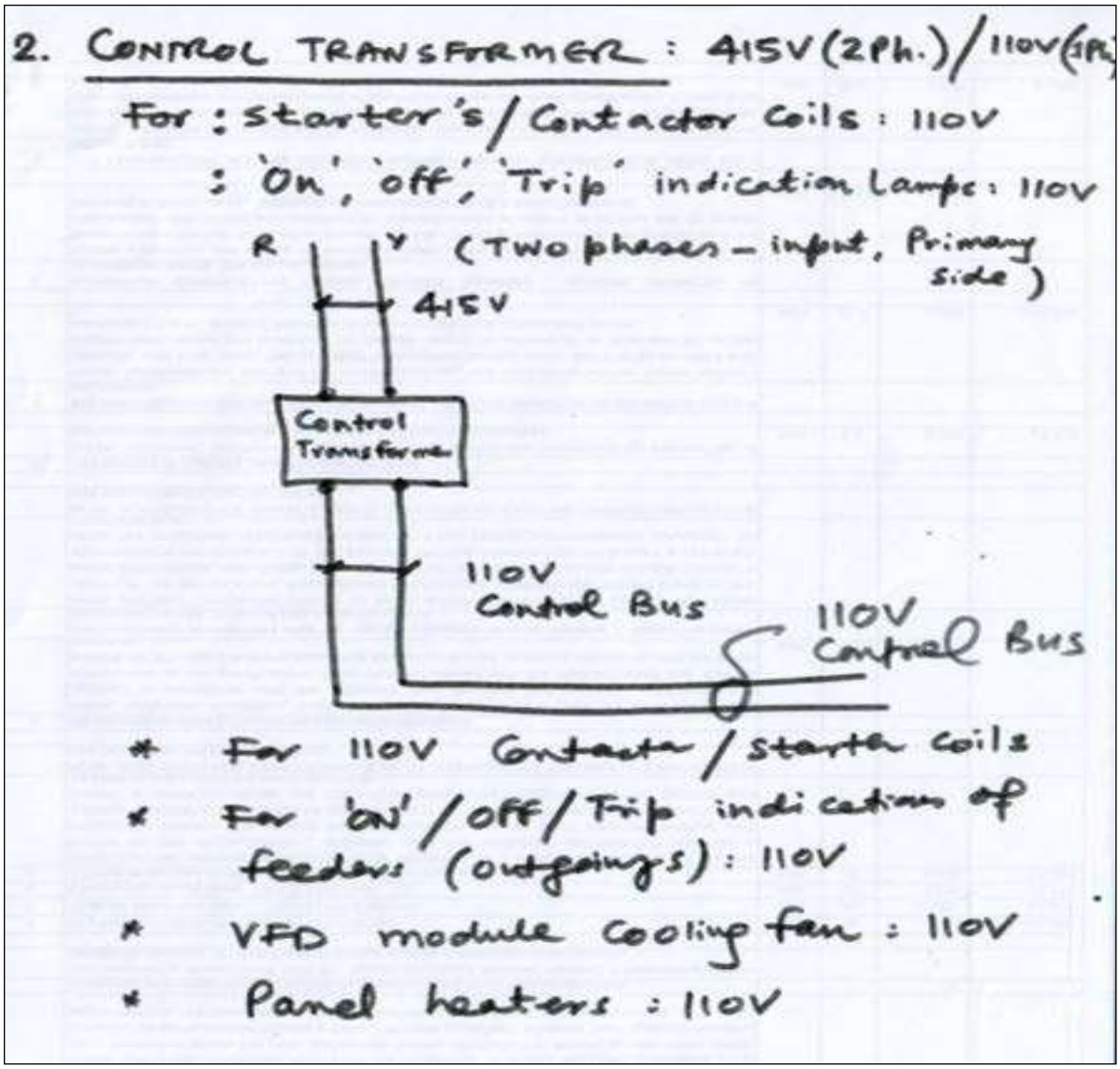
1. PT @ Panel's incomer: Metering PT

- 415 V/√3 / 110V / √3
- 3 nos. Single Phase PT's.
- Input Voltages: Primary Side
  - Phase to Phase: 415 V
  - Phase to Neutral: 230V
- Output Voltages: Secondary Side
  - Phase to Phase: 110V
  - Phase to Neutral: 63.5 V
- For:
  - R, Y, B phase indication Lamps: 63.5 V (1 Ph)
  - MFM's: 3 ph (110V)
  - On/Off/Trip indication Lamps: 110V (2 phase)



23b.1

23b.2



23b.3. SMPS & CONTROL TRANSFORMER FOR 'CO' SENSORS POWER & PLC:

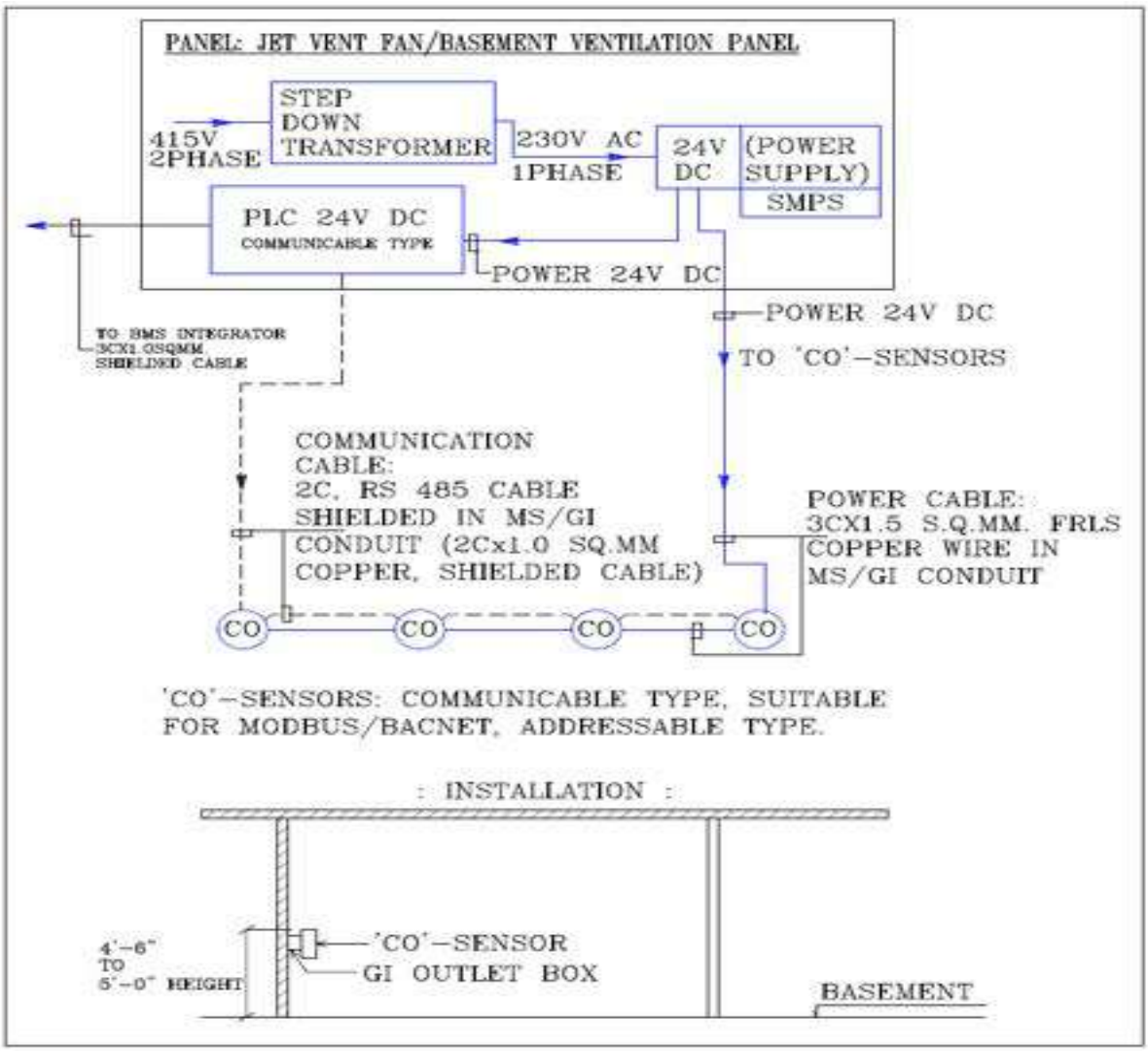
Step 1 (Control Transformer) : 415V (2 Phase) to 230V (1 Phase)

Step 2 (SMPS) : 230V (1 Phase) to 24V DC

24V DC Supply to:

- 'Co' Sensors
- 'PLC'

23b.4. PLC & CO SENSOR WIRING FOR BASEMENT VENTILATION PANELS:



SMPS & CONTROL TRANSFORMER FOR 'CO' SENSORS POWER & PLC:

Step 1 (Control Transformer) : 415V (2 Phase) to 230V (1 Phase)

Step 2 (SMPS) : 230V (1 Phase) to 24V DC

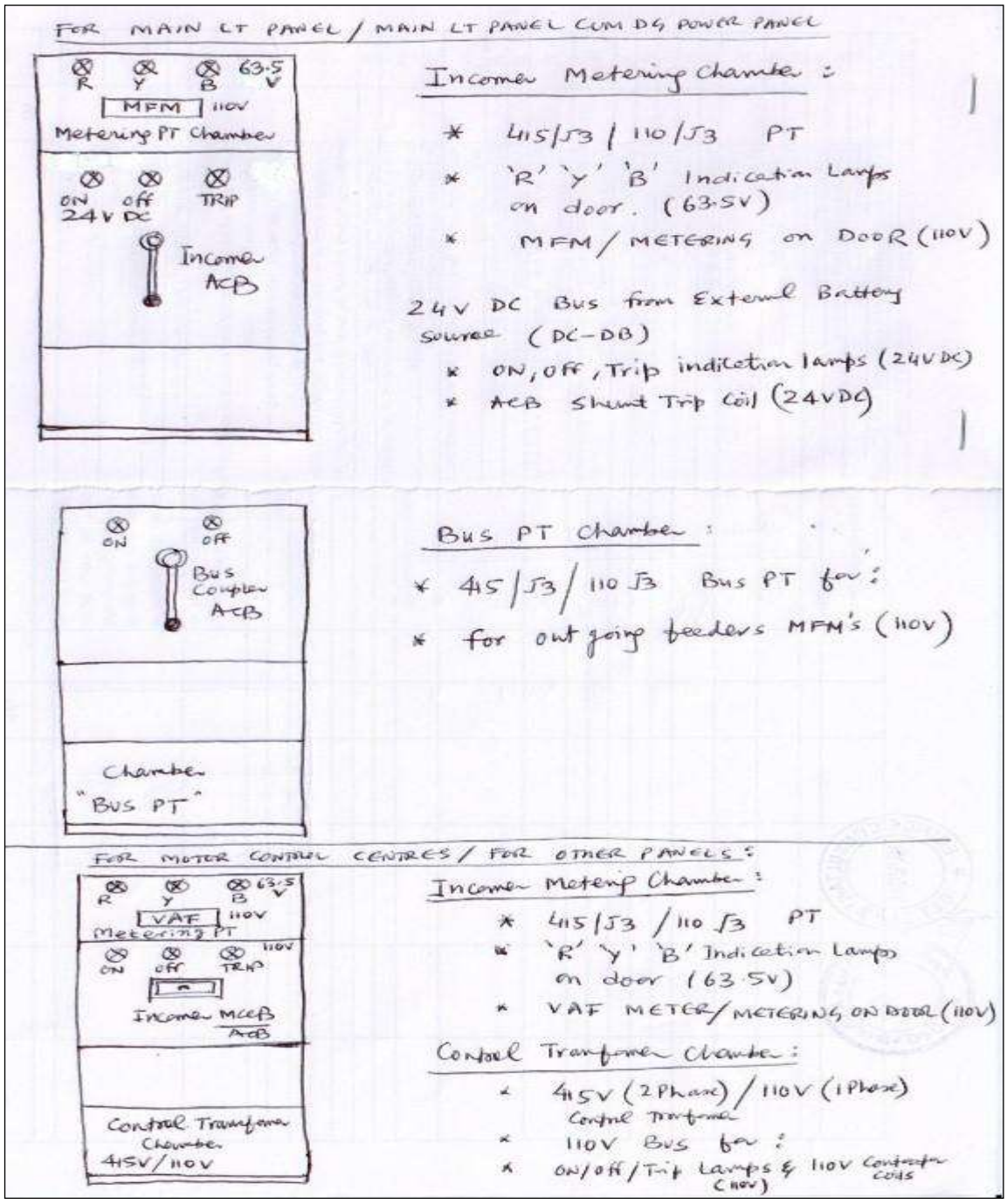
24V DC Supply to:

- 'Co' Sensors
- 'PLC'

PLC'S FOR JET FANS & BASEMENT VENTILATION FANS:

- Power Input: 24V DC
- Relay Outputs: 24 Nos.
- Analogue Outputs: 20 Nos.
- Modbus Input Ports (RS485) : 4 Nos.
- BMS Communication Port

23b.**5. FOR MAIN LT PANEL / MAIN LT PANEL CUM DG POWER PANEL:**

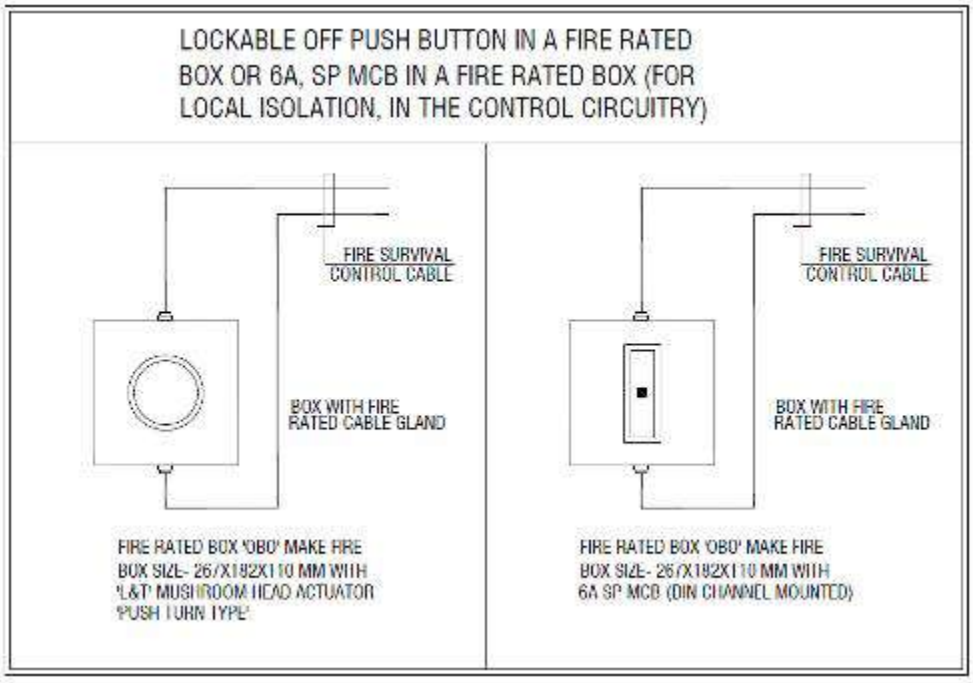


24 LOCAL ISOLATORS FOR MOTORS

Local Isolators

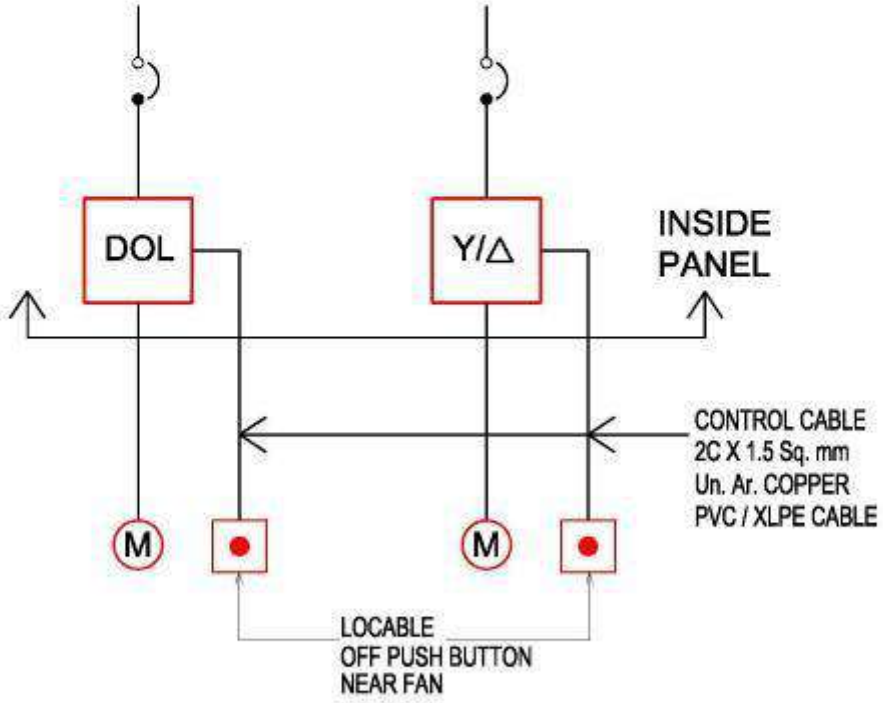
- Power Cables Isolators in power cables:
  - Cooling tower motor.
  - TFA motor.
  - HRW fresh air fan & exhaust air fan motors.
  - Staircase pressurization fan motor.
  - Lift lobby pressurization fan motor.
  - Lift well pressurization fan motor.
  - Toilet exhaust fan motor.
  - Pantry exhaust fan motor.
  - Terrace located smoke venting fan motor for smoke & fresh air fans.
  - STP exhaust fan motor.
  - STP fresh air fan motor.

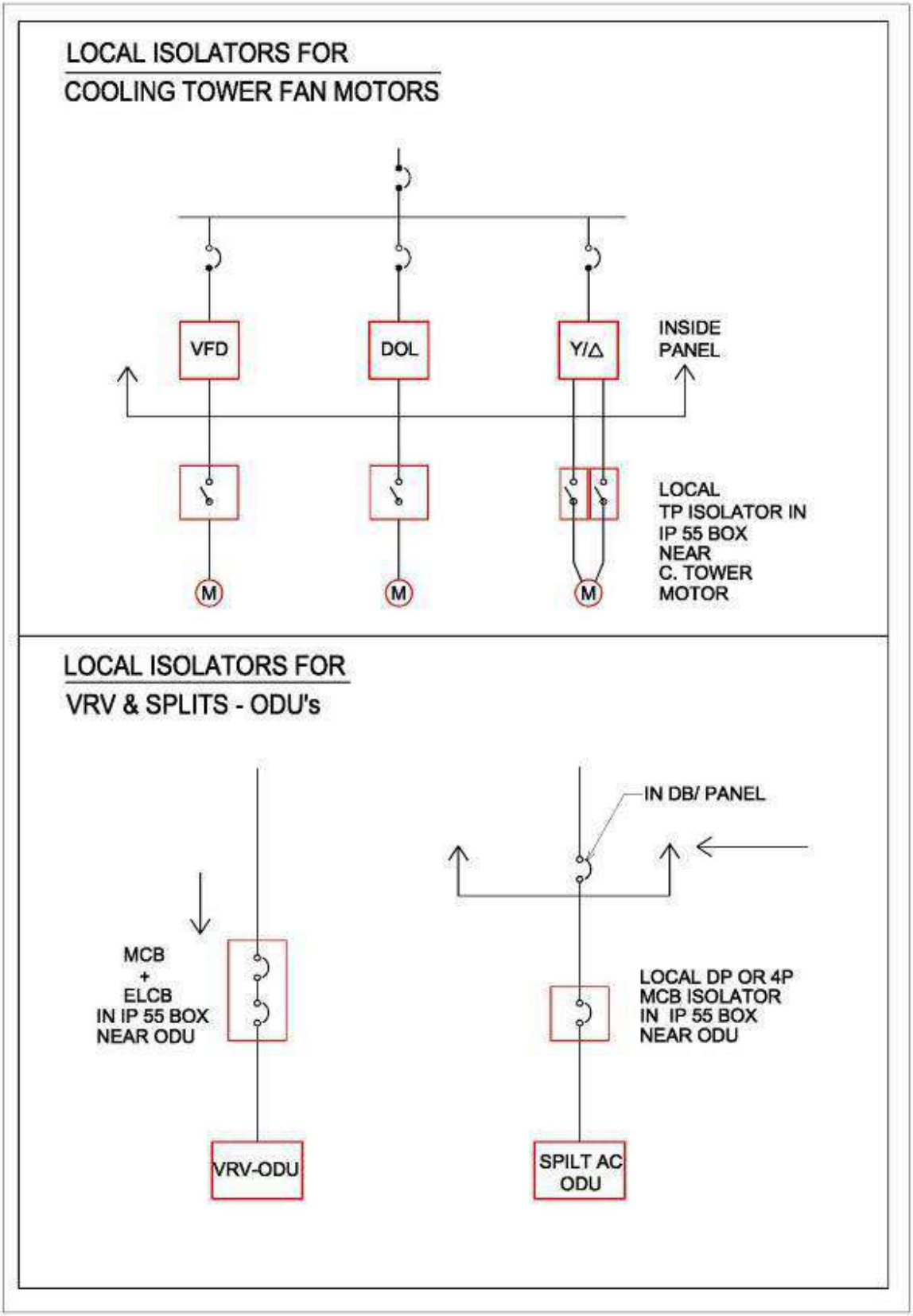
- Lockable off push buttons in control wiring for fans with fire rated cables (to avoid jointing in fire rated power cables):
  - Basement ventilation fan motors (fresh air & exhaust air).
  - Podium ventilation fan motors (fresh air & exhaust air).
  - Floor smoke venting fan motors (for fresh air & exhaust air).
  - MEP Rooms ventilation fan motors.



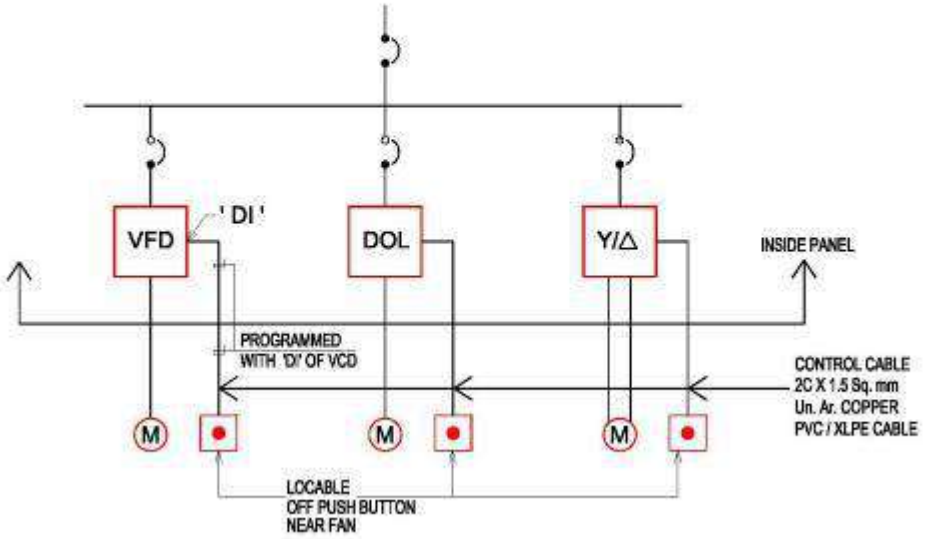
LOCAL ISOLATORS FOR

C.S. VENTILATION UNIT's (FRESH AIR / EXHAUST AIR)
FOR : LT PANEL
DG ROOM
SUB STATION AREA / TRANSFORMER ROOM
PUMP ROOM
STP ROOM
AC PLANT ROOM

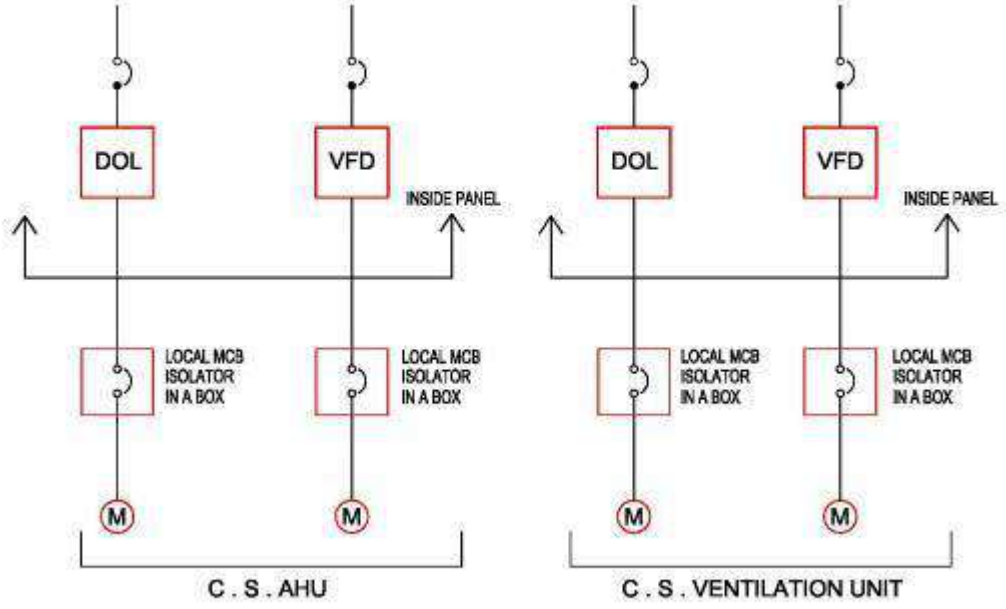


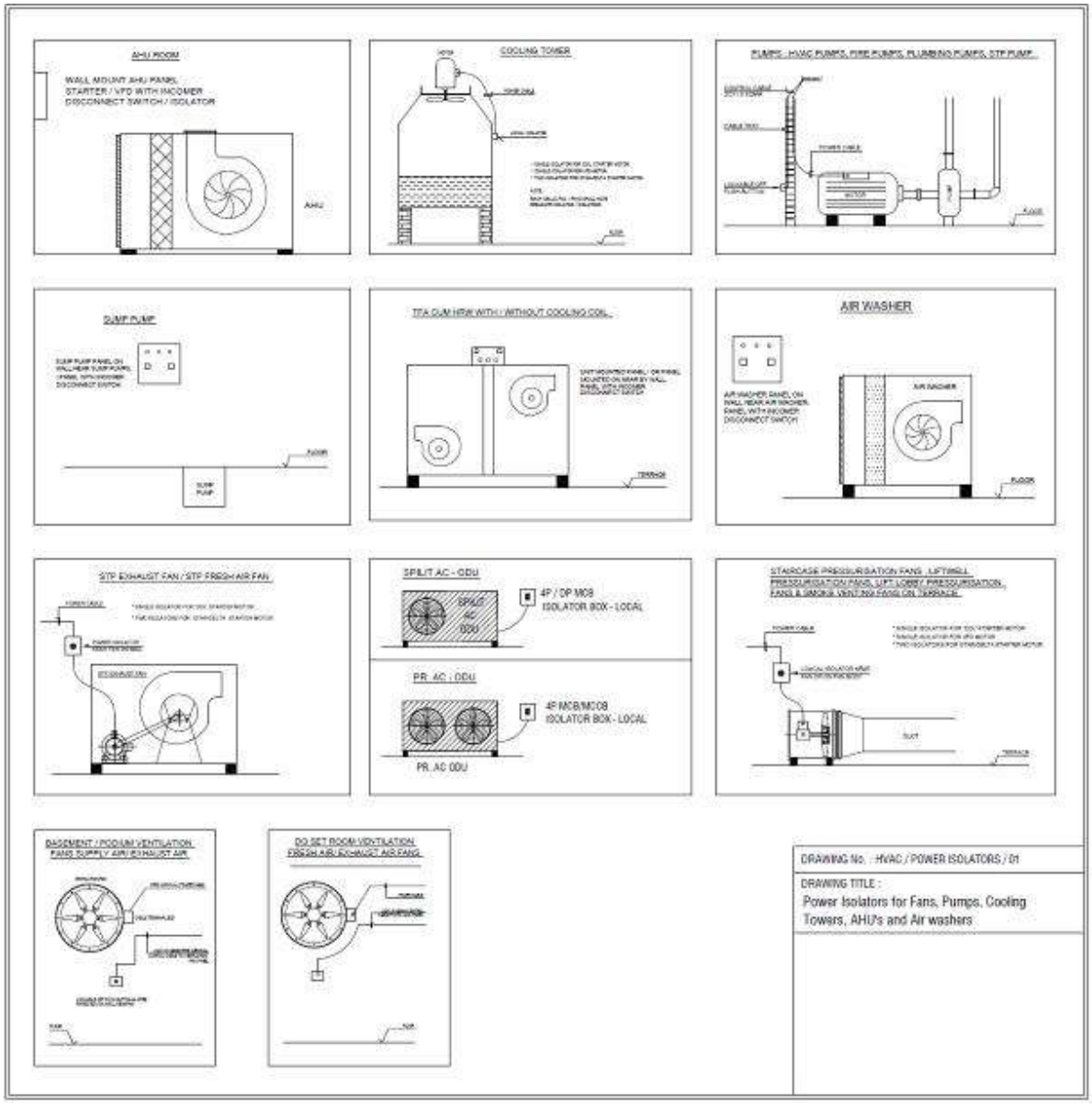

LOCAL ISOLATORS FOR
COOLING TOWER FAN MOTORS
VFD
DOL
Y/Δ
INSIDE PANEL
LOCAL TP ISOLATOR IN IP 55 BOX NEAR C. TOWER MOTOR
M
M
M
LOCAL ISOLATORS FOR
VRV & SPLITS - ODU's
MCB + ELCB IN IP 55 BOX NEAR ODU
VRV-ODU
IN DB/ PANEL
LOCAL DP OR 4P MCB ISOLATOR IN IP 55 BOX NEAR ODU
SPILT AC ODU

LOCAL ISOLATORS FOR
BASEMENT VENTILATION FANS / SMOKE VENTING FANS / CAR PARK VENTILATION / PODIUM VENTILATION / MCCB (WHERE FIRE RATED POWER CABLE ARE USED)



LOCAL ISOLATORS FOR
C.S.AHU 's / C.S. VENTILATION UNITS / TOILET EXHAUST VENTILATION UNIT PANTRY EXHAUST VENTILATION UNIT




AHU ROOM
WALL MOUNT AHU PANEL
STARTER / VFD WITH INCOMER
DISCONNECT SWITCH / ISOLATOR
AHU
COOLING TOWER
PUMPS - HVAC PUMPS, FIRE PUMPS, PLUMBING PUMPS, STP PUMP
SUMP PUMP
TFA DUM HRW WITH / WITHOUT COOLING COIL
AIR WASHER
STP EXHAUST FAN / STP FRESH AIR FAN
SPLIT AC - ODU
4P / DP MCB
ISOLATOR BOX - LOCAL
PR. AC : ODU
4P MCB/MCCB
ISOLATOR BOX - LOCAL
PR. AC ODU
STAIRCASE PRESSURISATION FANS, LIFTWELL PRESSURISATION FANS, LIFT LOBBY PRESSURISATION FANS & SMOKE VENT/AHJ FANS ON TERRACE
BASEMENT / PODIUM VENTILATION FANS SUPPLY AIR/EXHAUST AIR
DG SET ROOM VENTILATION FRESH AIR/EXHAUST AIR FANS
DRAWING No. : HVAC / POWER ISOLATORS / 01
DRAWING TITLE :
Power Isolators for Fans, Pumps, Cooling Towers, AHU's and Air washers

SUBHEAD-H. TESTING & COMMISSIONING

After completion of erection works before equipment is charged, the following minimum test shall be carried out. All tests shall be recorded in the format as approved by Architect/Consultant /PMC / Owner besides the test mentioned below any other tests specified by the local authority shall also be carried out. All tools and calibrated instruments for testing, labour, materials and incidentals necessary, to conduct the tests mentioned below shall be provided by the contractor at his own cost.

L.T. Switchgear & Distribution Boards.

Insulation resistance test of all the feeders by 500 V megger.

1. Test to Earth

This is made with all fuse links in place, all switches on and all lamps in position. The result must be not less than 50 megohms divided by number of outlets i.e., points and switch positions except that it need not exceed 1 megohm for the whole installations.

Control rheostats, heating and power appliances and electric signs may, if desired be disconnected for this test but if their insulation resistance must, in each case be not less than that given in the appropriate British Standard Specifications, or where there is no such specifications, be not less than half a megohm.

2. Test between Conductors

Where practicable, a test should be made between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or neutral or the other pole or phase conductors of the supply.

For this test, all lamps should be removed and all switches on. The result again must be 50 megohms divided by the number of outlets i.e., points and switch positions but need not exceed 1 megohm for the whole installation.

Continuity test of all breakers, MCCB and fuse switch units.

Earth continuity test between various non current carrying parts of equipment steel work et., and the earth bus provided in panels.

Operation of all meters and relays by secondary injection.

High voltage test 3 KV for 1 minute.

3. Cables

Insulation resistance test of all LT cables with 500 V megger.

Continuity test of all the cores and the armour.

Sheathing continuity test.

Earth test.

4. WIRING

4.1 Testing of Wiring

All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.

Testing of Earth Continuity Path

The earth continuity conductor, metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

4.2 Insulation resistance Test

The insulation resistance shall be measured by applying between earth and the whole system to conductors or any sections thereof with all fuses in place and all switches closed, and except in earthed concentric wiring all lamps in position or both poles or the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it need not exceed 500 V for medium voltage circuits. Where the supply is derived from the three wire DC or poly phase AC system, the neutral pole of which is connected to earth direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the phase conductor and the neutral.

The insulation resistance shall be measured between all conductors connected to one pole or phase conductor of all supply and all the conductors connected to the neutral or to the other pole or phase conductors of the supply with all lamps in position and switches in OFF position. The insulation resistance in mega ohm measured as above shall not be less than 50 mega ohm divided by the number of outlets or when PVC insulated cables are used for wiring 12.5 mega ohm divided by number of outlets.

4.3 Polarity test of switches

In two-wire installation, a test shall be made to verify that all switches in every circuit have been fitted in the same conductor throughout and such conductor shall be labelled or marked for connection to the phase conductor or to the non-earthed conductor.

In a three wire or a four-wire installation, test shall be made to verify that every non-linked single pole switch is fitted in a conductor, which is labelled or marked for connection to one of the phase conductor of the supply.

SUBHEAD-I. 24 VOLTS DC BATTERY CHARGER AND SEALED MAINTENANCE FREE BATTERIES

a. Scope:

This section covers supply, installation, testing and commissioning of Battery and Battery charger.

b. 24 volts DC battery:

12 volts each 180AH, (25 plates battery each) batteries comprising of 2 Nos. SMS (Sealed Maintenance Free) Lead Acid batteries.

i. Powder coated battery enclosure with rubber pads.

ii. Set of connectors with ends take-off suitable for connections.

c. Battery charger:

Battery float cum boost charger of continuous load current plus boost charge current & capable of achieving required specific gravity & suitable for charging batteries. The charger shall have following accessories:

i. 1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.

ii. Single phase double copper wound impregnated naturally air cooled mains transformer.

iii. 1 Set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at + 2% of time set value of AC input voltage variation of 230V±10%, frequency variation of ±5% from 50Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.

iv. 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.

v. 1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.

vi. 1 No. moving coil DC voltmeter to read the DC output voltage.

vii. 2 Sets potentiometer to adjust the output voltage during manual / auto float and boost modes.

viii. 1 No. double pole ON /OFF MCB for Charger Output (24V DC rating)

ix. 2 Sets DC output terminals. 1 set for the load and the other set for the battery.

Alarm annunciation: Visual and audible alarm with manual accept reset facility shall be provided for the following:

a. AC mains failure

b. Charger Failure

c. Load / Output over voltage

Rating:

AC Input	230±10% AC 50Hz single phase.
DC output	To float / boost charge 24V suitable rating batteries and also supply a continuous load.
Current Rating	As battery rating
Float Mode	27.0V nominal (adjustable) between 24-28.0V
Boost Mode	28.2V nominal (adjustable) between 24-29.0V
Voltage regulation	±2% for AC input variation of 230V ± 10%. Frequency variation of 50Hz±5% and DC load variation 0-100%
Ripple	Less than 5%

SUBHEAD-J. EXTERNAL & STRUCTURAL LIGHTNING PROTECTION SYSTEM AS PER INTERNATIONAL & NATIONAL STANDARDS- IS / IEC 62305-3/IS 3043

1.0 General

Lightning Protection System shall be in accordance with IS / IEC 62305-3 & IS 3043

2.0 Zone of Protection

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

3.0 LPL (Lightning Protection Level)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

LPL levels and probability of protection:

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

Components of External LPS

1.) Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
2.) Down conductor
3.) Earthing

3.1 Air termination system:

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.

Class of LPL/LPS	Rolling sphere radius(m)	Mesh size (m)	Protection angle
1	20	5*5	Refer figure 1
2	30	10*10	Refer figure 1
3	45	15*15	Refer figure 1
4	60	20*20	Refer figure 1

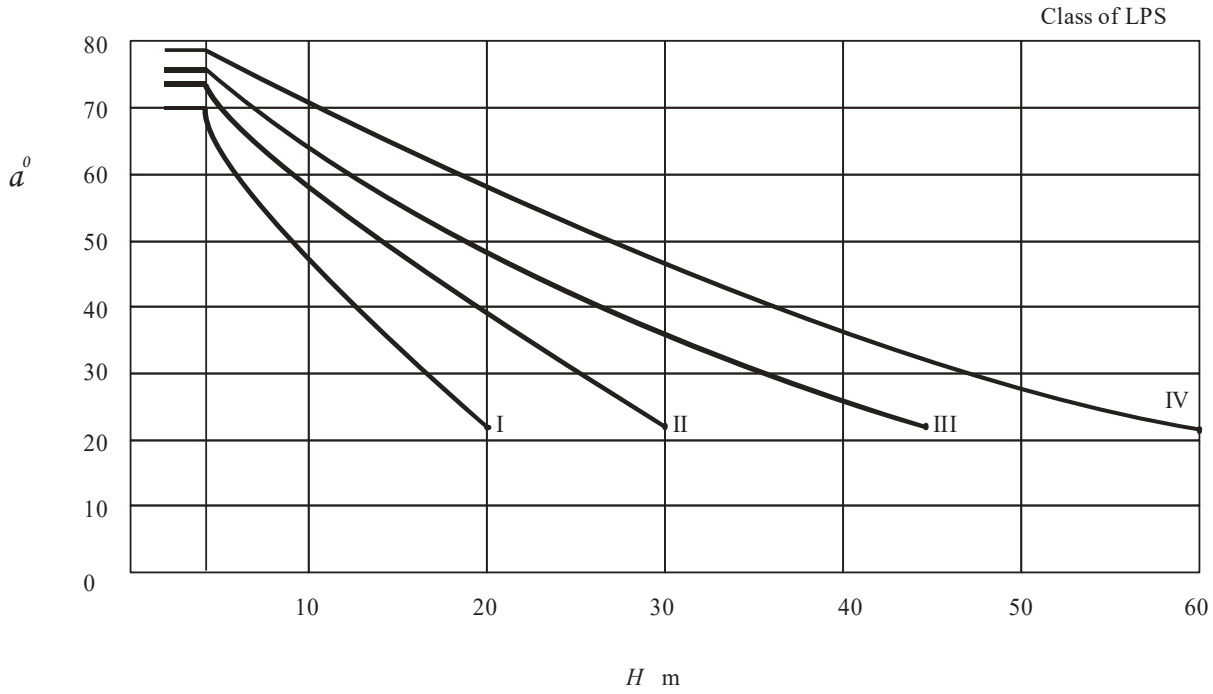


Fig 1. Class of LPS Vs Angle of protection.

If the structure height is more than 60 meters, top 20% of the height of the structure shall be protected with a lateral air termination system. This is needed because, the probability of flashes to the side is generally more for structures more than 60 meters in height.

3.1.1 Material and Dimensions

Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	May be destroyed by galvanic coupling with
Copper(Solid)	GI and Aluminium
Hot galvanized steel(Solid)	Copper
Stainless steel(Solid)	……
Aluminium(Solid)	Copper

Dissimilar metals (eg. Copper with GI) must be connected only by using bimetal connectors.

Minimum thickness of metal in air termination system for LPL /LPS

Material	Thickness (a) in mm	Thickness (b) in mm
Galvanized steel	4	0.5
Stainless steel	4	0.5
Copper	5	0.5
Aluminium	7	0.65

(a) Prevents puncture.

(b) Allowed only if **it is NOT important to prevent** puncture or water leakage.

Material, Configuration and Minimum cross sectional area of air terminal & down conductors

Material	Type	Minimum cross section area	Remarks
Copper	Solid tape	50 sq mm	2mm min thickness
Copper	Solid round	50 sq mm	8mm dia
Aluminum	Solid tape	70 sq mm	3 mm min thickness
Aluminium	Solid round	50 sq mm	8 mm dia
GI	Solid tape	50 sq mm	2.5 mm min thickness
Stainless steel	Solid tape	50 sq mm	2 mm min thickness

3.1.2 **Air terminal holder:**

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

3.1.3 Recommended distance between air terminal holders:

Arrangement	Recommended distance for SOLID TAPE	Recommended distance For ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

t the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

3.1.4 Safety or Separation distance:

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

3.1.5 Safety/Separation distance (S) in m = (ki * kc*L) / km

Coefficient ki depends on class of LPL/LPS
ki = 0.08 for LPL1,
ki = 0.06 for LPL 2,
ki = 0.04 for LPL3 and 4.

Coefficient kc depends on no of down conductors:
kc = 0.66 for 2 down conductors
kc = 0.44 for 3 or more down conductors

Value of coefficient km = 1

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

3.1.6 Expansion piece

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

3.1.7 Joints and Bonds

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

3.2 Down Conductor System

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum**.** Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure as a minimum.

Value of distance between down conductors as per Class of LPL / LPS

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

The Reinforcing rod of walls or Steel Structure frame may be used as natural Down conductor. A termination Joint of Suitable material should be provided on the roof to facilitate the connection of Air termination System. Termination Joints of Suitable material should be provided to facilitate the termination with the Earth Termination System.

While using a Particular rod of Reinforcement Steel as a Down Conductor; it should be taken in consideration that same rod should be used all the way down to provide the direct electrical Continuity.

If, while providing the straight path all the way down is not possible or Electrical continuity is not sure; Additional dedicated conductor should be used with Less number of joints. These additional conductors should be clamped to reinforcement Steel at proper distance (preferably 1-2 meter) with suitable clamp which can withstand the Lightning Current.

3.2.1 Test joints:

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

3.2.2 Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level.
The resistance of earthing system shall not exceed 10 ohm as per IEC 62305.
Lower earth resistance is more preferable.

For earth termination system, 2 basic types of earth electrode arrangements are applicable.
Type A & Type B arrangement.

Type A arrangement: Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type A arrangement, the total number of earth electrodes shall not be less than two.

Type A arrangement is suitable in places where electronic equipment are not located.

Type B arrangement: This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection.

In potentially corrosive areas, Stainless steel must be used.

The reinforcement rod of the foundation & the buried wall can be used as foundation Earth Electrode. This is the good earthing Solution at minimum cost. In addition to the interconnection of the reinforcing rod by wire lashing, the installation of additional meshed metal network to ensure good joint is recommended. This additional meshed metal network should be clamped with reinforcement steel with suitable metal of clamp confirming to IEC 62561/ tested for lightning Current. All connection clamp/joints shall have the ability to carry the lightning Current.

Earth Fixing Point or terminal to connect external down conductor should be taken out with suitable material to avoid the corrosion in case of dissimilar material.

3.2.3 **References:**

IS / IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles

Part 2: Risk Management
Part 3: Protection of structures
Part 4: Protection of Electrical & Electronic equipment within structure

IS3043: 1987: Code of practice for Earthing.

SUBHEAD-K. INTELLIGENT, ADDRESSABLE AND MONITORED EMERGENCY AND EXIT LUMINAIRES USING CENTRAL BATTERY SYSTEM

1. GENERAL

1.1 RELATED DOCUMENTS

a. Drawings.
b. General Provisions for Electrical Work to work of this section.

1.2 DESCRIPTION OF WORK

a. Supply, installation, testing, commissioning and maintenance during warrantee period of the central battery emergency lighting system as specified hereafter, as indicated in the relevant electrical system drawing.

b. Work includes providing all materials, equipment, accessories, services, tests and commissioning necessary to complete and make ready for operation central battery system in accordance with Drawings and Specifications.

c. The Emergency lighting system and all its components shall be designed and installed to meet the local Civil Defence requirements and fire and life safety code of practice & the respective EN 50172 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards applicable to this project.

d. Emergency lighting shall fulfill the following functions:

- Illuminate the escape routes.
- Indicate the escape route direction clearly
- Provide Exit signs on all Exits
- Ensure fire alarm call points, firefighting equipment and other lifesaving equipment on the premises are illuminated during Power failure period of time.
- Permit operations concerned with safety measures & to shut down the hazardous process.

1.3 QUALITY ASSURANCE

a. The contractor shall show evidence that the central battery system maintains a fully equipped service organization capable of furnishing adequate maintenance of the installed system. He shall be prepared to offer a service for the maintenance of the system after the guarantee period.

b. All products used in the system shall be manufactured by an ISO 9001 & ISO 14001 certified company, complying with the relevant standards and shall bear the CE certification for Electro-Magnetic compatibility.

1.4 SUBMITTALS

a. Shopdrawings: Indicating wiring diagrams and interconnections diagrams.

b. Product Data for each item of equipment; show specified ratings, feature, finishes, and physical dimensions.

c. Manufacturer's Installation Instruction: Indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 EQUIPMENT WARRANTY

Guarantee equipment furnished under these specifications against defective parts and workmanship under terms of the manufacturer's and dealer's standard warranties for a period of not less than one year from date of testing and commissioning or 18 months from date of delivery.

2. PRODUCTS

2.1 GENERAL

The central battery system and associated addressable luminaires will cover the Exit luminaires as detailed in the drawing and specifications. The system distribution shall be DC. The Central Battery Panels will be of modular nature for the ease of maintenance and reduced downtime.

2.2 CENTRAL BATTERY PANEL

a. Characteristics

- Each central emergency battery supply panels shall be used for supply, automatic testing and monitoring of minimum 30 no. EXIT and safety luminaries in each circuit.

- Each panel shall have a capacity of catering a minimum of 720 luminaires or as per the load distribution of the panel respectively.

- Panels shall be located inside electrical rooms and a trunking shall be provided inside electrical room as a riser to enable connection of panels located in different floors.

- Panel Shall have self learning feature which allows automatic update of new lights after new lamps are installed

- The panel shall have following electrical characteristics:

Input Voltage	:	220-240 AC 1Ph or 3 Ph
Output mains	:	220-240 V AC
Output Emergency	:	216 V DC
Emergency Duration	:	90 Minutes

- The number of emergency lighting system panels shall be appropriately decided for maximum reliability to ensure continued emergency supply and failure of one panel shall not result in total emergency lighting supply failure for the entire building. The system architecture should be of distributed battery type with each panel having its own dedicated battery charger and other accessories.

- System should consist of all main central battery panels with their own dedicated batteries and chargers respectively. Failure of one charger should not result in failure of the entire system. Sub panels being fed from main panels is not allowed. Separate power cables running from the main panels to sub panels is stricltly not allowed.
- Exit Lights & the Central Battery panels should be manufactured and supplied under the same brand name preferably from the north Europen region. All the components of the central battery system including light fittings and accessories should be supplied by a single manufacturer to ensure full compatibility.
- The system topology should consist of distributed panels with dedicated batteries, re chargers, boosters, changeover modules, complete monitoring in every panel. The distributed panels should be networkable over RS485 bus. The distributed Central battery panels should be modular. The batteries should not be located in a central room but should be distributed & dedicated to each panel.

- The manufacturer should have more than 40 years of experience manufacturing Central Battery Emergency Lighting System under the same brand name.
- The system supplier shall be authorized distributor of the equipment, maintaining a local staff of factory-trained personnel for Engineering assistance, installation and maintenance of such equipment in compliance with the requirements of the above mentioned EN standards and should have an authorization letter from the manufacturer for this project.
- Use of ELDB for power distribution to emergency lights is strictly not permitted
- Data and power shall be carried by a single fire survival CWZ category cable. The central battery panel shall be able to supply power and data all by itself. Use of separate panels such as easy check panels for data monitoring shall not be permitted.

b. Mechanical Construction

- The panel enclosure shall be made of sheet steel housing IP20 with separate rack or enclosures for batteries to maintain the safety distance of the battery according to EN50272-2. Panel shall be suitable for surface wall mounting. Panel shall have a screw fitted front door of lift away type, with front facia for status indication.
- Batteries to be mounted on suitable rack/ enclosure for easy maintenance of the batteries.
- The electronic compartment shall have large cabling compartment with cable entries from top with four or more undrilled removable metal flange plates. All incoming cables and looping circuits shall be connected on protected and fused terminals as per ENVDE0100.

c. Electrical Construction

- Changeover Module

  System shall be built up in a modular format. Each changeover module shall have 8 outputs of 250/350W. It shall be possible to connect each output circuit as maintained or non-maintained without any programming required. Changeover module shall have integrated transceiver circuit, which allows up to 32 addressable luminaires in each circuit depending upon wattage of each luminaire. Each changeover module communicates with the control module through the internal data bus. All out going circuit shall be protected with independent fuses. The unit shall not have a floating DC circuit and shall not require separate changeover relays for both L/DC(+) and N/DC(-).

- Battery Charger

  Charger module shall be controlled by the micro processor of the control module. There shall be automatic boost charge, cyclic charge and trickle charge facility for full battery capacity use and maximum battery life. The charger shall have built-in deep discharge protection for long battery life. The supply is taken from the batteries as long as mains supply failure persisits or battery voltage drops to deep discharge level of 175V. There shall be a DIP-switch for setting the maximum charging current, according to the battery capacity. Batteries shall have dedicated charger unit for each control panel.

  The system shall have temperature sensor at the battery for automatic charging voltage adjustment. Fuse protection shall be provided.

d. Central Module

- Control Module shall have the following LED indications:

i. Mains Operation,
ii. Battery Operation,
iii. Battery Overvoltage,
iv. Battery Under voltage,

v. Deep Discharge,
vi. Recharge,
vii. Current Limit,
viii. Battery Fault,
ix. Earth Leakage,
x. Internal Fault

- The emergency supply panel shall supervise the battery status such as Battery Over voltage / Battery Under voltage. Charging failure shall be indicated as an Internal fault by an indicator LED and potential free relay contact.

e. Control Module

- There shall be an own LED indicator for each luminaire in the same circuit providing simultaneous status information of the luminaires by a single view with corresponding group (circuit) number indicating on the segment display. The Control Module shall also have a Liquid Crystal Display (LCD) for the simultaneous display of the system status, faults and Luminaire status. Any modification such as extra data cabling in the system design due to use of non OEM products is not allowed.

- Control Module shall have the following Volt free contact:

i. Internal Fault
ii. Battery mode operation
iii. External Fault

- Control Module shall have the following Fault Indicator:

i. Internal Fault
ii. External Fault
iii. Fuse Fault
iv. Local Controller Alarm

- The control module of the panel shall have three main functions:

i. monitor and control all test cycles and functions.
ii. Indicate every status of the system and the connected luminaire
iii. communicate with the addressable electronic ballast on every luminaire.

- The emergency supply panel should be capable of continuously monitoring the circuits by means of current measurement thus making the system a continuously fully addressable system.
- The unit shall be fitted with a deep discharge protection circuit, which has two operation phases: When in battery mode the battery voltage decreases to 195V, a preliminary deep discharge alarm shall be given. When the battery voltage decreases to 175V, the load shall be disconnected. The circuit shall allow the battery to increase its voltage without switching the load ON again, thus avoiding detrimental full discharge. The panel shall automatically return to normal operation, once the mains supply recovers.

f. Central monitoring:

Each panel shall have web server capability for the entire emergency and exit lighting system to be controlled and monitored from a single point using the web browser on a standard personal computer. The system shall have capability to send email alerts to predefined email IDs.

Following functions shall be done by using the Central monitoring PC:

- Luminaire test of emergency supply panel.
- Battery test of emergency supply panel.

The panel shall also have an option for integration over BACNET/IP and MODBUS/IP to any BMS System.

The Gateway shall have the following specifications:

- Inbuilt Web Server
- Integrates with 3rd party BMS over BACNET/IP or MODBUS/IP
- Processor Speed: 1GHz
- Memory: 1GB DDR3 SDRAM
- 2 Nos. of 10/100MB Ethernet ports
- Real time clock
- Batteryless
- 24VAC/DC power supply
- BTL Listed
- Operating temperature: -20–60°C
- Storage temperature: -40–85°C
- Humidity: 5%–95% — Non condensing
- MTTF: 10 years+

2.3 EMERGENCY & EXIT LUMINAIRE

All luminaries shall meet following requirements:

- LED type with maximum input power not exceeding 10.5Watts.
- Supply voltage 220V/240V AC/DC
- The luminaire shall comply the requirements of EN60594
- Electronic ballast shall comply the requirements of EN60298/60294
- EMC or EMI protection to EN55015
- Exit lights shall be maintained type luminaire
- Minimum viewing distance 25 meters for Exit luminaires
- Shall be built according to EN60598-2-22
- Shall have Constant power output high frequency electronic control gear
- All exit luminaire shall be powered from central battery unit
- The luminaire shall have sheet steel or plastic polycarbonate housing
- EMC protection according to EN 55015
- Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
- Backup for 90 Minutes operation via Central Battery System

- Emergency luminaires shall be non-maintained type slave luminaires with long life and high efficiency LED light source and self-testing addressable electronics, which can communicate with central control module. LEDs shall be of surface mounted type with proper heat sink. It is not allowed to use free standing LEDs where the heat is conducted only through the connection leads. Electronics shall supply the LED(s) with constant current, which shall be regulated against supply voltage variations. With the constant current power supply feature, the light output should be maintained more than 90% till the end of 90 minutes battery backup. All electronics for the Emergency and Exit luminaires shall be manufactured by the emergency lighting system manufacturer. The indication of the correct operation shall rely on the actual light output of the LED(s), so that an excessive degradation of the light output is also detected. Manufacturer

is demanded to show a proof that the specified light output levels are maintained for minimum of 7 years. It shall be possible to connect both maintained and non-maintained luminaires to the same output circuit.

- All exit lights should be located on a single cable. A single 2 core + E fire rated cable with 1.5 sq mm thickness should be used. Separate cable for data will not be allowed.
- The supply connector shall be arranged to provide a possibility for both ingoing and outgoing cable to enable looped cabling between the luminaires without separate junction boxes.

Corridor Areas/ Offices / Lounge/ Waiting areas emergency luminaire

- Fully recessed, addressable and monitored LED luminaire - suitable for Offices/ Corridor Areas emergency luminaires:
  - Recessed Mounted luminaire with polycarbonate body
  - Ingress protection IP20
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

- Fully Surfaced, addressable and monitored LED luminaire - suitable for Staircases/ Parking Areas emergency luminaires:
  - Surface Mounted luminaire with polycarbonate body
  - Ingress protection IP65
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

Corridor Areas/ Offices / Lounge/ Waiting areas exit luminaire

- Single/ Double SIDED WALL/SURFACE mounting, addressable and monitored, EXIT Luminaire, High power LED 230VAC/DC luminaire:
  - Viewing distance up to 25m
  - Ingress protection IP44
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

2.4 BATTERIES

- The batteries shall be Ni-Cd type and shall be sized to power complete system for 90 minutes following mains failure at 100% light output of all emergency lamps.
- The batteries must be housed in an suitable rack.
- Separate battery rack must be provided for every bank of batteries and every CBS panel.

2.5 INSPECTION

- Examine areas and conditions under which the system are to be installed and notify in writing of conditions detrimental to proper completion of the work.

2.6 INSTALLATION

- Install the system, including associated control devices as indicated, in accordance with manufacturer's written instructions, requirements of applicable standards, and in accordance with recognized industry practices to ensure that installation complies with requirements and serves intended function.
- Coordinate with other work as necessary to interface installation of the system work with other work.
- Anchor mounting hardware firmly to walls, floors, or ceilings, to ensure enclosures are permanently and mechanically secured. Provide all accessories for proper mounting.
- The emergency light shall be connected such that in case of power failure in any of the area, the emergency light installed in that area shall be energized.
- All of the system installation work shall be supervised by the specialist supplier. However, the necessary containment and electrical power to support the emergency lighting system shall be the responsibility of the MEP Contractor.
- The central battery system shall integrate with other building systems as follows:

- Fire Alarm System
  The central battery system shall interface with the fire alarm system with hardwired integration
- Building Management System
  The central battery system shall interface with the building management system/ SCADA with hardwired integration and shall have option to integrate via BACNET/IP for software integration. Protocols other than BACNET/IP are not acceptable.

2.7 FIELD QUALITY CONTROL

- Upon completion of installation and after the equipments have been energized, demonstrate capability and compliance of the system with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

2.8 PERSONNEL TRAINING

- Building Operating Personnel Training: Train Owner's building personnel in procedures for starting up, testing and operating the system.

SUBHEAD-L. SOLAR PV SYSTEM

APPLICABLE STANDARDS - BALANCE OF SYSTEM (BOS) ITEMS/ COMPONENTS:

The BOS items / components of the SPV power plants/ systems deployed under the Mission must conform to the latest edition of IEC/ E equivalent BIS Standards/ MNRE specifications / as specified below:

BOS Item / System	Applicable BIS /Equivalent IEC Standard Or MNRE Specifications

Solar PV Lighting Systems:	Solar PV Home Lighting System Solar PV street Lighting System Solar PV Lantern	As per MNRE latest Specifications dated 09.09.2011
Charge Controller/MPPT Units	Environmental Testing	IEC 60068-2 (1,2,14,30) / Equivalent BIS Std.
Power Conditioners/ Inverters** including MPPT and Protections	Efficiency Measurements Environmental Testing	IEC 61683 / IS 61683 IEC 60068-2 (1, 2, 14, 30) / Equivalent BIS Std.
Storage Batteries	General Requirements & Methods of Testing Tubular Lead Acid / VRLA / GEL Capacity Test Charge/ Discharge Efficiency Self-Discharge	As per relevant BIS Std.
Cables	General Test and Measuring Method PVC insulated cables for working voltage up to and including 1100 V and UV resistant for outdoor installation	IEC 60227 / IS 694 IEC 60502 / IS 1554 (Pt. I & II)
Switches/Circuit Breakers /Connectors	General Requirements Connectors –safety A.C. /D.C.	IEC 60947 part I,II, III / IS 60947 Part I,II,III **EN 50521**
Junction Boxes / Enclosures for Inverters/ Charge Controllers / Luminaries	General Requirements	IP 54(for outdoor)/ IP 21(for indoor) as per IEC 529

Note: **In case if the Charge controller is in-built in the inverter, no separate IEC 62093 test is required and must additionally conform to the relevant national/international Electrical Safety Standards wherever applicable

A. SOLAR PV SYSTEM SHALL CONSIST OF FOLLOWING EQUIPMENTS:

1. Solar PV modules consisting of required number of PV cells.
2. Grid Tied Inverters having with SCADA / real time data monitoring over wifi.
3. Modules Mounting structures with SS-304 grade assembly hardware.
4. AC & DC Cables, Array Junction box and AC Combiner Panel / Distribution boxes.
5. Earthing kits and Lightning arrestors.
6. PVC pipes and accessories.
7. Earthing wires and strips.
8. Anchor Fastening with Chemical to avoid any Water leakage, Hardware, Civil foundation.

B. SOLAR PANELS:

The photovoltaic modules should be 60 / 70 / 72 Cells and dual glass, High Efficiency Panels >20.5% Mono / Multi Crystalline with a total under STC. The Photovoltaic modules must be qualified as per IEC 61215 standards and in addition, the modules must conform to IEC 61730-1 requirements for construction & Part-2 requirements for testing, for safety qualification. The supplier shall provide performance guarantee for

the PV modules used in the power plant must be warranted for their output peak watt capacity which should not be less than 90% at the end of 10 years and 80% at the end of 25 year. Each Solar Panel shall be equal to as per requirement.

C. SOLAR GRID INVERTER:

- The solar grid inverter converts the DC power of the solar PV modules to grid-compatible AC power. The detailed specifications of the solar grid inverter are given below.
- Total output power (AC) To match solar PV plant capacity while achieving optimum system efficiency Input DC voltage range As required for the solar grid inverter DC input.
- Dual Maximum power point (MPPT) tracking Shall be incorporated Number of independent MPPT inputs 1 or more Operation AC voltage Single phase 230V or Three phase 415V (+ 12.5%, -20%) Operating Frequency range 47.5 – 52.5 Hz Nominal frequency 50 Hz Power factor of the inverter >0.98 at nominal power Total harmonic distortion Less than 3% Built-in Protection AC high / low voltage; AC high /low frequency Anti-islanding protection As per VDE 0126-1-1, IEC 60255.5 / IEC 60255.27 Operating ambient temperature range -10 oC - +60 oC Humidity 0 – 95% RH. Real Time generation and past generation data should be monitored on cloud-based application in Smart phone / Laptop / Desktop.
- Inverter efficiency >98%
- Protection degree IP 65
- Warranty: 10 years extendable to 25 years

D. MOUNTING STRUCTURE ARRANGEMENT:

The Structure shall be designed for Wind velocity withstanding capacity 150 km / hour. Structure material shall be Hot dip galvanized steel with a minimum galvanization thickness of 80 microns. Bolts, nuts, fasteners, panel mounting clamps shall be of Stainless steel SS-304 grade fasteners. Mounting arrangement for RCC-flat roofs shall be by using Chemical based anchor fastening method.

The structure has to be securely anchored to the supporting surface through Chemical anchor fastening. Concrete foundations of appropriate weight and depth for elevated / Standard Height structures mounted directly on the ground; Bolted with anchor bolts of appropriate strength for elevated structures mounted on RCC surfaces. Minimum distance between roof edge and mounting structure should be 500mm in case of standard height structure. STAAD report shall be submitted for approval for the designed wind speed of 150kmph along with the layout, GA, Side view drawings.
All MMS Structures shall be properly earthed through GI earthing strip of suitable size in independent pits with redundant earthing circuit.

E. CABLES:

All cables shall be supplied conforming to IEC 60227/ IS 694 & IEC 60502/ IS 1554. Voltage rating: 1,100V AC, 1,500V DC. For the DC cabling, UV Protected XLPO Cable should be used, UV stabilized single core flexible copper cables shall be used. Multi-core cables shall not be used. For the AC cabling, PVC or XLPE insulated and PVC sheathed single or multi-core flexible copper cables shall be used between Inverters and ACDB or AC Combiner Panel. Outdoor AC cables shall have a UV-stabilized outer sheath, one or more runs of 3.5C XLPE 1100V AC of required size AC Power cable between ACDB / AC Combiner Panel to Main LT Panel Solar Power evacuation feeder shall be used. The total voltage drop on the cable segments from the solar PV modules to the solar grid inverter shall not exceed 2.0%. The total voltage drop on the cable

segments from the solar grid inverter to the building distribution board shall not exceed 2.0%. Cables and wires used for the interconnection of solar PV modules shall be provided with solar PV connectors (MC4) and couplers. All DC Cables between PV modules strings to Inverters shall be taken through the PVC Conduit of required size with necessary Junctions and L bends. DC Cabling Conduit routing shall be decided in such a way that it shouldn't cross the walkways and must not submerged in rain water.

F. DC COMBINER BOX:

A DC Combiner Box shall be used to combine the DC cables of the solar module arrays with DC fuse protection for the outgoing DC cable(s) to the DC Distribution Box, in case it is not inbuilt in the Inverters.

DC Distribution Box DC distribution box shall be mounted close to the solar grid inverter. The DC distribution box shall be of the thermo-plastic IP65 DIN-rail mounting type and shall comprise the following components and cable terminations: − Incoming positive and negative DC cables from the DC Combiner Box; − DC circuit breaker, 2 pole (the cables from the DC Combiner Box will be connected to this circuit breaker on the incoming side); − DC surge protection device (SPD), class 2 as per IEC 60364-5-53; − Outgoing positive and negative DC cables to the solar grid inverter. As an alternative to the DC circuit breaker a DC isolator may be used inside the DC Distribution Box or in a separate external thermoplastic IP 65 enclosure adjacent to the DC Distribution Box. If a DC isolator is used instead of a DC circuit breaker, a DC fuse shall be installed inside the DC Distribution Box to protect the DC cable that runs from the DC Distribution Box to the Solar Grid Inverter.

G. ACDB (AC DISTRIBUTION BOX) / ACCB (AC COMBINER BOX)

An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of IP:54/55 Single/double door Indoor/Outdoor application made with 2mm CRCA powder coated Panel. Type and shall comprise the following components and cable terminations: − Incoming 4-core (three-phase) cable from the solar grid inverters – AC 4P MCB/MCCB with KWH Meter with CTs, Ph Ind. Lamps, On/Off Lamps, I/C qty equal to the no of Inverters, O/G MCCB feeder of suitable rating for terminating the AC Power evacuation cable, 4-pole − AC surge protection device (SPD), class 2 as per IEC 60364-5-53 − Outgoing cable to the building electrical distribution board.

H. EARTHING:

Maintenance Free Earthing System consisting of 1 Nos. CPRI tested 'UL' Listed copper bonded carbon steel core electrode of 25 mm dia each With a minimum coating thickness of 250 microns and length of 3 meters. 25 kgs/Electrode or more as required of earth enhancing compound needs to be considered to fill the 100mm augered hole surrounding to the electrode.

I. LIGHTNING ARRESTORS:

ESE (Early Steamer Emmission) Type Air Terminal Lightning Arrestor Level-1 with the covering radius of complete Solar Plant, made with minimum SS304 grade suitable for corrosive environment, tested and certified as per NF C17-102(2011) Standard having triggering time deltaT not more than 15 sec, with down conductor of minimum 70sqmm Cu Cable PV Insulated, warranted for minimum 20years, UL certified, supported with steel guy wire, mounted on GI mast pole at suitable location and height. LA shadow must not fall on the PV Modules.

J. IDENTIFICATION AND TRACEABILITY:

Each PV module must use a RF identification tag (RFID), which must contain the following information:

(i) Name of the manufacturer of PV Module

(ii) Name of the Manufacturer of Solar cells

(iii) Month and year of the manufacture (separately for solar cells and module)
(iv) Country of origin (separately for solar cells and module)
(v) I-V curve for the module
(vi) Peak Wattage, Im, Vm and FF for the module
(vii) Unique Serial No and Model No of the module
(viii) Date and year of obtaining IEC PV module qualification certificate
(ix) Name of the test lab issuing IEC certificate
(x) Other relevant information on traceability of solar cells and module as per ISO 9000 series.

K. AUTHORIZED TESTING LABORATORIES/ CENTERS:

PV modules must qualify (enclose test reports/ certificate from IEC/NABL accredited laboratory) as per relevant IEC standard. Additionally the performance of PV modules at STC conditions must be tested and approved by one of the IEC / NABL Accredited Testing Laboratories including Solar Energy Centre. For small capacity PV modules upto 50Wp capacity STC performance as above will be sufficient. However, qualification certificate from IEC/NABL accredited laboratory as per relevant standard for any of the higher wattage regular module should be accompanied with the STC report/ certificate.

Details of Test Labs: Beyond 10KVA self-certification by the manufactures is acceptable.
While applying for Testing, the Manufacturer has to give the following details:

- A copy of registration of the company particularly for the relevant product/ component/ PV system to be tested.
- An adequate proof from the manufacturer, actually showing that they are manufacturing product by way production, testing and other facilities.
- Certification as per JNNSM standards for other bought out items used in the system
- Without above proof test centers are advised not to accept the samples.

SUBHEAD-M. EXTERNAL & STRUCTURAL LIGHTNING PROTECTION SYSTEM
AS PER INTERNATIONAL & NATIONAL STANDARDS- IS / IEC 62305-3/IS 3043

1.0 General

Lightning Protection System shall be in accordance with IS / IEC 62305-3 & IS 3043

2.0 Zone of Protection

The zone of protection of a lightning conductor defines the space within which Air Terminal provides protection against a direct lightning strike with probability of protection as per LPL.

3.0 LPL (Lightning Protection Level)

LPL is a number associated with a set of lightning current parameters relevant to the probability that the associated minimum & maximum values do not exceed the normally occurring lightning. LPL can be determined by Risk analysis as explained in IS / IEC 62305-2.

LPL levels and probability of protection:

Lightning protection Class	Lightning current peak value MINIMUM	Lightning current peak value MAXIMUM	Interception probability
LPL 1:	3 kA	200 kA	98%
LPL 2:	5 kA	150 kA	95%
LPL 3:	10 kA	100 kA	88%
LPL 4:	16 kA	100 kA	81%

Components of External LPS

1.) Air terminal (as per rolling sphere or mesh or protective angle method or any combination thereof.)
2.) Down conductor
3.) Earthing

4.0 Air termination system:

No drilling is allowed in the terrace for fixing the air terminal, if the roof is made of concrete. Parapet wall is exception to this.

Values of Rolling sphere radius, Mesh size and protection angle as per Class of LPL/LPS.

Class of LPL/LPS	Rolling sphere radius(m)	Mesh size (m)	Protection angle
1	20	5*5	Refer figure 1
2	30	10*10	Refer figure 1
3	45	15*15	Refer figure 1
4	60	20*20	Refer figure 1

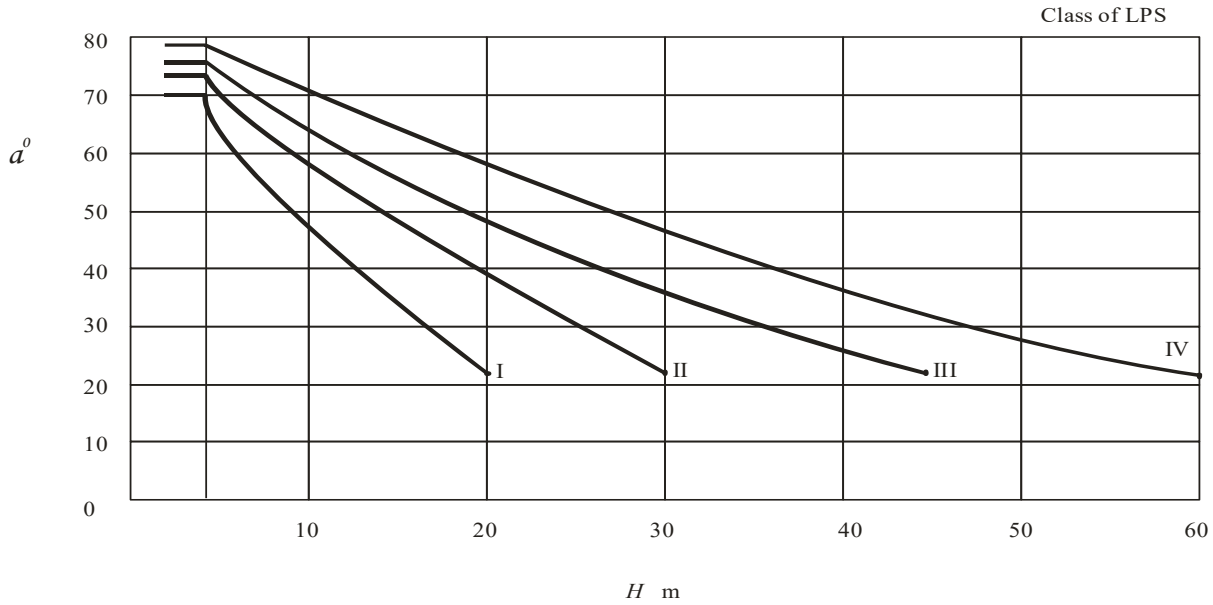


Fig 1. Class of LPS Vs Angle of protection.

If the structure height is more than 60 meters, top 20% of the height of the structure shall be protected with a lateral air termination system. This is needed because, the probability of flashes to the side is generally more for structures more than 60 meters in height.

5.0 Material and Dimensions

Material of air terminal, down conductor, earth termination etc. shall be as below:

Material	**May be destroyed by galvanic coupling with**
Copper(Solid)	GI and Aluminium
Hot galvanized steel(Solid)	Copper
Stainless steel(Solid)	……
Aluminium(Solid)	Copper

Dissimilar metals (eg. Copper with GI) must be connected only by using bimetal connectors.

Minimum thickness of metal in air termination system for LPL /LPS

Material	**Thickness (a) in mm**	**Thickness (b) in mm**
Galvanized steel	4	0.5
Stainless steel	4	0.5
Copper	5	0.5
Aluminium	7	0.65

(c) Prevents puncture.

(d) Allowed only if **it is NOT important to prevent** puncture or water leakage.

Material, Configuration and Minimum cross sectional area of air terminal & down conductors

Material	Type	Minimum cross section area	Remarks
Copper	Solid tape	50 sq mm	2mm min thickness
Copper	Solid round	50 sq mm	8mm dia
Aluminum	Solid tape	70 sq mm	3 mm min thickness
Aluminium	Solid round	50 sq mm	8 mm dia
GI	Solid tape	50 sq mm	2.5 mm min thickness
Stainless steel	Solid tape	50 sq mm	2 mm min thickness

6.0 Air terminal holder:

Concrete Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by adhesive of good quality taking care of varying weather conditions. Air conductor holder is an insulator & should be of minimum 50 mm height so that even small amount of water logging on terrace is below the level of conductor holder.

Metal Roof structure: Conductors shall be securely fixed on the terrace by means of air terminal holder which is fixed on the roof by metal conductor holder of good quality which is tested for lightning current as per IEC standard. Vendor need to give proof. As metal roof structures are normally tapered at an angle, there is no min. height criteria for metal conductor holder.

7.0 Recommended distance between air terminal holders:

Arrangement	Recommended distance for SOLID TAPE	Recommended distance For ROUND conductors
Horizontal conductor on horizontal surface	500 mm	1000 mm
Horizontal conductor on vertical surface	500 mm	1000 mm
Vertical conductor from Ground to 20m height	1000 mm	1000 mm
Vertical conductor above 20m height	500 mm	1000 mm

If antenna, air cooler or any other electrical equipment is present above terrace level, the same have to be protected by using vertical air terminal after calculating the safety or separation distance. The vertical air terminal has to have suitable supports to hold it. Wind speed need to be taken into account. Vertical air terminal must be connected to horizontal air terminal by using suitable connectors.

t the crossings of the horizontal air terminals, suitable Cross connector has to be used for secure connection which is tested for lightning current as per IEC standard. Vendor has to provide proof.

8.0 Safety or Separation distance:

It is must to calculate safety or separation distance in order to avoid flash over to the electrical equipment when the lightning current is passing through the vertical air terminal.

9.0 Safety/Separation distance (S) in m = (ki * kc*L) / km

Coefficient ki depends on class of LPL/LPS

ki = 0.08 for LPL1,
ki = 0.06 for LPL 2,
ki = 0.04 for LPL3 and 4.

Coefficient kc depends on no of down conductors:

kc = 0.66 for 2 down conductors
kc = 0.44 for 3 or more down conductors

Value of coefficient km = 1

Value of L is the total distance between the equipment to be protected (for e.g. Antenna) to the equi-potential bonding bar situated just above the ground.

10.0 Expansion piece

In order to take care the expansion of the metal in summer and contraction of the metal in winter, expansion piece with suitable connectors have to be used at every 20m distance of horizontal air terminal.

11.0 Joints and Bonds

The lightning protective system shall have few joints as far as possible & air terminal & down conductor have to be straight. Where it is not possible, it should NOT be bent at 90 degree (right angles) & should have a curved path of 45 degree bend.

12.0 Down Conductor System

In order to reduce the probability of damage to electronic/electrical equipment, the down conductors shall be arranged in equi distance in such a way that from the point of strike to earth, several parallel current paths should exist & length of the current path should be minimum**.** Down conductors can be installed separately or more wisely it can be part of natural components of the building. Examples are steel reinforcement in RCC columns, metal facades, profile rails, metal doors & windows. Down conductors should be installed at each exposed corner of the structure as a minimum.

Value of distance between down conductors as per Class of LPL / LPS

Class of LPL/LPS	Typical distance (m)
1	10
2	10
3	15
4	20

The Reinforcing rod of walls or Steel Structure frame may be used as natural Down conductor. A termination Joint of Suitable material should be provided on the roof to facilitate the connection of Air termination

System. Termination Joints of Suitable material should be provided to facilitate the termination with the Earth Termination System.

While using a Particular rod of Reinforcement Steel as a Down Conductor; it should be taken in consideration that same rod should be used all the way down to provide the direct electrical Continuity.

If, while providing the straight path all the way down is not possible or Electrical continuity is not sure; Additional dedicated conductor should be used with Less number of joints. These additional conductors should be clamped to reinforcement Steel at proper distance (preferably 1-2 meter) with suitable clamp which can withstand the Lightning Current.

13.0 Test joints:

At the connection of the earth terminal, a test joint should be fitted on each down conductor at a height of 1 m from the ground, except in the case of natural down conductors combined with foundation earth electrode. The purpose of test joint is to measure the earth resistance value. The remaining portion of down conductor (i.e., after the test joint should be mounted inside a plastic pipe of minimum 3 mm thickness.)

14.0 Earth Terminations

Earth mat is most preferable. Where earth mat is not possible, ring earthing is the next best method. Ring earthing must be 1 meter away from the building and 0.5m below the ground level.
The resistance of earthing system shall not exceed 10 ohm as per IEC 62305.
Lower earth resistance is more preferable.

For earth termination system, 2 basic types of earth electrode arrangements are applicable.
Type A & Type B arrangement.

Type A arrangement: Comprises of horizontal or vertical earth electrode installed outside the structure to be protected connected to each down conductor.

In type A arrangement, the total number of earth electrodes shall not be less than two.

Type A arrangement is suitable in places where electronic equipment are not located.

Type B arrangement: This type of arrangement comprises either a ring conductor external to the structure to be protected, in contact with the soil for at least 80% of its total length or a foundation earth electrode. Such earth electrodes can also be meshed. For structures with extensive electronic systems or with high risk of fire, type B earthing is most preferable method. Corrosion proofing band has to be used wherever down conductor is connected to earth termination system. Bitumen has to be applied at the point of inter-connection.

In potentially corrosive areas, Stainless steel must be used.

The reinforcement rod of the foundation & the buried wall can be used as foundation Earth Electrode. This is the good earthing Solution at minimum cost. In addition to the interconnection of the reinforcing rod by wire lashing, the installation of additional meshed metal network to ensure good joint is recommended. This additional meshed metal network should be clamped with reinforcement steel with suitable metal of clamp confirming to IEC 62561/ tested for lightning Current. All connection clamp/joints shall have the ability to carry the lightning Current.

Earth Fixing Point or terminal to connect external down conductor should be taken out with suitable material to avoid the corrosion in case of dissimilar material.

15.0 References:

IS / IEC62305 – PROTECTION AGAINST LIGHTNING:

Part 1: General Principles

Part 2: Risk Management
Part 3: Protection of structures
Part 4: Protection of Electrical & Electronic equipment within structure
IS3043: 1987: Code of practice for Earthing.

SUBHEAD-N. INTELLIGENT, ADDRESSABLE AND MONITORED EMERGENCY AND EXIT LUMINAIRES USING CENTRAL BATTERY SYSTEM

1. GENERAL

1.1 RELATED DOCUMENTS

a. Drawings.
b. General Provisions for Electrical Work to work of this section.

1.2 DESCRIPTION OF WORK

a. Supply, installation, testing, commissioning and maintenance during warrantee period of the central battery emergency lighting system as specified hereafter, as indicated in the relevant electrical system drawing.
b. Work includes providing all materials, equipment, accessories, services, tests and commissioning necessary to complete and make ready for operation central battery system in accordance with Drawings and Specifications.
c. The Emergency lighting system and all its components shall be designed and installed to meet the local Civil Defence requirements and fire and life safety code of practice & the respective EN 50172 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards applicable to this project.
d. Emergency lighting shall fulfill the following functions:-

- Illuminate the escape routes.
- Indicate the escape route direction clearly
- Provide Exit signs on all Exits
- Ensure fire alarm call points, firefighting equipment and other lifesaving equipment on the premises are illuminated during Power failure period of time.
- Permit operations concerned with safety measures & to shut down the hazardous process.

1.3 QUALITY ASSURANCE

a. The contractor shall show evidence that the central battery system maintains a fully equipped service organization capable of furnishing adequate maintenance of the installed system. He shall be prepared to offer a service for the maintenance of the system after the guarantee period.
b. All products used in the system shall be manufactured by an ISO 9001 & ISO 14001 certified company, complying with the relevant standards and shall bear the CE certification for Electro-Magnetic compatibility.

1.4 SUBMITTALS

a. Shop drawings: Indicating wiring diagrams and interconnections diagrams.
b. Product Data for each item of equipment; show specified ratings, feature, finishes, and physical dimensions.
c. Manufacturer's Installation Instruction: Indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.5 EQUIPMENT WARRANTY

Guarantee equipment furnished under these specifications against defective parts and workmanship under terms of the manufacturer's and dealer's standard warranties for a period of not less than one year from date of testing and commissioning or 18 months from date of delivery.

2. PRODUCTS

2.1 GENERAL

The central battery system and associated addressable luminaires will cover the Exit luminaires as detailed in the drawing and specifications. The system distribution shall be DC. The Central Battery Panels will be of modular nature for the ease of maintenance and reduced downtime.

2.2 CENTRAL BATTERY PANEL

a. Characteristics

- Each central emergency battery supply panels shall be used for supply, automatic testing and monitoring of minimum 30 no. EXIT and safety luminaries in each circuit.

- Each panel shall have a capacity of catering a minimum of 720 luminaires or as per the load distribution of the panel respectively.

- Panels shall be located inside electrical rooms and a trunking shall be provided inside electrical room as a riser to enable connection of panels located in different floors.

- Panel Shall have self learning feature which allows automatic update of new lights after new lamps are installed

- The panel shall have following electrical characteristics:

Input Voltage	:	220-240 AC 1Ph or 3 Ph
Output mains	:	220-240 V AC
Output Emergency	:	216 V DC
Emergency Duration	:	90 Minutes

- The number of emergency lighting system panels shall be appropriately decided for maximum reliability to ensure continued emergency supply and failure of one panel shall not result in total emergency lighting supply failure for the entire building. The system architecture should be of distributed battery type with each panel having its own dedicated battery charger and other accessories.

- System should consist of all main central battery panels with their own dedicated batteries and chargers respectively. Failure of one charger should not result in failure of the entire system. Sub panels being fed from main panels is not allowed. Separate power cables running from the main panels to sub panels is stricltly not allowed.

- Exit Lights & the Central Battery panels should be manufactured and supplied under the same brand name preferably from the north Europen region. All the components of the central battery system including light fittings and accessories should be supplied by a single manufacturer to ensure full compatibility.

- The system topology should consist of distributed panels with dedicated batteries, re chargers, boosters, changeover modules, complete monitoring in every panel. The distributed panels should be networkable over RS485 bus. The distributed Central battery panels should be modular. The batteries should not be located in a central room but should be distributed & dedicated to each panel.

- The manufacturer should have more than 40 years of experience manufacturing Central Battery Emergency Lighting System under the same brand name.

- The system supplier shall be authorized distributor of the equipment, maintaining a local staff of factory-trained personnel for Engineering assistance, installation and maintenance of such equipment in compliance with the requirements of the above mentioned EN standards and should have an authorization letter from the manufacturer for this project.

- Use of ELDB for power distribution to emergency lights is strictly not permitted

- Data and power shall be carried by a single fire survival CWZ category cable. The central battery panel shall be able to supply power and data all by itself. Use of separate panels such as easy check panels for data monitoring shall not be permitted.

b. Mechanical Construction

- The panel enclosure shall be made of sheet steel housing IP20 with separate rack or enclosures for batteries to maintain the safety distance of the battery according to EN50272-2. Panel shall be suitable for surface wall mounting. Panel shall have a screw fitted front door of lift away type, with front facia for status indication.
- Batteries to be mounted on suitable rack/ enclosure for easy maintenance of the batteries.
- The electronic compartment shall have large cabling compartment with cable entries from top with four or more undrilled removable metal flange plates. All incoming cables and looping circuits shall be connected on protected and fused terminals as per ENVDE0100.

c. Electrical Construction

- Changeover Module
  System shall be built up in a modular format. Each changeover module shall have 8 outputs of 250/350W. It shall be possible to connect each output circuit as maintained or non-maintained without any programming required. Changeover module shall have integrated transceiver circuit, which allows up to 32 addressable luminaires in each circuit depending upon wattage of each luminaire. Each changeover module communicates with the control module through the internal data bus. All out going circuit shall be protected with independent fuses. The unit shall not have a floating DC circuit and shall not require separate changeover relays for both L/DC(+) and N/DC(-).

- Battery Charger
  Charger module shall be controlled by the micro processor of the control module. There shall be automatic boost charge, cyclic charge and trickle charge facility for full battery capacity use and maximum battery life. The charger shall have built-in deep discharge protection for long battery life. The supply is taken from the batteries as long as mains supply failure persisits or battery voltage drops to deep discharge level of 175V. There shall be a DIP-switch for setting the maximum charging current, according to the battery capacity. Batteries shall have dedicated charger unit for each control panel.

  The system shall have temperature sensor at the battery for automatic charging voltage adjustment. Fuse protection shall be provided.

d. Central Module

- Control Module shall have the following LED indications:

xi. Mains Operation,
xii. Battery Operation,
xiii. Battery Overvoltage,
xiv. Battery Under voltage,
xv. Deep Discharge,

xvi. Recharge,
xvii. Current Limit,
xviii. Battery Fault,
xix. Earth Leakage,
xx. Internal Fault

- The emergency supply panel shall supervise the battery status such as Battery Over voltage / Battery Under voltage. Charging failure shall be indicated as an Internal fault by an indicator LED and potential free relay contact.

e. Control Module

- There shall be an own LED indicator for each luminaire in the same circuit providing simultaneous status information of the luminaires by a single view with corresponding group (circuit) number indicating on the segment display. The Control Module shall also have a Liquid Crystal Display (LCD) for the simultaneous display of the system status, faults and Luminaire status. Any modification such as extra data cabling in the system design due to use of non OEM products is not allowed.

- Control Module shall have the following Volt free contact:

iv. Internal Fault
v. Battery mode operation
vi. External Fault

- Control Module shall have the following Fault Indicator:

v. Internal Fault
vi. External Fault
vii. Fuse Fault
viii. Local Controller Alarm

- The control module of the panel shall have three main functions:

iv. monitor and control all test cycles and functions.
v. Indicate every status of the system and the connected luminaire
vi. communicate with the addressable electronic ballast on every luminaire.

- The emergency supply panel should be capable of continuously monitoring the circuits by means of current measurement thus making the system a continuously fully addressable system.
- The unit shall be fitted with a deep discharge protection circuit, which has two operation phases: When in battery mode the battery voltage decreases to 195V, a preliminary deep discharge alarm shall be given. When the battery voltage decreases to 175V, the load shall be disconnected. The circuit shall allow the battery to increase its voltage without switching the load ON again, thus avoiding detrimental full discharge. The panel shall automatically return to normal operation, once the mains supply recovers.

f. Central monitoring:

Each panel shall have web server capability for the entire emergency and exit lighting system to be controlled and monitored from a single point using the web browser on a standard personal computer. The system shall have capability to send email alerts to predefined email IDs.

Following functions shall be done by using the Central monitoring PC:

- Luminaire test of emergency supply panel.

- Battery test of emergency supply panel.

The panel shall also have an option for integration over BACNET/IP and MODBUS/IP to any BMS System. The Gateway shall have the following specifications:

- Inbuilt Web Server
- Integrates with 3rd party BMS over BACNET/IP or MODBUS/IP
- Processor Speed: 1GHz
- Memory: 1GB DDR3 SDRAM
- 2 Nos. of 10/100MB Ethernet ports
- Real time clock
- Batteryless
- 24VAC/DC power supply
- BTL Listed
- Operating temperature: -20–60°C
- Storage temperature: -40–85°C
- Humidity: 5%–95% — Non condensing
- MTTF: 10 years+

2.3 EMERGENCY & EXIT LUMINAIRE

All luminaries shall meet following requirements:

- LED type with maximum input power not exceeding 10.5Watts.
- Supply voltage 220V/240V AC/DC
- The luminaire shall comply the requirements of EN60594
- Electronic ballast shall comply the requirements of EN60298/60294
- EMC or EMI protection to EN55015
- Exit lights shall be maintained type luminaire
- Minimum viewing distance 25 meters for Exit luminaires
- Shall be built according to EN60598-2-22
- Shall have Constant power output high frequency electronic control gear
- All exit luminaire shall be powered from central battery unit
- The luminaire shall have sheet steel or plastic polycarbonate housing
- EMC protection according to EN 55015
- Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
- Backup for 90 Minutes operation via Central Battery System

- Emergency luminaires shall be non-maintained type slave luminaires with long life and high efficiency LED light source and self-testing addressable electronics, which can communicate with central control module. LEDs shall be of surface mounted type with proper heat sink. It is not allowed to use free standing LEDs where the heat is conducted only through the connection leads. Electronics shall supply the LED(s) with constant current, which shall be regulated against supply voltage variations. With the constant current power supply feature, the light output should be maintained more than 90% till the end of 90 minutes battery backup. All electronics for the Emergency and Exit luminaires shall be manufactured by the emergency lighting system manufacturer. The indication of the correct operation shall rely on the actual light output of the LED(s), so that an excessive degradation of the light output is also detected. Manufacturer is demanded to show a proof that the specified light output levels are maintained for minimum of 7 years. It shall be possible to connect both maintained and non-maintained luminaires to the same output circuit.
- All exit lights should be located on a single cable. A single 2 core + E fire rated cable with 1.5 sq mm thickness should be used. Separate cable for data will not be allowed.

- The supply connector shall be arranged to provide a possibility for both ingoing and outgoing cable to enable looped cabling between the luminaires without separate junction boxes.

Corridor Areas/ Offices / Lounge/ Waiting areas emergency luminaire

- Fully recessed, addressable and monitored LED luminaire - suitable for Offices/ Corridor Areas emergency luminaires:
  - Recessed Mounted luminaire with polycarbonate body
  - Ingress protection IP20
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

- Fully Surfaced, addressable and monitored LED luminaire - suitable for Staircases/ Parking Areas emergency luminaires:
  - Surface Mounted luminaire with polycarbonate body
  - Ingress protection IP65
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

Corridor Areas/ Offices / Lounge/ Waiting areas exit luminaire

- Single/ Double SIDED WALL/SURFACE mounting, addressable and monitored, EXIT Luminaire, High power LED 230VAC/DC luminaire:
  - Viewing distance up to 25m
  - Ingress protection IP44
  - Supply Voltage 220V/ 240V AC/DC
  - Fully compliant with requirements of the fire and safety code of practice & the respective EN 60598-2-22 and the system designed in compliance with EN50171, EN50272-2, EN50172, and EN1838 standards
  - With Backup for 90 Minutes operation via Central Battery System

2.4 BATTERIES

- The batteries shall be Ni-Cd type and shall be sized to power complete system for 90 minutes following mains failure at 100% light output of all emergency lamps.

- The batteries must be housed in an suitable rack.

- Separate battery rack must be provided for every bank of batteries and every CBS panel.

2.5 INSPECTION

- Examine areas and conditions under which the system are to be installed and notify in writing of conditions detrimental to proper completion of the work.

2.6 INSTALLATION

- Install the system, including associated control devices as indicated, in accordance with manufacturer's written instructions, requirements of applicable standards, and in accordance with recognized industry practices to ensure that installation complies with requirements and serves intended function.
- Coordinate with other work as necessary to interface installation of the system work with other work.

- Anchor mounting hardware firmly to walls, floors, or ceilings, to ensure enclosures are permanently and mechanically secured. Provide all accessories for proper mounting.
- The emergency light shall be connected such that in case of power failure in any of the area, the emergency light installed in that area shall be energized.
- All of the system installation work shall be supervised by the specialist supplier. However, the necessary containment and electrical power to support the emergency lighting system shall be the responsibility of the MEP Contractor.
- The central battery system shall integrate with other building systems as follows:

- Fire Alarm System
  The central battery system shall interface with the fire alarm system with hardwired integration
- Building Management System
  The central battery system shall interface with the building management system/ SCADA with hardwired integration and shall have option to integrate via BACNET/IP for software integration. Protocols other than BACNET/IP are not acceptable.

2.7 FIELD QUALITY CONTROL

- Upon completion of installation and after the equipments have been energized, demonstrate capability and compliance of the system with requirements. Where possible, correct malfunctioning units at site then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.

2.8 PERSONNEL TRAINING

- Building Operating Personnel Training: Train Owner's building personnel in procedures for starting up, testing and operating the system.

****

SUBHEAD O: UPS & TECHNICAL SPECIFICATIONS OF UPS

UPS SYSTEM

1.0 General

1.1 Summary

The units wi*l* have state-of-the-art technology with high degree of reliability in operation for continuous operation 24 hrs. and 365 days an year. This specification defines the electrical and mechanical characteristics and requirements for a continuous duty, highly reliable stand alone type **true on-line double conversion UPS system using PWM IGBT technology** i.e. the **IGBT** Rectifier of the UPS system converts the input AC power to DC and then the **IGBT** inverter converts the DC into clean AC power. The UPS must use the most advanced Microprocessor technology. The UPS shall provide high quality AC power for sensitive electronic equipment loads. It should also supply clean power

automatically without any break in the supply in the the protected system get direct supply from the system.

absence of raw power. Under no conditions will raw mains unless there is fault in the protected

System Configuration and operation in normal conditions:

Each modular UPS unit shall be made up of the following components, described in detail in this specification:

- IGBT rectifier
- battery charger
- IGBT inverter
- Isolation Transformer
- battery
- automatic bypass (via a static switch)
- user and communications interface
- battery management system.

Following protections shall be provided with each UPS module:

- Inverter Under & Over voltage protection.
- Inverter over temperature protection.
- Over load current protection.
- Battery under / over voltage protection.
- Battery end of discharge protection.
- Manual by-pass closed.
- By-pass SCR failure.
- Back feed fault.
- Output short circuit.
- Rectifier input under / over voltage.
- EPO (Emergency power off)
- Rectifier input
- Over temperature.
- Input single phase / phase reversal.
- Rectifier input under / over frequency.
- DC short circuit

Software base control & monitoring on remote PC on LAN shall be provided.

2.0 Modes of Operation

The UPS system shall operate in double-conversion mode as indicated below.

2.1. Normal operation

(normal AC source available)

The rectifier of each modular UPS unit shall supply its inverter and charger. The UPS shall continuously supply the load with backed up electrical energy and the charger shall float charge the battery.

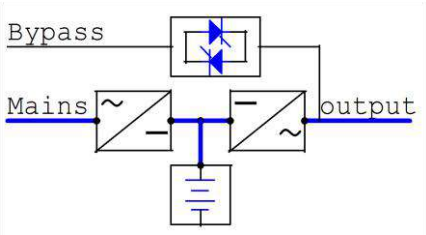


Fig-2 (A)

2.2. Operation on battery power

(normal AC source not available or outside tolerances)

Upon failure or excessive deterioration of the normal AC source, the inverter of UPS unit shall continue to supply the load from battery power without interruption or disturbance, within the limits imposed by the battery backup time.

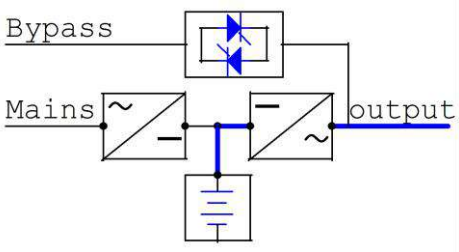


Fig.-2(B)

2.3. Battery recharging

(normal AC source restored)

When the normal AC source is restored, the rectifier of each modular UPS unit shall again power its inverter, without interruption or disturbance to the load, while the charger automatically recharges the battery.

2.4. Transfer to bypass AC source

(☞ system without redundancy)

The system does not provide redundancy. The inverter of the UPS shall supply the load. The automatic bypass of UPS unit shall be connected to the same bypass AC source.

Voluntary shutdown or a major fault on a modular UPS unit shall result in automatic transfer, without interruption, of the load to the bypass AC source via the bypass of each modular UPS unit, including the unit shut down, if the AC bypass is within tolerances and synchronised with the inverter outputs.

On request, the UPS system may automatically transfer the load with a micro-interruption (adjustable from 15 to 1000 ms) if synchronisation with the bypass source has not been established, to enable operation in

downgraded mode and enhance supply of power to the load.
In all cases, to ensure load transfer in complete safety, the system shall simultaneously control the static switch.
Modular UPS units shall continue to supply the load.

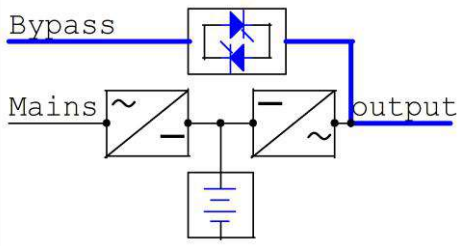


Fig.-2(C)

2.5. UPS-system maintenance

All power and control electronics of the modular UPS units making up the UPS system shall be accessible from the front of the UPS.
For maintenance purposes, the UPS system shall include an external, mechanical, manual bypass system with one-button operation, common to all modular UPS units.
For personnel safety during servicing or testing, this system shall be designed to isolate the UPS system while continuing to supply power to the load from the bypass AC source. The UPS shall also include a device making it possible to isolate the rectifier and the charger of each modular UPS unit from the normal AC source.

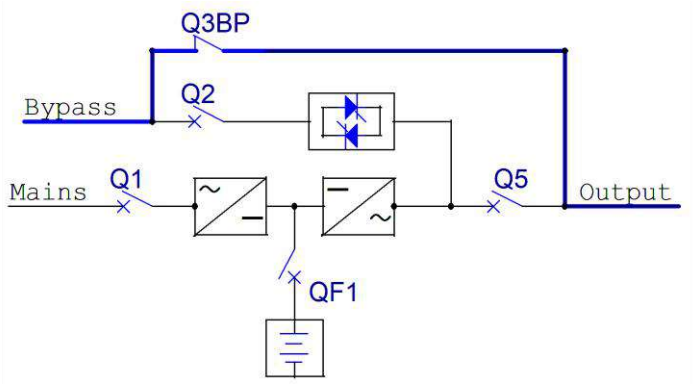


Fig. –2(D)

2.6. Battery maintenance

For safe maintenance, the battery of each modular UPS unit shall include a circuit breaker to isolate the battery from the rectifier, the charger and the inverter. When the battery is isolated from the system, the UPS shall continue to supply the load without interruption or disturbance, except in the event of a normal AC source outage.

2.7. Cold start (normal AC source absent)

The battery of each modular UPS unit shall be capable of starting the UPS if the normal AC source is absent and continue supplying power to the load within the specified backup time. Cold start on battery power shall be possible on the condition that the system shall have started at least once on normal AC power.

Sizing and general characteristics

3.1. Technology

The UPS system technology shall be based on IGBT transistors for all the power converters (rectifier, charger and inverter with variable chopping frequency).

3.2. Rating

The UPS system shall be sized to continuously supply a load of **AS PER BOQ** at a power factor of 0.8.
The UPS system shall be made up of 1 UPS unit, having a power rating of **AS PER BOQ.**
There shall be **AS PER BOQ** units operating independently, with independent battery backups as per BOQ.

3.3. Battery backup time

The battery backup time in the event of a normal AC source outage shall be as per BOQ, for a load power factor of 0.8 for each UPS.

The battery of each UPS unit shall be designed for a service life of 5 years. It shall be selected and sized correspondingly, for a load power factor of 0.8

3.4. Types of loads accepted

The UPS system shall accept high crest factors (3:1) without derating (kW) to ensure correct operation with computer loads and loads where the leading power factor can reach 0.9.

The total harmonic voltage distortion at UPS output (THDU downstream) shall respect the following limits:

- THDU downstream ph/ph $\leq$ 3% for non-linear loads.

3.5. PFC sinusoidal-current input rectifiers

The UPS system shall not draw a level of harmonic currents that could disturb the upstream AC system, i.e. it shall comply with the stipulations of guide IEC 61000-3-4.

The PFC input rectifiers of the modular UPS units, using sinusoidal-current IGBTs, shall have the following performance levels:

- total harmonic current distortion (THDI) upstream of the rectifier not exceeding 5%
- input power factor (PF) greater than 0.99 from 50% load upwards.

3.6. Outputs without a transformer

To reduce losses, dimensions and weight, the output of each UPS unit shall be of the transformer less type and the neutral shall be recreated electronically.

3.7. Efficiency

Overall efficiency (between the rectifier inputs and the UPS output) shall be greater than or equal to:

- 93% from 50% load to full rated load (In).

Battery Management Function - The UPS has advanced battery management functions including battery fault detection, backup time & remaining life forecast.

Soft Start Function - Complete delay soft start function can reduce the surge to the UPS unit and utility source.

Alarm and Protection Function - The UPS can generate audible and visual alarm through LCD, input/output contacts and network transmission. It can help maintenance personnel to locate and clear the faults that are sent out in time, accurately and in detail.

Automatic Re-start when Utility returns – On failure of the input mains supply the UPS goes to battery mode. After the batteries are completely discharged the UPS system shuts down. It must automatically restart on the resumption of the input supply.

1.2 SYSTEM DESCRIPTION

1.2.1 Design Requirements - UPS Module

A. Voltage.

Input/Out voltage specifications of the UPS shall be:
Rectifier Input: (380) (400)(415) volts, three-phase 4-wire-plus-ground.
Bypass Input (if used): (380)(400)(415) volts, three-phase, 4-wire-plus-ground.
Output: 415 volts, 3 phase, 4-wire-plus-ground.

B. Output Load Capacity

Specified output load capacity of the UPS rating shall be **as per BOQ** at 0.8 lagging power factor.

1.2.2 PERFORMANCE REQUIREMENTS

1. AC Input to UPS

A. Voltage Configuration: three-phase, 4-wire plus ground.
B. Voltage: (380)(400)(415) V
C. Voltage Range: +/-15% of nominal.
D. Frequency: Field selectable 50Hz or 60 Hz
E. Frequency: Nominal frequency range +/- 10%
F. Voltage distortion: The harmonic content introduced into the mains supply shall comply with IEC 61000-3-4 / AS2279 Part 2 for harmonic voltage distortion at the Point of Common Coupling (PCC) with other loads. Where higher impedance Mains or Generator supplies are present, the manufacturer shall offer reduced current distortion options to ensure IEC 61000-3-4 / AS2279 Part 2 requirements are complied to when interfaced with the proposed UPS system.
G. Input PF: > 0.99 from 50% to 100% of rated load.
H. Input power Factor at low operating loads of <25% shall not lead to leading power factor at any time.

2. AC Output, UPS Inverter

a) Inverter Shall be IGBT based
b) Voltage: (415)V
c) Voltage Configuration: Three-phase, 4-wire plus ground.
d) Voltage Regulation: ± 1% steady state.
e) Frequency: Field selectable 50 Hz or 60Hz, (+ 0.5 or 2Hz adjustable).
f) Frequency Slew Rate: 1Hz /sec to 2Hz /sec adjustable
g) Phase Displacement: ± 1 degree for balanced load.
± 1 degree for 100% unbalanced load.

h) Voltage Distortion: 1% Typical 2% maximum for liner loads
<5% total harmonic distortion (THD) for 100% non-linear loads with 3:1 crest factor.

i) Output Power Rating: Rated kVA at 0.8 lagging power factor.
j) Overload Capability: 110% for 60 minutes
125% for 10 minutes
150% for 30 seconds
200% for 500 milliseconds

k) Voltage Transient Response: ± 2%
l) Transient Recovery Time: to within ±1% of output voltage within 60 milliseconds
m) Voltage Unbalance: Balanced load 1%

100% unbalanced load 2%

n) Inverter Short Circuit Current Limit:
150% full load current for 30 seconds
270% full load current for 150 milliseconds

1.3 ENVIRONMENTAL CONDITION

1.3.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

A. Operating Ambient temperature

UPS Module: 0ºC to 40ºC
Battery: 25 ± 5ºC

B. Storage/Transport Ambient Temperature

-25ºC to 70ºC

C. Relative Humidity: <90% at 20ºC

D. Altitude Operating: to 1000 meters above mean Sea Level de-rated for higher altitude applications. 1% per 100m between 1000 & 2000

E. Audible Noise

Noise generated by the UPS under any condition or normal operation shall not exceed 65 dbA measured 1.5 meter from surface of the UPS.

1.3.2 Design Requirements - Matching Battery

A. Battery Cells: Sealed, lead-acid, valve-regulated.

C. **Reserve Time**: ( ) minutes at full load, 0.8 power factor, with ambient temperature between 20 and 30ºC.

1.4 UPS Delivery Submittals

Submittal upon UPS delivery shall include:

One instruction manual: Manual shall include a functional description of the equipment with block diagrams, safety precautions, instructions, step-by-step operating procedures and routine maintenance guidelines, including illustrations.

1.5 Quality Assurance

1.5.1 Manufacturer Qualifications

A minimum of five year's experience in the design, manufacture, and testing of solid-state UPS systems is required. Standards ISO90001, CE certified to level A of EN55022.

1.5.2 Factory Testing

Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

2.0 PRODUCT

2.1 Fabrication

2.1.1 Materials

All materials of the UPS shall be new, of current manufacture, high grade and free from all defects and shall not have been in prior service except as required during factory testing.

2.1.2 Construction and Mounting

The UPS unit, comprised of input isolator, rectifier/charger, inverter, static transfer switch, maintenance bypass switch, and static bypass input switch should be housed in a freestanding steel enclosure with key-lockable doors. Front access only shall be required for expedient servicing, adjustments, and installation. The enclosure will be built to comply with IP20 when the doors are open. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. The UPS shall be constructed of replaceable subassemblies. Printed circuit assemblies shall be plug-in. Like assemblies and like components shall be interchangeable.

2.1.3 Cooling

Cooling of the UPS shall be forced-air. Low velocity fans shall be used to minimize audible noise output. Fan power shall be provided by the UPS output. Temperature will be monitored by thermal sensors.

2.2 Components

2.2.1 Rectifier/Charger

A. General

The term rectifier/charger shall denote the solid-state equipment and controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging. The rectifier/charger shall be 6 Pulse three phase-controlled IGBT based bridge type with constant voltage/current limiting control circuitry.

B. Input Current Walk-In

The rectifier/charger shall contain a timed walk-in circuit that causes the unit to gradually assume the load over a 10-second time interval after input voltage is applied.

C. Fuse Failure Protection

Power semiconductors in the rectifier/charger shall be fused with fast-acting fuses, so that loss of any one-power semiconductor shall not cause cascading failures.

D. DC Filter

The rectifier/charger shall have an output filter to minimize ripple voltage into the battery. Under no conditions shall ripple voltage into the battery exceed 1% RMS. The filter shall be adequate to insure that the DC output of the rectifier/charger will meet the input requirements of the inverter. The inverter shall be able to operate from the rectifier/charger with the battery disconnected.

E. Battery Recharge

In addition to supplying power for the inverter load, the rectifier/charger shall be capable of producing battery-charging current to recharge the battery. After the battery is recharged the rectifier/charger shall maintain the battery at full charge until the next emergency operation. The charging shall be an automatic cycle per DIN 41772 characteristic I -U (boost to floating charge switching, with current measuring criteria and control during recharge). Both float and recharge voltages shall be adjustable. The charge voltage can also be manually controlled. The use of the inverter is inhibited during manual charging.

2.2.2 Inverter

A. General

The term inverter shall denote the solid-state equipment and controls to convert DC power from the rectifier/charger or battery to regulated AC power for supporting the critical load. The inverter shall be an **Insulated Gate Bipolar Transistor, phase-controlled, pulse width modulated (PWM)** design capable of proving the specified AC output.

B. Overload Capability

The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 150% of full load current. A status indicator and audible alarm shall indicate overload operation. The UPS shall transfer the load to bypass when overload capacity is exceeded.

C. Fault Clearing and Current Limit

Without bypass supply available to the inverter shall be capable of supplying an overload current of **150% of its full-load rating in excess of Thirty Seconds**. For greater currents or longer time duration, the inverter shall have electronic greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. The inverter shall be self-protecting against any magnitude of connected output overload (Vce Trip). Inverter control logic shall sense and disconnect the inverter from the critical AC load without the requirement **to clear protective fuses**.

D. Output Frequency

The output frequency of the inverter shall be controlled by an oscillator. The oscillator shall hold the inverter output frequency to + .01% for steady state and transient conditions.

2.2.3 Display and Controls

A. Monitoring and Control

The UPS shall be provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. A system controls section designed for convenient and reliable user operation. A system power flow diagram, a percentage load and battery time remaining display shall be provided as part of the monitoring and controls sections, which depicts a single-line diagram of the UPS. Illuminated visual indicators shall be of the long-life light-emitting diode (LED) type. All of the operator

controls and monitors shall be located on the front of the UPS cabinet. The monitoring functions such as metering, and alarms shall be displayed on an alphanumeric LCD display. Additional features of the monitoring system shall include:
Menu-driven display with test format selectable in five (5) languages (English,
German, French, Spanish, or Italian).

B. Metering

The following parameters shall be displayed:
Battery voltage
Battery charge/discharge current
Battery remaining backup time
Input voltage, frequency and current
Output AC voltage line-to-line and line to neutral Output AC current for each phase and neutral and % load used of nominal capacity for each phase.
Output frequency
Output Crest Factor
Output Power Factor
Active Power (kW) Apparent Power (kVA)
Temperature - Ambient, battery

C. Warning and Alarm Messages

Normal Operation Input breaker open
Output breaker open Rect. breaker open
Battery breaker open On Manual bypass
Bypass absent Bypass over limits
Bypass under limits Bypass freq. over limit
Bypass Phase Rotation Bypass SCR fail
Bypass inhibit Local Bypass inhibit remote
Load on bypass on bypass due to over temperature
Rectifier off Local Rect. off remotely
Rectifier Block Rectifier overload
Rectifier over temp Rectifier Fuse fail
Inverter off local. Inverter off remotely
Inverter block Inverter overload
Inverter overtemp Inverter out of sync
Inverter overvoltage Inverter undervoltage
Inverter fuse fail D.C Volts High
D.C Volts low Inverter no voltage
Inverter Peak Volts low Battery under test
Battery test fail Discharge battery
Battery E.O.D. Boost Charge
DC Bus over volt Battery Low
Battery Fuse Fail Bat. Fast over volt
Bypass overuse Cut-off overload
Cut-off overtemp Cut-off emergency stop
Overload Cut-off max overload

Software Warnings
Bad EPROM program Err. LRC param. Pag 1

Err. LRC Param Pag 2 Err. LRC Param Pag 3
Err. LRC Alar Hist Err. LRC Even Hist
Back-up battery low Error LRC table
Error LRC Panel Modem Wrong Config
Modem no response Modem false command
Modem time-out trasm Can bus no response
Autonomy XXXX min

D. Controls

Four pushbuttons shall be located on the operator control panel.
Enter
Escape
Up
Down
The push buttons shall permit the operator either to select options from a menu for display on the LCD winder or to change the value of some parameters. One push-button - alarm silence switch.

E. Power Status Diagram

A mimic panel shall be provided to depict a single line diagram of the UPS.
Indicating lights shall be integrated within the single line diagram to illustrate the status of the UPS. The three LEDs shall indicate the following status.
Bypass voltage OK
Load on bypass
Load on inverter
The % load with respect to the nominal power and the real time remaining battery backup time should be displayed in the LCD display of the UPS.

F. Ethernet Connectivity Interface Port

An Ethernet Connectivity based interface port shall be provided for remote display of UPS status information on a computer terminal (by others).

2.2.4 Static Transfer Switch

A. General

A static transfer switch and bypass circuit shall be provided as an integral part of the UPS. The static switch shall be naturally commutated high-speed static (SCR-type) device rated to conduct full load current continuously to enable the critical load to be connected to the inverter output or bypass power source. The static transfer switch control logic shall contain and automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarm conditions. This control circuit shall provide an uninterrupted transfer of the load to an alternate bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS, or for bypassing the UPS for maintenance.

B. Uninterrupted Transfer

The transfer control logic shall automatically turn on the static transfer switch, transferring the critical AC load to the bypass source, after the transfer logic senses any of the following conditions:
Inverter overload capacity exceeded
Critical AC load over voltage or under-voltage
UPS fault condition.

The transfer control logic shall inhibit and automatic transfer of the critical load to the bypass source if any of the following conditions are present:
Inverter/bypass voltage difference exceeding pre-set limits
Bypass frequency out of limits
Bypass out-of-synchronization range with inverter output.

C. Uninterrupted Retransfer

Retransfer of the critical AC load from the bypass source to the invert output shall be automatically initiated unless inhibited by manual control. The transfer control logic shall inhibit an automatic retransfer of the critical load to the inverter if one of the following conditions exists:
Bypass out of synchronization range with inverter output
Inverter/bypass voltage difference exceeding pre-set limits
Overload condition exists in excess of inverter full load rating
UPS fault condition present.

2.2.5 Maintenance Bypass Isolator

A. General

A manually operated maintenance bypass isolator shall be incorporated into the UPS cabinet to directly connect the critical load to the input AC power source, bypassing the rectifier/charger, inverter, and static transfer switch.

B. Maintenance Capability

With the critical load powered from the maintenance bypass circuit, it shall be possible to check out the operation of the rectifier/charger, invert, battery, and static transfer switch.

C. Wall Mounted Battery Circuit Breaker (BCB)

A battery circuit breaker shall be provided to isolate the battery from the UPS. This breaker together with battery circuit breaker controller board shall be in a separate wall mounted enclosure. The battery breaker provides a manual disconnecting means, short circuit protection, and over-current protection for the battery system. When opened, there shall be no battery voltage in the UPS enclosure.

D. Split Bypass feature

UPS shall have both a rectifier input and bypass input. Two separate input sources must be provided. An internal bypass circuit breaker shall be provided for connection to the bypass source.

E. BMS connectivity

Each UPS should have Network Interface Card for Modbus BMS & LAN Connectivity simultaneously. RS 485 Port has to be available for BMS interface in the UPS module. RJ 45 connectivity over Ethernet has to be available for LAN Connectivity.

3.0 FIELD ENGINEERING SUPPORT

The UPS manufacturer shall directly employ a national field service network staffed by factory trained field service engineers to provide start up, maintenance and repair of the UPS equipment.

Standards and tests

3.1. Standards

All equipment shall be designed and built in accordance with accepted engineering practice and applicable international standards, in particular the standards listed below.

A. Safety:

- IEC 60950-1 / EN 60950-1
  Information technology equipment - Safety - Part: General requirements
- IEC 62040-1/ EN 62040-1
  Uninterruptible power systems (UPS) - General and safety requirements for UPS.
- IEC 62040-3 / EN 1000-3
  Uninterruptible power systems (UPS) - Method of specifying the test and performance requirements.
- IEC 60439
  Low-voltage switchgear and controlgear assemblies.
- LV directive: 2006/95/EC

B. Harmonics:

- IEC 61000-2-2 / EN 61000-2-2
  Compatibility levels for low-frequency conducted disturbances and signalling in public low-voltage power supply systems.
- IEC 61000-3-2 / EN 61000-3-2
  Limits for harmonic current emissions (equipment input current ≤ 16 A/ph).
- IEC 61000-3-4 / EN 61000-3-4
  Limits for harmonic current emissions (equipment input current > 16 A/ph).
- IEC 61000-3-5 / EN 61000-3-5
  Limitation of voltage fluctuations and flicker.
- EN 50160
  Voltage characteristics of public networks.
- IEEE 519
  Recommended practices and requirements for harmonic control in electrical power systems.

C. EMC:

- EN 50091-2
  UPS - EMC.
- IEC 62040-2/ EN 62040-2
  Uninterruptible power systems (UPS) - Electromagnetic compatibility (EMC) requirements.
- EMC Directive 2004/108/EC
  For equipment liable to cause or be affected by electromagnetic disturbances.

D. Quality:

- Design , production and servicing in compliance with standard ISO 9001 - quality organisation.

E. Ecological environment:

- Manufacturing in compliance with standard ISO 14001.

F. Acoustic noise

- ISO 3746 : Sound power levels.
- ISO 7779 / EN 27779 : Measurement of airborne noise emitted by computer and business equipment.

What is more, the equipment shall comply with eco-design and eco-manufacturing criteria in view of sustainable development and to that end, the manufacturer shall be able to demonstrate:

- R&D and production on an ISO 14001 certified site
- Manufacture with over 90% recyclable materials
- Capacity to recover products at the end of their service life and provide proof of destruction by a certified organisation.
- The environmental profile of the product, which shall be supplied with the sales offer.

3.2. Certification of conformity

The manufacturer shall provide, on request, a complete qualification file demonstrating compliance with the above standards. What is more, the indicated levels of performance shall be confirmed by certification from independent laboratories (e.g. TÜV or Veritas).

GALGOTIAS UNIVERSITY

TECHNICAL SPECIFICATIONS OF UPS SYSTEM

	UPS TOPOLOGY	True on-line double conversion PWM IGBT based.
A	**INPUT**	
1	Input voltage	415V, 3 phase, 4 wires
2	Input voltage tolerance	+10 %, -15%
3	Input frequency	50 Hz
4	Input frequency tolerance	+/- 15 %
5	Input current limit	115% (Adjustable between 100 - 125%)
6	Power walk - in period	30 seconds
	Input THDi	<5% for 25% to 100% load
	Input Pf (from 50% load)	>0.99
7	Input circuit Preferred	IGBT based, PFC bridge rectifier
8	Inbuilt Input & Bypass Isolator	Required, Isolator

B	**OUTPUT**	
1	Module full load rating kVA/ kW	30 KVA
2	Rated voltage	3 phase
3	Rated current	Vendor to specify
4	Phase Voltage asymmetry (For Three Phase output UPS only) a] Balance load b] 100% unbalanced load	 1% 2%
5	Voltage Phase shift (In case of three phase Output UPS) - With balanced load - With Unbalanced load	 120 +/- 1 deg 120 +/- 1 deg
6	Output voltage adjustment range	+/- 5%
7	Phase displacement (In case of three phase Output UPS) a] Balance load b] 100% unbalanced load	 120 deg. +/- 1 deg 120 deg. +/- 1 deg
8	Output power factor range	0.8 or better
9	Internal oscillator stability	+/- 0.1 %
10	Mains synchronization tracking	+/- 1 Hz (settable to +/-2)
11	Max. Rate of change of frequency	1 Hz. Per second
12	Output voltage harmonics a] Linear load b] Non-linear load (Crest factor of 3:1)	 < 2% < 5 %
13	Crest Factor	3: 1
14	Overload rating	110% for 60 minutes 125% for 10 minutes 150% for 30 seconds
15	Overload trip	10 min at 125% reducing to 30 seconds at 150%

16	Inverter Efficiency	> 94%
17	Current limit short	Set at 150% of the output power
18	Transient Response a] 100% load change b) Manual transfer of load from UPS to bypass and vice-versa C] Automatic transfer of load form UPS to bypass	 +/- 2% 0 msecs when in sync 0 msecs in sync
19	Transient recovery time	Recovery to +/- 1 % in < 60 msec.
20	Manual Bypass Isolator	One with each UPS Module
21	Confirmed Overall Efficiency of UPS with all Filter Options at	
	100% Load 75% Load 50% Load 25% Load	>94% >94% >93% >92%

C	**DC CHARACTERISTICS**	
1	Nominal DC bus voltage	408 V to 576 V
2	Battery isolation	Manually closed circuit breaker with under voltage release and over current trip
3	Battery fully discharge voltage	326V
4	Allowable voltage drop in battery cables	3 volts at end of discharge voltage.
5	Battery float voltage	459 V
6	Battery end voltage	340 V
7	DC Bus voltage ripple	< 1 RMS
8	Battery recharge current limit	Amps, Vendor to specify
9	No. Of cells	Vendor to specify

D	**CONTROLS**
1	Charger input Isolator
2	Battery circuit breaker (mounted separately in its own enclosure)
3	Inverter output Isolator
4	Bypass line Isolator
5	Maintenance Bypass Isolator
6	Alarm acknowledge / Reset button
7	Inverter On-Off Pushbutton for Manually switching of the Inverter
8	Emergency off push button
E	**MEASURING INSTRUMENTS**
1	LCD panel for Measuring Input Voltage, output currents and Frequency, Output voltages, Output currents and Frequency, Battery Voltage and Charging / Discharging current.
2	LCD panel should display status of the Battery capacity and backup Time in minutes.
3	Log of time-stamped events This function shall store in memory and make available, for automatic or manually initiated recall, time-stamped logs of all important status changes, faults and malfunctions, complete with an

	analysis and display of troubleshooting procedures. It shall be possible to time stamp and store at least 2500 events.
E	**PROTECTIONS**
1	RC surge suppressor.
2	Sustained under voltage on input side
3	Phase loss on input side.
4	Negative sequence on input side
5	Semiconductor fuses in the lines for thyristor
6	Snubber circuit for device dv/ dt protection
7	Charger input current limit
8	HRC fuses for filter capacitors
9	Battery current limit
10	DC over voltage
11	Low battery
12	Semiconductor fuses at inverter output
13	Overload
14	Over temperature for the inverter
15	HRC fuses in the control circuit

F	**INDICATIONS (ALARMS)**
1	Inverter Failure
2	Overload (if load exceeds 100%)
3	Overload shutdown
4	Emergency shutdown
5	Equipment over temperature
6	Maintenance Bypass ON
7	DC over voltage
8	Low battery
9	Battery circuit breaker open
10	Battery on load
11	Mains failure
12	Rectifier Failed or Off
13	Inverter Unsynchronized
14	Load on bypass
15	Output voltage error

G. DC link characteristic with battery back-up (as per BOQ)	
NO. of 2/12V SMF lead acid batteries	Vendor to Specify
AH rating for each UPS	Vendor to Specify rating and no. along with VAH
Model / Make	G & Y/ Panasonic
Float voltage	459 V
Final discharge voltage	340 V
Voltage tolerance	+/- 1 %
DC ripple	< 1 %

Charging current limit	10 %
Battery Isolation	With U/V release type Battery Circuit Breaker

Mechanical Dimensions:

Weight of UPS – Kg	Vendor to specify
Dimension of UPS (L x D x H) in mm	Vendor to specify
Ventilation	Forced air cooled with internal fans
Protection Level: * With enclosure closed * With front doors open	 IP 20 IP 20

Environmental:

Operating temperature	0 – 40 deg. C.
Relative humidity	< 90 % (20 deg. C.)
Altitude	1000 m
Storage temp.	From -25 to + 70 deg. C.

The following shall be filled in all respects by the tenderer for technical evaluation.

S.No	Description	To be filled by Tenderer
1	Name of the Organization	
2	Total years of Experience	
3	Total list of customers	
4	Highest capacity of UPS installed	
5	Capacity of UPS offered for CLIENT	
6	Model no.	
1	**INPUT**	
i	Input voltage	
ii	Input voltage tolerance	
iii	Input frequency	
iv	Input frequency tolerance	
v	Input Power factor at nominal voltage and full load	
vi	Harmonic Filters	
vii	Input current limit	
viii	Power walk - in period	
ix	Input circuit	
2	**OUTPUT**	
i	Module full load rating KVA/ KW	
ii	Rated voltage	
iii	Rated current	
iv	Output voltage adjustment range	
v	Output power factor range	
vi	Internal oscillator stability	
vii	Mains synchronization tracking	
viii	Max. rate of change of frequency	
ix	Output voltage harmonics	
x	a] Linear load	
xi	b] Non-linear load (Crest factor of 3:1)	
xii	Crest Factor	
xiii	Overload rating	
xiv	Overload trip	
xv	Inverter Efficiency	
xvi	Current limit short	
xvii	Transient Response	
xviii	a] 100% load change	
xix	b) Manual transfer of load from UPS to	
xx	by-pass and vice-versa	
xxi	C] Automatic transfer of load form UPS	
xxii	to bypass	
xxiii	Transient recovery time	

S.No	Description	To be filled by Tenderer
3	**DC CHARACTERISTICS**	
i	Nominal DC bus voltage	
ii	Battery isolation	
iii	Battery fully discharge voltage	
iv	Allowable voltage drop in battery cables	
v	Battery float voltage	
vi	Battery end voltage	
vii	DC Bus voltage ripple	
viii	Battery recharge current limit	
ix	No. of cells	
x	Battery sharing cubicle	
4	**H. DC link characteristic for …. min battery run time on full load**	
i	No. of 12V SMF lead acid batteries (or)	
ii	AH rating	
iii	Model / Make	
iv	Float voltage	
v	Final discharge voltage	
vi	Voltage tolerance	
vii	DC ripple	
viii	Charging current limit	
ix	AH/ Nos.	
x	Battery Isolation	
xi	Battery sharing Cubicle	
xii	Weight of UPS – Kg	
xiii	Dimension of UPS (W x D x H) in mm	
xiv	Ventilation	
xv	Colour (two tone)	
xvi	Protection Level	
xvii	Operating temperature	
xviii	Max. Temp. for 8 hr. day	
xix	Relative humidity	
xx	Altitude	
xxi	Storage temp.	
xxii	Warranty offered on UPS	
xxiii	Warranty offered on Battery bank	
xxiv	Delivery Period	

****

TECHNICAL SPECIFICATIONS ELV WORKS

INDEX

GALGOTIAS UNIVERSITY

TECHNICAL SPECIFICATIONS

SUBHEAD-A. **INTELLIGENT REPORTING FIRE DETECTION SYSTEM**

GENERAL

DESCRIPTION:

This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

The fire alarm system shall comply with requirements of NFPA Standard 72/EN54 LPCB for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

The system and its components shall be Underwriters Laboratories or Loss Prevention Certification Board Inc. listed under the appropriate UL/ EN54testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL/EN54 listing.

SCOPE:

A new intelligent reporting, microprocessor-controlled fire detection system shall be installed in accordance to the project specifications and drawings.

Basic Performance:

Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 6 (Class A) Signaling Line Circuits (SLC).

Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.

Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z) as part of an addressable device connected by the SLC Circuit.

On Style 6 or 7 (Class A) configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

NAC speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.

Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

NAC speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

Two-way telephone communication circuits shall be supervised for open and short circuit conditions.

DRAWINGS & TECHNICAL SUBMITTALS

General:

Two copies of all submittals shall be submitted to the Architect/Engineer for review.

All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

Shop Drawings:

Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
Show annunciator layout, configurations, and terminations.

Manuals:
Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

Software Modifications
Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

Certifications:
Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

WARRANTY:
All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

POST CONTRACT MAINTENANCE:
Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.
Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:
Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
Each circuit in the fire alarm system shall be tested semiannually.
Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

POST CONTRACT EXPANSIONS:
The contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.
As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).
The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labor necessary to install this hardware.
Do not include cost of conduit or wire or the cost to install conduit or wire except for labor to make final connections at the FACP and at each intelligent addressable device. Do not include the cost of conventional peripherals or the cost of initiating devices or notification appliances connected to the addressable monitor/control modules.
Submittals that do not include this estimate of post contract expansion cost will not be accepted.

APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

National Fire Protection Association (NFPA) - USA:

NFPA 13	Sprinkler Systems
NFPA 16	Foam/Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 72	National Fire Alarm Code
NFPA 76	Telecommunication Facilities
NFPA 101	Life Safety Code
NFPA 90A	Air conditioning & ventilation system
EN 54	European Standards

B. Underwriters Laboratories Inc. (UL) - USA:

UL 268	Smoke Detectors for Fire Protective Signaling Systems 7th Edition Listed
UL 864	Control Units for Fire Protective Signaling Systems **10th Edition Listed**
UL 268	A Smoke Detectors for Duct Applications
UL 521	Heat Detectors for Fire Protective Signaling Systems
UL 464	Audible Signaling Appliances
UL 38	Manually Actuated Signaling Boxes
UL 346	Water flow Indicators for Fire Protective Signaling Systems
UL 1971	Visual Notification Appliances
UL 228	Door Holders
EN54 LPCB	European Standards

NATIONAL BUILDING CODES

DELHI FIRE CODES

The Video Display Terminal (VDT) shall comply with Swedish magnetic emission and X-radiation guidelines MPR 1990:10.

APPROVALS:

The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL Underwriters Laboratories Inc **(10th Edition)**

LPCB Loss Prevention Certification Board

The fire alarm control panel shall meet UL Standard 864 10th Edition/ EN54 / LPCB (Control Units).

The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

PRODUCTS

EQUIPMENT AND MATERIAL, GENERAL:

All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.

All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

CONDUIT AND WIRE:

Conduit:

Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.
Conduit shall be 25mm minimum, 16G MS.

Wire:

All wires shall be of FRLS PVC insulated copper conductor as per BOQ

MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:

The main FACP Central Console shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, panel modules including initiating circuits, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.

1. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to Emergency mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

d. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.

2. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system alarm LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

3. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

4. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a. The system trouble LED shall flash.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The 640 -character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
5. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
a. The system security LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640 -character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
6. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
a. The system pre-alarm LED shall flash.
b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.
c. The 640-character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

Operator Control

Acknowledge Switch:

a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.

b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

Signal Silence Switch:

Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.

1. Drill Switch:

Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

2. System Reset Switch:

Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

3. Lamp Test:

The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.

4. Scroll Display Keys:

There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

5. Print Screen:

Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640character display to the printer.

System Capacity and General Operation:

1. The control panel shall be capable of expansion via up to 10 SLC modules. Each module shall support a maximum of 250 analog/Intelligent/addressable devices for a maximum system capacity of 1000 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.
2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company / software programming.
3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

The FACP shall be able to provide the following software and hardware features:

a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

d. Action: If programmed for action, and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on alarm level.

e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.

g. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of NFPA 72/EN54.

h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.

j. History Events: The panel shall maintain a history file of the last 5000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 5000 event history file.

k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.

l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID’s and associate that ID with the corresponding address of the device.

m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or “drill”. If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function

n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
Incorporate two alternative methods to prevent unauthorized use of the manual controls (with the exception of the 'SILENCE BUZZER' control) using a key, (RFID (Mandatory) and/or a password

o. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions

p. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

r. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

s. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

t. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non-fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by SLC points, panel circuits, logic zones, annunicators, releasing zones, spal zones, and trouble zones.

u. Local Mode: If communication is lost to the central processor the system shall provide added loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

v. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will resound the panel sounder.

w. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

x. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bit-mapped graphic to the display screen. Graphic shall display when all systems are normal.

y. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

z. Tracking/Latching Duct: The system shall support both tracking and latching duct detectors.

aa. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.

bb. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.

cc. Security Monitor Points: The system shall provide means to monitor any point as a type security.

dd. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation

automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field- supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.

ee. Control By Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.

ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.

gg. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.

hh. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

ii. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.

jj. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.

kk. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone with four abort options to satisfy any local jurisdiction requirements.

ll. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

Central Processing Unit

1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
2. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.
3. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
5. Consistent with UL864, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

7. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
8. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.
9. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.
10. The CPU shall provide one high-speed serial connection for support of network communication modules.
11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

Display

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
3. The system display shall provide a 640 character backlit alphanumeric Liquid Crystal Display (LCD) or 8.4”inch Colour Touch Screen Display. It shall also provide ten Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.
4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming / software programming.
5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640character LCD.

Loop (Signaling Line Circuit) Control Module:

1. The control panel shall be capable of expansion via up to 10 SLC loops. Each loop shall support minimum 125 detectors & 125 devices excluding 20% buffer for a system capacity of 3000 points including buffer.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Style 6 (Class B) circuit.
4. The SLC interface board shall be able to drive an NFPA Style 6 twisted shielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Style 6, no twist, no shield circuit up to 3,000/14,000 feet in length. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.
5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine any no. whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic / by module detector testing and the automatic determination of detector maintenance requirements.

Enclosures:

1. The control panel shall be housed in a UL-listed/EN54 cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.
3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be site configured for either right or left hand hinging.
4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

Power Supply:

1. The Addressable Main Power Supply shall operate on 240 VAC, 50 Hz, and shall provide all necessary power for the FACP.

2. The Addressable Main Power Supply shall provide sufficient power to the CPU, using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25-200 amp-hours within a 48-hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power-limited per 1995 UL864 requirements.

System Circuit Supervision:

1. The FACP shall supervise all circuits to intelligent devices, annunciators and conventional peripherals and annunciate loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding and print the information in the history buffer and on a printer.
2. Sprinkler system valves, standpipe control valves, PIV and main gate valves shall be supervised for off-normal position.

Field Wiring Terminal Blocks:

All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

Printer

1. Printers shall be of the automatic type, printing code, time, date, location, category, and condition.
2. The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table and UL, ULC listed. The printer shall communicate with the control using an interface complying with Electrical Industries Association standard EIA-232D. The printer power shall be 230 VAC @ 50 Hz.
3. Thermal printers are not acceptable.
4. The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery backup if AC mains are lost. The strip printer shall be UL 864 listed.

Field Programming

1. The system shall be programmable, configurable and expandable in the field with / without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. It shall be possible to program through the standard FACP keyboard all system functions / software.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.

Specific System Operations

1. Smoke Detector Sensitivity Adjust: Software means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.
2. Alarm Verification: Each of the intelligent addressable Smoke Detectors in the system may independently selected and enable to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. System Point Operations:

a. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.

b. System output points shall be capable of being turned on or off from the system keypad or the video terminal.

4. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
   a. Device Status.
   b. Device Type.
   c. Custom Device Label.
   d. Software Zone Label.
   e. Device Zone Assignments.
   f. Analog Detector Sensitivity.
   g. All Program Parameters.
5. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.
   The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
   If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

Signaling Line Circuits (SLC)

Each FACP or FACP network node shall support up to two SLCs. Each SLC interface shall provide power to and communicate with up to 159intelligent detectors (ionization, photoelectric or thermal) and 159/125 intelligent modules (monitor or control) for a loop capacity of 318/250 devices. The addition of the optional second loop shall double the device capacity, supporting a total of 636 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.

CPU shall receive analog information from all intelligent detectors to be processed to determine whether normal, alarm, pre-alarm, or trouble conditions exist for each detector. The software shall automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information shall also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

Serial Interfaces

The system shall include two serial EIA-232 interfaces. Each interface shall be a means of connecting UL Listed Information Technology Equipment (ITE) peripherals.

One EIA-232 interface shall be used to connect an UL-Listed 40 or 80 column printer. Printers that are not UL-Listed are not considered acceptable substitutes.

One EIA-232 interface shall be used to connect a UL-listed CRT terminal. This interface shall include special protocol methods that allow off-site monitoring of the FACP over standard dial-up phone lines. This ancillary capability shall allow remote readout of all status information, including analog values, and shall not interfere with or degrade FACP operations when used. It shall allow remote FACP Acknowledge, Reset, or Signal Silence in this mode. It shall also allow adjustment of detector sensitivity and readout of the history file.
The system shall include an EIA-485 port for the serial connection of optional annunciators and remote LCD displays.
The EIA-485 interface may be used for network connection to a proprietary-receiving unit.

Digital Voice Command Center

The Digital Voice Command Center located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset.

Function: The Voice Command Center equipment shall perform the following functions:
Operate as a supervised multi-channel emergency voice communication system.
Operate as a two-way emergency telephone system control center.

Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.

Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.

Provide all-call Emergency Paging activities through activation of a single control switch.

As required, provide vectored paging control to specific audio zones via dedicated control switches.

Provide a factory recorded “library” of voice messages and tones in standard WAV. File format, which may be edited and saved on a PC running a current Windows® operating system.
Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the VCC shall not inhibit the emergency operation of other nodes on the fire alarm network.

Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.

The Digital Voice Command shall be modular in construction, and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without requiring use of any external computers or other programming equipment.

The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.

Audio Amplifiers

he Audio Amplifiers will provide Audio Power (@70 Volts RMS) for distribution to speaker circuits.

Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).

The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:

Earth Fault on DAP A (Digital Audio Port A)
Earth Fault on DAP B (Digital Audio Port B)
Audio Amplifier Failure Detected
Trouble
Active Alarm Bus input

Audio Detected on Aux Input A
Audio Detected on Aux Input B
Audio Detected on Fire Fighter's Telephone Riser
Receiving Audio from digital audio riser
Short circuit on speaker circuit 1
Short circuit on speaker circuit 2
Short circuit on speaker circuit 3
Short circuit on speaker circuit 4
Data Transmitted on DAP A
Data Received on DAP A
Data Transmitted on DAP B
Data Received on DAP B
Board failure
Active fiberoptic media connection on port A (fiberoptic media applications)
Active fiberoptic media connection on port B (fiberoptic media applications)
Power supply Earth Fault
Power supply 5V present
Power supply conditions – Brownout, High Battery, Low Battery, Charger Trouble
The audio amplifier shall provide the following built-in controls:
Amplifier Address Selection Switches
Signal Silence of communication loss annunciation
Reset
Level adjustment for background music
Enable/Disable for Earth Fault detection on DAP A
Enable/Disable for Earth Fault detection on DAP A
Switch for 2-wire/4-wire FFT riser.

Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.

Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).

System shall be capable of backing up digital amplifiers.

Audio Message Generator (Prerecorded Voice)/Speaker Control:
Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.

A built-in microphone shall be provided to allow paging through speaker circuits.

Speaker Switches/Indicators
The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

Fire Fighters Telephone System
The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

Waterflow Operation
An alarm from a waterflow detection device shall activate the appropriate alarm message on the main panel display; turn on all programmed notification appliance circuits and shall not be affected by the signal silence switch.
Supervisory Operation

An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
Signal Silence Operation
The FACP shall have the ability to program each output circuit (notification, relay, speaker etc) to deactivate upon depression of the signal silence switch.
Non-Alarm Input Operation
Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.
SYSTEM COMPONENTS:
Printer
The printer shall provide hard-copy printout of all changes in status of the system and shall time-stamp such printouts with the current time-of-day and date. The printer shall be standard carriage with 80-characters per line and shall use standard pin-feed paper. The printer shall be enclosed in a separate cabinet suitable for placement on a desktop or table. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 230 VAC @ 50 Hz.
The system shall have a strip printer capable of being mounted directly in the main FACP enclosure. Alarms shall be printed in easy-to-read RED, other messages, such as a trouble, shall be printed in BLACK. This printer shall receive power from the system power supply and shall operate via battery back-up if AC mains are lost. The strip printer shall be UL 864 listed.

Repeater Panel (RP)
A network control annunciator shall be provided to display all system intelligent points. The NCA shall be capable of displaying all information for **200,000 points on the network**. Network display devices, which are only capable of displaying a subset of network points, shall not be suitable substitutes.

The NCA shall include a 8.4”” (1024 x 600) Color touchscreen display with QWERTY Keypad. Additionally, the network display shall include environmental adjustment controls to maximize LCD legibility and the ability to scroll events by type. i.e. Fire Alarm, Supervisory Alarm, Trouble, etc.

The network control annunciator shall have the ability to display multiple events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type.

The NCA shall mount in any of the network node fire alarm control panels. Optionally, the network display may mount in a backbox designed for this use and shall connect to the network over either a wire or fiber interface.

The network control annunciator shall have an event history buffer capable of storing a minimum of 1000 events in non-volatile memory. Additionally, the NCA shall have a fire alarm history buffer capable of storing a minimum of 200 events in non-volatile memory. Systems that do not protect fire alarm events from being overwritten by other events are not suitable substitutes.

The NCA shall include Three USB connection, USB C, USB B Micro, and USB A, industry standard RS-232 ports for UL864 listed printers and CRT's. These peripheral devices shall print or display network activity.

The network control annunciator shall include control switches for system wide control of Acknowledge, Signal Silence, System Reset, Drill, and local Lamp Test. A mechanical means by which the controls switches are "locked out", such as a key, shall be available.
The NCA shall include long life LEDs to display Power, Fire Alarm, Pre-Alarm, Security Alarm, System Trouble, Supervisory, Signals Silenced, Disabled Points, Other (non-fire) Events, and CPU Failure.

The network control annunciator shall include a Master password and up to nine User passwords. Each password shall be up to eight alpha-numeric characters in length. The Master password shall be authorized to access the programming and alter status menus. Each User password may have different levels of authorization assigned by the Master password.

The NCA shall allow editing of labels for all points within the network; control on/off of outputs; enable/disable of all network points; alter detector sensitivity; clear detector verification counters for any analog addressable detector within the network; clear any history log within the network; change the Time/Date settings; initiate a Walk Test.

The network control annunciator shall support an optional Windows TM based program utility. This utility shall allow the user create an NCA database, upload/download an NCA database, and download an upgrade to the NCA executive. To ensure program validity, this utility shall check stored databases for errors. A compare function shall be included to identify differences between databases.

For time keeping purposes the NCA shall include a time of day clock.

Speakers:
All speakers shall operate on 70 VRMS or with field selectable output taps from 0.25 to 2.0 Watts.

Speakers in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).

Frequency response shall be a minimum of 400 HZ to 4000 HZ.
The back of each speaker shall be sealed to protect the speaker cone from damage and dust.

Network Control Station / Graphics User Interface
The NCS shall utilize a Microsoft(tm) operating system. Each Network Control Station shall be capable of graphically annunciating and controlling all network activity and at least 2,50,000 network points. Network display devices that are only capable of displaying a subset of network points shall not be suitable substitutes.
The NCS shall be an IBM (or compatible) personal computer with the following minimum requirements: Intel Pentium II(tm)-processor, operating at a minimum of 400 Mhz, 128Mbytes of RAM, 8 Mbytes Video RAM, 1.44 Mbyte floppy drive, 3.2 Gbyte hard disk, mouse, 32X CD-ROM, 3PCI / 1 ISA expansion slots, internal 3.2 Gbyte tape drive, sound card, 200 watt power supply, and SVGA graphics with a screen resolution of 1024 x 768. The network control station shall include a 19-inch monitor.
The NCS shall be capable of storing over 100,000 network events in a history file. Events shall be stored on hard disk and shall be capable of back-up storage to a tape drive. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out. The ability to print NCS history files shall also be available.
The NCS shall use a Windows(tm) dialog box technology to address, interrogate, control, and/or modify intelligent points on each fire alarm node. This shall include, and not be limited to: Activating outputs, enabling or disabling points, adding or removing intelligent points, viewing intelligent detector sensitivity levels and modifying point information (custom messages, detector type, verification, day/night selection etc.)
The NCS shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device. The NCS shall also provide the ability to auto-vector to the floor plan (screen) of the device that is active. By selecting a device in the graphic presentation, the operator of the NCS shall have the ability to log onto the corresponding node and interrogate the associated intelligent point.
The NCS shall have the ability to provide the following information through a Windows(tm) pull down menu: An Event Counter that contains the number of new and total events on the network. The information that is displayed shall consist of Fire Alarms, Pre-Alarms, Security Alarms, Supervisory Alarms, and Troubles. A Detailed Event window that contains all Off-Normal events, both unacknowledged and acknowledged that are present in the system. It shall contain two views, Fire events and Non-fire events that shall be user selectable. A Current Event window that shall contain all network and local events as well as system

messages with a maximum of 1,000 events displayed. A Disabled Device window that shall contain all disabled devices in the system.
The NCS shall have the option, from a Windows pull down menu, to connect to a third party paging service that allows the NCS to automatically send text-based messages regarding system status to a typical text pager.
The NCS shall include help screens, available to aid the user without leaving the selected application screen.
The NCS shall be UL-Listed for fire protection (UL864) and burglary (UL1076).
The NCS shall interface with other panels as a node in the pear to pear network.
The operator shall be able to monitor the FFT system from GUI software and shall be able to monitor and control Integrated Voice Evacuation System.
The NCS shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high-level "administrator" who shall have complete control over levels of control. If no action has taken place on the NCS after 10 minutes, the current operator shall be logged out and require a new log-in.
The NCS shall include an industry-standard RS-232 port for a UL864 listed printer.
The NCS shall be a table top hardware configuration.

Interactive Firefighters' Touchscreen Display

The network will interface and report the individually monitored system's alarm status via a user-friendly Graphical User Interface (GUI) based software.
The software shall operate under Microsoft® Windows® 7 or Higher Operating System in Embedded platform as manufactured by Microsoft Corporation.
The GUI based software must be capable of graphically representing the facility being monitored with floor plans and icons depicting the actual locations of the fire alarm device locations. It shall be capable of mapping at least 2,50,000 network points

The software shall use a 1280 pixel x 1024 pixel GUI display capable of showing a large primary floor plan display, a site plan representative of an aerial view of the facility, the first active fire alarm on the system.
The software shall permit automatic navigation to the screen containing an icon that represents the first fire alarm device in alarm in the event of an off-normal condition.
The fire alarm device icon shall be visible only when it is in an alarm (or active) condition.
The software shall display the activated smoke detectors in a time sequence to track smoke progression.
The software shall allow the importation of externally developed floor plans in Windows Metafile (WMF), JPEG (JPG), Graphics Interchange Format (GIF) and Bitmap (BMP) format.
The software shall provide a intuitive and easy way to navigate to different screens representing floors and areas within a facility.
The system shall provide for continuous monitoring of all fire alarm conditions regardless of the current activity displayed on the screen.
The software shall display "YOU ARE HERE" along with icons representing standard building objects (stairs, elevators, etc) to be shown on the floor plan.
The software shall allow icons that represent hazardous materials stored in a facility.
The software shall provide a screen that displays preprogrammed building contact information.
The software shall provide a screen the displays building occupancy and other general building information.
The software shall allow a site plan to be imported that shows an aerial view of the facility.
The software shall display all active fire, supervisory, and security events within an event list.
Bidders also have the option to propose UL Listed Software with UL Listed Industrial Grade Hardware to achieve this functional requirement.

Cloud Based Facility Management Software

Remote cloud based facility management monitoring solution utilizing cloud based software-as-a-service web application & supplementary network gateway hardware. System shall provide secure web access to cloud based web application using any of the web browsers like Google Chrome (preferable), Internet Explorer etc. from any computer/ tablet/ smartphone connected over internet via defined credentials – username and password.
The Cloud Based Facility Management Software shall be a software product that provides a platform and applications designed to integrate multiple disparate security applications and devices and control them through one comprehensive user interface.
The Cloud Based Facility Management Software shall be agnostic in regard to third-party platform integrations and shall not require or rely on its own subsystem, such as video management system, for operation.
The Cloud Based Facility Management Software shall be based on a service-oriented architecture (SOA) with the ability to

distribute alarm and event processing services onto multiple servers. It shall also be possible to install the software in a Failover Cluster for increased availability.
The Cloud Based Facility Management Software should be capable to use latest DevOps technologies for deployment and continuous development.

The Cloud Based Facility Management Software shall integrate a wide range of security products including Video Management Systems (VMSs), Access Control Systems (ACSs), Fire Alarms, Intruder Alarm and Perimeter Intrusion Detection Systems (PIDSs). The Cloud Based Facility Management Software shall be capable of receiving events from integrated systems and execute functions on the integrated systems. The Cloud Based Facility Management Software shall incorporate a graphical workflow designer to create and modify process guidance that are presented to operators in response to alarms.

It shall be possible to change the workflows and process guidance, so that the relevant information is provided to the operators, increasing the situational awareness while resolving incidents.
The Cloud Based Facility Management Software shall include interactive map capability including the display of alarm locations, data layers, and camera infrastructure locations. It shall be possible to display maps from GIS, Web Map Service (WMS), site map in DWG or PNG format, Keyhole Markup Language (KML) and OpenStreetMap (OSM) compatible map data source.
Owner shall receive login and passwords at first training session. The Owner shall have full licensing and full access rights for remote monitoring system.
Cloud Based Application: The cloud-hosted web application shall provide an intuitive user interface and shall provide the following features as a minimum:
Real time view of all connected desperate system effectiveness
Multi-location unified view
Custom dashboard view
Device level detailed information including current status.
Event list
System reports
Alerts Handling SOP
Device Error and non-functionality alerts
Panel & System report
Custom reports
Report export in PDF/ DOC format
Report scheduler Settings – add, delete, modify email addresses
Email ID settings for emailing critical alarms
Web Browser Navigation: The cloud hosted web application shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using Google Chrome web browser to accomplish requirements of this specification. The Web application shall (as a minimum) provide for navigation, and for display of intuitive dashboards, device information, alarms/events, reports, configuration menus for report settings
Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
Navigation: Navigation through the web application shall be accomplished by clicking on dynamic links on dashboards to access detailed system information and by clicking on appropriate tabs for application settings and preferences. Both the tabs and dynamic links shall be displayed simultaneously, enabling the operator to select a specific system information and application settings and preferences.
System Dashboards: The system dashboard shall provide several functional information for each system specified. This view shall be accessed by right after logging in to the system:
Each building dashboard (in case of multiple buildings) shall be visible along with system effectiveness of different Sub-System alarm information like –
Number of panels
Number of devices
Detailed information Section – this can be accessed upon clicking relevant links. Detailed system information like device list along with corresponding address, current status and time stamping can be viewed. Events data is also visible.
Search: User shall have multiple options for searching data based upon device type, device status.

Reports: The Web application can be used to access system health reports of past and as-on-date. Provision for system reports to be emailed to predefined email IDs and time intervals in PDF or DOC format. Different report types –
Fault Handling report – Effective measurement of turnaround time (TAT) of various
issues and capable of drawing detailed report at individual fault level.
Device Replacement Report - Proactive alerts along with active insights on the faulty devices & detectors which need attention or replacement helping customers save time and reducing fire risk.
Device Contamination Report - Real time statistics of device contamination showing dirt levels along with detector efficiency
Panel & System Report - List of panel faults with trouble date and time stamped, beyond the panel memory of 5000 events can store upto 100,000 events.
Alarms: Alarms associated with a specific equipment and or device, shall be displayed dynamically in a window.
The Alarm remain in the application until it is acknowledged, or Panel is reset.
The Alarm status also viewed in the LIST VIEW section of the application.
Security Access: Cloud hosted Remote monitoring web application for different sub-systems can be accessed by Google chrome web browser and shall require a Login Name and Strong Password. Separate access credentials for the owner and service provider shall be provisioned.

The Cloud Based Facility Management Software shall provide a monitoring interface for display of live and playback video from multiple connected CCTV Devices in the same video display area. The interface shall be unified and consistent regardless of the underlying video system manufacturer. It shall provide functionality for viewing live video, recorded video, saving snapshots, viewing video in full screen, should be able to forward and backward in video player instantaneously while live monitoring and playback. Should have PIP mode in live view.
The Cloud Based Facility Management Software shall contain a dedicated feature for searching video. The feature shall allow to search of all related video for an incident regardless of sub-system type or combination of sub-systems providing the video for the location where the incident occurred. The video shall be stored on a configured network share for easy access.
The Cloud Based Facility Management Software shall allow to manual/schedule trigger to record video during an incident in a centralize location.
The Cloud Based Facility Management Software shall have the ability to use databases such as Microsoft SQL/PostgreSQL Server Services. It shall allow to generate reports on data collected and generated by the Cloud Based Facility Management Software shall be possible to generate these reports automatically or because of an event.
The Cloud Based Facility Management Software shall contain user interface components for the creation of Dashboards. Dashboard components shall include Charts (bar, pie, donut), RSS, Grids, Lists, Number labels. It shall be possible to link the Dashboard indicators to data sources.
The Cloud Based Facility Management Software shall allow for granular permissions control for users and user groups and include permission inheritance. Areas that it shall be possible to restrict through permission configuration shall include: Alarm visibility, access to physical locations, visibility of CCTV infrastructure, video playback control, configuration etc like this 100+ rights can be configured.
The Cloud Based Facility Management Software shall include an easy-to-use administration interface containing functionality for managing users and groups, viewing and configuring devices infrastructure, managing branch onboarding, CCTV tag creation, alert configuration: color, code and dynamic zone name.
The Cloud Based Facility Management Software shall be designed to run with thin clients using any browser and shall support Windows Failover clustering. Software and its components shall support windows and Linux operating systems.
The Cloud Based Facility Management Software shall support integration with different protocols and APIs.
The Cloud Based Facility Management Software shall support a flexible deployment architecture. Alert receiver, scheduler, media software, database services may run on different server and application on other server to reduce latency and performance optimization.
The Cloud Based Facility Management Software shall include dynamic video wall with adaptive increase in video channel grids according to number of cameras being monitored.
The Cloud Based Facility Management Software shall include a graphical workflow engine, allowing users to create custom logic and workflows based around the customers' business process without changing the core build.
The Cloud Based Facility Management Software shall be able to integrate any sub-system, not just those that are traditionally related to security.
The Cloud Based Facility Management Software must seamlessly integrate with Risk Intelligence, mass notification and other critical communication methodologies.

GATEWAY AND WEB SERVERS

a. BACnet Interface Gateway: The system shall be capable of being interfaced with BACNet compliant clients. A BACnet interface supporting BACnet/IP communication shall be available from the fire alarm control panel manufacturer. BACnet shall support 14000 data points. BACnet gateway shall communicate with all the panels in a peer to peer network.

b. MODbus Interface Gateway: The system shall be capable of being interfaced with MODbus compliant clients. A MODbus interface supporting MODbus/TCP communication shall be available from the fire alarm control panel manufacturer. MODbus shall support 12000 data points. MODbus gateway shall communicate with all the panels in a peer to peer network.

c. Webserver: The system shall support a webserver allowing remote connection via the Internet or Intranet. Authorized users will have the ability to view panel/network history, event status and device properties. The webserver shall also support sending event information via email or text to up to 50 registered users, the webserver shall be available from the fire alarm control panel manufacturer.

d. Web Portal Interface: The system shall be capable of being interfaced with a web portal to integrate with Inspection and Service Manager utilities. The web portal and inspection and service manager utilities shall be available from the fire alarm control panel manufacturer.

SYSTEM COMPONENTS - ADDRESSABLE DEVICES

Addressable Devices - General

1. Addressable devices shall provide an address-setting means using **rotary /decade switches**. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute.
2. Addressable devices shall use simple to install and maintain decade, /decade address switches.
3. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
4. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
5. **Addressable smoke and thermal detectors shall provide dual alarm and power/polling bi-colour LEDs.** Both LEDs shall flash green under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
6. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
7. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
8. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications. The system shall also support an intelligent programmable sounder base, the programmable sounder base shall be capable of providing multiple tones based on programming and at a minimum be capable of providing a Temp-4 tone for CO (Carbon Monoxide) activation and a Temp-3 tone for fire activations and be capable of being synchronized with other programmable sounder bases and common area notification appliances; 85 DBA minimum.
9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (PHOTO, THERMAL).
10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
12. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.

13. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be available.
14. Detectors / Bases with connection terminals exposed to Ceiling / False Ceiling shall be provided with Protective Insulation of the same make as of Detectors.

Addressable Manual Call Point (Break Glass / Pull Down Type)

1. Addressable manual call point shall send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
3. Manual fire alarm boxes shall be constructed of Lexan / ABS Plastic with clearly visible operating instructions provided on the cover. The word FIRE / Fire Sign shall appear on the front of the stations.

Intelligent Photoelectric Smoke Detector:

The intelligent photoelectric smoke detector shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

1. Designed to meet UL268 7th Edition.
2. Modern profile with White color for improved aesthetics.
3. Sensitvity Range of 0.5% to 4.0% obs/ft
4. Stable communication technique with noise immunity.
5. Low standby current. 200 micro Amps @ 24 VDC
6. Two-wire SLC connection.
7. Rotary, /decade addressing
8. Dual bi-color LED design providing 360° viewing angle. LEDs blink green in normal condition and illuminate steady red on alarm
9. Remote test feature from the panel.
10. Walk test with address display
11. Built-in functional test switch activated by external magnet.
12. Built-in tamper-resistant feature.
13. Sealed against back pressure.
14. Expanded color options.
15. Optional relay, isolator, and sounder bases.

Intelligent High Sensitivity Photo Smoke Detector

The intelligent high sensitivity photo smoke detector shall be a spot type detector that incorporates an extremely bright high sensitivity diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.

1. Designed to meet UL268, 7th Edition
2. The high sensitivity detector shall have conductive plastic so that dust accumulation is reduced significantly.
3. **The intelligent high sensitivity photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.**
4. The high sensitivity detector shall not require expensive conduit, special fittings or PVC pipe.
5. The intelligent high sensitivity photo detector shall support standard, relay, isolator and sounder detector bases.
6. The high sensitivity photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
7. The high sensitivity photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

Intelligent Multi Criteria Detector

The intelligent multi-criteria detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The detector design shall allow a wide sensitivity window, 0.5 to 4.0% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.

1. **Designed to meet UL268, 7th Edition**

2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena**.**

Intelligent Thermal Detectors

The intelligent thermal detectors shall be addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. **A high heat thermal detector rated at 190 degrees Fahrenheit (87.8 degrees Celsius) shall also be available.** The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

1. Modern profile with White color for improved aesthetics.
2. Advanced thermal technology for fast response.
3. Fixed temperature model factory preset to 135°F
4. Rate of Rise model preset to 15°F/min
5. High temperature model factory preset to 190°F
6. Low standby current. 200 micro Amps @ 24 VDC
7. Two-wire SLC connection.
8. Rotary, /decade addressing
9. Dual bi-color LED design providing 360° viewing angle.LEDs blink green in normal condition and illuminate steady red on alarm
10. Remote test feature from the panel.
11. Walk test with address display
12. Built-in functional test switch activated by external magnet.
13. Built-in tamper-resistant feature.
14. Sealed against back pressure.
15. Optional relay, isolator, and sounder bases.

Intelligent Duct Smoke Detector

The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely.

Advanced Multi-Criteria Intelligent Fire/CO Detector

1. Advanced Multi-Criteria Fire/CO detector be an addressable advanced multi-criteria smoke detector with a separate signal for carbon monoxide (CO) detection per UL 2075 standards.
2. **The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C).** The device shall be able to indicate distinct smoke and heat alarms.
3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
5. The detector shall be capable of automatically adjusting its sensitivity by means of drift compensation and smoothing algorithms. The device shall provide unique signals to indicate when 20 percent of the drift range is remaining, when 100 percent of drift range is used, and when there is a chamber fault to show the unit requires maintenance.

6. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self-test failure, IR self-test failure, and freeze warning.
7. The detector shall provide address-setting means on the detector head using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the detector address are not acceptable. The detector shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the detector address (including temporary connection at the panel) are labor intensive and not acceptable. Each detector occupies any one of at least 150 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status.
8. The detector shall provide a test means whereby it will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a switch) or initiated remotely on command from the control panel. There shall be four test methods: functional magnet, smoke entry aerosol, carbon monoxide aerosol or direct heat method.
9. The detector shall provide two LEDs to provide 360° visibility. The LEDs shall be placed into steady red illumination by the control panel indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED. The detector must be capable of connecting to a sounder base that provides both temporal 3 and temporal 4 patterns for fire and CO alarm.
10. Two LEDs on the sensor shall be controlled by the panel to indicate sensor status. Coded signals, transmitted from the panel, shall cause the LEDs to blink, latch on, or latch off. Refer to the control panel technical documentation for sensor LED status operation and expected delay to alarm.
11. The detector shall be plug-in mounted into a twist-lock base. The detector shall be constructed of off-white, UV-resistant polymer and shall be detachable from the mounting base to simplify installation, service and maintenance. Mounting base wiring connections shall be made by means of SEMS screws. The detector shall allow pre-wiring of the base and the head shall be a plug-in type. The mounting base shall be mounted on a junction box that is at least 1.5 inches (3.81 cm) deep. The mounting base shall be available to mount to standard junction boxes. Suitable boxes include:
    a. 4.0" (10.16 cm) square box with and without plaster ring.
    b. 4.0" (10.16 cm) octagonal box.
    c. 3.5" (8.89 cm) octagonal box.
    d. Single-gang box.
    e. Double-gang box

12. Meets Agency Standards
    a. ANSI/UL 268 -Smoke Detectors for Fire Alarm Signaling Systems
    b. CAN/ULC-S529- Smoke Detectors for Fire Alarm Systems
    c. FM 3230-3250- Smoke Actuated Detectors for Automatic Fire Alarm Signaling
    d. UL 2075 – Gas and Vapor Detector and Sensors – Systems Connected

Intelligent Addressable Aspiration Detector

The intelligent aspiration detector shall be an addressable aspiration detector that communicates directly with the fire alarm control panel via the SLC communication protocol, no modules or high level interfaces shall be required.. The aspiration detector shall have Infra-red laser optical smoke detection for a wide range of fire detection with enhanced immunity to nuisance particulates. The FACP shall be capable of monitoring and annunciating up to five smoke event thresholds and eleven trouble conditions. Each event threshold shall be capable of being assigned a discrete type ID at the FACP.

Intelligent Addressable Reflected Beam Detector

1. The detector shall be an intelligent reflected beam smoke detector. The detector shall include a transmitter and receiver both within the detector unit (imager). The detector shall include a reflector. The detector shall allow for beam alignment between the detector and the reflector to be done at the detector. The detector shall have automatic sensitivity settings. The detector shall be rated for use in temperatures between 32° F and 100° F. The Operating Humidity Range shall be 0 to 95% RH non-condensing. An internal heater shall be provided to prevent condensation build-up in the detector when installed in low temperatures. Protection range shall be 16 ft. to 328 ft. Optical filters shall be available for a calibrated test to be performed. An optional unit shall be available that shall allow a remote electronic smoke simulated test at ground level. The detector (imager) shall be adjustable 50° horizontally and 20° vertically. The reflector shall be adjustable 10°. In Normal (standby) mode the local LED shall blink Green and in Alarm mode the local LED shall be solid Red, controlled by the fire panel. In Trouble mode, the local LED shall blink Yellow. During alignment, the arrow LEDs on the detector (imager) shall guide the alignment of the detector (imager) to the reflector.
2. It should be listed to Underwriters Laboratories UL 268 for Fire Protection Signaling Systems.
3. Electrical Specifications: The detector (imager) shall be loop powered. The Operating Voltage shall be; Nominal: 24VDC, Minimum: 15VDC, Maximum: 32.0VDC. The Maximum Standby Current shall be 14mA at 24 VDC. The Maximum Alarm Current shall be 15mA at 24 VDC.

Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Class A or Class B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device)
2. The IDC zone may be wired for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional circuit of compatible Notification Appliances, 24 VDC powered, polarized audio/visual notification appliances
2. The control module NAC may be wired for Class A/B with a current rating of 2 Amps
3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.

Addressable Releasing Control Module

1. An addressable releasing module shall be available to supervise and control compatible releasing agent solenoids
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Class A/B and support one 24 volt or two 12 volt solenoids.

Addressable 4-20 mA Module

Addressable 4-20 mA module shall be available to monitor industry-standard, linear-scale, 4-20 mA protocol sensors. The module converts the sensor output to communication protocol that can be interpreted by the FACP for monitoring and display

1. The module shall support programming of up to five programmable event thresholds.
2. The System shall be FM 6320 (Factory Mutual) approved as a Gas Detection system when employed with the FMM-4-20 monitor module and industry standard 4-20 mA gas detectors.

Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other network building functions
2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.
3. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires;
4. For multiple relay control a module shall be available that provides 6 programmable Form-C relays.

Addressable Two-In / Two-Out Monitor/Relay Module

1. An addressable Two-In / Two-Out module shall be available.
2. The two-in/two-out module shall provide two Class B/Style B dry-contact input circuits and two independent Form-C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive.

Isolator Module

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

1. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
2. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
3. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
4. **If Isolator Bases are proposed, Vendor needs to consider Isolator base for all detectors**

Addressable Portable Emergency Telephone Handset Jack

1. Portable emergency telephone handset jacks shall be flush mounted on stainless steel plates as indicated on plans. Handset jacks shall be approved for emergency telephone system application.
2. Insertion of a remote handset plug into a jack shall send a signal to the fire command center which shall audibly and visually indicate the on-line condition, and shall sound a ring indication in the handset.
3. The two-way emergency telephone system shall support thirty five (35) handsets on line without degradation of the signal.
4. **Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.**

Addressable Fixed Emergency Telephone Handset

1. The telephone cabinet shall be painted red and clearly labeled emergency telephone. The cabinets shall be located where shown on drawings.
2. The handset cradle shall have a switch connection such that lifting the handset off of the cradle shall send a signal to the fire command center which shall audibly and visually indicate its on-line (off-hook) condition.
3. The two-way emergency telephone system shall support thirty five (35) handsets on line (off hook) without degradation of the signal.
4. **Remote Telephone Handset shall be capable of making paging announcement across all the zones in the system.**

Batteries

The battery shall have sufficient capacity to power the fire alarm system for not less than 48 hours in standby plus 2 hours of alarm upon a normal AC power failure.

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.

If necessary to meet standby requirements, external battery and charger systems may be used.

EXECUTION

INSTALLATION:

Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. 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 smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual fire alarm boxes shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches (1067 mm), nor more than 48 inches (122 mm) above the finished floor.

FIRE SURVIVAL / RESISTANCE CABLES

LPCB certified fire Survival / Resistance armoured / un-armoured cable (600/1000V) with class-2 Copper conductor having halogen free ceramified silicon rubber insulation as per BS EN 50363 and low smoke zero halogen (LSZH) inner & outer sheath. Should comply to EN 61034-2 & EN 60754-1. LPCB-FPC certificate to be submitted. The cables should meet fire performance circuit integrity test as per BS EN 50200: PH-120. Outer sheath should be in red colour with Anti-rodent & LSZH properties, 950°C rating for three hours.

Fire Resistance armoured / un-armoured cable should be of 600/1000 volts, twisted, with class-2 Copper conductor having halogen free ceramified silicon rubber insulation as per BS EN 50363 and LSZH inner & outer sheath. Outer sheath should be anti-rodent with LSZH properties.

The cable should retain circuit integrity as per as per BS EN 50200:PH-120.

The cables should not emit toxic gases in case of fire. The toxicity index should be less than 3 (refer NES 713).

The cables shall comply with the requirements of IEC-61034 Part 1&2 (Measurement of Smoke density of cables burning under defined conditions).

The cables shall comply with the requirements of BS EN 60754 (Determination for amount of halogen acid gas content which shall not be greater than 0.5%).

The cable manufacturer should provide factory production control certificate related to the manufacturing of Fire Resistant Wires & cables from LPCB.

TEST:

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

Verify activation of all waterflow switches.

Open initiating device circuits and verify that the trouble signal actuates.

Open and short signaling line circuits and verify that the trouble signal actuates.

Open and short notification appliance circuits and verify that trouble signal actuates.

Ground all circuits and verify response of trouble signals.

Check presence and audibility of tone at all alarm notification devices.

Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

FINAL INSPECTION:

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

INSTRUCTION:

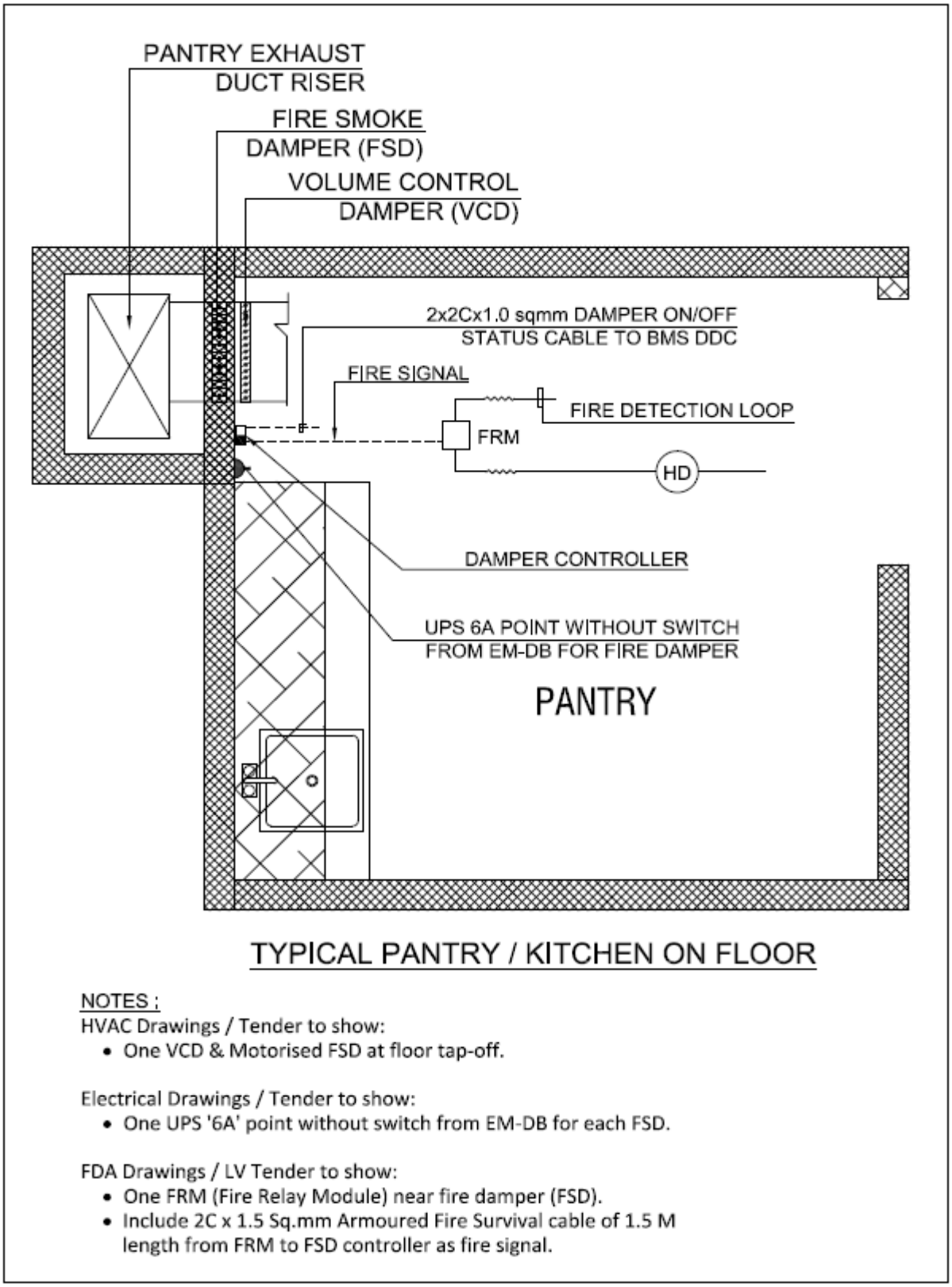
Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

FIRE SURVIVAL CABLES

2C x 1.5 sq.mm Fire Survival Armoured cable with Class-2 Copper conductor with glass mica tape, as per BS 7846, Fire Test as per BS 6387 CWZ, BSEN 8434-2, LPCB / TUV / BRE Global Certified. Fire Survival cable shall be suitable 950°C rating for three hours for fire alarm system.

PROVISION AND WIRING DETAILS FOR FIRE DAMPERS, MOTORIZED DAMPERS AND AHU'S FOR TRIPPING / OPERATION LINKED WITH FIRE DETECTION SYSTEM AND BMS



TYPICAL PANTRY / KITCHEN ON FLOOR

NOTES ;

HVAC Drawings / Tender to show:

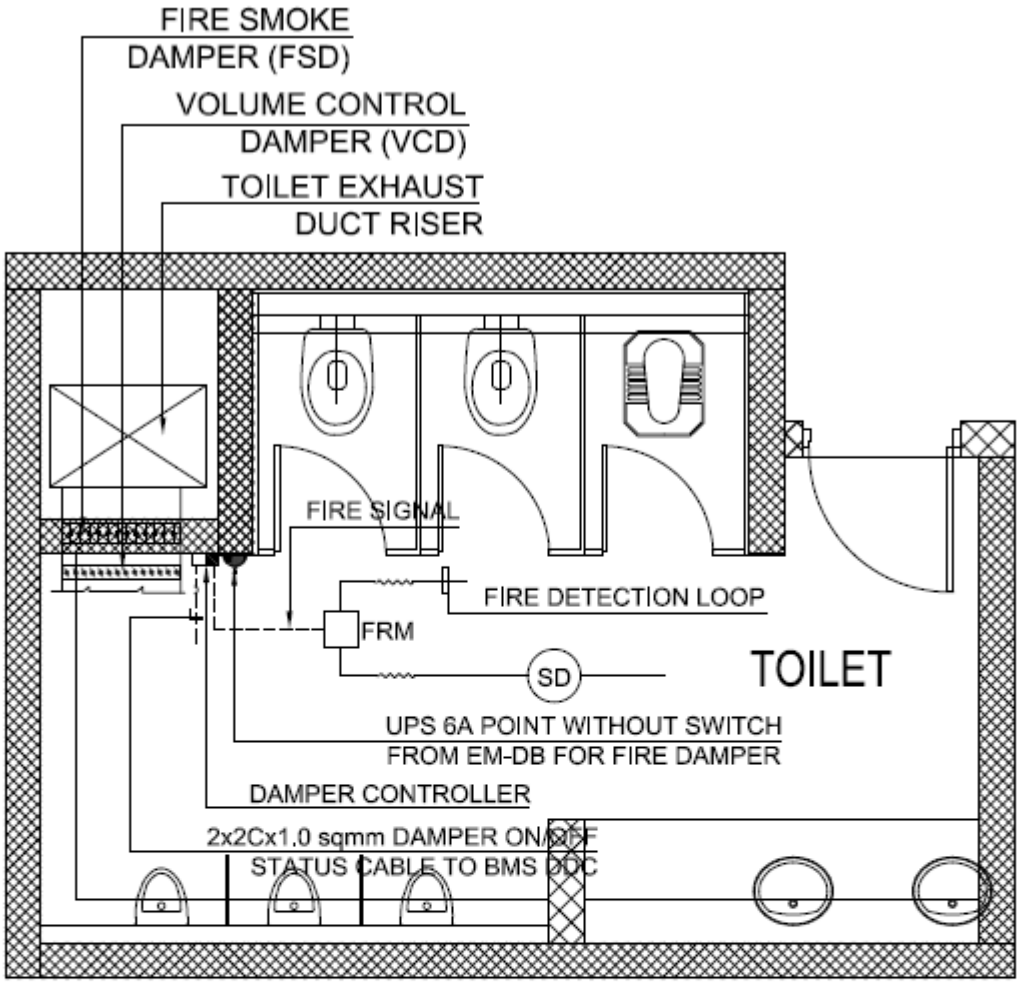
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL TOILET ON FLOOR

NOTES :

HVAC Drawings / Tender to show:

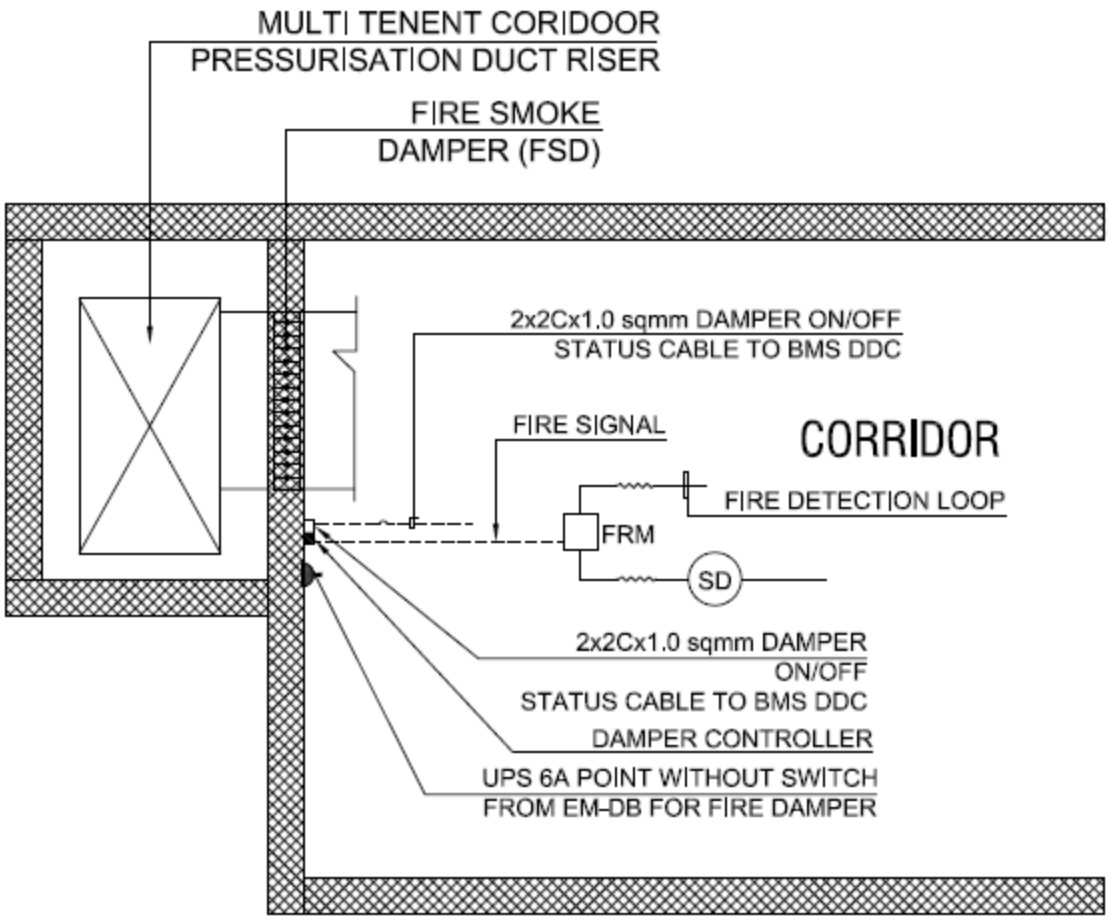
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL MULTI TENENT CORIDOOR PRESSURISATION

NOTES :

HVAC Drawings / Tender to show:

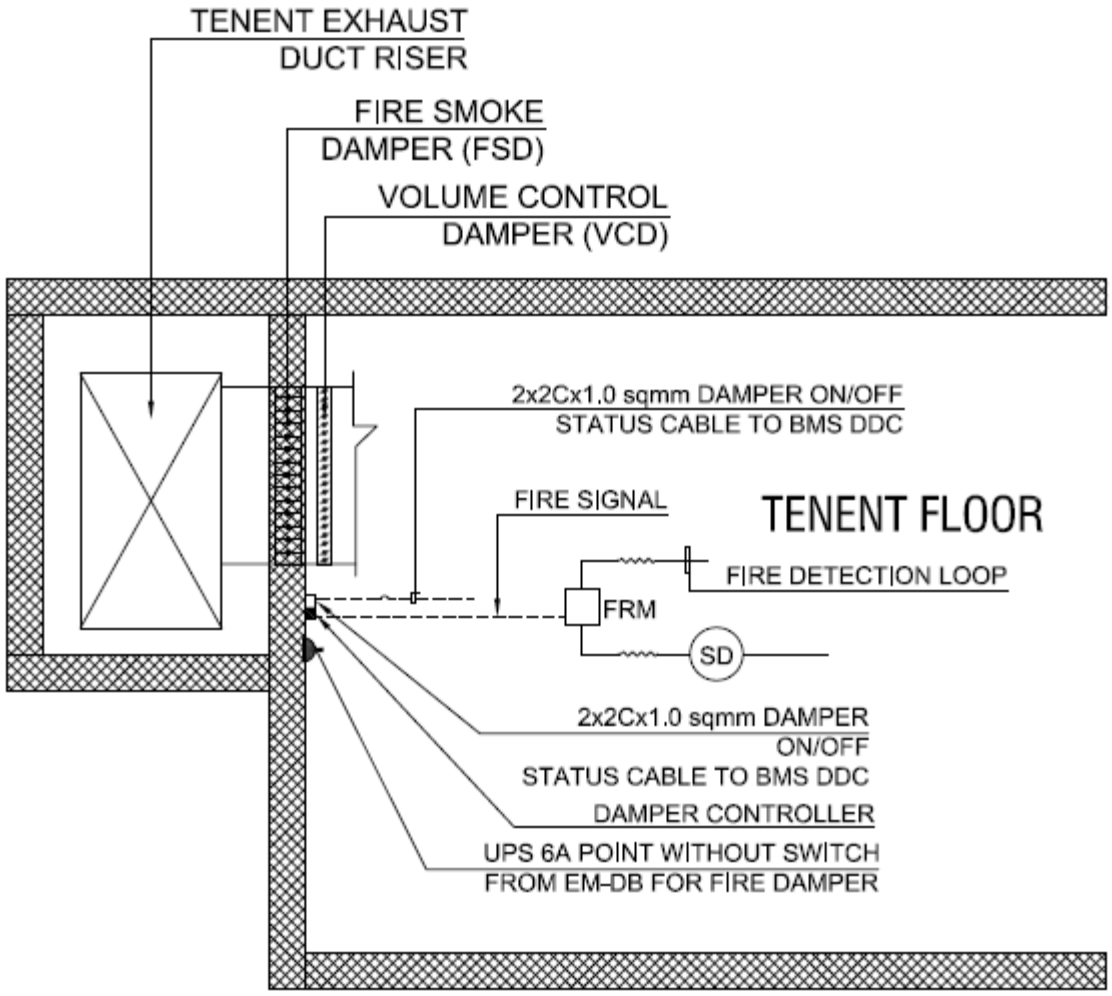
- Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL DUCT TENENT EXHAUST

NOTES :

HVAC Drawings / Tender to show:

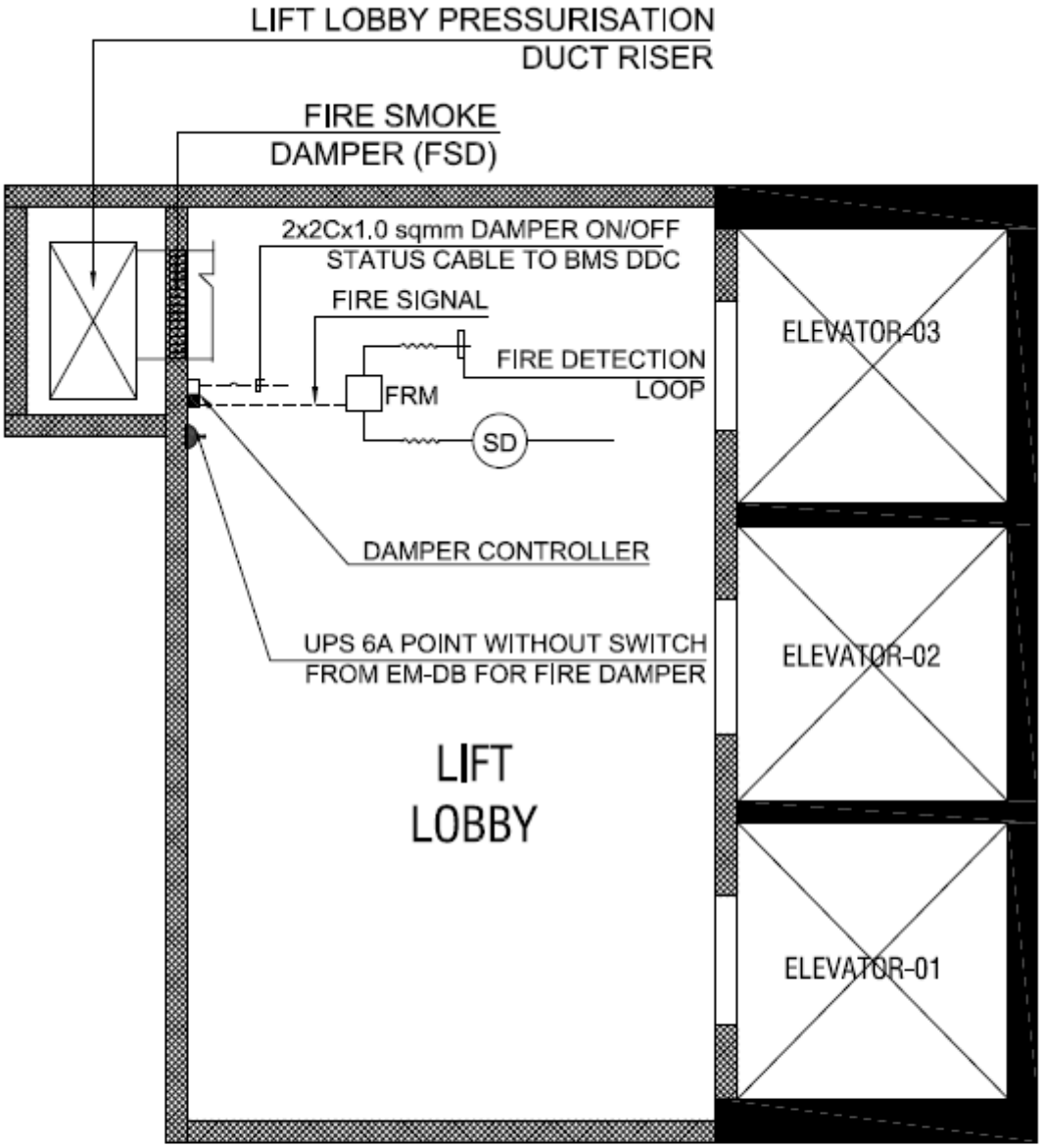
- One VCD & Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL LIFT LOBBY PRESSURISATION DUCT ON FLOOR

NOTES :

HVAC Drawings / Tender to show:

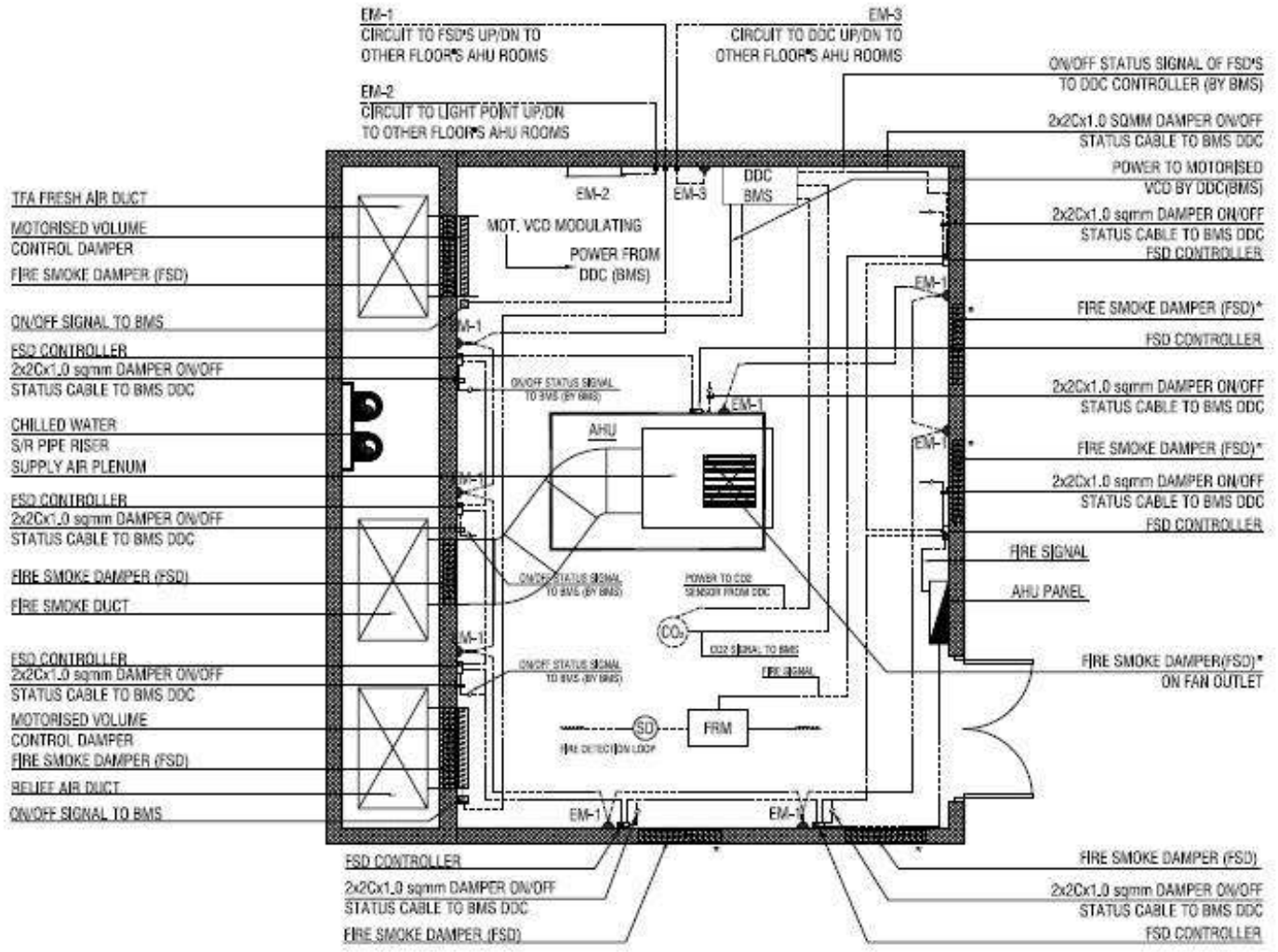
- Motorised FSD at floor tap-off.

Electrical Drawings / Tender to show:

- One UPS '6A' point without switch from EM-DB for each FSD.

FDA Drawings / LV Tender to show:

- One FRM (Fire Relay Module) near fire damper (FSD).
- Include 2C x 1.5 Sq.mm Armoured Fire Survival cable of 1.5 M length from FRM to FSD controller as fire signal.



TYPICAL AHU ROOM DETAIL

NOTES :

PROVISIONS:

HVAC:

Provide FSD's In:

- TFA duct floor tee-off.
- Smoke Exhaust duct floor tee-off.
- Relief air duct tee-off.
- AHU supply & return air duct. *
- AHU Outlet tee-off. *

Provide Motorized VCD In:

- TFA duct floor tee-off.
- Relief Air duct floor tee-off.
- Provide 2C x 1.5 Sq.mm armoured fire survival cable loop-on - loop-out from first FSD controller to last and to AHU VFD / Starter.

ELECTRICAL:

- Provide 6A UPS point without switch from EM-DB for each FSD.

FDA & LV:

- Provide smoke detector / multi detector in AHU room.
- Provide one FRM (Fire Relay Module).
- Provide 2C x 1.5 Sq.mm Copper Conductor Armoured fire survival cable from FRM to first FSD controller, say 2 M per AHU room.

* AHU SUPPLY AND RETURN AIR DAMPERS MAY BE BY TENENT AS PART OF INTERIOR FITOUT

SUBHEAD-B. **ACCESS CONTROL**

S. No.		Details	Compliance Yes / No	In case of non-compliance, deviation to be indicated
1	**2.1.1 - BIOMETRIC CUM SMART CARD ELECTRONIC READER (ECR) with OPTICAL FINGER PRINT SENSOR (WALL MOUNTED)**	Highly reliable Electronic Card Reader machine should be biometric finger scanner having contactless smart card sensing facility with finger only, card only, card + finger, Finger+ PIN etc. The finger print scanner should be scratch proof type.	Yes	
		Smart Card Reader shall comply with ISO 14443 and ISO 15693 cards Processor: 64 bit Enroll Time ≤ 2 sec. 1:1 verification ≤ 1 sec Equal Error Rate: < 0.1%	Yes	
		Clear Audio visual verification Identifiable beep sound for successful/Unauthorized/ Already Punched (successive punch).	Yes	
		Identification speed of punch: less than 1 second.	Yes	
		Finger scanner optical with minimum 500 dpi resolution.	Yes	
		Finger print reader should have High Quality Scratch Resistance Optical Sensor.	Yes	
		Finger Template storage capacity: no of templates— minimum 5000 per machine(1:N)	Yes	
		Finger print template should be ISO standard.	Yes	
		Log capacity capacity at least 50,0000.	Yes	
		No of fingers per user to be recorded: 10 fingers at the time of enrolment and at least 02 templates per user to be stored in designated readers.	Yes	
		1 : 2,000 fingerprint identification in 1 second		
		The device should be able to accept minimum 8 digit alphanumeric employee no.	Yes	
		Display: - LED/LCD with backlit Display for high visibility in day/night.	Yes	
		On swiping of card the audio visual message should display the Personnel No and Name of the employee on the LCD of the device with a beep sound and Colored LED indication.	Yes	
		ECR machine should display date and time continuously and display screen should not go off when idle.	Yes	
		It should have built-in controller as well as reader Interface: - USB, TCP/IP (static IP)	Yes	
		Device should be IP rated 65 or higher		
		Inbuilt Robust 12/15 key numeric Keypad	YEs	
		All ECR machines should have real time clock sync with central server timing.	Yes	

S. No.		Details	Compliance Yes / No	In case of non-compliance, deviation to be indicated
		Device Security enhanced using username and password for securing the device and to restrict access from any unknown computer.	Yes	
		ECR machine must be out door compatible, fit for industrial use and withstanding Operating temp. 0 degree to 50 degree. Humidity range 20 to 80 %.	Yes	
		Network interface by TCP/IP or RS485 Wiegand input/output configurable up to 64 bits Internal relay for direct lock interface (standalone control mode)	Yes	
		Design should be slick and slim for narrow space	Yes	

SUBHEAD-C. **CCTV SYSTEM**

1. 5 MP Dome Camera

S No	5MP Fixed Lens Dome Camera	Comply (Yes/No)
1	Supply and installation of 5 MP IR Dome Camera, with 1 / 2.7" Progressive Scan CMOS H.265H.264.	
2	Resolution support: 5MP 2880(H)x1620(V) 4MP (2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240	
3	Focal Length 2.8mm/3.6mm lens@F1.4, Min. IR distance up to 30m	
4	Supports WDR, 3D DNR, HLC & BLC, Defog, Triple streams, Smart codec by ROI, Cyber Security-HTTPS / IP Filter / IEEE 802.1X /Blacklist & whitelist/account security/telnet access control/serial password,	
5	Camera shall offer intelligent analysis functions, Face Detection, Human & Vehicle Detection, Perimeter Intrusion Detection, Line Crossing Detection, Cross Counting, Stationary Object Detection, Heat Map, Crowd Density Detection, Queue Length Detection, License Plate, Detection, Rare Sound Detection	
6	Network Protocol: TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP,HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, Ipv4, Ipv6	
7	Cyber Security : HTTPS / IP Filter / IEEE 802.1X / account security	
8	Edge Storage Built-in micro-SD card slot, up to 128GB, Class 10 (not included). Inbuilt Mic for Audio Recording	
9	Protection Level IP67 & IK10,	
10	Compatibility: Onvif S & G	
11	Certification: CE, FCC & BIS	

2. 64 CH NVR

NETWORK VIDEO RECORDER:			
NVR & SOFTWARE			
HARDWARE SPECIFICATIONS			
Professional and Reliable			
• New logical and visualized GUI design			
• Dual-OS design to ensure high reliability of system running			
• RAID0, RAID1, RAID5, RAID6 and RAID10 storage scheme configurable			
Video Input and Transmission			
• Adopt stream over TLS encryption technology (enhanced SDK service and RTP over HTTPS protocol) which provides more secure stream transmission service (max. 128 Mbps TLS stream outgoing bandwidth, when RAID is enabled, it will restrict TLS stream outgoing bandwidth to 64 Mbps)			
• Up to 32 / 64-Ch cameras can be connected (up to 12 MP)			
• Connectable to the third-party network cameras			
Compression and Recording			
• H.265+ compression effectively reduces the storage space by up to 75%			
• Full channel recording at up to 12MP resolution			
HD Video Output			
• HDMI1/VGA1 and HDMI2/VGA2 outputs provided			
• HDMI1 Video output at up to 4K (3840 × 2160) resolution			
Storage and Playback			
• Up to 8 SATA interfaces and 1 e SATA interface for HDD connection 10TB capacity for each HDD			
• 16-ch synchronous playback at up to 1080p resolution			
• Important files management			
• HDD health monitoring			
Smart Function			
• Supports multiple VCA (Video Content Analytics) events			
• Smart search for the selected area in the video; and smart playback to improve the playback efficiency			
• 1 Gigabit Ethernet network interfaces			

ITEM	DESCRIPTION	Comply (Yes /No)	
Operating System	LINUX/Windows		
Processor	High performance Dual-core embedded microprocessor		
Video Input	64 channel @D1/ 32 channel @720P/ 16 channel @1080P/4 channel @ 3MP		
Compatible Protocol	Support ONVIF		
Video Output	2HDMI(1920x1080,1280x1024), VGA(1920x1080,1280x1024),		
Video Standard	PAL or NTSC		
Compression	H.265 /H.264 / MJPEG		
Video Recording	64channels@D1/4CIF		
Multi-screen Channels	1 and 4 Channels		
Audio Input	The audio input with video. It requires that IPC supports audio input.		
Motion Detection	It requires that IP Camera and Encoder support motion detection.		
Alarm Event	Recording, Alarm, Buzzer and Screen tips		
Alarm Input	16 alarm inputs for local, network alarm from IP camera		
Alarm Output	4 outputs		
Internal HDD	8 SATA ports, 80TB storage supported		
Backup	USB HDD, Network download		
HDD Management	HDD faulty alarm		
Recording Mode	Manual, Schedule, Video Event trigger(Motion detection) ,Panic and Alarm trigger		
Search Mode	Date/Time, Event (Alarm, Motion detection), codec type search (accurate to second),Log link		
Playback	4 Channel simultaneous playback (forward / reverse, fast playback, slow playback, pause, full screen, backup selection)		
Digital Zoom	Digital zoom in live view and playback		
Protocol Support	HTTP, HTTPS, TCP/IP, RTSP, RTP/RTCP, UDP, NTP, DHCP,IPC search		
Remote Client Control Function	Monitor, PTZ control, Playback, Configuration, File download, Log information, Alarm collect, Firmware Upgrade		
Concurrent User	Min 20, accessible over web, IOS, Android Mobile devices.		
Network Interface	2 RJ-45 port (10/100M/1000M) with Load Balancing Feature		
USB Interface	3 USB2.0 ports		
Serial Interface	1 RS-232		

ITEM	DESCRIPTION	Comply (Yes /No)	
PTZ Control Interface	1 RS-485		
Power Input	100~240 VAC 50~60Hz		
Power Consumption	< 50W (without HDD)		
Operating Temperature	-10°C ~ 55°C		
Relative Humidity	20% to 80%		
Dimensions	Standard 2U height,		
Web Client	Required		
Instant Playback	Required		
Certification	CE, FCC, BIS		

3. 5MP Motorized Dome Camera

#	Minimum Specification	Description	Bidders Compliance (Yes/No)
1	Image Sensor	1/2.7" Progressive Scan CMOS	
2	Effective Pixels	5MP 2880(H)x1620(V)	
3	Min. Illumination	Color 0.004lux @ F1.6(AGC ON) ; B/W 0 lux @ IR ON	
4	Shutter Speed	1/5 ~ 1/20000s	
5	S/N Ratio	≥52 dB	
6	Angle Adjustment	Horizontal: 107-34°, Vertical: 55-19°, Diagonal: 134-38°	
7	Focal Length	2.8 ~ 12 mm, motorized varifocal zoom lens, autofocus	
8	Iris Type	DC-Iris	
9	Video Compression	H.265 / H.264 / MJPEG	
10	H.264 Compression Standard	Base Line / Main Profile / High Profile	
11	H.265 Compression Standard	Main Profile @ Leve4.1 High Tier	
12	Resolution	5MP(2592×1944),4MP(2560×1440), 3MP(2304×1296), 1080P(1920×1080), 720P (1280×720), D1, CIF, 480×240	
13	Max. Frame Rate	30fps @ all resolution, 30fps @ 1080P	
14	Video Bit Rate	256Kbps ~ 8Mbps	
15	Multiple Streaming	Triple Streams	
16	Main Stream	5MP(1-30fps) / 4MP(1-30fps) / 2K(1-30fps) / 3MP(1-30fps) / 1080P(1-60fps) / 720P(1-30fps)	
17	Sub Stream	720P/D1/CIF /480×240 (1-30fps)	

#	Minimum Specification	Description	Bidders Compliance (Yes/No)
18	Third Stream	D1 (1-30fps) / 480x240 (1-30fps) / CIF (1-30fps)	
19	Smart Codec	ROI, 3 zones	
20	Quality Control	Five levels under VBR; Freely adjustable under CBR	
21	Image Setting	time stamp, text overlay, flip & mirror, ROI, Saturation, Brightness, Chroma, Contrast, Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings, AGC etc. Wide Dynamic, Sharpen, white balance, video rotation, Scheduled profile settings, AGC etc.	
22	Audio Communication	Bi-directional audio (2-way)	
23	Audio Compression Format	G711ulaw / G711alaw	
24	Audio Bit Rate	128 Kbps	
25	Day & Night	IR cut filter with auto switch	
26	Wide Dynamic Range	True WDR, 120dB	
27	IR Distance	Up to 30M	
28	Digital Zoom	Yes	
29	Image Features	Defog, BLC, HLC, 2D/3D DNR	
30	Corridor Pattern	Yes	
31	Video Privacy	4 zones video mask	
32	Intelligent Video Analytics	Camera shall offer intelligent analysis functions, Face Detection, Human & Vehicle Detection, Perimeter Intrusion Detection, Line Crossing Detection, Cross Counting, Stationary Object Detection, Heat Map, Crowd Density Detection, Queue Length Detection, License Plate, Detection, Rare Sound Detection	
33	Alarm Triggers	Motion detection, Intelligent video analytics, Network disconnect, video tampering, IP address conflict, illegal login, HDD full, HDD error, Alarm input, Alarm output	
34	Edge Storage	Built-in micro SD card slot, up to 128GB	
35	Backfilling	Supported	
36	Network Protocol	TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, SMTP, FTP, SNMP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, IPv4, IPv6, Bonjour, ARP	
37	Cyber Security	HTTPS / IP Filter / IEEE 802.1X account security	
38	Online Connection	Support simultaneous monitoring, Multiple users access; Support multi-stream real time transmission	

#	Minimum Specification	Description	Bidders Compliance (Yes/No)
39	Remote Monitoring	Webviewer browsing, VMS	
40	API	ONVIF Profile (S, G & T)	
41	Network	1 RJ45 10M/100M self-adaptive ethernet port	
42	Audio	Line IN × 1, Line OUT × 1	
43			
44	Onboard Storage	Built-in micro-SD/SDHC/SDXC slot	
45	Alarm	Alarm IN x 1, Alarm OUT x 1	
46	Hardware Reset	Yes	
47	Input Voltage	12 VDC, 0.6 A, max. 7.5 W PoE (802.3af, 36 V to 57 V), 0.2 A to 0.1 A, max. 9.5 W	
48	Operating Temperature	-30°C to 60°C	
49	Operating Humidity	95% or less (non-condensing)	
50	Ingress Protection	IP67	
51	Vandal Resistance	IK10	
52	Power Supply	DC12V / PoE	
53	Power Consumption	< 9.5W	
	Certification	CE, FCC, BIS	

4. 5MP Motorized Bullet camera

S No	5MP Varifocal Lens Bullet Camera	Comply (Yes /No)
1	Supply and installation of WDR 5MP IR Dome Camera, with 1 / 2.8" Progressive Scan CMOS H.265H.264.	
2	Resolution support: 5MP 2880x1620 4MP (2560×1440), 1080P(1920x1080), 720P(1280x720), D1, CIF, 480 x 240	
3	Focal Length 2.8 ~ 12 mm @ F1.4Min. IR distance up to 50m,	
4	Supports WDR, 3D DNR, HLC & BLC, Defog, Triple streams, Smart codec by ROI, Cyber Security-HTTPS / IP Filter / IEEE 802.1X /account security	
5	Video Analytics: intrusion and line crossing, Face Detection, Human & Vehicle Detection, Perimeter Intrusion Detection, Line Crossing Detection, Cross Counting, Stationary Object Detection, Heat Map, Crowd Density Detection, Queue Length Detection, License Plate	
6	Network Protocol: TCP/IP, UDP, DHCP, NTP, RTSP, PPPoE, DDNS, SMTP, FTP, UPnP, Unicast, Multicast, ICMP, HTTP, HTTPS, DNS, DDNS, RTP, RTCP, IGMP, 802.1X, QoS, Ipv4, Ipv6	
7	Cyber Security: HTTPS / IP Filter / IEEE 802.1X / account security	

S No	5MP Varifocal Lens Bullet Camera	Comply (Yes /No)
8	Edge Storage Built-in micro SD card slot, up to 128GB , Class 10 (not included).	
9	Protection Level IP67 & Metal body	
10	Compatibility: Onvif S & G	
11	Certification: CE, FCC & BIS	

SUBHEAD-D. **EPABX SYSTEM**

1. ALE 300

Type 2 IP Phone	
Parameters	**Technical Specifications**
Physical characteristics with handset & Cable	¬ Height: 219 mm
	¬ Width: 228 mm
	¬ Depth: 162 mm
Display	3.5 inch colour LCD screen: 240 x 320 pixels
Power	• Power over Ethernet (IEEE 802.3af)
	• corded handset: 1.4 W - 1.8 W
	• Optional USB-C power supply 5V/3A
Audio characteristics	• Comfort Handset with Hearing Aid Compatible (HAC)
	• Full-duplex speakerphone, acoustic echo cancellation, Comfort noise generation (CNG)
	• G711 (A-law and Mu-law), OPUS codec, G722, G729 AB
Environmental Conditions	• Operating Temperature: -5°C to +45°C
	• Relative humidity: 5% to 85%
	• Storage/Transportation Temperature: -25°C/+70°C
	• IP class: IP 20
Maintenance	Syslog mode, Port mirroring
Keypad	• Navigator: 4 way navigation + OK + Cancel
	• 2x5 Contextual touch keys, 3 programmable keys
	• Option to connect external Magnetic Alphabetic Keyboard
Connectivity	• Dual RJ-45 Gigabit Ethernet 10/100/1000 Network Interface for LAN and PC connection or Dual Homing
	• 2 x USB-C ports
	• RJ-9 connector for corded headset
Regulatory Standards SAFETY	• Safety ¬ IEC/EN 62368-1 ¬ UL/CSA 62368-1 • EMC ¬ EN 55032 Class B ¬ EN 55035 ¬ EN 61000-3-2 ¬ EN 61000-3-3
Languages	Multi-language support (menu)

Sr. No	**System Features:**	**Compliance (Yes/No)**
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
1.20	The system should be state of the art and deployable over both packet and circuit switching infrastructure.	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
1.30	The system should provide advanced, embedded solutions without the need of any external hardware & software. It should have strong convergence solution for voice, Internet, e-mail applications including LAN services.	
1.40	The system should support traditional telephony, VOIP features and Mobile telephone features in one single system through pluggable interface boards.	
1.50	The system Moreover, should be fully extremely modular - meaning total adaptation easy migration, modular, scalable.	
1.60	The system should be using latest Linux Operating system with native Internet protocols	
1.70	The system should be modular at every level; it should be rack mountable, stackable.	
1.80	The system should have universal slots for the interface boards.	
1.90	The system should provide the following features as part of the system without the need for any external hardware or software:	
1.10	Same features as a router with a firewall and Proxy cache server for internet access, An inbuilt DHCP server, An inbuilt CTI server	
1.11	The system should be based standard protocols like CSTA, TAPI, IP etc	
1.12	The system should provide a single management interface window for all application management. The management software should be based on web browser	
1.13	The System should be expandable to 300 extensions with single CPU and 500 with 2 CPU; the expansions should be achieved through addition of interface boards. There should not be any change of the CPU or the system software during expansions.	
1.14	EPBX System should provide advance facilities for Analog users minimum upto 150 Extensions, like incoming call and outgoing call records at every extension through PC, dial by click facility from day 1.	
1.15	System should offer Hot-Desking functionality for minimum 150 Users.	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
1.16	System should have very simple and same type of Licenses for all users (irrespective of user type whether Analog, Digital, IP, license Type should remain same)	
1.17	System should support built-in Contact center functionality just by enabling licenses (No need to have any external Hardware)	
1.18	System to support Intelligent call routing	
1.19	System to have BHCA value upto 1500	
1.20	System to support SSL V3 and HTTPS for secured sessions	
2.00	**Voice features:**	
2.01	The system should support the following voice terminals:	
2.02	Analog telephones	
2.03	Digital telephones	
2.04	DECT Telephones	
2.05	High - end IP hard phones	
2.06	High- end IP soft phones	
2.07	Client / server based CTI solutions	
2.08	It should support the following telephone features:	
2.09	Music on hold (up to 2mn customizable)	
2.10	Personal assistant	
2.11	Voice mail	
2.12	Call forwarding	
2.13	Call transfer	
2.14	Call Back	
2.15	Park / Retrieve	
2.16	3-way conference	
2.17	6 Party meet me conference	
2.18	Dial by name	
2.19	Directory (3000 names)	
2.20	Company greeting	
2.21	Hunting group (cyclical, sequential, parallel)	
2.22	External loudspeaker broadcasting	
2.23	Pick up (group, individual, supervised line...)	
2.24	Manager / Secretary profile	
2.25	Automatic Route Selection (ARS)	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
2.26	The system should have in-skin voicemail expandable to 8 ports with 200 hrs of storage. The system should be offered with 2 ports, 60 minutes of recording	
2.27	The voice mail should be Easy to use: User should be able to navigate through the voice mail features using voice prompts and the digital phones with soft keys should provide display for accessing the voice mailbox.	
2.28	Following features should be supported:	
2.29	Direct access to any message whatever its rank, Record online function, Screening function.	
2.30	Notification by message LED	
2.31	Remote consultation to mailbox	
2.32	External notification (on mobile, phone pager, home set, …)	
2.33	Personal options: customized greeting, protection by password, resend with comments, dial by name, reply function key, Answer only mode	
2.34	Unconditional / on busy / on no answer forward on voice mail with specific message.	
2.35	The users should have Personal assistant function for all users	
2.36	Different options should be offered to the callers to reach different destinations like secretary, mobile phone, outside number, operator, voicemail.	
2.38	The system should support VOIP features without any additional cards. IP users should register directly on processor	
2.39	It should support: IP Telephony, IP trunking SIP(H323 protocols and SIP protocols)	
2.40	QOS features should be supported. It should be able to tag the voice packets at the level 3 (IP) using TOS and DiffServ.	
2.41	The system should support the following compression algorithm for VOIP:	
2.42	G711 when packets will stay in the LAN,	
2.43	G722, G723.A and G729.AB when packets will be sent over the WAN	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
2.44	System to offer Multi-level and Multi group Auto Attendant functionality	
3.00	**Networking:**	
3.01	Branch office and remote ext IP solutions	
3.02	It should be possible to have Remote IP phones in the branches, managed by the call server in the headquarters. The IP phones at the remote site should have exactly the same features as they would at the headquarters.	
3.03	The system should be compliant with QSIG standards.	
3.04	The system should have networking features and it should allow to build the networks over the following physical interfaces:	
3.05	ISDN	
3.06	Leased lines, IP networks using H323 protocols,	
3.07	The system should allow building feature transparent networks. It should support the following features when networked:	
3.08	Basic call	
3.09	Block dialing	
3.10	Call forwarding indication on Cent. OP	
3.11	Called party state indication on Display	
3.12	Caller's repertory	
3.13	CLIP/CLIR & COLP/COLR	
3.14	Diversion / Dynamic Routing	
3.15	DTMF transparency	
3.16	I/C call processing as Int. or Ext. calls	
3.17	Name identification Carried via UUS	
3.18	Optimized path in case of Forwarding	
3.19	Optimized path in case of Transfer	
3.20	Private / public call differentiation	
3.21	Sub/address	
3.22	Transfer	
4.00	**Data features:**	
4.01	The LAN services offered by the system should have advanced features like: Powerful LAN: Switch 100 BT	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
4.02	The users should be able to move from one place to other and also it should be possible to add new users easily. For this the system should support embedded DHCP server	
4.03	System to support NTP FOR Network wide synchronization	
5.00	**Internet / UC features**	
5.01	The Internet access should be possible through ISDN or ADSL lines or through Leased Lines through separate interface	
5.02	The system should support embedded Internet access solution. Following features should be supports	
5.03	Shared internet access through ISDN or DSL	
5.04	Firewall, Proxy/cache server,	
5.05	VPN features for the remote workers to access the emails, or voice communication with the extensions of the system over internet.	
5.06	The system should have standards based solution for Internet, email and VPN features. It should support the following industry standards:	
5.07	Internet standard protocols support	
5.08	E-mail protocol support (POP3, SMTP, MIME) with multi-vendor e-mail client support	
5.09	VPN standard protocol support for secure remote access (PAP/CHAP, PPTP, IPSec).	
5.10	The system should have following email features:	
5.11	It should offer a fully featured internal and external mail application.	
5.12	The system should offer features for combining with an existing e-mail solution from an ISP (Internet Service Provider) or from an existing e-mail server on the LAN.	
5.13	The system should offer features for optimizing communication costs	
5.14	Dial on demand function for internet access, as well as e-mail sending and retrieval which should be possible to set up at predefined intervals	
5.15	Cache mechanism for information access with no connection	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
5.16	Time range definition, which should allow to control and limit Internet access usage during business hours in example.	
6.00	**CTI features:**	
6.01	The system should support high-end CTI (Compter Telephony Integration) features. It should allow users to access all the telephony features from their PC, irrespective of telephone type like Digital phones, Mobile DECT phone, Analog, without any physical phone	
6.02	System to offer Screen Pop functionality	
6.03	System to have embedded Database and flexibility to connect with external CRM	
7.00	**DECT features:**	
7.01	The system should offer mobility features inside the office It should be based on DECT technology. The DECT telephones should offer following features apart from the standard features like big display, icons based display etc :	
7.02	Built in loudspeaker,	
7.03	Built in vibrator,	
7.04	Headset connection	
7.05	Large graphical display	
7.06	Navigation key	
7.07	Pop –up menus	
7.08	Wireless desktop digital telephones should be supported. It means standard digital telephones should be equipped with additional hardware, so that it can work with the DECT infrastructure and no cables should be used to connect the set with the system.	
7.09	System management and Call accounting application:	
8.00	**Unified Features**	
8.01	System to support and control Desktop Phone and Mobile Phone from PC	
8.02	System to have universal Phone directory	
8.03	Each User to have single identity irrespective of having multiple devices and Contact options	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
8.04	System should be Cloud Connect ready and should support connectivity with cloud based applications	
8.05	System to offer Unified Directory	
8.06	System to offer features like Instant Messaging, Presence	
8.07	System to support Manager/Secretary feature	
8.08	System to have Multi-line functionality	
8.09	System to offer Click to Call functionality	
8.10	System to offer LDAP integration	
8.11	System to offer Yahoo and Microsoft Skype integration	
8.12	Comp ability with Mac, Android and Windows Handheld devices	
8.13	System to support Peer to Peer Video Calling functionality	
9.00	**GUI based software should be offered for the system management and call accounting. The software should have the following features:**	
9.01	Windows user interface	
9.02	Access control by password	
9.03	Multi-language	
9.04	Traffic analysis (incoming & outgoing calls)	
9.05	Pre-defined reports	
10.00	**Unified Communication (Must be from Same OEM)**	
10.01	General Specification of UC Client	
10.02	The solution must be enterprise grade	
10.03	Solution must work on all platforms like Desktop, Laptop, Windows and MAC OS, iOS and Android mobiles. It should also support browser based access without the need for client installation.	
10.04	The registration must be based on email address and not mobile numbers. It should support mix and match of email domains and should not restrict from one domain only.	
10.05	The solution should be UCaas ready and should be ready to use without any customization.	
10.06	The solution should be integrated with end customer Mobile and web application and provide cPaas thru API/SDK	
10.07	The application should work on any WiFi or 3G/4G	

Sr. No	System Features:	Compliance (Yes/No)
1.10	The offered system should be the latest model of the vendor being supplied worldwide. Old models / releases will not be accepted.	
10.08	The solution should be integrated with IP Telephony from similar or different vendors to provide call notification, on screen call control and click to call feature.	
10.09	It should have a channel thru which the administrator of end customer will make general announcements and instructions. Department specific channels should be available for users to subscribe. These channels should be available for all users when they log-in to the application	
10.10	UC Specification	
10.11	Instant Messaging	
10.12	Point-to-Point Video on 3G/4G	
10.13	Remote Screen Share	
10.14	File Share up to 1GB storage space	
10.15	Safety and Security features	
10.16	Should be governed under GDPR regulation	
10.17	Data collected should not be used for advertisement or commercialization	
10.18	Should be compliant with ISO 27001	
10.19	Solution should be present in Gartner Magic Quadrant (Optional)	

OEM Prequalification Criteria	
	Proposed Solution's OEM must be in Gartner's Magic Quadrant for "Unified communication"
	Proposed Voice, Network and WLAN OEM's must have Research and Development center, Technical support center and Office in India from last minimum 5 years. Valid documentation proof must produced
SIP Phone	
Parameters	**Technical Specifications**
Physical characteristics / Mechanics	• Width: Min. 180mm (7 inches)
	• Depth : Min. 45 mm (1.8 inches)
	• Height: Min. 200mm (8 inches)
	• Adjustable foot Stand: 45° and 50°
Display	• Visible area: Min. 2.2 inches 128x64 pixels
	• Graphical Black/White LCD display
	• Viewing area (WxH): Min. 53 x25 mm (2x1 inches)
	• White backlit LCD
Connectivity	• RJ-45 LAN: 10/100M Ethernet

	• RJ-45 PC through 10/100M Ethernet switch
	• RJ-9 connector for corded handset
Power	• Power over Ethernet (IEEE 802.3af), Class 1
	• External Power supply: 5V/0.6A (Optional accessory)
Audio characteristics	• Hearing Aid Compatible (HAC), VAD (Voice Activity Detection), Comfort Noise Generation (CNG)
	• Acoustic echo cancellation, DTMF: In-Band, RFC2833, SIP INFO
	• G711 (A-law and Mu-law), G.729AB, G.722, OPUS, iLBC
Environmental Conditions	• Operating Temperature: -5°C to +45°C
	• Relative humidity: 5% to 95%
	• Storage/Transportation Temperature: -25°C/+70°C
Configuration	• Web-based management
Keypad	• 2 Line keys (Line 1/2) with LED
	• 4 menu keys, Dial Pad
	• Navigator: 4 way navigation + OK
	• Hands-free, mute and message keys
	• Call hold, call transfer and redial key
Telephony features	• 2 SIP accounts, Mute/unmute, voicemail, DND, auto answer
	• Local 3-party conference
	• Call log (1000), local contacts (1000)
Regulatory Standards SAFETY	• IEC 62368-1:2014, ANSI/UL 62368- 1-2014, CAN/CSA-C22.2 NO. 62368- 1-14
Languages	Multi-language support (menu)

SL No.	Technical specifications	Compliance Yes/No	Remarks
24 Port POE+ L2 Switch Specifications			
1	**Switch Scalability and Speed**		
i	Gigabit Ethernet standalone chassis in fixed 1RU chassis 24 PoE 1G BaseT, 2 1G (upgradeable upto 10G) RJ45/SFP+ combo, 2 1G/10G SFP+ uplink/VFL ports.		
ii	Minimum Switching capacity 56 Gb/s and Minimum throughput 41 Mpps		
iii	Wire rate at layer 2 and layer 3 on all ports		
iv	Total number of MAC addresses: 16,000		
v	Total number of static IPv4 routes: 8		
vi	Number of VLANs: 4,000		
vii	Jumbo frame size: 9 216 bytes		
viii	PoE power budget of 380W		
2	**Resiliency and high availability**		

SL No.	Technical specifications	Compliance Yes/No	Remarks
i	Ring Rapid Spanning Tree (RRSTP)optimized for ring topology to provide less than 100 ms convergence time.		
ii	Broadcast and multicast storm control to avoid degradation in overall system performance		
iii	Unidirectional Link Detection (UDLD) for detecting and disabling unidirectional links on fiber optic interfaces		
iv	IEEE 802.1s Multiple Spanning Tree Protocol (MSTP) encompasses IEEE 802.1D Spanning Tree Protocol (STP) and IEEE 802.1w Rapid Spanning Tree Protocol (RSTP),ITU-T G.8032 Ethernet Ring Protection		
v	Per-VLAN spanning tree (PVST+), Remote stacking upto 10KM		
vi	IEEE 802.3ad/802.1AX Link Aggregation Control Protocol (LACP) and static LAG groups across modules,Path MTU Discovery		
vii	Virtual Router Redundancy Protocol (VRRP) providing highly available routed environments		
viii	Layer-2 port loopback detection for preventing customer loops on Ethernet access ports		
3	**Layer-3 routing and multicast**		
i	Static Routing for IPV4 & IPV6		
ii	Up to 8 IPV4 and IPV6 interfaces		
iii	DHCP relay , Address Resolution Protocol (ARP)		
iv	Internet Group Management Protocol (IGMP) v1/v2/v3 snooping		
v	Multicast Listener Discovery (MLD) v1/v2 snooping		
4	**QoS and security**		
i	Priority queues: Eight hardware-based queues per port for flexible QoS management		
ii	Flow-based QoS,Flow-based traffic policing and bandwidth management		
iii	Egress traffic shaping and DiffServ architecture		
iv	Support for endto-end head-of-line (E2E-HOL) blocking prevention, Configurable scheduling algorithms, including Strict Priority Queuing (SPQ), Weighted Round Robin (WRR) and Deficit Round Robin (DRR)		

SL No.	Technical specifications	Compliance Yes/No	Remarks
v	Autosensing IEEE 802.1X multi-client,multi-VLAN support, MAC-based authentication for non-IEEE 802.1X hosts, Web based authentication a customizable web portal residing on the switch		
vi	Dynamically providing pre-defined policy configuration to authenticated clients — VLAN, ACL, BW		
vii	Secure Shell (SSH) with public key infrastructure (PKI) support ,Terminal Access Controller Access-Control System Plus (TACACS+) client ,Centralized Remote Access Dial-In User Service (RADIUS) and Lightweight Directory Access Protocol (LDAP) administrator authentication , Centralized RADIUS for device authentication and network access control authorization		
5	**Manageability**		
i	CLI in a scriptable BASH environment via console, Telnet or Secure Shell (SSH) v2		
ii	WebView Graphical Web Interface via HTTP and HTTPS		
iii	Full configuration and reporting using SNMPv1/2/3 to facilitate third-party network management over IPv4/IPv6		
iv	File upload using USB, TFTP, FTP, SFTP or SCP		
v	Multiple software image support with fallback recovery		
vi	IEEE 802.1AB Link Layer Discover Protocol (LLDP)		
vii	Policy- and port-based mirroring , Remote port mirroring ,Flow v5 and Remote Monitoring (RMON), Digital Diagnostic Monitoring (DDM), and Time Domain Reflectometry (TDR)		
viii	Network Time Protocol (NTP)		
ix	Switch should support IEEE 802.3af or IEEE 802.3at-compliant end devices		
x	Configurable per-port PoE priority and max power for power allocation		
xi	Dynamic PoE allocation: Delivering only the amount of power needed by the powered devices (PD) up to the total power budget for most efficient power consumption		

SUBHEAD-E. **PUBLIC ADDRESS AND VOICE ALARM SYSTEM**

1. General requirements

The contractor shall supply, install, test, connect and commission a high quality fast-acting Public Address and Voice Alarm System complying strictly with BS 5839 part8 and EN60849 and shall be Applus or Equivalent Agency approved.

The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Audio rack all mounted on a 19" Rack and fully connected and integrated on the fire alarm loop.

The system shall be used for Professional Sound Reproduction for all the areas where possible special events take place. Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components. Customer can ask for acoustic calculation reports to verify the requirement of BS5839 part8 RASTI (Room Acoustic Speech Transmission Index) for 0.5 on the STI scale and 0,7 on the CIS scale, Contractor has to submit the simulation reports for customer approvals.

The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project.

In order to ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local supplier who will be responsible for the design, global operation, management and interfacing of the system.

The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicate less power tapings. The contactor must endure minimum of 10dB above the ambient noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to the buildings.

The System should have Control Software where customer can insert the MAP of a building and can monitor the system over GUI Software.

APPLICABLE STANDARD:

EVAC Compliant with IEC/EN60849 & Certified EN54

Controllers, Amplifier, Microphones with EN54 – 16 Certificates

Loudspeakers -Rated power IEC 60286-Part 5, EN54 Certification, With Fire dome

Tested in accordance with BSEN60268-5

Acoustic models ready for CATT, ULYSSES & EASE

Battery backup/charger compliant with EN54 part 4

2. System Design Requirement

The system shall be de-centralized and centralized both in nature, each distributed rack DCAU (Distributed Controller Amplifier Unit) shall have all the DSP (Digital Signal Processing), messages, amplifiers, monitoring in such a way that can work in a standalone mode in case the any rack is faulty or down.

The DCAU shall utilize the latest DSP (Digital Signal Processing) capabilities in order to perform high quality and site programming flexibility, as well providing high fidelity music over 40 audio channels.

The System allow for Man Machine Interface (MMI) shall be of touch screen type and connected back to the control room, to monitor and control the entire PAVA system, as well to start/stop any music programs, page any zone via touch screen buttons, route any message to any zone as required. The MMI is loaded with the GUI Software to Control, Monitor and Operation of Entire system. With help of Normal PTT Microphone the MMI should be able to broadcast any Live messages into any zone.

The DCAU shall play background / Foreground music and in case of Fire Alarm / Paging announcement, the system shall go to full power as programmed to provide the enough SPL (Sound Pressure Level) levels to comply with BS5839 part8, with minimum of 10dB above the noise levels.

All system components shall be digitally monitored including and not limited to, Messages, Amplifiers, and back up amplifiers, Speaker Circuits, Audio Matrix units, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier / line circuit shall be monitored individually and shall report any faults back to the Master Audio Matrix Unit as well as the MMI.

The system shall be capable of sending messages automatically to any zone at any time interval, without affecting the music in the other areas. Music Should not stop in case of any announcement happening in other zone. Both Zones should work Independently.

There shall be one back up amplifier for maximum 7 amplifier channels, the system shall automatically change over to the back up in case of any amplifier failure, and the backup amplifiers shall be monitored as well. All amplifier gain shall be monitored and measured for open, short or earth faults.

The System should have at least one backup amplifier for the maximum 7 Nos of Amplifier. Backup amplifier sharing more than 7 Amplifier channel shall not be acceptable. Contractor shall use two backup amplifiers in case of more than 7 Working Amplifier channels.

In case of Master Audio Matrix unit failure, the paging microphone shall override the Audio Matrix unit and provide the paging in other zones. This Bypass feature must comply to the system design.

The System can provide any Cause & Effect programs after integrating with the Fire Alarm System, thus Alert/Evacuate messages can be programmed and delayed as well as played on any zone / floor as per the Cause & Effect approved by the Engineer. The system should support phased evacuation and having capability to broadcast 2 simultaneous messages alert and evac in different zones at same time.

The System should be able to control from the Microphone and microphone should be able to broadcast any live message, generate pre-recorded messages, start and stop music, selection of any event.

The main Audio matrix unit shall have monitor loudspeaker to monitor the output of system.

According to EN60849 the system should be supplied with the Battery Charger to using system in case of Power failure. Customer can ask to provide the Batteries as per requirement but there should be provision for connection of Batteries with the system. Any Equipment required to connect the battery with system will be part of this project and no extra cost will be pay for any battery charger or any accessories.

The Battery Backup in system shall provide 24 hours of back up and 30 min of alarm operation. The power supply / charger must comply with EN54 part 4 and shall be 19” rack mounted. Battery calculation must strictly comply with BS5839 part 8 and shall be based on the amplifier size and not the speaker circuit load. The Battery calculation with Battery requirement will be submitted to customer.

The PAVA system shall be properly integrated with the fire alarm system. The Integration with fire should be zone wise phased evacuation. The System should be able to make cause and effect as per the total number of zones. The integrated PAVA system shall cover all normally accessible areas including the car parks. All stair cases shall have dedicated zone riser.

The system shall be capable of being used for everyday background music and public announcement duties with the fire alarm initiated emergency announcements overriding all other facilities. The System should be completely digital and less power consumption.

Initiation of voice alarm shall take immediate priority and shall cancel all other PA operations.
The voice alarm system shall be capable of broadcasting pre-recorded emergency alarm messages and live speech in the event of fire detection system activating. Evacuate signal relates to a general evacuation message and alert message corresponds to standby instructions.
In addition, a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL-CLEAR message shall be incorporated into the operation. A fire alarm broadcast signal shall cancel any public address operation and shall override it.

When a touch screen fireman's microphone from the Audio Matrix unit is operated, this shall override any automatic voice alarm signal being transmitted to the zone selected. The Alert and Evacuate pre-recorded messages will be maintained in other zones while live voice fire announcements are being broadcast to selected loudspeaker zones.

The Entertainment Rack shall be located in the Control/Security Room enabling the operator to select music from the CD player, FM tuner or the double cassette deck to transmit music to selected zones or all the zones in the building from the touch screen paging microphone. A public address announcement shall override the music transmission to selected zones or all zones. Paging any zone shall not interrupt music in other zones.

The System shall be able to integrate with Fiber optic transmission and can be Monitored and Operational from Centralized location though software or from local rack.
Loudspeaker, Audio matrix with amplifier, EOL Devices, Microphones shall be from the same manufacturer. Multiple OEM for one system shall be not acceptable.

3. System Components

3.1 Digital Audio Amplifier Matrix

The Digital Audio Amplifier Matrix shall be a mains and battery backed unit and shall be installed next to the Fire Alarm Control Panel (please refer the schematic for the locations). These units shall be connected to the loops of the FACPs and the voice system audio loop. These units shall initiate the broadcast of live speech in the designated public areas using manual controls as well automatically according to the FACP cause & effect. The System shall be integrated with FACPs over RS485 protocol. The use of these units shall be primarily for broadcast fire messages and other optional auxiliary messages as well the back ground music which is site and application specific, as well live evacuation messages and instructions from the operator or the fire brigade to direct the people to the safety points of the building.

The Digital Audio Amplifier Matrix must comply with EN60849 for medium and large-scale installations. The DAAU shall be certified as per the EN54-16 from the authorized laboratory and need to submit the test reports to the customer. It comprises the latest technology in Voice Alarm through DSP (Digital Signal Processing) and has the capability to expand up to More than 1000 channels through cascading master / expander configuration.

The DAAU shall be capable of playing back ground Music for up to 40 music/audio channels, with high quality music features, fully programmable route from any source to any zone. The DAAU shall be have inbuilt mixer and any audio input can be routed to any output.

The PAVA Main Controller should be of 8 zones and having built in 8 Zone Amplifier with Minimum 120W Each. The PA/VA System Main Controller and Amplifier will be certified according EN 54-16 standard for Voice Alarm Systems and be compliant to EN 60894 standard fir Security Systems. The whole PA/VA System Main Controller will be able to fit 2U of 19-inch rack and will include all these features:

EMERGENCY FEATURES

Detection and indication of all emergency and failure states with LEDs and on-screen messages.

10 x Fully Supervised Input Dry Contacts for integration with Fire Alarm Panels.

2 x Fully Supervised Output Dry Contacts for integration with Fire Alarm Panels.

3 x Fully Supervised Input Dry Contacts for integration with Battery Chargers.

485 Serial Port for Integration with Fire Alarm.

Integration with Fire Alarm via Ethernet commands.

Full Supervision of Emergency Microphones.

Simultaneous Evacuation and Alert emergency messages.

Phased evacuation.

Manual control of emergency states with access control via on-screen passwords.

Recording output for emergency warning.

Emergency and Functional Log.

CONNECTIVITY AND INTEGRATION

14 programmable GPIO ports.

8 Control input for the Integration with third party.

Fully integration with Fire Alarm Panel over RS485 protocol.

2 x 485 Serial Port for advanced integrations with third party systems.

Integrated Ethernet switch with 3 x RJ45 ports.

Integration with third party systems via Ethernet commands.

Open platform for programming all integration commands with third party systems.

8 x 24V Override outputs for attenuators and strobes control.

Integration with BMS System and PA/VA System should support MODBUS Integration.

Integration with Radio and IP telephone System.

SYSTEM FEATURES

Digital Signal Processor (DSP):

48 kHz, 24 bits - 344 MIPS

7-band input Parametric Equalizer.

7-band output Parametric Equalizer.

Loudness.

Sound enhancer.

Independent volume control for each I/O channel.

Audio filters.

4,3'' Frontal touch screen.

Integrated frontal speaker for monitoring.

8 x Balanced line-level audio outputs (one for each zone).

Power Supply 110- 240V ~ 50/60Hz, Fused

Emergency Power Supply 20-25V DC, 20A, Fused.

Protection against over-temperature, DC, infrasonic, short-circuit, slow start-up, overload and start-up test.

EXPANDABILITY

The PA/VA System Main Controller will be able to be easily expanded by using “Extension” devices that will add more amplifiers and audio zones; Connection between the PA/VA System Controller and the Extension devices will be done through a standard Ethernet connection in loop mode (redundant). Redundant connection between PA/VA System Controller and the Extension with automatic switching. No additional switches or devices should be required for fully connectivity.

AMPLIFIERS AND AUDIO OUTPUTS

8 independent Class D amplifiers of 120 W power for PA lines of 100V.

Possibility to operate in dynamic bridged mode: up to 4 amplifiers of 250 W power for PA lines of 100V.

All amplifiers will be fully supervised.

DSP Features available in Amplifier. 7 Band Parameter Equalizer in the amplifier

Possibility to use one of the integrated amplifiers as automatic backup amplifier. This amplifier will remain in stand-by, in case of failure of another amplifier, the backup amplifier will be automatically switched to substitute the faulty amplifier without any human intervention.

2 outputs per amplifier for A+B wiring of speaker lines. Each output fully supervised.

Speaker line supervision via End of Line device and Impedance Measurement.

Frequency Response: 20 - 20.000Hz +/-1dB o Signal to noise ratio: R>98dB, A-weighted

Distortion Factor: <0.05%

Gain Adjustment per channel: -100dB -0dB, 1dB steps

TECHNICAL SPECIFICATION

Power supply	110-120V / 220-240V (50/60 Hz)
Frequency response	80Hz - 20.000 Hz +/-3 dB
Signal to noise ratio	>92 dB, A-weighted
Distortion factor	<0.5% under IEC 62368-3
Gain adjustment per channel	-100 dB -0 dB, 1 dB steps
DSP Integrated.	48 kHz, 24 bits - 344 MIPS
Flex Net/ Cobra net	2 x Flex Net redundant / Cobra net
Audio inputs	5 x balanced audio

ACSI bus	1 x balanced audio
Pre-amp audio outputs	8 x balanced audio
Rec. audio /ctrl. outputs	1 x balanced audio
ATT control	8 x override 24 V DC
Emergency control inputs	10 x 0 -5 V DC, monitored inputs
Emergency control outputs	2 x relay contact isolated output, NO
General control (GPIO)	14 x Control I/O, 0 - 5 V, 100 Ohm
Amplifier	8 x 120W Class D @ 70 / 100 V
Protection	Over-temperature, DC, infrasonic, short circuit, slow start-up, overload, start-up test
Emergency power input	1 x 20 - 25V DC, 20A, fused, 2 Pin
Display	TFT 480x272 (4,3'') with Touch Panel

3.2 Digital Audio Amplifier Matrix Expander 4 Zones (4 x 250)

The Expander unit shall be capable to expand 4 Zones and Each Zone should be able to provide 250W Output. Total Amplification Wattage should be 1000 Watt. Audio Should be transmitted from Controller to Extension through Ethernet or Flex Net and can be expand with daisy chain connection. The Expander shall have built in of external amplification of Class – D technology and having built in DSP features. Analog amplifier shall not be acceptable. The Expander shall allow flexibility in the Amplifier output to use as per the requirement. The Power output shall not be limited to fix value and can be used from one channel to another channel.

Configuration

It should possible to configure extension via software and should be able to create event to perform actions in the system triggered by conditions of: input level, date & time, UDP command, a GPIO or microphone.

Features

- 4 Class D Amplifiers of 250W Each for 70 or 100V lines
- 4-pre-amp outputs for external PA amplifiers connection.
- DSP: 7-band input/output Parametric Equalizer, loudness, Sound enhancer, independent volume control per each output channel and audio filters.
- Ethernet port: for Digital Audio Cobra net, remote control and supervision.
- Expansion Capability – Up to 1024 Zones
- Control for up to 32 attenuators.
- Integrated frontal loudspeaker for monitoring.
- 12 supervised contact relays for integration with Fire Alarm Control Panel.

TECHNICAL SPECIFICATION

Power supply	110-120V / 220-240V (50/60 Hz)
Frequency response	80Hz - 20.000 Hz +/-3 dB
Signal to noise ratio	>92 dB, A-weighted
Distortion factor	≤0,5% under IEC 62368-3
Gain adjustment per channel	-100 dB -0 dB, 1 dB steps
DSP Integrated	48 kHz, 24 bits - 344 MIPS
Flex Net/ Cobra net	3 x Flex Net redundant (automatic switching)/ Cobra net
Pre-amp audio outputs	4 x balanced audio 1Vp, 0,707Vrms
Rec. audio /ctrl. outputs	1 x balanced audio, 1Vp, 0,707Vrms
ATT control	4 x override 24 V DC, 8 x 40 mA, 2 Pin
Emergency control inputs	10 x 0 -5 V DC, monitored inputs, 2 Pin
Emergency control outputs	2 x relay contact isolated output, NO, max 60 V DC 130 mA
Amplifier	4 x 250W (TOTAL MAX 1000W) @ Class D @ 70 / 100 V
Protection	Over-temperature, DC, infrasonic, short circuit, slow start-up, overload, start-up test
Emergency power input	1 x 20 - 25V DC, 20A, fused, 2 Pin

3.3 Digital Audio Amplifier Matrix Expander 4 Zones (4 x 500)

The Expander unit shall be capable to expand 4 Zones and Each Zone should be able to provide 500W Output. Total Amplification Wattage should be 2000 Watt. Audio Should be transmitted from Controller to Extension through Ethernet or Flex Net and can be expand with daisy chain connection.

Configuration

It should possible to configure extension via software and should be able to create event to perform actions in the system triggered by conditions of: input level, date & time, UDP command, a GPIO or microphone.

Features

- 4 Class D Amplifiers of 500W Each for 70 or 100V lines
- 4-pre-amp outputs for external PA amplifiers connection.
- DSP: 7-band input/output Parametric Equalizer, loudness, Sound enhancer, independent volume control per each output channel and audio filters.
- Ethernet port: for Digital Audio Cobra net, remote control and supervision.

- Expansion Capability – Up to 1024 Zones
- Control for up to 32 attenuators.
- Integrated frontal loudspeaker for monitoring.
- 12 supervised contact relays for integration with Fire Alarm Control Panel.

TECHNICAL SPECIFICATION

Power supply	110-120V / 220-240V (50/60 Hz)
Frequency response	80Hz - 20.000 Hz +/-3 dB
Signal to noise ratio	>92 dB, A-weighted
Distortion factor	<0.5% under IEC 62368-3
Gain adjustment per channel	-100 dB -0 dB, 1 dB steps
DSP Integrated.	48 kHz, 24 bits - 344 MIPS
Flex Net/ Cobra net	3 x Flex Net auto redundant / Cobra net
Pre-amp audio outputs	4 x balanced audio
Rec. audio /ctrl. Outputs	1 x balanced audio
ATT control	4 x override 24 V DC
Emergency control inputs	10 x 0 -5 V DC, monitored inputs
Emergency control outputs	2 x relay contact isolated output, NO
Amplifier	4 x 500W (TOTAL 2000W) @ Class D @ 70/100 V
Protection	Over-temperature, DC, infrasonic, short circuit, slow start-up, overload, start-up test
Emergency power input	1 x 20 - 25V DC, 20A, fused, 2 Pin

3.4 Digital Audio Amplifier Matrix Expander 8 Zones (8 x 500)

The Expander unit shall be capable to expand 8 Zones and Each Zone should be able to provide 250W Output. Total Amplification Wattage should be 2000 Watt. Audio Should be transmitted from Controller to Extension through Ethernet or Flex Net and can be expand with daisy chain connection.

Configuration

It should possible to configure extension via software and should be able to create event to perform actions in the system triggered by conditions of: input level, date & time, UDP command, a GPIO or microphone.

Features

- 8 Class D Amplifiers of 250W Each for 70 or 100V lines
- 8-pre-amp outputs for external PA amplifiers connection.
- DSP: 7-band input/output Parametric Equalizer, loudness, Sound enhancer, independent volume control per each output channel and audio filters.
- Ethernet port: for Digital Audio Cobra net, remote control and supervision.
- Expansion Capability – Up to 1024 Zones
- Control for up to 32 attenuators.
- Integrated frontal loudspeaker for monitoring.
- 12 supervised contact relays for integration with Fire Alarm Control Panel.

TECHNICAL SPECIFICATION

Power supply	110-120V / 220-240V (50/60 Hz)
Frequency response	80Hz - 20.000 Hz +/-3 dB
Signal to noise ratio	>92 dB, A-weighted
Distortion factor	<0,5% under IEC 62368-3
Gain adjustment per channel	-100 dB -0 dB, 1 dB steps
DSP Integrated	48 kHz, 24 bits - 344 MIPS
Flex Net/ Cobra net	3 x Flex Net auto redundant / Cobra net
Pre-amp audio outputs	8 x balanced audio
Rec. audio /ctrl. Outputs	1 x balanced audio
ATT control	8 x override 24 V DC
Emergency control inputs	10 x 0 -5 V DC, monitored inputs
Emergency control outputs	2 x relay contact isolated output, NO
Amplifier	8 x 250W (TOTAL 2000W) @ Class D @ 70/100 V
Protection	Over-temperature, DC, infrasonic, short circuit, slow start-up, overload, start-up test
Emergency power input	1 x 20 - 25V DC, 20A, fused, 2 Pin

3.5 Remote paging microphone

The PAVA Microphone should digital microphone connected with the controller via CAT6 / CAT5 Cable. It features an "all-call" button, busy line signal and auto-lock function. Suitable for playing Event - launching pre-recorded messages or loading presets. Up to 64 zone with 8 addressing zones per memory (512 zones through expansion keyboards)

- 8 memories for events system
- Recall (until 1 minute)
- Chime/No chime
- External microphone input
- Volume Adjustment
- System evacuation condition indicator
- System fault indicator
- Link system indicator
- 8 zone memory indicators
- Keyboard lock
- Zone memories shortlist memory
- DSA (Dynamic Sound Adjust)

INDICATORS

- "EMERGENCY" condition of emergency operation
- "FAULT" system is in fault condition
- "LINK" equipment is linked to the system
- "CONCEDED WORD" Free to use that Zone
- "BUSY" - When Zone is busy

Technical specifications: -

Power Supply	4.5- 5.5V DC, 1 x mini-USB type AB
Expansion Keyboard Consumption	40 mA max
Frequency Response	200 Hz -15000 Hz (+/- 2dB)
Signal to noise ratio	>98dB, A-weighted
Sensitivity	-43 dB (1KHz)
Directionality	Axial with hipercardioid type diagram
Type of transducer	Condenser
DSP	Integrated. 48 kHz, 24 bits, 172 MIPS
External microphone input	1 x Unbalanced audio 15mV,

ACSI Bus	2 x Identical ACSI ports:
Expansion Port	1 x Pin row, 2 rows x 5 female contact
Indicators	Condition: Emergency, Fault, Link, Busy line, Conceded Word, zones selection, Illuminated ring in gooseneck for conceded word
Gooseneck length	> 345mm

3.6 Cobranet Encoder / Decoder

The Cobranet Encoder / Decoder should be connected with the controller via LAN / Cobranet. It shall have 4 balanced audio ports which can be configure as input or output as per site requirement and these audio port should have high quality of A/D and D/A converters. The unit shall have built in DSP features like gain control, Equalizer and dynamic range, parameter equalization and compressor / limiter. The Unit shall be able to transmit up to 64 simultaneous audio channels over 100 Mbps LAN Network.

Features

- 4 Audio Ports with Flexible Input/Output Configuration
- Audio Over Cobranet
- Phantom Power for Local Microphone
- Priority audio input aux.
- PrioNet over Cobranet priority channel

Technical specifications: -

Power Supply	110 - 240V ~ 50/60 Hz
Consumption	<20W
Phantom power supply	12V (in all inputs, configurable)
Frequency response I/O	20Hz-20kHz +/-0,05dB
Input sensibility	1Vp, 0,707Vrms, 10 KΩ.
Audio input	Analog, 4 x audio balanced 3 Pin
Sensibility adjustment	+20dB / 0dB / -10dB
S/N	>94dB @1Vrms
Audio Connectors	Euro block connector
DSP Resolution	48kHz 24bits
GPIO	16 I/O configurable TTL 5V
Ethernet and Cobranet Interface	2 x RJ-45. Redundant
ATT output	24V 40mA, monitored and protected

3.7 Wall / Rack Mount Voice Alarm System

The Wall mount controller should be EN54 – 16 certified and designed as per EN60849 standards. The unit comprise of 2 Class – D amplifier, 6 speaker output, 3 Audio input, 6 x 6 Audio Matrix, built in DSP with LCD Display. The unit shall have built in Battery Charger and the unit shall be EN54 – 4 certified for the power supply requirements. The unit shall have feature to install both Wall mounting and rack mounting installation capability. The LCD screen should be easily accessible in both case without any change in hardware.

Features

- 3 balanced Audio input for Music / PTT Microphone
- Expandable up to 64 Zones using more units over CAT5 Network.
- Should be able to connect Remote Paging Microphones
- Built in / External 2 Class – D Amplifier with working as separate channel with total output of 500W. Both Amplifier shall be interconnected with hot swapping in case of one amplifier failure. One Amplifier will take over the other amplifier in case of failure.
- Backup amplifier included
- 4 Audio Output for External Amplifier with balanced audio output.
- Built in DSP with 3/7-band input/output parametric equalizer, loudness, sound enhancer, independent volume control per each input and output master.

- Access control by LCD display.
- Control for up to 16 attenuators.
- 8+2 GPIO ports, supervised for integration with Fire Alarm Control Panel.
- Certified under EN 54-16, EN 54-4 and EN 60849 standards.
- Failure detection and indication in all emergency functions.
- Fire Alarm Control Panel integration.
- Double player for pre-recorded evacuation messages.
- Manual control of emergency states with access control.
- Emergency log.
- Loudspeaker lines supervision.
- 10 minutes storage for pre-recorded messages

Technical specifications: -

Power supply	100 - 240V~ 50/60Hz
Frequency response	80 – 20000Hz +/-1dB
Signal to noise ratio	SNR > 94dB, A-weighted
Distortion factor	<0.1% according to IEC 60268
Gain adjustment per channel	-100dB +10dB, 1dB steps
DSP	Integrated - 48 kHz, 24 bits - 344 MIPS
Audio inputs	3 x balanced audio
General control (GPIO)	2 x control I/O
ACSI Bus	1 x balanced audio RJ-45 female, total 800m / 2624.7ft
Master / Slave connectivity	2 x RJ-45 female, total 800m / 2624.7ft
Pre-amp audio outputs	4 x balanced audio 1 Vrms. 100 Ω
Attenuator's control	6 x override 24V DC, 6 x 30mA
Emergency control inputs	8 x 0 - 5V DC, monitored inputs
Emergency control outputs	2 x contact closure output, NO
Amplifier	2 x 500W D class (250Wrms x 2) @ 70 / 100V
Speaker line outputs	6 x 100V audio.
Output power	500 W according to EN60065
Protection	Over-temperature, infrasonic, short circuit, slow start-up, overload

Emergency power	181x76x167mm battery housing, up to 22Ah Battery charger Integrated, smart charging up to 3 amperes
Display Backlit LCD	2 rows x 16 characters

3.8 Microcontroller based PTT Microphone

The PAVA System shall have wall mounted fireman microphone voice alarm panel capable for broadcast both live and pre-recorded alarm and evacuation messages. The Voice Alarm panel shall have fireman microphone for making live announcement in all zones and can be done zonewise with the use of expansion keypad. The voice alarm panel shall have EVAC & ALERT message selection and RED button to activate these messages. The RED button should be protected with the cover for protection. The Voice alarm panel should be able to work with Matrix Unit up to 1000 Meter and can be connected up to 8 Voice alarm panel in daisy chain.

- Up to 56 group memories of up to 8 zones per memory (448 zones of the system).
- Built in Chime or Notice tone.
- Volume adjustment
- LED indication for Power supply, Emergency, General, Fault, Link with system fault, Power supply fault, Emergency microphone fault, Broadcasting of voice evacuation message, Broadcasting of voice evacuation recorded message indicator, Broadcasting of voice alarm message, Remote control indicator, 8 Zone Memory Indication, System Fault indication.
- Emergency controls, Reset, Acknowledge, Test, Alarm message, Evacuation message
- Connect up to 7 expansion keyboards
- External microphone input
- Volume Adjustment
- Keyboard lock
- Zone memories shortlist memory
- DSA (Dynamic Sound Adjust)
- Priority configuration and operating parameters
- Local or peripheral power supply
- Wall or 19” rack installation

Technical specifications: -

Power supply	4.5- 5.5V DC, 1 x miniUSB AB
Frequency response	200 Hz – 12000 Hz (+/- 2dB)
Signal to noise ratio	>98dB, A-weighted
Sensitivity	-43 dB (1KHz)
Directionality	Axial, with hypercardioid type polar diagram
Type of transducer	Dynamic with moving coil
DSP	Integrated. 48 kHz, 24 bits – 172 MIPS
ACSI Bus	2 x Identical ACSI ports: Balanced audio 1Vp, 0,707Vrms. 10 KΩ, female RJ-45, Total 1000m. / 3280ft
Expansion Port	1 x Pin row, 2 rows x 5 female contacts

Indicators	Condition: Emergency, General Fault, Remote Control Fault: Link, Supply, Emergency microphone Message in broadcast: Evacuation recorded, Warning recorded, live message
Buttons	Emergency, Reset, Confirmation, (EMG, RST, ACK) 1 button for talking (TALK) Recorded message: Evacuation and Warning Indicators test
Functions	Prior notice tone, volume control, DSA (Dynamic sound adjuster). Directionality until 448 system zones.
Microphone cable length	500mm / 13,75”

3.9 Microcontroller based PTT Microphone

The PTT Microphone shall be desktop microphone for broadcast a message with one press to talk button and microphone. The microphone shall have lighting indicator to show its active status, busy or permission to speak. The Microphone shall have built in Microcontroller to change PTT mode into Lock Mode

- High performances dynamic capsule
- Local power supply.
- Audio gain setting.
- Configurable contact relay for auxiliary system.
- Busy line and conceded-word indicators.
- Lighting indicator placed in the goose-neck

Technical specifications: -

Power supply	5V DC , 200mA.
Frequency response	200- 15000 Hz (+/-2dB).
Audio output	750mV 600 balanced
S/N ratio	100 dB (A weighting)
Sensitivity	-43 dB. at 1KHz
Direction	Axial polar hypercardioid diagram
Transducer type	Dynamic with mobile coil.
Length of gooseneck	350mm

3.10 Cloud Based Facility Management Software

The System shall have one Cloud Based Facility Management Softwareeither same as GUI Software or different software with some additional features. This Software can be used to monitor one project or multiple project from any one Centralized location. For Multiple buildings this Cloud Based Facility Management Softwarecan be used for customer to monitor, operate and supervise system from the centralized location. The Software shall be web based and easy to install in any PC.

This software allows system control, volume control, audio sources or prerecorded messages routing to the zone or group of zones desired and emergency functions and system profiles management, Integration with 3rd party technologies through standard, monitoring the message and zone that are being activated at any time during an

evacuation / alert process through the color code, Events by date and time in the chosen zones of the local system. Events by date and time automation, Audio content distribution, Playlists creation
The software shall be able to record the messages and broadcast to any zone. It shall have built in text to speech features. Unlicensed text to speech or google based text to speech software shall not be acceptable. All the component in the software shall be from the same manufacturer.

3.11 GUI Software for Monitor and Supervision

The System shall have GUI based software which allows total control and supervision of the entire system through ethernet network, an easy and intuitive installation and with no configuration required. It allows a centralized control of the system, volume control, source routing, pre-recorded messages broadcasting, management of emergency functions and system profiles. It allows setting installation floor plans as GUI interface. Single-user license.

The Software shall have facility to insert Floor Plans of building as GUI interface and each activity shall be monitored with indication on floor plan location in the software

- Central and secure control of the system.
- Routing of quality audio.
- Functions - Volume control, Total system supervision (failure, evac mode, etc) by zones.
- Allows to add installation drawing plans.

4. Loudspeaker

Loudspeakers shall be especially designed for broadcasting high quality, integrated emergency fire alarm signals and voice communications and approved by an appropriate authority for use in such situations.
All the speakers shall be EN54 – 24 certified and used as per IEC60849.
Loudspeakers shall be ceiling, wall mounted, Projector or Horn Loudspeakers as shown in the schedule of work and shall be completed with mounting brackets accessories etc.
Ceiling Loudspeaker shall have fire dome manufactured by the same OEM. The Loudspeakers shall have testing certificate with fire dome. Local supplied fire dome shall be not acceptable. The Loudspeakers should have ceramic terminals and isolation fuse.

Loudspeakers shall be of high efficiency providing maximum output at minimum power across 120 – 14000 Hz frequency range for Indoor Speakers.

Loudspeakers shall have a line matching transformer for direct connection to amplifiers with multiple taps.

Loudspeakers external appearance shall be approved by the Architects.

Loudspeakers shall be interconnected in the zone configuration.

4.1 6W Ceiling Loudspeaker

The ceiling mounted 6 W speakers shall be installed as depicted in the drawing. The speakers support EASE acoustic models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The Ceiling speaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application according to room size and ambient noise environment. The Loudspeaker shall be equipped with ceramic terminals and an isolation fuse to avoid that any damage in the unit could cause a general failure in the speaker line which is connected. The Ceiling loudspeaker shall be EN54 – 24 certified and having EN54 – 24 tested fire dome.

Technical specifications: -

Speaker diameter	6"

Max power	9 W
Nominal power	6 W rms
Tapping @ 100 V	6 W / 3 W / 1.5 W / 0.75 W
Tapping @ 70 V	3 W / 1.5 W / 0.75 W/ 0.375 W
SPL (Pmax / 1m)	97 dB +/- 1dB
SPL (1W / 1m)	89 dB +/- 1dB
Frequency response (- 10 dB)	100 Hz-20K Hz
Dispersion (-6 dB) @ 1kHz/2kHz	170º/140ºV
Nominal impedance	1.7 kΩ / 3.3 KΩ / 6.7kΩ / 13kΩ
Protection	Ceramic terminal
Thermal Fuse	150°
Colour	White (RAL 9016) / Red (RAL 3000)
IP protection grade	IP44

4.2 6W Wall Mount Loudspeaker

The wall mounted 6 W speakers shall be installed as depicted in the drawing. The speakers support EASE acoustic models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The wall mount speaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application according to room size and ambient noise environment. The Ceiling loudspeaker shall be EN54 – 24 certified. The Wall mount cabinet should protect loudspeaker from fire and vandalism. The Loudspeaker shall have ceramic terminal and insulation fuse to protect in emergency condition.

Speaker diameter	5"
Max power	9 W
Nominal power	6 W rms
Tapping @ 100 V	6 W / 3 W / 1.5 W / 0.75 W
Tapping @ 70 V	3 W / 1.5 W / 0.75 W/ 0.375 W
SPL (Pmax / 1m)	95 dB +/- 1dB
SPL (1W / 1m)	87 dB +/- 1dB
Frequency response (- 10 dB)	300 Hz – 15 kHz
Dispersion (-6 dB) @ 1kHz/2kHz	180º/100ºV

Nominal impedance	1.7 kΩ / 3.3 KΩ / 6.7kΩ / 13kΩ
Protection	Ceramic terminal
Thermal Fuse	150°
Colour	White (RAL 9016)
IP protection grade	IP21C

4.3 20W Sound Projector Loudspeaker

The sound projector shall be 20 W speakers shall be installed as depicted in the drawing. The speakers support EASE acoustic models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The wall mount speaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application according to room size and ambient noise environment. The sound projector shall be EN54 – 24 certified. The sound projector shall have fire protected ABS 5VB cabinet. The Loudspeaker shall have ceramic terminal and insulation fuse to protect in emergency condition.

Speaker diameter	5"
Max power	30 W
Nominal power	20 W rms
Tapping @ 100 V	20 W / 10 W / 5 / 2.5W
Tapping @ 70 V	10 W / 5 W / 2.5 W / 1.25 W
SPL (Pmax / 1m)	99 dB +/- 1dB
SPL (1W / 1m)	89 dB +/- 1dB
Frequency response (- 10 **dB)**	130 Hz - 20 KHz
Dispersion (-6 **dB)** @ 1kHz/2kHz	180º/100ºV
Nominal impedance	500 Ω / 1 KΩ / 2 KΩ / 4KΩ
Protection	Ceramic terminal
Thermal Fuse	150°
Colour	White (RAL 9016)
IP protection grade	IP21C

4.4 15W Outdoor Horn Loudspeaker

The Horn loudspeaker shall be 15 W speakers shall be installed as depicted in the drawing. The speakers support EASE acoustic models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The horn loudspeaker shall work on 100V line so that it can reduce line losses over long

distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application according to room size and ambient noise environment. The horn loudspeaker shall be EN54 – 24 certified. The Loudspeaker shall have ceramic terminal and insulation fuse to protect in emergency condition. Ergonomic, low profile and stylish design, blends easily into any outdoor application. High-strength UV resistive UL94V0 ABS housing.

Max power	25 W
Nominal power	15 W rms
Tapping @ 100 V	15 W / 10 W / 5 W / 8 @100V
Tapping @ 70 V	7.5 W / 5 W / 2.5 W / 8 @70V
SPL (1W / 1m)	105 dB +/- 1dB
Frequency response (- 10 **dB)**	350 Hz -12 kHz
Protection	Fire resistant cable
Material	ABS with UV protection
Colour	Grey (RAL 7035)
IP protection grade	IP66 (B type according to EN54-24)

4.5 20W Column Loudspeaker

The column loudspeaker shall be 20 W speakers shall be installed as depicted in the drawing. The speakers support EASE acoustic models for acoustic studies. This mean the acoustic model can be designed to simulate the sound quality and distortion prior to installation. The column loudspeaker shall work on 100V line so that it can reduce line losses over long distance and allow easy parallel connection of multiple loudspeakers. The Speaker shall have multiple tapping for different application according to room size and ambient noise environment. The column loudspeaker shall be EN54 – 24 certified. Robust aluminum housing. Includes universal swivel bracket for easy angle adjustment

Max power	30 W
Nominal power	20 W rms
Tapping @ 100 V	20 / 10 / 5 / 2,5W @ 100V
Tapping @ 70 V	10 / 5 / 2,5 / 1,25W @ 70V
SPL at 20W/1W (100Hz-10kHz, 1m)	103 dB (20W/1m) / 92 dB (1W/1m)
Frequency response (- 10 dB)	300 Hz -15 kHz (-10 dB)
Protection	Fire resistant cable
Material	Aluminum
Speaker size	4'' x 2
Colour	White (RAL9003)

IP protection grade	IP66 (B type according to EN54-24)

5. Accessories

5.1 CD PLAYER

The CD/DVD all-in-one multi-audio source player that includes a CD player, a FM/AM radio, and USB and SD cards. Integrates CD player, FM/AM and USB and SD interface, supports USB 1.1 and USB 2.0, Independent AM/FM and CD/USB lines output, Supported audio formats: MP3, WMA, WAV.

Inputs	FM antenna: female coaxial RF IEC, 75 Ω AM antenna: male XH2,54-2P, 75 Ω USB: female type A
Frequency bands	FM: 87MHz – 108 MHz AM: 522KHz – 1620 KHz
Outputs	FM/AM radio: stereo 2 x RCA female (red/white). 2 + 0,2V CD/USB player: stereo 2 x RCA female (red/white). 2 + 0,2V
Frequency response	20 Hz – 20.000 Hz
THD distortion	0,05%
SNR	> 60 dB
Crosstalk	> 75dB

5.2 19" Rack

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment. Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

The site shall be fitted with man / machine interface terminal facilities, which shall allow live speech broadcasts to be addressed to selected areas of the site. The unit shall also allow initiation of stored messages and alarm signals.

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment.

Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

Rack should comply with ANSI/EIA RS-310-D; DIN41491; DIN41494; IEC297-2; and GB/T3047.2-92. The Rack should have DIN Rail Mounted Terminal Blocks for termination of Speaker Zone cables on the rear.

All cables coming from Speaker zones, Call Stations, Power supply should enter from Bottom.

Rack should be installed at location which has minimum 600mm space from front & back for accessing it easily. Rack should be installed in well ventilated room preferable Air conditioned. The unit should have Fans from top.

The unit should have Lockable Glass door at front

5.3 Server

The System should have windows-based server installed in workstation suitable as per OEM requirement of software. The Server should be latest configuration and should be approved from customer and OEM before supplying at project site. It will be Contractor responsibility to provide all licenses of Office and Antivirus with minimum 1 TB hard disk.

The Server should be supplied with Customer approval letter on the configuration datasheet.

6. WIRING

6.1 Speaker Cable

All cables associated with PA System shall be of following specifications:

The 2-core speaker cable will be connected to the speakers by screw terminals before which it shall be crimped using 1.5 sq. mm. bootlace lugs. Care has to be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.

Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq.mm PVC insulated, PVCFRLS sheathed control Cable as per IS 694.

These Cables shall be laid in G.I. Conduits concealed/surface.

6.2 Microphone & Data Cables

CAT5 unshielded type Fire rated low smoke with 24AWG Multi-Stranded gauge per conductor.

7. Project Completion:

7.1 INSTALLATION

Installation shall be as shown on the drawings, and as recommended by the major equipment manufacturer. All cables, junction boxes, cables supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.

7.2 TESTING

Sr. No.	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance etc.			√
2	System installation proper as per drawing	√		
3	Carry out visual checks on all speakers & Processors are free from any mechanical damage, cables, inter phase modules etc.to ensure they are properly installed.	√		
4	Check for proper termination of bootlace lugs & feruling	√		
5	Check Input A/C Supply Voltage		√	
6	Check location / spacing of loudspeakers as in drawing.	√		√
7	Check Distribution of Zones as per Drawing.	√		√
8	Check full load speaker sound quality & measure Sound pressure level (SPL) in dB.	√	√	
9	Check if local loudspeakers override by voice messages in case of emergency evacuation.	√		√

10	If power fails, whether Voice evacuation system is working on battery supply if yes for what time		√	
11	Check if recorder messages are CLEAR, free from any noise distortion & easy to understand with Room acoustic speech transmission Index (RaSTI) value >0.5.	√	√	
12	Processor LED's and all keys are working properly	√		
13	Check for Microphone locations & the sensitivity by paging	√		√
14	Play a soft music & check sound quality	√		

7.3 COMMISSIONING

At final commissioning of each system, the Contractor shall confirm that:

All devices, control panels are tested and operate correctly. The standby batteries are adequately sized. (Measurements of the quiescent and full loads shall be taken and compared to calculated values used at the design stage.) Calculations and measurements shall be submitted to the Engineer.
Commissioning shall be fully documented and the documentation submitted to the Engineer.

The Contractor shall demonstrate each zone and main panel to the satisfaction of the Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall take place after the above final commissioning and following receipt of the commissioning documentation by the Engineer.

Both the installation and the commissioning activities shall be undertaken as a single continuous operation. Upon completion of the installation activity, the contractor shall Test, Start-up, Commission and Handover the system to the customer.

The contractor shall make use of the following documents to record test results and details of commissioning tests:

- Cable Test Sheets
- Installation Check Report
- System Layout Drawing(s)
- System Schematic Diagram(s)

The contractor shall be responsible for inspecting and testing the complete system. The contractor shall present an Acceptance Certificate for signature by the customer.

7.4 DOCUMENTATION

The contractor, upon completion of the commissioning activity, shall hand over the system to the customer.
At the time of hand over, the contractor shall provide the customer with the following documentation:

1. Copy of detailed report
2. Component and equipment list
3. Product description sheets
4. System design drawing(s)
6. System schematic diagram(s)
7. System operating manuals

7.5 HANDOVER

Prior to final acceptance, the installing contractor shall provide complete operation and maintenance instruction manuals to the owner. All aspects of system operation and maintenance shall be detailed, including wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s), illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, maintenance operations and procedures shall be included in the manual.

7.6 TRAINING

The contractor shall provide the customer with details of the training required by personnel to operate and maintain the PA System. The Contractor and the customer shall jointly agree the number of staff to attend the training courses.

SECTION: 8

LIST OF APPROVED MAKES

GALGOTIAS UNIVERSITY

LIST OF APPROVED MAKES- Electrical

Instruction to bidders:

a. **Submit catalogues with the offers.**
b. **Final choice of makes among the approved list shall rest with the Owner / Project Managers /**
c. **Produce test certificates for equipment/material supplied with bills for certification.**
d. **Submittals and samples must be gotten approved before supply from Owner / Project Managers / Architect / Consultants.**

Sl. No.		EQUIPMENT/MATERIAL			APPROVED MANUFACTURER
1		HT Switchgear			EATON / RITTAL / L&T / Siemens
2		HT Cable Termination Kit	:		Birla 3m / M-seal
3		Battery Charger	:		Ambit / Crompton Greaves
4		MCCB's	:		Schneider: NSX Series / Hager/ Legrand
5		ACB's	:		Schneider: NSX Series / Eaton/ Legrand
6		MPCB's :	:		Schneider: Tesys Series / Eaton / Legrand
7		MCB's, ELCB's, RCBO's & RCCB's	:		Schneider –Acti-9 Series / Hager / Legrand
8		MCB DB's	:		Schneider –Acti-9 Series / Hager / Legrand
9		HRC Fuses & Fues Switch Units			Schneider Electric / Siemens/ L&T
10		Moulded Socket outlets / Weatherproof / Metal Clad Socket Outlets	:		Clipsal / Neptune-Bals/ Legrand
11		Industrial Socket in moulded enclosure / in powder coated sheet steel enclosure			Clipsal / Neptune-Bals/ Legrand
12		Weatherproof Enclosure	:		Hensel / Cape/ Legrand
13		Manual On load, 4P Change Over Switchs	:		HPL Socomec / L&T/ Legrand
14		Contactors & O/L relays within built SPP	:		Schneider: Tesys Series / Siemens: 3TF Series / Legrand
15		Aux. Relays for control and tripping circuits for fire etc.	:		Schneider / Siemens / Legrand
16		SPP	:		Minilec / L&T
17		Indication Lamps	:		Schneider Electric / Siemens / L&T
18		Push Buttons	:		Schneider Electric / Siemens / L&T
19		Selector Switches	:		L&T -Salzer / Kaycee / Siemens
20		Electrical Terminals	:		Elmex / Connect Well / Schneider
21		Multifuction Meter – Digital / Multifunction / VAF / VA / V /A/ Hz / kWH meters (BMS / Non BMS compatible) & Dual source KWH meters with Cut-off / Pre-paid type	:		Schneider-Conzerv / Neptune Ducati / Secure
22		Meters-Analogue	:		Schneider-Conzerv / Neptune Ducati / Secure
23		Timers	:		Schneider Electric / Siemens / Honeywell

24		Relays (Numeric Type)	:		Alstom/ Schneider/ Legrand
25		Relays (Electromagnetic Type)			Areva / Easun Reyrolle / Schneider
26		Cast Resin CTs / Cast Resin PT's / Control Transformers in Panels for metering & protection	:		AE / Gilberts & Maxwell / Kappa
27		Capacitors : Heavy duty type (MPPH type) / Inert gas type	:		Schneider Electric / Ducati-Neptune / Legrand
28		APFCR (Automatic power factor correction relay) Micro Processor Based (BMS / Non BMS Compatible) 3 Phase type	:		Schneider Electric / Ducati-Neptune / Legrand
29		Detuned Filters			Neptune-Ducati / Schneider Electric / Epcos
30		Active Harmonic Filter			Neptune-Ducati / Schneider Electric / Epcos
31		DG Controllers	:		Dief / Woodword / Cummins
32		Softstarter	:		Schneider Electric / Siemens
33		PLC	:		Allen Bradley / Siemens / Schneider
34		Annunciator, Water Level Controller	:		Minilec / L&T-GIC
35		VFD (Variable Frequency Drives)			Danfoss / Schneider
36		Surge Suppressor Device	:		ASCO / Vitzrotech / Vertiv
37		ATS (Automatic Transfer Switch)	:		ASCO (Imported) / Vitzrotech
38		FRLS PVC / MS / GI Conduits & Accessories	:		BEC / RM Con / Polypack
39		Switches & Sockets- Modular type	:		Legrand - Arteor / Hager – Insysta / Schneider – Neo C-metro
43		Pop-up Boxes	:		Legrand / AH Meyer-Freser Techno
44		Lighting Fixtures	:		Philips / Regent / Havells
45		Tube Lights & Lamps	:		Philips / Osram / Havells
46		LV Halogens Lamp transformers (Electronic)	:		Philips / Havells
47		High Performance, HF Electronic Ballasts (DIM & NON DIM) for lamps	:		Philips / Havells
48		Exhaust Fans / Ceiling Fans	:		Usha / Havells / Crompton Greaves
49		Wires - Copper Armoured / Unarmoured	:		Bonton / Havells / Polycab
		Cables (Power & Control) - Aluminum / Copper Armoured / Unarmoured			Gloster / Havells / Polycab

Sl. No.		EQUIPMENT/MATERIAL			APPROVED MANUFACTURER
50		11kV / 33kV Grade XLPE HT Cables	:		Gloster / Havells / Polycab
51		Fire Survival Cables	:		AFW / India Impex (FR-Tek) / Polycab
52		HT Jointing Kit	:		Raychem / Birla 3M
53		Cable lugs & thimbles	:		Dowells / Jainson / Comet
54		Cable glands	:		Comet / HMI / Dowells
55		TV Co-axial Cable	:		Finolex / Bonton / Delton
56		Paging / Music Speaker Wire (Twin Twisted)	:		Finolex / Bonton
57		Jelly Filled Armoured Tele. Cables	:		Finolex / Bonton
58		GI / MS Raceways & Cable Trays	:		KM Enterprises, Faridabad / Profab / MK
59		Modular Hanging / Supporting system for cable trays, rising mains & bus ducting (Channel, Threaded Roads & Clamps)	:		HIRA WALRAVEN / MUPRO / Gripple
60		Wire Mesh Cable Trays	:		Legrand - Cablofil / Gewiss – OBO / MK
61		Factory Assembled Modular socket outlet boxes (for workstation and meeting rooms etc.) / Floor Outlet Boxes	:		AH Meyer / Schulte / Schneider
62		Table Top Power Cube	:		AH Meyer / Schulte / Legrand
63		Table POP-UP Boxes	:		AH Meyer / Schulte / Legrand
64		Cat-5 / Cat-6 Voice / Data Cables	:		Lucent - Avaya / AMP
65		Voice / Data Face Plates			Lucent - Avaya / AMP
66		Tele Tag Blocks			Krone / Poyet
67		LT Panels and Sub Panels	:		Tricolite / Adlec
67.1		TTA Panels	:		Schneider - Blocket / Rittal / Tricolite
68		Panel Construction materials :			
	a.	Electrolytic grade Aluminium bus bars	:		Hindalco / Jindal
	b.	Electrolytic grade Copper bus bars	:		Leebo Metal / Century
	c.	Heat Shrinkable Sleeves	:		Pla-Tech
	d.	Hardware			
	e.	High Tensile Alloy Hardware for Panels / Distribution boards / earthing tapes (Zinc coated) (Grade 8.8 & Grade 5.6)	:		Unbreako / TVS / GSK
	f.	Stanless Steel Hardware for Panels, boards & earthing tapes (SS-304, SS-316)	:		Duplex Fastners (Ramesh Steel Corporation, Gujarat) / Red Earth Steels, Mumbai
	g.	Moulded Bus Bar Supports SMC/Nylon 6.6	:		Power Mat / Ramanuj / Hindalco
	h.	Panel Cooling Ventilation Fans	:		High Cool / Rexnord
	i.	Thermostat/Humidistat for Panel	:		Honeywell / Gerrisg eco
	j.	Panel Space Heater	:		Telelec / Norma
69		Final Distribution Boards	:		Schneider –Acti-9 Series / Hager / Legrand
70		Lightning Arrestor System (As per IS- IEC 62305)	:		OBO / ERICO / JMV
71		Earthing System			
	a.	Maintenance free chemical earthing (As per IS-IEC 62561)	:		OBO / ERICO / JMV

	b.	Exothermic Welding (UL Listed Only)	:		Erico-CADWELD / KLK
	c.	SS-304 / SS-316 Cross, T, L & Straight Connectors (GI, Copper & SS connectors)	:		OBO / ERICO
	d.	Copper Bonded 'MS' earth Tape	:		OBO / ERICO
	e.	Copper Bonded 'MS' Conductor	:		OBO / ERICO
	f.	High Tensile Alloy Hardware for Panels / Distribution boards / earthing tapes (Zinc coated) (Grade 8.8 & Grade 5.6)	:		Unbreako / TVS
	g.	Stanless Steel Hardware for Panels, boards & earthing tapes (SS-304, SS-316)	:		Duplex Fastners (Ramesh Steel Corporation, Gujarat) / Red Earth Steels, Mumbai
72		Fire sealing compound	:		Hilti / Vijay Fire
73		Dimming System & Sensors	:		Signify/ Siemens – Enlighted/ Schneider
74		Rising Main & Bus Duct			Schneider
	a.	Compact sandwitch type Bus Duct (IP54, IP55 & IP66) & Rising Main	:		Eline-Turkey / Legrand - France
	b.	Compact sandwitch type Cast Resin Bus Duct (IP 68)	:		Eline-Turkey / Legrand – France / Schneider
	c.	Air Insulated Rising Main & Bus Duct	:		Tricolite / Adlec
75		Inverter	:		Luminous / Su-kam / Microtek
76		UPS	:		Vertiv / Eaton / Emerson
77	a.	Batteries (Selaed Maintenance Free)			Panasonic / Global Yuasa / Exide
	b.	Lithium ion Batteries			SAMSUNG / LG / Exide
78		K13 Isolation Transformers	:		Datsun / Jindal Rectifiers / Schneider
79		PA Speakers	:		Honeywell / Siemens / Bosch
80		PA Amplifier / Mixer / Zone Selection Console	:		Honeywell / Siemens / Bosch
81		Street Light Pole - GI Octagonal	:		Signify / Regent / Philips

Sl. No.		EQUIPMENT/MATERIAL			APPROVED MANUFACTURER
82		Street Light Pole - GRP	:		Signify / Regent / Ligman
83		Street Light Pole - Swaged	:		Signify / Regent / Ligman
84		Street Light Pole - Hi-mast	:		Signify / Regent / Ligman
85		Rubber Mats	:		Jyoti / Maruti
86		Fire Extinguisher	:		Tyco / Minimax / New Age
87		Weatherproof moulded junction box for loop in loop out connectors for external lighting			Hensel / OBO / Legrand
88		External lighting loop in loop out connectors (upto 35mm2 cable)	:		AH Meyer / Phoenix Contact / Connectwell
89		Video Door Phone	:		Honeywell / Legrand / One touch (Discreet)
90		Intelligent, Addressable & Monitored Emergency & Exit Luminares Using Central Battery System	:		Teknoware/ Eaton/ Integrare
91		EV Chargers	:		EATON / Legrand / Panasonic

GALGOTIAS UNIVERSITY

APPROVED MAKES OF MATERIAL for ELV

S.NO	ITEMS		APPROVED MAKES
A.	**Intelligent Fire Alarm System**		
1.	Analogue Address fire detection & alarm system including (complete with detector, sensors, fire panel, MCP's, modules and complete all detectors & devices with graphic software etc.)	:	Notifier – Onyx Series / Honeywell XLS 3000
2.	DIGITAL VOICE EVACUATION SYSTEM		Notifier, Honeywell XLS 3000
3.	LPG Detectors	:	Notifier, Honeywell XLS 3000
4.	Response Indicator	:	Notifier, Honeywell XLS 3000, Agni
5.	Aspiration System	:	Notifier, Honeywell XLS 3000
6.	MS /GI Conduit (Heavy duty)	:	AKG / RM Con / BEC
7.	Fire Survival Cable	:	AFW / India Impex (FR-Tek)
B.	**ACCESS CONTROL SYSTEMS**		
1.	Access Control System & Controllers with software	:	HID / Smart eye / Suprema
2.	Card Readers & Cards	:	Suprema / HID
3.	Electromagnetic Locks	:	ESSL / Suprema / Honeywell
4.	Magnetic Contacts	:	Suprema / Honeywell / ESSL
5.	Push to Exit button	:	Suprema / Schneider/ Honeywell
6.	Cables	:	Bonton / Havells / Polycab
7	MS / FRLS PVC Conduit	:	AKG / RM Con / BEC
9	CAT 6 Cables	:	AVAYA / AMP
10	Boom Barriers / Turnstile / Flap Barriers	:	Honeywell / Dormakaba / MOTWANE
11	RFID Tags & Readers	:	Honeywell / Suprema / HID
C.	**CCTV**		
1.	CCTV System and Cameras	:	CP Plus / Honeywell / Hikvision

S.NO	ITEMS		APPROVED MAKES
	(Cameras, NVR, DVR, VMS, Software etc.)		
2.	Transmitter & Receiver for Lift Car Cameras	:	Cambium / Ubiquity
3.	Monitor	:	Samsung / LG / Panasonic
4.	DVR / NVR / VMS	:	CP Plus / Hikvision/ Honeywell
5.	Switch	:	Cisco / Huawei / Avaya
6.	Co- axial / Multicore Cable	:	Finolex / Bonton/ Havells
7.	MS / FRLS PVC Conduit	:	AKG / RM Con / BEC

****

SECTION: 9

COMPLIANCE UNDER EIA

Contractor to comply with the provisions under EIA, but not limited to following provisions:

1. Contractor would not be permitted to store/dump construction material or debris on metalled road.
2. Beyond the metalled road the area where such the construction material or debris can be stored shall be physically demarcated by 'the Contractor ensuring that it would not cause any obstruction to the free flow of traffic/inconvenience to the pedestrians. It should be ensured that no accidents occur on account of such permissible storage.
3. Contractor shall ensure that the construction material is covered by tarpaulin and all other precaution should be taken to ensure that no dust particles are permitted to pollute air quality as a result of such storage.
   It shall also be ensured that appropriate protection measures are taken by raising wind breakers of appropriate height on all sides of the plot/area using plastic and for other similar material to ensure that no construction material dust fly outside the plot area and it will be the builder/contractor responsibility to ensure that their activity does not cause any air pollution during course of construction and/or storage of material or construction activity. This condition shall be strictly adhered to by every builder, contractor, person or authority. In the event of default they shall be liable to be prosecuted under the law in force, as well as for causing environmental pollution and will be liable to pay compensation which would be determined by Tribunal in accordance with law.
4. All the trucks or vehicles of any kind which are used for construction purposes/or are carrying construction material like cement, sand and other allied material should be fully covered. The vehicles should be properly cleaned, should be dust free and every necessary precautions is to be taken to ensure that enroute their destination, the dust, sand or any other particles are not permitted to be released in air/contaminate air. Any truck not complying with the above directions would not be permitted to enter the area.
   And whereas Hon'ble National Green Tribunal in order dated 10.04.2015 interalia directed as follows:
   a. Contractor shall put tarpaulin on scaffolding around the area of construction and the building. No person including builder, owner can be permitted to store any construction material, particularly sand on any part ofthe street, roads in any colony.
   b. The construction material of any kind that is stored in the site will be fully covered in all respects so that it does not disperse in the Air in any form.
   c. All the construction material and debris shall be carried in the trucks or other vehicles which are fully covered and protected so as to ensure that the construction debris or the construction material does not get dispersed into the air or atmosphere, in any form whatsoever.
   d. The dust emissions from the construction site should be completely controlled and all precautions taken inthat behalf.
   e. The vehicles carrying construction material and construction debris of any kind should be cleaned before it is permitted to ply on the road after unloading of such material.
   f. Every worker working on the construction site and involved in loading, unloading and carriage of construction material and construction debris shall be provided with mask to prevent inhalation of dust particles.
   g. Every owner and or builder shall be under obligation to provide all medical help, investigation and treatment to the workers involved in the construction of building and carry of construction material and debris relatable to dust emission.
   h. It shall be the responsibility of every builder to transport construction material and debris waste to construction site, dumping site or any other place in accordance with rules and in terms of this order.
   i. All to take appropriate measures and to ensure that the terms and conditions of the earlier order and these orders should strictly comply with by fixing sprinklers, creations of green air barriers.
   j. Compulsory use of wet jet in grinding and stone cutting.
   k. Wind breaking walls around construction site.
   l. All the builders who are building commercial, residential complexes which are covered under the EIA

Notification of 2006 shall provide green belt around the building that they construct. All Authorities shall ensure that such green belts are in existence prior to issuance of occupancy certificate.

m. All builders shall ensure that C&D waste is transported in terms of this order to the C & D Waste site only and due record in that behalf shall be maintained by the builders, transporters and NCR of Delhi.

n. Even if constructions have been started after seeking Environmental Clearance under the EIA notification 2006 and after taking other travel but is being carried out without taking the preventive and protective environmental steps as stated in this order and MoEF guidelines, 2010, the State Government, SPCB and any officer of any department as afore stated shall be entitled to direct stoppage of work.

And whereas, Environmental Impact Assessment Guidance Manual for Building, Construction, Township and area Development Projects of February, 2010 is available on the website of MoEF &CC envisaging the following guidelines for mitigation measures in respect of dust control from Building, Construction projects:

"*Adopting techniques like, air extraction equipment, and covering scaffolding, hosing down road surfaces and cleaning of vehicles can reduce dust and vapour emissions. Measures include appropriate containment around bulk storage tanks and materials stores to prevent spillages entering watercourses.*

The other measures to reduce the air pollution on site are:

- *Sprinkling of water and fine spray from nozzles to suppress the dust.*
- *On-Road- Inspection should be done for black smoke generating machinery.*
- *Promotion of use of cleaner fuel should be done.*
- *All DG sets should comply emission norms notified by MoEF.*
- *Vehicles having pollution under control certificate may be allowed to ply.*
- *Use of covering sheet to prevent dust dispersion at buildings and infrastructure sites, which are being constructed.*
- *Use of covering sheets should be done for trucks to prevent dust dispersion from the trucks, implemented by district offices.*
- *Paving is a more permanent solution to dust control, suitable for longer duration projects. High cost is the major drawback to paving.*
- *Reducing the speed of a vehicle to 20 kmph can reduce emissions by a large extent.*

Speed bumps are commonly used to ensure speed reduction. In cases where speed reduction can't effectively reduce fugitive duct, it may be necessary to divert traffic to nearby paved area.

Material storages – care should be taken to keep all material storages adequately covered contained so that they are not exposed to situation where winds on site could lead to dust / particulate emissions. Fabric and plastics for covering piles of soil and debris is an effective means to reduce fugitive dust.

SECTION: 10

HSE GUIDELINES

GU SAFETY

This document sets out **GU** expectations from contractors on Environment, Health and Safety aspect of the construction workers deployed at the project site. It provides general EHS procedures for most, but not all, construction activities to prevent accidents and to monitor/correct violations of procedures through regular Safety meetings. However, a key requirement for EHS success is serious commitment from senior management and strong safety leadership at the project site with well-defined roles and responsibilities of the assigned individuals. Towards that, it is imperative that the selected Managing Contractor employs a well-qualified (relevant qualifications) and experienced Safety Officer responsible for implementing and continuously communicating and driving the procedures throughout the labour force. Being one of the key critical to quality (CTQ's) parameters, the contractors shall be required to submit with their tenders their organization safety policy, risk assessment along with brief summary of the safety performance on projects that they have managed in the last three years (i.e. number of man-hours, number of fatalities, accidents, near misses, type and cause of accidents, etc).

Scope of procedures and relationship with GU:

The Contractor's Safety & Health Procedures applies to all contractor and its subcontractor employees and to all construction and maintenance activities on the job site. A close relationship and continuous interaction must be maintained with **GU** Project team by the construction manager of the contractor. **GU** does have specific safety and health requirements as perthe **GU**'s EHS policy to be observed and cooperation with its representative, Architects, consultant various audit teams and other contractors at site, throughout the contract period is essential.

Selection of sub-contractor:

The main contractor shall select sub or works contractors, using the same criteria of practical safety policy. Again, it must be ensured that the terms of contract include adequate provision for safe working practices & for specified safety and health items.

Standards

The prime contractor and all subcontractors are to comply with the Client specific rules and procedures, the national legislation and codes and in particular the following standards;

IS: 3696 (Part I) -1966 Safety code for scaffolds and ladders: Part I Scaffolds IS:
3696 (Part II)-1966 Safety code for scaffolds and ladders: Part II Ladders IS: 3764-
1966 Safety code for excavation work

IS: 4082-1977 Recommendations on stacking and storage of construction materials at site (first revision)IS:
4130-1976 Safety code for demolition of building (first revision)

IS: 4912-1978 Safety requirements for floor and wall openings, railings and toe boards (first revision)IS:
5121-1969 Safety code for piling and other deep foundations

IS: 5916-1970 Safety code constructions involving use of hot bituminous materialsIS:
7205-1974 Safety code for erection of structural steel work

IS: 7969-1975 Safety code for handling and storage of building materialsIS:
8989-1978 Safety code for erection of concrete framed structures

IS: 7293-1974 Safety code for working with construction machineryIS:
10291-1982 Code of dress in Civil Engineering works, safety

IS: 875-1964 Code of practice for structural safety of buildings and loading standardsIS:
1905-1980 Code of practice for structural safety of buildings, masonry walls

IS: 10386-1983 General aspects Part 1 – 1983, Part 2 – 1982, Part 6 – 1983, Part 10 – 1983 Amenities, protective clothing and equipment, construction, storage, handling, detection and safety measures for gases, chemicals and flammable liquids IS: 2925-1984 Safety helmet tests

IS: 5983-1980 Testing for Eye protectorsIS:
7524 (Part I)-1979 Safety goggles

IS: 1179-1967 Welding helmetsIS:
5914-1970 Safety shoes

IS: 4770-1991 Safety gloves

IS: 12254-1993 Rubber/ PVC knee boots/ gum boots

Client specific requirements for compliance with OSHA standards

SECTION 2: ELEMENTS OF CONSTRUCTION SAFETY

Planning:

Detailed planning should take the following matters in to account;

- Obtaining work specific permits like;
- Permit for work at Height
- Hot work permit
- Disposal permit
- Excavation permit
- Night work permit
- Permit for working in restricted areas
- Confined space Entry permit
- Shaft work permit

- Know the hazardous operations eg. Use of cranes and site transport, structural erection, excavation and false work, scaffolding, roof work, demolition etc.
- Requirement for plant and equipment to ensure safe working or ease of handling
- Sequence of work and its phasing between contractors to minimize the possibility of one contractor placing another contractor's men at risk, where appropriate the segregation of contractors should be considered
- Need to provide information, instruction and appropriate training, both on general site safety and hazardous specific in the site. The latter could range from restricted zones, Permit-to-work systems, lifting operation to the wearing of Personal protective equipment
- Need for fire precautions and emergency procedures
- Need for environmental monitoring and health surveillance
- Site security and foreseeable risks to the public, including the need for directional and warning signs
- Safe access across the site for persons, vehicles and equipment. Thought should be given to arrangements for keepingthe site tidy, accommodation for site staff, safety welfare, first aid and other facilities
- Provision of safe places of work at different stages of the job including the provision of scaffolding, ladders for a numberof sub-contractors.

Control:

Sub and works contractors shall be briefed about the safety policy and site including site specific safety procedures of the prime contractor at the pre-bid meeting itself and further reiterated during the kick-off meeting. Responsibilities of all parties shall be clearly defined before contractors start work at site. Such matters should include:

- Appropriate precautions and methods for identified hazards or hazardous work

- Necessary plant, equipment and arrangements for its provision, maintenance use and inspection
- Question of trade union or other workforce safety representation and the need for a joint safety committee
- A formal joint safety committee must be appointed to review results and to initiate further actions (should be done eitherduring kick-off meeting or subsequently)
- Arrangement for initiation of introduction training for new states on site
- Arrangements for any specialized training
- Arrangements for promulgating safety and health information e.g. On-site notice boards

It is important that such safety and health arrangements are reviewed at the Kick-off meeting as well as first project and first Safety meeting, where the site management can set the tone for the conduct of work by resolving at an early stage the difficulties which may arise at a later date. It is expected that each subcontractor will provide employees adequately licensed(if required for specific works), trained and capable of doing the specialty work.

Coordination:

The Site In-charge appointed by the prime contractor shall be totally responsible for compliance with this health and safety code. The contractor must appoint a Chief Safety Officer and form a "contractor safety committee" along with safety representatives from its sub-contractors. This committee will be chaired by the Site In-charge and meet at least once a weekto review status on EHS issues. It is expected that each contractor and sub-contractor will participate in Daily "Tool BoxTalks" and other safety meeting to co-ordinate project work for the day across trades. The site in-charge must make suitable arrangements to ensure the effective coordination of the work of all its sub-contractors on site. Clear lines of communication should be set up between each sub-contractor's Safety Officer and Safety officer of the prime Contractor. Effective co-ordination will be enhanced by ensuring that 'Safety and Health' figures prominently on the agenda of regular project meetings, as well as Safety meetings. For better coordination on project related EHS issues, the safety meeting participants shall include Project Manager, Project Manager's Safety representative, all contractor's safety representatives along with 's safety rep. Project Manager's Safety officer shall convene this meeting and participants from all contractors safety representatives will be mandatory. Minutes of this meeting shall be circulated to all concerned.

Monitoring:

Arrangements must be made for safety and health monitoring of the site on a regular basis. This will include, not only ensuring the safety issues associated with working at heights, excavations, working with energy sources, etc. but also environmental matters such as hazardous dust, fumes, noise etc. In all cases, the contractor's Site- In-charge shall ensure that daily site inspections are carried out by the contractor's Safety Officer, more in depth inspection being done periodically

by visiting safety advisor. It may be necessary for arrangements to be made for specialist occupational health and hygiene advice. The checklist for daily inspection is provided which must be included in the Behaviour Observation Process (BOP).

Records:

The prime contractor should ensure that all statutory notification, examinations and inspections are carried out. Except for equipment used exclusively by individual contractors, all records should be kept & updated by the contractor's Site In-charge. This individual shall also keep track of all Safety statistics and send report to **GU** Project team on periodic basis, as determined by **GU** Project Manager.

Non-Compliance with Safety and Health Provisions:

The compliance with Environmental Health and Safety provisions is of utmost importance to the. The contractors must note that the will take a serious view of any Safety non-compliance notices. The has a right to order stoppage of work till rectification is carried out to the satisfaction of the safety committee or safe arrangements are made for the execution of work and all stoppages on this account will be at the entire risk, costs and consequences of the contractor.

Disciplinary action:

Noncompliance of the Safety and Health Provisions will result in disciplinary action as per the procedure below:1st time violation: Written warning

2nd time violation: Imposition of penalty as deemed fit by **GU** Project Manager3rd time violation: Removal from site

In the event of the offender bringing itself or others in direct life-threatening situation or where he/she creates a large material damage, will result in immediate removal from site. Repeated violations by a contracting company shall lead to termination of contract and removal of contracting firm from the job site. Any losses incurred by the contracting company, whatsoever, shall be the responsibility of contracting company.

Imposition of penalties for non-compliance with EHS guidelines:

The contractor will be required to comply with all the requirements laid down in these EHS guidelines, Special safety conditions, General conditions of contract and any other safety requirements as a matter of general prudence. Upon failure to comply with any of these, Project Manager is authorized to impose penalty on the contractor as per the details below:

Schedule of Charges to Contractors who are in breach of the employer's Site Safety, Site Safety Cycle and Environmental Rules and Regulations:		
S No.	**Nature of Offence**	**Amount of Safety or Environmental Charge to be levied against the Sub Contractor for each breach of the employer's Rules & Regulations (Indian Rs)**
1	Smoking in an unauthorized area and/or consumption ofalcohol and/or use of illegal substances.	Rs 1000.00
2	Burning of waste or smoldering of combustible materials on site other than for heat treatment processes required for the execution of the Sub Contract works.	Rs 3000.00
3	Failure to wear personal protective equipment (P.P.E.) e.g. Safety helmets, safety boots, goggles etc. respirator, ear plugs, safety belts which shall include failure to anchor belt to a secure structure.	1) Rs.1000.00 per worker when lack of enforcement of the usage of P.P.E. by the Contractor/ Sub-contractor is observed by the employer.
	Where any site operation requires the use of PPE then all workmen must use the required PPE eg. grinding, welding, burning, unloading hazardous materials etc.	2) Rs. 2,000.00 where issuance of the required P.P.E. by the Sub Contractor equipment is not carried out.
4	Failure to attend general safety induction courseconducted by the employer / the employer.	1) Rs.5000.00 per worker for not attending the course; and
		2) Workers to attend course within 2 working days orbe dismissed.

5	Failure to attend a notified site safety meeting.	Rs 5,000.00
6	Failure to submit, within the specified time to the employer, safety supervisor reports which shall include other relevant statutory reports made under the F&IUO Cap. 59, tool box briefing records, weekly Labour return, issuance of personal protective equipment records, safety data sheets of toxic and harmful materials and others related certificates.	Rs 5,000.00
7	Failure to submit a written report for an accident and/or other dangerous occurrence, to the employer within 24 hours of its occurrence.	Rs 5,000.00
8	Failure to carry out within the specified time thenecessary improvement action against any notified safety violation.	Rs 8,000.00
9	Damaged to or misuse of the employer's property.	1) Rs. 5,000.00; and 2) in addition the Sub Contractor to pay for the cost of items damaged.
10	Failure to maintain work area, facility storage and preparation yard, office premises and workers changing and rest area in a clean and orderly state and free from health and fire hazards.	1) Rs 3,000.00; And 2)in addition the Sub Contractor shall clean up thedisorderly and untidy areas within 3 days.
11	Obstruction of passageways, entrance, door, way's, stairs, access to firefighting equipment etc. and /or theerection unsafe access and crossing's	Rs 5,000.00 In addition sub-contractor shall clean up the disorderly and untidy areas within 1 day.
12	Use of equipment that has not been examined by an approved person as required under the factories and industries undertaking ordinance and its related regulations.	Rs 7,000.00
13	Use of defective or uncertified sling's for liftingoperations	Rs. 8,000.00;
14	Executing unsafe hoisting of materials and include unsafe use of lifting appliance.	Rs 10,000.00
15	Erecting and / or using unsafe or unstable scaffolding,working platforms and temporary structures.	Rs 7,000.00
16	Failure to provide and use proper working platforms and safe means of access to the work place, where work is required to be carried out beyond person's normal reach.	Rs 10,000.00
17	Allowing workers to occupy or work on unguarded elevated platforms, floor edges and without adopting adequate safety measures against the risk of person falling from height.	Rs.7,000.00; .

18	Not providing safety barricades / barriers to hazardous floor edge, openings, gaps and shafts.	Rs.7,000.00;
19	Rendering scaffold or working platform unsafe bytampering / alternation.	Rs.10,000.00;
20	Placing of heavy items unsafely on scaffold orworking platforms.	Rs 5,000.00
21	Throwing or allowing objects to drop from heights.	Rs.10,000.00
22	Stacking or leaving materials include work in progress articles and tools in unstable condition and or along flooredges such they are likely to endanger workers.	Rs 8,000.00;
23	Failure to effectively cordon off guard and warn other workers from entering into the danger areas when they are likely to be affected by falling materials from the sub-contractor work.	Rs 8,000.00
24	Violating the permit to work system	Rs 10,000.00
25	Dismantling and rendering any safety guards or protective features of any part of a machine or any partof building structure to extend that such guards and protective features are not operational or are incapable of providing the necessary protection for its design and purpose.	Rs. 10,000.00 .
26	Adopting unsafe tapping, connections and termination of electrical lines and including the use of defective electrical fittings, power cables and electrical tools. Allowing cables / equipment to be merged into water.	Rs 5000.00;
27	Using any defective or unsafe equipment.	Rs 5,000.00
28	Unauthorized use of fire equipment provided foremergency purposes.	Rs.5,000.00
29	Failure to comply with an order issued by the employer's construction manager, safety officer in regard tosafety/environment matters.	Rs.8,000.00
30	Threatening safety personal, misbehaver, fighting orintentional causing hurt to others.	Rs.10,000.00 Person to be banned from the site and report will be made to the police.
31	Failure to wear safety harness and anchor to a secure structure, while working at height.	Rs 5,000.00 if there is 2nd time violation by the sameperson or group attract penalty Rs. 10,000 or more
32	Failure to provide valid certificates for lifting appliances and accessories including any lifting appliance / accessories on vehicles delivering goods to the site.	Rs.8,000.00
33	Failure to provide voltage reducing device onwelding machine.	Rs 4,000.00;
34	Failure to attend site safety walk	Rs 5,000.00

35	Deploying under age or over age worker worker or staff	Rs. 10, 000.00
36	Pregnant women to be not engaged at the constructionsite	Rs. 10, 000.00
37	Failure to provide site safety officer as per the requirement of latest ordinance.	Rs 10,000.00

Note:-

Procedure of Debit:-

- A debit Note will be issued to vendors with the backup records of Non-Conformity and the Penalty amount will bedebited from the Running Bill.
- Prior to the above a 'non conformity notice' shall be issued to give last opportunity to the vendor to comply therequirements.
- Please ensure that all OHSE NON –Conformities with debits are in the notice of client with acceptance beforetaking forward to the contactors.

SECTION 3: SAFETY AUDITS

1) It is essential to conduct formal periodic safety audits to prevent deviations from safety standards.
2) The audit should take the form of a full survey covering all aspects of safety throughout the project site. Reports should be submitted to the Safety Committee. Copies of the results of a survey should be sent to the persons in charge of the respective areas so that corrective measures can be taken. A copy of the Audit report should also be sent to the ProjectHead.
3) Audit team should cover the following aspects:

- Organization
- Accident control
- Hygiene facilities
- Electrical systems
- Fire prevention
- Demarcated areas
- Mechanical equipment
- Safe work practices
- Storage areas
- Material stacking
- Housekeeping
- Safety statistics
- Display of emergency numbers
- MSDS sheets
- Personal Protective Equipment
- Safety training
- Safety meetings
- First aid facilities
- Traffic control, Signage, etc.

4) Findings of the safety audits shall be sent to Safety committee and also be discussed in the Safety committee meetings.
5) Work place audits should also be carried out at job site frequently (at least every week) conducted by representatives of respective contractors to make sure that all Safety provisions are getting complied with. These should primarily focus on Safe working systems, Housekeeping, Machine guarding and use of PPE. Results of these audits shall be reported to the Safety committee.

SECTION 4: ACCIDENT PREVENTION, REPORTING AND INVESTIGATION

Definition:

An accident is commonly defined as: "An unplanned event which may or may not result in injury or damage". As is clear from the definition, an accident need not necessarily involve either injury or damage to person or property. A "near miss" is by definition an accident and should be regarded as a warning that a problem exists and that some action is required to avoid a possible accident/ incident in future.

Causes of Accidents:

88% of all accidents are caused by human error, 10% are caused by mechanical failures and the other 2% are considered outside human control eg. Earthquake etc. The likely causes of accidents should be identified in advance and the appropriate action taken to ensure that the accident never actually takes place. The most important and effective accident prevention technique is training the actions and attitudes of all personnel.

Accident Recording and Investigation

It is essential to have an effective management system for recording accidents. All accidents should be thoroughly investigated. A near miss or incident should be investigated as though an accident had occurred. The prime objective of all investigations of this type is to identify the causes in order to eliminate the risk. Such aspects as systems training and guarding should all be considered in addition to what actually happened and why. The accidents record should include accidents to employees and non employees on company premises i.e. Contractors, construction workers, maintenance workers, visitors etc. and to those using company vehicles. Supervisory staff and, when possible, department personnel should be involved in any investigation relating to their area of control and should be delegated in writing to conduct a detailed analysis of the causes. They should determine how best to prevent a recurrence and this should be taken into account in the report. The depth of the investigation and the effectiveness of the follow up action should be monitored. Records of all accidents must be kept to enable statistics to be analyzed and root causes determined.

Incident Control System

Unsafe acts & conditions and "near misses", if they are not dealt with appropriately, can turn into accidents. It is essential that companies operate an incident control system to ensure that these potential hazards are reported and eliminated. The system should;

- Ensure that whenever possible safety representatives and other employees are involved
- Encourage any person to register an unsafe action or conditions
- Ensure that reports are recorded and acted upon
- Identify the responsibility for investigation and for carrying out corrective action
- Specify the time within which the corrective action should be completed or progress reported
- Ensure that a report is made to management and to the originator when
- corrective action has been completed

Levels of Accident Investigation:

The type or level of accident investigation depends on the nature and seriousness of the incident. In most cases, an "Accident and Incident investigation panel will be formed which will determine the appropriate level of investigation.

Types of Investigation:

• A full investigation which requires a panel including a Project Manager, Safety Officer and Contractor's Safetyrepresentative and GU Corporation Pvt Ltd project team representative or a panel as determined by Project Manager.
• A departmental investigation involving the departmental manager(s) the safety officers and the appropriate supervisor

• An investigation by the supervisor involving, where appropriate, the employees concerned

Lost Time Accidents (LTA):

This refers to the total number of accidents of all types which result in lost man hours. Lost man hours occur if the person involved is unable to return to normal duties immediately after any treatment.

Reportable Accidents:

When an employee, as a result of a lost time accident, is absent from work for more than two days (48 hour), then this will be recorded not only as a lost time accident but also a reportable accident. Brief details of each reportable accident and the steps taken to avoid repetition should be given in the Project Mangers monthly Report.

Serious Accident:

This is an accident which causes death or serious injury e.g. a broken limb, amputation serious burns etc., or hospitalization for one or more nights. In addition any escape of gases/toxics substances, which affect the environment and the surrounding area / community even if it does not cause injury to people, is considered a serious accident. This definition applies to employees and non employees, the yardstick that defines whether it is a serious accident in site terms is whether the victim was on company premises on company business, or using company equipment or transport. Thus if an operating companyis in any way involved in a serious accident then it must be fully investigated and reported to company management.

Incident / Near Miss:

This can be described as an undesired event which, under slightly different circumstances, could have resulted in an accident.

Reporting Accidents/ Incidents/ Near Misses:

All Accidents/ Near misses must be reported to Project managers of the company immediately, with brief details. A preliminary report will then be submitted by the Project Manager to the Zonal Associate Director and Executive Director, as per the procedure outlined in Project Management firm's Standard Operating Procedures. A full and final report will subsequently need to be prepared and submitted. The contractor shall submit the report in the standardized format attached with these EHS guidelines.

Reporting Accident Statistics:

Accident statistics reported to company should be based on employees at job site. Accidents to non-employees (vendors or sub-vendors) should be reported as separate statistics.

Statistical formulae:

Lost time Accidents: This is the total number of accidents including all reportable and serious accidents

Reportable Accident: This is the number of accidents where an employee is absent from work for more than 48 hours consecutively (excluding the day of accident).

Percentage man hours lost: This is the total number of hours lost expressed as a percentage of total man hours worked.Total man hours lost X 100%

Total man hours worked

The lost time accidents, reportable accidents and percentage man hours lost should be reported on a monthly basis as part of the Project Manager's review. The figures given in each category should be for the month under review, the year to date and the previous year to date.

Accident Frequency rate:

This is the total number of lost time accidents per 1 million man hours worked by permanent and temporary employeesTotal number of lost time accidents X 1,000,000

Total number of man hours worked

Accident incident rate:

This is the total number of any accidents per 1000 employees.Total number of lost time accident X 1000

Average number of persons employed

For this calculation the total number of employees should be averaged out over the year. Part time employees should be included in proportion to the time worked. The accident frequency rate and accident incidence rate should be calculated annually and reported in the year end results. In addition to the statistics referred to above, all data pertaining to incidents must also be kept at site.

SECTION 5: MANAGEMENT RESPONSIBILITY FOR SAFETY

Management has the responsibility to ensure that a well developed Safety program is in place. The contractors are obligated to provide;

- Safe place of work, which includes safe means of access and exit during normal daily work routine as well as in emergencies
- Safe plant and equipment including the maintenance of it
- Safe systems of work. This includes safe working practices and work instructions for all jobs taking particular account of hazardous situations
- Safe working environment and proper arrangements for employee welfare. This responsibility includes proper lighting, ventilation, fume and dust extraction, noise control, housekeeping, seating, drinking water, sanitary facilities and a wide range of other factors
- Safe methods for storing, handling and transporting goods and substances
- Such information instruction, training and supervision as are necessary to ensure efficient and safe workingpractices, which comply with national legislation and company rules.
- Basic and job related safety training for all its and as well its Sub contractor's
- Temporary and permanent employees.
- Consultation with employee with a view to making and maintaining adequate and effective arrangements for health safety and welfare
- A written statement with respect to the health, safety and welfare of the employees containing details of procedures which will put the policy into effect and define individual responsibilities for safety
- Where accommodation provided in the GU CORPORATION PVT LTD premises, this must conform to the same safety and hygiene standards as other company premises, in respect of the premises itself and the working of any staff.
- Safe and correct work procedures must be followed for carrying out any construction activity.

SECTION 6: SAFETY ORGANISATION

The contractor/ contracting company shall appoint in writing a person to direct and co-ordinate job site safety program. This person should be a full time, technically qualified safety officer and must have received formal training in Health and Safety.In addition, the contracting company shall also appoint required number of safety stewards, as per prevailing Laws and regulations, but in any event, a Safety steward shall be on the job site at all times when work is ongoing. The duties and responsibilities of contractor's safety manager should be clearly defined at the outset, which will include managing the company health and safety program in order to achieve an accident free environment.

Duties of contractor's Safety Manager

The precise duties of the manager responsible for health and safety will be determined by the contractor/ contracting company concerned and the following should only be taken as a minimum guideline. In general the duties shall include:

- To manage the company Health and Safety program
- To make recommendations on matters concerning health and safety to the Director responsible for the company health and safety program in order to achieve the company's health and safety objectives To inspect all or part of the premises daily to ensure the program is being complied with To carry out full inspection at least once everyweek for potential hazards To prepare Pre task plans and make necessary modifications till they are accepted by Project Manager's Safety representative
- To recommend any necessary health and safety rules including changes where appropriate
- To arrange adequate materials and publicity for the Health and Safety Program
- To arrange, attend and supply relevant material for Safety Committee Meetings and weekly safety meetings
- To conduct appropriate job related health and safety training for all new and existing staff whether temporary orpermanent. Any job change should be accompanied by relevant retraining.
- To carry out specific health and safety training for managers, supervisors and safety representatives.
- To properly investigate all accidents, damage to property and near miss incidents and make sure that anycorrective action is implemented
- To maintain accident records and make a weekly inspection of first aid records and implement any necessarysubsequent action
- To prepare weekly summaries of injury/damage and inspection reports for senior management
- To ensure that all fire equipment is regularly inspected and serviced.
- To ensure the provision of safe tools, equipments and protective clothing where appropriate, and their safe use.

SECTION 7: SAFETY COMMITTEE

Formation of a site specific safety committee is one of the best methods of obtaining employee involvement in safety. The committee should have formal status and its members shall include;

- Project Manager's Safety representative
- GU's Safety representative
- Contractor's safety representative
- Subcontractor's safety representatives
- Head – Site security
- Fire officer
- Any other members the management may decide to include

Objectives of Safety Committees:

The prime objective of a safety committee is to promote co-operation between employers and employees in order to investigate, develop and carry out measures designed to ensure the health and safety at work of the company's employees, non employees and other project participants on job site.

Functions of Safety Committees:

The key functions of Safety Committee shall include;

- To study the accident statistics and trends within their area
- To report on unsafe or unhealthy conditions together with recommendations which can then be made tomanagement and the safety group
- Examining safety audits relating to their area
- Considering reports comments and suggestions of safety representatives
- Giving assistance in the development of safety rules/ systems of work
- Commenting on the effectiveness of the safety content of staff training program

- Commenting on the adequacy of health and safety
- Communications in the workplace including on-the-job safety meetings
- Co-operating with management in carrying out regular safety inspection of departmental areas and reporting theresults of these inspections to the main safety committee.
- Organize safety training and demonstrations etc to make to make everyone aware about the safety procedures.
- Organize safety competitions for motivating people at site

The safety committees can only assist Management in taking decisions; they cannot substitute for Management. Management must still take overall responsibility for executive action with a view to ensuring that health and safety arrangements are checked regularly and that the health and safety policy as a whole is being implemented properly.

GALGOTIAS UNIVERSITY

SECTION 8: CONTACTOR'S SAFETY INSPECTION CHECK LIST

Contractor Contract No. /Purchase order no ----------

Project----------

Location----------

Type of Work----------

Date Checked By----------

S	ITEM	STATUS	REMARKS
	Accident prevention Organization Trained First Aid person First Aid Kit Safety Material Posted Emergency Phone # Posted		
	Housekeeping & Sanitation General neatness of working areas Daily disposal of waste and trash Passageways and walkways clear Adequate lighting Projecting nails removed Oil and grease removed Waste containers provided & used Sanitary facilities adequate and clean Drinking water tested and approved Adequate supply of water Drinking cups, Clean Dispensers Exit sign posted		
	Fire Prevention Fire extinguishers identified, checked, charged Hydrants clear access to public thoroughfare Open Good Housekeeping		
	NO SMOKING posted and enforced where needed		
	Personal Protection Hard-hats Noise Level Exposure / Ear protection Eye Protection Safety Lines & harnesses Life Jackets (If necessary) Safety shoes / Gum Boots Gloves		
	Electrical Installation Adequate well insulated wiring Fuses & GFI provided Fire hazards checked Electrical dangers posted Open wires without adaptors not used Lock out / Tag out procedures used for maintenance of Electrical system, Temporary wiring not used as permanent installation. Personal protective equipment and clothing provided.		
	Gas Cutting Flash back arrester in all the gas cutting nozzles. Use of DA or industrial LPG only no domestic cylinders. Availability of fire extinguishers / water close by		
	Hand & Power Tools Tools and cords in good condition Proper grounding All mechanical safeguards in use Tools neatly stored when not in use Right tool being used for the job at hand Wiring properly installed Enough men used to handle material Use of GFCI for tools usedoutdoors		
	Ladders Stock ladders in good condition Stock ladders not spliced Properly secured, top and bottom Side rails on fixed ladders extend above top landing Built-up ladders constructed of sound materials Rungs not over 12 inches on center Stepladders fully open when in use Metal ladders not used around electrical hazards Proper maintenance and storage		
	Hoists, Cranes & Derricks Inspect cables and sheaves Check slings and chains, hooks and eyes Equipment firmly supported Outriggers used if needed Power lines inactivated, removed, or at safe distance Proper Loading for capacity at lifting radius All equipment properly lubricated and maintained Signalmen where needed Hoisting plan. Test certificate of all the lifting equipments.		

	All equipments should display the last inspection date and the next due date		
	Motor Vehicles Brakes, lights, warning devices or barricaded Weight limits and load sizes controlled Personnel carried in safe manner. Seat belts provided and used. Reverse horn in working condition, PUC certificate available		
	Barricades Floor opening planked over or barricaded Roadways and sidewalks effectively protected Adequate lighting provided Traffic controlled		
	Handling & Storage of Materials Neat storage area, clear passageway Stacks on firm footings, not too high Men picking up		
S	**ITEM**	**STATUS**	**REMARKS**
	loads, correctly Materials protected from heat and moisture Protection against falling intohoppers and bins Dust protection observed		
	Excavation & Shoring Shoring of adjacent structures Shoring and sheathing as needed for soil and Depth Public roads and sidewalks supported and protected Materials not too close to the edge of excavation Lighting at night Water controlled Equipment at safe distance from edge		
	Concrete Construction Forms properly installed and braced Adequate shoring, plumbed and cross braced Shoring remains in place until strength is attained Proper curing period and procedures Check heating devices Adequate runways Protection from cement dust Hard-hats, safety shoes, shirts covering skin Nails and stripped form material removed from area		
	Masonry Proper scaffolding Masonry saws properly equipped, dust protection provided Safe hoistingequipment		
	Hoists, Cranes & Derricks Inspect cables and sheaves Check slings and chains, hooks and eyes Equipment firmly supported Outriggers used if needed Power lines inactivated, removed, or at safe distance Proper Loading for capacity at lifting radius All equipment properly lubricated and maintained Signalmen where needed Hoisting plan. Test certificate of all the lifting equipments. All equipments should display the last inspection date and the next due date		
	Motor Vehicles Brakes, lights, warning devices or barricaded Weight limits and load sizes controlled Personnel carried in safe manner. Seat belts provided and used. Reverse horn in working condition, PUC certificate available		
	Barricades Floor opening planked over or barricaded Roadways and sidewalks effectively protected Adequate lighting provided Traffic controlled		
	Handling & Storage of Materials Neat storage area, clear passageway Stacks on firm footings, not too high Men picking up loads, correctly Materials protected from heat and moisture Protection against falling intohoppers and bins Dust protection observed		

	Excavation & Shoring Shoring of adjacent structures Shoring and sheathing as needed for soil and Depth Public roads and sidewalks supported and protected Materials not too close to the edge of excavation Lighting at night Water controlled Equipment at safe distance from edge		
	Concrete Construction Forms properly installed and braced Adequate shoring, plumbed and cross braced Shoring remains in place until strength is attained Proper curing period and procedures Check heating devices Adequate runways Protection from cement dust Hard-hats, safety shoes, shirts covering skin Nails and stripped form material removed from area		
	Masonry Proper scaffolding Masonry saws properly equipped, dust protection provided Safe hoistingequipment		

SECTION 9: FIRST AID AND EMERGENCIES

Trained First Aid Person

A contractor shall provide, or ensure that required number of suitable persons as adequate and appropriate are provided inthe circumstances for rendering first aid to people deployed at site if they are injured or become ill at work. The trained first aid person should have undergone:

a) Such training and has qualifications as the Health and Safety Executive may approve for the time being in respect of that case or the class of case, and

b) Such additional training, if any, as may be appropriate in the circumstances of that case. In practice, (a) refers to a trained first aider and (b) to an occupational first aider. In addition, a person who holds a current first aid certificate issued by registered medical association or Indian Red Cross Society will be classed as a "Suitable Person" for the purposes of regulation. The contractors shall ensure that sufficient first aides are appointed to provide adequate coverage for each shift. Provisions for medical care must be made available by the contractor for every employee covered by the regulations. In the absence of dispensaries, clinics, or hospitals in proximity to the work site, properly trained and certified first aid personnel must be available, and first aid supplies must be provided by the contractor. Appropriate equipment for transportation ofinjured personnel to a physician or hospital must be provided for. An emergency plan, medical care, firefighting and evacuation plan must be developed by the main contractor.

First Aid Kit:

Regardless of the number of people there must be at least one first-aid box on site. Every first aide and occupational firstaider should have easy access to first-aid equipment, and provision should be made for every person to have reasonably rapid access to first aid. Each box should be placed in a clearly identified and readily accessible location, and contain asufficient quantity of suitable first-aid materials and nothing else. Boxes and kits should be checked frequently to ensure they are fully stocked and all items are in a usable condition. Sufficient quantities of each item should always be available in every first aid box or cabinet.

S.No	Item	Numbers of People working at Site				
		1-5	6-10	11-50	100	150
1	Guidance card individually wrapped	1	1	1	1	1
2	Sterile adhesive dressings	10	20	40	40	40
3	Sterile eye pads with attachment	1	2	4	6	8
4	Triangular bandages	1	2	4	5	8
5	Sterile coverings for serious wounds	1	2	4	5	8
6	Safety pins	6	6	12	12	12
7	Medium sized sterile un-medicated	3	6	8	10	12
8	large sterile un-medicated dressings	1	2	4	6	8

9	X-large sterile un-medicated dressing	1	2	4	6	8
10	Sterile water in 300 ml disposable containers, where tap water unavailable	1	1	3	6	6

The first-aid box or cupboard should protect the content from dampness and dust and be clearly marked with a white cross on green background

First Aid Rooms:

Where there are 250 or more persons at work on site, a suitably staffed and equipped first-aid room should be provided. In addition, where there is a large (over 150) number of employees divided into several dispersed working groups, or the location of the site makes access to places of treatment outside difficult, the contractor should consider whether a centralized first-aid room may be needed. A First aid room should:

- Be under the charge of an occupational first aider in most circumstances: names and locations of all first aiders should be displayed
- Be readily available and used only for the rendering of first aid
- Be clearly identified and of sufficient size to allow access for a stretcher, wheelchair, etc. And hold a couch withspace for people to work around it
- Contain in addition to the previously mentioned first aid materials: a sink with hot and cold running water, drinking water, paper towels, impermeable work surfaces, clean garments for use by first aiders and occupational first aider's clinical thermometer a couch with pillow and blankets frequently cleaned
- Be heated, lighted, ventilated and cleaned regularly
- Be designed so that immediate contact can be made with the person on call, e.g radio, siren, and a telephone linkif feasible. It should be stressed that a sufficient number of first-aid boxes must be provided for any work area,which is not within easy reach of the first aid room.

Emergency Phone # Posted

Project name---------- **Project No. ----------**

-

The following are the business telephone numbers where project key personnel can be reached at all times. In addition, the emergency telephone numbers of other vital agencies are listed:

BUSINESS RESIDENCE

Project Manager

GU Project Manager
Contractor Safety Officer
Fire/ Security officer

OTHER EMERGENCY TELEPHONE NUMBERS

Fire :

Ambulance :

Doctor :

Hospital :

Police :

Gas Company :

Electric Company :

Water Company :

Telephone Company :

Insurance Carrier :

SECTION 10: HOUSEKEEPING AND SANITATION

At the work site, an adequate supply of potable water must be provided, as well as clean drinking water dispensers. Potable water for clean up must be provided. Where non potable water is used for industrial or fire fighting purpose it must be identified by appropriate signs.

Apart from the above, the contractor has to adhere to general neatness of working areas, daily disposal of waste and trash, maintenance of clear passageways and walkways, providing adequate temporary lighting and ventilation (both natural as well as artificial) to perform the project related works, removal of projecting nails, removal of oil and grease, removal of loose unused construction material, provision for waste containers, and maintaining adequate sanitary facilities for the work force. The contractor and in turn its sub-contractors shall be responsible for cleaning behind them on daily basis. The accumulation of construction materials/ debris shall not be permitted at any location.

SECTION 11: FIRE PREVENTION

An emerging plan for firefighting and evacuation must be made. A training plan must be developed. Electrical wiring equipment for heating, light or power purposes must be installed in compliance with the statutory requirements. Internal combustion engine-powered equipment must be located with exhausts well away from combustible materials. Smoking is tobe prohibited in the vicinity of fire hazards, and such areas must be conspicuously posted. Care shall be taken properly to ground nozzles, hoses or steam lines used in hazardous tanks or vessels. In location of temporary buildings and yard storage, appropriate care shall be taken for proper separation to allow an accumulation of fire potential. The contractor is responsible for maintaining the entire construction area, but particularly storage areas, free from accumulation of unnecessary combustible materials. Sufficient fire extinguishers must be installed in all temporary buildings and storerooms. The contractor must identify and maintain proper escape routes at the project site in the event of a fire emergency. The escape routes should be sufficient in number and free from any encumbrances. All the workers as well as others working at job site should be made aware of them through training, mock drills and posting of exit signs. The contractor, consultation with the Project Manager must identify a “Mustering point” where all the workers would be required to gather in the event offire. The contractor must generate an “Evacuation Procedure” in the event of fire and post it at multiple locations on theproject site. The assembly area should be clearly defined and marked out. The procedure should include what should bedone to the ongoing activity when such a situation arises, which escape routes to follow, safe location to gather, who to call(with telephone numbers), how to inform the site security, etc.

Site Fire Check List

- Are safe ashtrays provided where smoking is permitted? And are fire extinguishers installed?
- Are heaters properly guarded?
- Are wet clothes kept clear of heaters?
- Are portable heaters secure from being knocked over?
- Is all temporary wiring well supported and protected?
- Are any circuits overloaded?
- Are all flammable liquids, gas cylinders and flammable materials separately and properly stored?
- Are all gas appliances fitted with control taps?
- No burning of rubbish is permitted outside
- Is all flame cutting and welding taking place with proper precautions?
- Are all blow lamps and blow torches being used correctly and all the hoses protected?

- Do all night watchmen and security patrols know the fire routines?

Preventing the spread of fire:

- Is waste accumulating in hoist shafts, under belts, in odd corners?
- Are separate metal waste containers supplied for each of the following : oily rags, paint rags, paint scrapings,waste flammable liquids, wood shavings and offcuts?
- Is all waste regularly cleared?
- Are all huts safely located?

Means of escape:

- Are all gangways, stair and platforms free from obstruction?
- Does everyone know what to do in an emergency?
- Is fire drill practiced, and is there a system to ensure that all persons have
- evacuated the area?

Fire Fighting:

- Have all extinguishers been checked and / or recharged?
- Are they clearly identified and easily accessible?
- Are operatives trained in their use?

SECTION 12: PERSONNEL PROTECTION

The required personnel protective equipment (PPE) should be worn at all times. The contractor is encouraged to supply comfortable personnel protective equipment to the site workers. All necessary personnel safety equipment as considered adequate by the Engineer-in-charge shall be available for use of persons employed on the site and maintained in a condition suitable for immediate use, and the contractor shall take adequate steps to ensure proper use of equipment by those concerned. Irrespective of the type of work being performed, contractor will have 100% compliance with Safety hard hats, safety glasses and safety shoes. In addition for specific works described below though not limited to these only, additional safety precautions as stated will be taken by the contractor. Workers employed on mixing asphalt materials, cement and lime mortars/ concrete shall be provided with protective footwear and protective gloves. Those engaged in handling any material which is injurious to eyes shall be provided with protective goggles. Special protective goggles must be used by graining,sawing and drilling. Those engaged in welding works shall be provided with welder's protective eye-shields. Stone workers are employed in sewer and manholes, which are in use, the contractor shall ensure that manholes are ventilated at least foran hour before workers are allowed to get into them. Manholes so opened shall be cordoned off with suitable railing andprovided with warning signals or boards to prevent accident to public

During these activities in sewers and manholes, regular monitoring of oxygen levels and the presence of explosive mixtures and toxic gases are to be controlled. Suitable face masks shall be supplied for use by workers during painting work. Overalls shall be supplied by the contractor to workmen and adequate facilities shall be provided to enable working painters to wash during and on cessation of work. Special care should be taken with regards to the hygiene of the temporary facilities.

SECTION 13: ELECTRICAL INSTALLATION

The National Indian electric codes and regulations shall apply to all permanent and temporary electrical installations. A temporary power distribution system shall be installed in accordance with the national codes All other temporary connections and sub distribution systems shall be connected to this main system. All temporary power systems shall be properly grounded. Circuit breakers (incl. fuses) shall be used in all temporary power connections for system and cable protection. All

wires shall be colour coded in accordance with the national codes. All electrical cables shall consist of solid copper conductors (stranded wires shall not be used). Only certified electricians will be allowed to enter high tension station, transformer and low voltage areas. All electrical installation work and all connections to the main power distribution system shall be done by qualified electricians from certified contractors. Usage of 30Ma ELCB as per IE guidelines (or as stated inits subsequent revisions)

SECTION 14: LADDERS

Work activities situated above 2.5m from ground floor level Precautions shall be made to avoid workers from falling down. For work above 2.5m from ground level, proper scaffolds need to be erected. No metal ladders to be used around electrical hazards. Special attention shall be paid to the material of the ladder for the type of work to be performed i.e. whether the ladder shall be metal or wooden.

Use of ladders and folding step ladders

This regulation applies to all ladders and pairs of steps but not roof ladders and crawling boards. Ladders must:

- Be fixed near the top if practicable, or near the bottom if not: if suspended they must be secure.
- Be placed (except when suspended) on a firm level base; they must not stand on loose packing (eg. Bricks)
- Be intermediately secured, where necessary, to prevent swaying and sagging
- Be supported, or suspended, equally on each stile.
- When working on a ladder above 2.5m, fall protection must be used.
- Extend at least 1.05m above any landing place beyond the highest rung from which a person may be working or have a nearby handhold of equivalent height.
- Be placed so that there is space behind each rung for proper foothold (eg. No rung should coincide with a scaffoldtube)

SECTION 15: SCAFFOLDING

Work activities above 2.5m from the ground level:

Precautions shall be made to avoid workers from falling down. For work above 2.5m above a floor level proper scaffolds need to be erected. Ladders properly secured can be used, but only for light work which can be done with one hand.

Supervision of work and inspection of material:

Scaffolds must be erected, altered or dismantled only under competent supervision and as far as possible, by experienced persons. All scaffolding materials must be inspected before use to check that they are up to standard. All inspected scaffolds must bear a sign “ready for use”.

Construction and material:

Sufficient sound material must be provided for a scaffold to be strong and stable enough for the job. Wherever timber is used for any kind of scaffolding purpose, it must be of the right type for the job and must not be painted so that any defects are hidden. Scaffold tubes and fittings must not be bent, distorted or unduly rusty.

Defective material:

Scaffold tubes, couples or fittings that are bent unduly rusty or distorted should be rejected. Timber with dangerous splits and knots should always be rejected. Ropes and lashings showing signs of chafing through wear, or of being corroded, should be rejected. All scaffold components must be properly stored when not in use and kept separately from all other building materials

Maintenance of scaffolds:

Scaffolding must be kept in good order and every effort made to prevent the accidental displacement of any part.

Partly erected or dismantled scaffolds:

If any scaffold is either partly erected (or partly dismantled), but nevertheless is still capable of being used to some extent, it must have a bold warning notice fixed, or all access blocked off or barred, at the point beyond which it cannot be safely used.

Standards or Uprights, Ledgers and Putlogs:

Scaffold standards should be vertical and spaced closely enough for the intended use of the scaffold. Base plates must be used. Timber sole plates should also be used to distribute the

load from the standard over a wide area, as well as to offset possible local subsidence. Ledgers must be level and fixed to standards with right-angle couplers. Putlogs and transoms must be firmly fixed to ledgers or standards. The flattened end of the putlog must be pushed right into the wall to provide maximum support. Putlogs and transoms should be spaced according to the expected load and the thickness of the boards to be used in the platform. In normal use, putlogs and transoms should be spaced so that the spans of scaffold boards should not be greater than :

32mm boards: 1m 38mm
boards: 1.50 m50mm
boards: 4.60 m

Ladders used in Scaffolds:

Ladders used as uprights must be:

- Strong enough to carry the load of both the work and the workers.
- Equally supported on each side.
- Secured to prevent slipping.

Ladders to be placed under an angle of 70 ° with the vertical and shall extend 1m above the railing. Ladders are only to be used to support a scaffold platform when the work is light, e.g., painting.

Stability of Scaffolds:

All scaffolds must be:

- On a solid, even base ; or suspended from a sound structure
- Braced to prevent failure, and
- Tied to the building or structure unless specially designed to be completely independent.
- Any building or structure which supports a scaffold must be strong enough to carry the scaffold and its load A scaffold only used as a working platform for workers when a scaffold also used to store material etc, a calculationis needed to check if that scaffold is safe to carry the total load. Mobile scaffolds must:
- Be stable, weighted at the base if necessary
- Be used only on a flat, level surface.
- Have the wheels locked to prevent movement whilst being used for work,
- Be pushed, or pulled only at the base when being moved. Scaffolds must not be built on loose bricks, drain pipes, chimney pots, etc. Bricks or blocks can be used to support a platform no higher than 600mm from the ground orfloor.

Slung Scaffolds

- Be strong enough
- Be properly secured to be overhead anchor-ages and to be platform frame,
- Be spaced so as to keep the platform stable,
- Be vertical, and
- Be kept straight
- No rope other than wire rope may be used for suspension
- Packing must be used to prevent damage to suspension ropes or chains at any point where sharp or rough-edgedprotrusions could cause chafing.
- The platform must be secured to prevent swaying whilst in use.

Cantilever, Jib figure and Bracket scaffolds:

Cantilever or jib scaffolds must be anchored to a structure which is strong enough to carry the total load Outriggers must be long enough and strong enough and the scaffold must be braced to ensure stability. Figure or bracket scaffolds supported by dogs or spikes must not be used if there is any danger of these pulling out of the brickwork or stone-work.

Support for Scaffolds:

No part of the building may be used to support scaffolding unless it is strong enough to do so. Unless gutters have been designed as walkways and are strong enough to bear the weight, they must not be used to support scaffolding or ladders.

Suspended Scaffolds (Not Power Operated)

The ropes, winches, block and tackle must be strong enough and correctly rigged. A safe anchorage for the suspension must be provided.

Winches or similar lifting devices must:

a. have brakes which apply when the operating lever is released, and
b. be protected from the weather, falling dirt, etc.

Outriggers must:

a. be long enough and strong enough,
b. be horizontal (light cradles are excepted)
c. have stops at their outer ends (light cradles excepted)
d. be tied down or properly counter-weighted at the tail, and
e. be close enough together to support the rails and scaffolds properly .

Counterweight Must

a. be bolted or securely attached to the outriggers, and

Runways must:

be strong enough and in good condition, have stops at each, and be bolted or tied securely to their supports

Platforms of suspended scaffolds must: be closely boarded be at least 430mm wide on light weight cradles and be atleast 600mm wide on all other types, if used only for workmen, or be at least 800mm wide, if used for workmen and materials Never be used to carry higher platform

Platforms should be as close as possible to the face of the building but where persons sit on the edge of the platform to carry out their work then the distance between platform and building can be upto 300mm

Winches must:

Have at least two full turns of rope on the drum when the platform is in its lowest position and

Be marked with the length of rope on the drum Suspended scaffolds and associated equipment must be maintained in good conditions. Platforms must be prevented from tipping or swaying whilst in use. Steel wire rope must be used for the suspension for all platforms other than light weight cradles Light cradles may be suspended by fibre ropes and pulley blocks

which should not be more than 3.20m apart. (Only ropes recommended by manufacturers for this purpose should be used)

Boatswain's Chair's Cages, Skips etc. (Not Power Operated)

Hand-operated boatswain's chairs, skip etc. must:

- Be well constructed, strong enough, and properly maintained
- Have outriggers strong enough and firmly anchored,
- Have chains, ropes and lifting gear firmly secured to the outriggers above and to the chair, skip etc. Theconstruction (lifting operations) regulations apply to the lifting gear,
- Be designed so that the occupant cannot fall out
- Carry no loose materials which could interfere with the safety of occupant
- Have means of preventing spinning and tipping (a swivel connection at the suspension points is strongly advised)
- In the case of skips, be at least 910 mm deep
- Be under the supervision of a competent person during installation and use, and
- A boatswain's chair may only be used as a workplace when the work would not take long enough to make the useof a suspended (or standard) scaffold reasonably practicable.
- Persons working in these must wear fall protection harnesses connected to a rope or chain separate from the chairor skip suspension rope or chain.

SECTION 16: HOISTS, CRANES AND DERRICKS

Safety of Hoist ways, Platform and Cage:

Hoist ways must be enclosed wherever access is provided or wherever persons could be struck by the platform or other moving parts. Gates must be fitted in the enclosure at all landing places and must normally be at least 2m high, but gates 910 mm high are acceptable where persons are not at the risk of falling down the hoist ways or coming into contact with moving parts. Gates must be kept closed except for the movement of men and materials; it is the duty of all persons to ensure it is done. Hoists platforms and cages must be fitted with a device capable of supporting them, fully loaded, should hoists, ropes or driving gear fail. Hoists must be fitted with verrun stops at the top.

Operation of Hoists

a) Hoists must only be capable of being operated from one position at a time, whether by rope, lever or switch. Hoists mustnot be operated from the cage.

b) Where the hoist driver cannot see the platform or cage during it s movement, a signaling system, which covers all landingplaces, must be used.

c) All hoists, prior to their use, have to be inspected by a competent person

Safe Working Load and Marking of Hoists

a) The platform of materials or goods hoists must carry a notice stating

(i) the safe working load and

(ii) that the passenger must not ride on platform

The safe working load must not be exceeded except for test purposes.

b) Cages for passengers hoists must carry a notice stating

(i) the safe working load and

(ii) the number of passengers permitted.

No greater number of passengers may be carried and safe working load must not be exceeded except for the test purposes.

SECTION 17: MOTOR VEHICLES

A site traffic plan must be developed at the beginning of the project to control all traffic on site and movement of materials, parking etc. Motor equipment left unattended at night near areas where work is in progress must have appropriate lights, reflectors or barricades to identify the locations of the equipment. A safety tie rack, cage, or equivalent protection must be used when a worker is inflating, mounting, tires installed on split rims or rims equipped with locking rings. Heavy machinery that is suspended or held aloft by the use of slings, hoists, or jacks must be blocked or cribbed to prevent falling or shifting before employees are permitted to work under them. Bulldozer and scraper blades and similar equipment shall be either fully lowered or blocked when being repaired or when not in use. All controls must be in the neutral position and the motor stopped and brakes set, unless work being performed requires otherwise. Parked equipment must be checked and parking brakes set. All cab glass shall be safety glass. All vehicles must have a service brake system, an emergency brake system, and a parking brake system. Vehicles that require additional light shall have at least two headlights, as well as brake lights. The vehicles must also be equipped with back horn which automatically sets off as and when the vehicle is in reverse gear. Other standard vehicles equipment such as seat belts, rear-view mirrors and safety latches on operating levers shall be in accordance with standard vehicle codes, and state-inspected where appropriate. The authorized individuals with valid driving license only shall be allowed to drive.

SECTION 18: BARRICADES

(i) Contractor shall erect and maintain barricades required in connection with its operation to guard or protect,

a) Hoisting areas.

b) Areas adjudged hazardous by contractor's safety management and/ or Project Manager's Inspectors

c) 's existing property subject to damage by the contractor's operations

(ii) Contractor's employees and those of his subcontractors shall become acquainted with Project Managers barricadingpractice and shall respect the provisions thereof.

Guarding of floor opening and floor holes:

Every temporary floor opening shall have railings, or shall be constantly attended by Supervisors appointed by Contractor's safety officer / Manager. Every floor hole into which persons can accidentally fall shall be guarded by either:

a) A railing with toe board on all exposed sides, or

b) A floor hole cover of adequate strength and it should be hinged in place. When the cover is not in place, the place the floor hole shall be constantly attended by some one or shall be protected by a removable railing. Barricades must be strong enough to carry the weight of people. Every stairway floor opening shall be guarded by a railing on all exposed sides, except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board on all exposed sides (except at entrance to opening) with the passage through the railing either provided with a swinginggate or so offset that a person can not directly into the opening.

Guarding if open-side floors and platform

Every open-sided floor or platform 120cm or more above adjacent floor or ground level shall be guarded by a railing (or the equivalent) or all open sides except where there is entrance to ramp, stairway or fixed ladder. The railing shall be provided with a toe board beneath the open sides wherever,

(a) Persons may pass,

(b) there is moving machinery and

(c) there is equipment with which failing materials could create a hazard

SECTION 19: HANDLING AND STORAGE OF MATERIALS

Cement:

Storage and stacking: Cement shall be stored at the work site in a building or a shed which is dry, leak proof and moisture proof. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed. Cement received in bags shall be kept in such a way that the bags are kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep them 150 to 200mm clear from the floor and space of 450mm minimum shall be left all round between the exterior walls and in the stacks. In the stacks the cement shall be kept close together to reduce circulation of air as much as possible. Owing to pressure on bottom layer of bags sometimes 'warehouse pack' is developed in these bags. This can be removed easily by rolling the bags when cement is taken out for use. The height of stack shall not be more than 15 bags to prevent the possibility of lumping up under pressure. The width of the stack shall be not more than four bags length or 3m. In stacks more than eight bags high, the cement bags shall be

arranged alternately lengthwise and crosswise so as to tie the stacks together and

minimize the danger of toppling over. For extra safety during monsoon or when it is expected to store for an unusually long period, the stack shall be completely enclosed by a water proofing membrane such as polyethylene, which shall close on the top of the stack. Care shall be taken to see that the waterproofing membrane is not damaged any time during the use. Drums or other heavy containers of cement shall not be stacked more than two

layers high. The manner of storage shall facilitate the requirement that lots of cement received are removed and used more or less in the order in which they are received.

Handling – Hooks shall not be used for handling cement bags unless specifically permitted by the engineer-in-charge.

Polyethylene pipes

(a) Storage & stacking:

Black polyethylene pipes may, be stored either under cover or in the open. Natural polyethylene pipes however, should be stored under cover and protected from direct sunlight. Coils may be stored either on edge or stacked flat one on top of the other, but in either case they should not be allowed to come into contact with hot water or steam pipes and should be kept away from hot surface. Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set. Storage of pipes in heated areas exceeding 270 C should be avoided.

(b) Handling: Removal of pipe from a pile shall be accomplished by working from the ends of the pipe.

Pipes of conducting materials:

(a) Storage and stacking: Pipes shall be stacked on solid level sills and contained in a manner to prevent spreading or rolling of the pipe. Where quantity storage is necessary suitable packing shall be placed between succeeding layers to reduce the pressure and resulting spreading of the pile. In stacking and handing of pipes and other conducting materials the following minimum safety distances shall be ensured from the overhead power line:

11KV and below 40m

Above 11and below 33KV 60m Above
33 and below 132KV 70m Above 132
and below 275KV 70mAbove 275and
below 400KV 50m

(b) Handling: Removal of pipes from a pile shall be accomplished by working from the ends of the pipe. Duringtransportation, the pipes shall be so secured as to ensure against displacement.

Paints, Varnishes and Thinners:

(a) Storage and stacking: Paints, varnishes lacquers, thinners and other flammable materials shall be kept in properly sealed or closed containers. The containers shall be kept in a well ventilated location, free from excessive heat, smoke, sparks or flame. The floor of the paint stores shall be made up of 10cm thick loose sand and stored in a collection drip pan to prevent leakage's to the ground and/or the soil.

Paint materials in quantities other than required for daily use shall be kept stocked under regular storage place. Where the paint is likely to deteriorate with age the manner of storage shall facilitate removal and use if lots in the same order in which they are received. Temporary electrical wiring / fittings shall not be installed in the paint store. When electric lights, switchesor electrical equipment are necessary, they shall be of explosion proof design.

(b) Handling: Ventilation shall be adequate to prevent the accumulation of flammable vapors to hazardous levels of concentration shall be provided in all areas where painting is done.

When painting is done in confined spaces where flammable or explosive vapors may develop any necessary heat shall be provided through duct work remote from the source of flame. Sources of ignition such as open flame and exposed heating elements shall not be permitted in area or rooms where spray painting is done nor shall smoking be allowed there. Careshould be taken not to use any naked flame inside the paint store. Buckets containing sand shall be kept ready for use incase of fire. Fire extinguisher when required shall be of foam type confirming to accepted standards.

Bitumen, Road Tar, Asphalt etc.:

(a) Storage and stacking: Drums or containers containing all types of bitumen, road tar, asphalt etc. shall be stacked vertically on their bottoms in upto 3 tiers. Leaky drums shall be segregated and either their contents shall be emptied intointact drums or contained in larger containers. All spillages or leakages onto natural soil shall be immediately cleaned up and placed in a contained area. Empty drums shall be stored in pyramidal stacks neatly in rows.

(b) Handling: Bitumen / Tar – Bitumen / tar shall not be heated beyond the temperature recommended by the manufacturer of the product. While discharging heated binder from the boiler, workers shall not stand opposite to the jet so as to avoid the possibility of hot binder falling on them. The container shall be handled only after closing the control valve. While handlinghot bitumen / tar, workers shall exercise scrupulous care to prevent accidental spillage thereof. The buckets and cans inwhich the hot material is carried from boiler shall be checked before use to ensure that they are intact and safe. Mops and other applicators contaminated with bituminous materials shall not be stored inside buildings

Bituminous roofing felts:

(a) Storage and stacking: Bituminous roofing felts shall be stored away from other combustible, flammable materials. Forlong storage it shall be kept under shade.

(b) Handling: Bituminous roofing felts should be handled in a manner to prevent cracking and other damages

Flammable materials:

(a) Storage and stacking: In addition the following provisions shall also apply: Outdoor storage of drums required some care to avoid contamination because moisture and dirt in hydraulic brake and transmission fluid, gasoline or lubricants may cause malfunction of failure or equipment with possible danger to personnel. The storage area should be free of accumulations of spilled products, debris and other hazards and Compressed gases and petroleum products shall not be stored in the same building or close to each other.

(b) Handling: Petroleum products delivered to the job site and stored there in drums shall be protected during handling to prevent loss of identification through damage to drum markings, tag, etc. Unidentifiable petroleum products may result in improper use with possible fire hazard damage to equipment or operating failure. Workmen shall be required to guard carefully against any part their clothing becoming contaminated with flammable fluids. They shall not be allowed to continue work when their clothing becomes so contaminated. All flammable and toxic liquids shall be stored in suitable collecting drip

pans to avoid spill contamination into the ground/soil. All workers shall be provided training as part of the induction as to how to correctly handle and lift materials and the maximum load they can lift or handle at any point.

SECTION 20: EXCAVATION AND SHORING

Excavation and Trenching: All trenches, 1.5m or more in depth, shall at all times be supplied with at least one ladder for each 30m in length or fraction thereof. Ladder shall be extended from bottom of trench to at least 1meter above surface of the ground. Sides of a trench which is 1.5m or more in depth shall be stepped back to give suitable slope or securely held by timber bracing so as to avoid the danger of sides collapsing. Excavated material shall not be placed within 1.5m of edge of trench of half of depth of trench, whichever is more cutting undermining or undercutting be done. Safety procedures for the operation of the excavation and grading equipment (such as the safe distance from excavations) should be developed.

SECTION 21: CONCRETE CONSTRUCTION

Handling of plant

Mixers: All gears, chains and rollers of mixers shall be properly guarded. If the mixer has a charging skip the operator shall ensure that the workmen are out of danger before the skip is lowered. Railings shall be provided on the ground to prevent anyone walking under the skip while it is being lowered. All cables, clamps, hooks, wire ropes, gears and clutches etc. of the mixer, shall be checked and cleaned, oiled and greased and service once a week. A trial run of the mixer shall be made and defects shall be removed before operating a mixer. When workmen are cleaning the inside of the drums and operating power of the mixer shall be locked in the off position and all fuses shall be removed and a suitable notice hung at the place.

Trucks:

When trucks are being used on the site, traffic problems shall be taken care of. A reasonably smooth traffic surface shall be provided. If practicable, a loop road shall be provided to permit continuous operation of vehicles and to eliminate their backing. If a continuous loop is not possible a turnout shall be provided. Backing operations shall be controlled by a signalman positioned so as to have a clear view of the area behind the truck and to be clearly visible to the truck driver. Movement of workmen and plant shall be routed to avoid crossing as much as possible the truck lanes.

Formwork:

Formwork shall be designed after taking into considering spans, setting temperature of concrete, dead load and working load to be supported and safety factor for the material used for formwork. All timber formwork shall be carefully inspected before use and members having cracks and excessive knots shall be discarded The vertical supports shall be adequately braced or otherwise secured in position that these do not fall when the load gets released or the supports are accidentally hit. Tubular steel centering shall be used in accordance with the manufacturer's instructions. When tubular steel and timber centering isto be used in combination necessary precautions shall be taken to avoid any unequal settlement under load.

All centering shall be finally inspected to ensure that:

a) Footings or sills under every post of the centering are sound
b) All tower adjustment screws or wedges are snug against the legs of the panels.
c) All upper adjustment screws or heads of jacks are in full contact with the formwork.
d) Panels are plumb in both directions.
e) All cross braces are in place and locking devices are in closed and secure position.
f) In case of chajjas and balconies the props shall be adequate to transfer the load to the supporting point.

Ramps and gangways:

Ramps and gangways shall be of adequate strength and evenly supported. They shall either have a sufficiently flat slope or shall have cleats fixed to the surface to prevent slipping of workmen. Ramps and gangways shall be kept free from grease, mud, snow or other slipping hazards or other obstructions leading to tripping and accidental fall of workman. Ramps andgangways meant for transporting materials shall have even surface and be of sufficient width and provided with skirt boardson open sides.

Pre-stressed concrete:

In pre-stressing operations, operating, maintenance and replacement instructions of the supplier of the equipment shall be strictly adhered to. Necessary shields should be put up immediately behind the pre-stressing jacks during stressing operations. Wedges and other temporary anchoring devices shall be inspected before use. The pre-stressing jacks shall be periodically examined for wear and tear. A spreader beam shall be used wherever possible so that the cable can be as perpendicular to the members being lifted as practical. The angle between the cable and the members to be lifted shall not be less than 600. Methods of assembly and erection specified by the designer, shall be strictly adhered to at site. Immediately on erecting any unit in position, temporary connections or supports as specified shall be provided before releasing the lifting equipment. The permanent structural connections shall be established at the earliest opportunity.

Heated concrete:

When heaters are being used to heat aggregates and other materials and to maintain proper curing temperatures, the heaters shall be frequently checked for functioning and precautions shall be taken to avoid hazards in using coal, liquid, gasor any fuel.

SECTION 22: MASONARY WORK

Walls

General: Depending on the type of wall to be constructed the height of construction per day shall be restricted to ensure that the newly constructed wall does not come down due to lack of strength in the lower layers. Similarly, in long walls adequate expansion / crumple joints shall be provided to ensure safety.

Opening in walls: Whenever making of an opening in the existing walls is contemplated, adequate supports against the collapse or cracking of the wall portion above or roof or adjoining walls shall be provided. Guarding of wall openings and Holes: Wall opening barriers and screens shall be of such construction and mounting that they are capable of withstanding the intended loads safely. For detailed information reference may be made to good practice. Every wall opening from which there is a drop of more than 120mm shall be one of the following: Rail, roller, picket fence, half door or equivalent barrier:The guard may be removable but should be preferable be hinged or otherwise mounted so as to be conveniently replaceable. Where there is danger to persons working or passing below on account of the falling materials, a removable toe board or the equivalent shall also be provided. When the opening is not in use for handling materials the guards shall be kept in position regardless of a door in the opening. In addition a grab handle shall be provided on each side of the opening. The opening should have a sill that projects above the floor level at least 2.5cm. Extension platform into which materials may be hoisted for handling, shall be of full length of the opening shall be of full length of the opening and shall have side rails orequivalent guards. Every chute wall opening from which there is a drop of more than 120mm shall be guarded by one ormore of the barriers specified in 16.2.1 or as required by the

conditions.

SECTION 23: HEALTH & HYGIENE STANDARDS

Drinking water:

a) In every work place, there shall be provided and maintained at suitable places, easily accessible to labour, a sufficientsupply of cold water fit for drinking.

b) Where drinking water is obtained from an intermittent public water supply, each work place shall be provided with storage where such drinking water shall be stored.

c) Every water supply or storage shall be at a distance of not less than 50 feet from any latrine drain or any other source ofpollution.

Washing facilities:

a) In every work place adequate and suitable facilities for washing shall be provided and maintained for the use of contractlabour employee therein

b) Separate and adequate cleaning facilities shall be provided for the use of male and female workers

c) Such facilities shall be conveniently accessible and shall be kept in clean and hygienic condition.

Latrines and Urinals

a. (a). Latrines shall be provided in every work place on the following scale namely:

(i) Where females are employed there shall be at least one latrine for every 25 females.

(ii) Where males are employed there shall be at least one latrine for every 25 males.

b. Provided that where the number of males or females exceeds 100, it shall be sufficient if there is one latrine for 25males orfemales as the case may be upto first 100 and one for every 50 thereafter.

c. Every latrine shall be under cover and so partitioned off as to secure privacy and shall have proper door and fastenings.

d. Construction of latrines: The inside walls shall be constructed of masonry or some suitable heat-resisting non-absorbent materials and shall be cement washed inside and outside at least once a year, latrines shall not be of standard lower than borehole system.

(i) Where workers of both sexes are employed, there shall be displayed out side each block of latrine and urinal a notice inthe language understood by the majority of the workers “for men only” or for” women only” as the case may be.

(ii) The notice shall also bear the figure of man or woman as the case may be.

e. There shall be at least one urinal for male workers upto 50 and for female workers upto 50 employed at a time, provided that where the number of male or female workers as the case may exceed 500 it shall be sufficient if there is one urinal for every 50 males or females upto the first 500 and one for every 100 or part thereafter.

(i) The latrines and urinals shall be adequately lighted and shall be maintained in a clean and sanitary condition at all times

(ii) Latrines and urinals other than those connected with flush sewage system shall comply with the requirements of Public Health Authorities.

f. Water shall be provided by means of tap or otherwise so as to conveniently accessible in or near the latrines and urinals.

g. Disposal of excreta: Unless otherwise arranged by the local sanitary authority, arrangements for proper disposal of excreta by incineration at the work place shall be made by means of a suitable incinerator. Alternately excreta may be disposed of by putting a layer of night soil at the bottom of pucca tank prepared for the purpose and covering it with 15cm layer of waste or refuse and then covering it with a layer of earth for a fortnight (then it will turn to manure)

(i) The contractor shall at his own expense, carry out all instructions issued to him by the Engineer-in-charge to effect proper disposal of night soil and other conservancy work in respect of the contractor's workmen or employees of the site. The contractor shall be responsible for payment of any charges which may be levied by the municipal or cantonment authority for execution of such on behalf.

Provision of shelter during rest:

At every place there shall be provided free of cost, for suitable sheds two for meals and other two for rest separately for the use of men and women labour. The height of each shelter shall not be less than 3m from the floor level to the lowest part of the of the shed roof. These shall be kept clean and the space provided shall be on the basis of 0.6sqm per head. Providedthat the engineer-in-charge may permit subject to its satisfaction, a portion of building under construction or other alternative accommodation to be used for the purpose.

Café/Eating place:

a. In every work place where the work regarding the employment of contract labour is likely to continue for six months and where in contract labour numbering 100 or more are ordinarily employed an adequate place shall be provided by the contractor for the use of such labour.

b. The café shall be maintained by the contractor in an efficient manner.

c. The café shall consist of at least a dining hall, cafe, storeroom, pantry and washing places separately for workers andutensils.

d. The floor shall be made of smooth and impervious materials and inside walls shall be lime washed or colour washed at least once a year. Provided that the inside walls of the cafe shall be lime washed every four months.

e. The premises of the cafe shall be maintained in a clean and sanitary condition

f. Suitable arrangements shall be made for the collection of disposal of garbage.

g. Waste water shall be carried away in suitable covered drains and shall not be allowed to accumulate so as to cause nuisance.

h. The dining hall shall accommodate at a time 30% of the contract labour working at a time.

i. The floor area of the dining hall, excluding the area occupied by the service counter and any furniture except tables andchairs shall not to be less than 1sqm per diner to be accommodated as prescribed in sub-rule (i)

j. There shall be provided and maintained sufficient utensils crockery, furniture and any other equipment necessary for efficient running of cafe

k. The furniture, utensils and other equipment shall be maintained in clean and hygienic condition.

l. Suitable clean clothes for the employees serving in the café shall be provided and maintained.

m. A service counter, if provided shall have top of smooth and impervious material.

n. Suitable facilities including an adequate supply of hot water shall be provided for the cleaning of utensils and equipment.

o. A portion of the dining hall and service counter shall be partitioned off and reserved for women workers in proportion totheir number.

p. Sufficient tables stools or benches shall be available for the number of diners to be accommodated as prescribed in subrule (i)

q. The food stuff and other items to be served in the cafe shall be in conformity with the normal habits of the contract labour.

r. The charges of food stuffs, beverages and other items served in the cafe shall be based on 'No profit no loss' and shall beconspicuously displayed in the cafe.

s. In arriving at the price of the foodstuffs and other article served in the cafe, the following items shall not be taken in toconsideration as expenditure namely:

t. The rent of land and building

u. The depreciation and maintenance charges for the building and equipment provided for the cafe.

v. The purchase, repairs and replacement of equipment including furniture, crockery, cutlery and utensils.

w. The water charges and other charges incurred for lighting and ventilation

x. The interest and amount spend on the provision and maintenance of equipment provided for the cafe.

y. The accounts pertaining to the cafe shall be audited once every 12months

z. by registered accountants and auditors.

Anti-malarial precautions:

The contractor shall at its own expense, conform to all anti-malarial instructions given to him by Engineer-in-charge including the filing up of any borrow pits which may have been dug by him.

SECTION 24: RESPONSIBILITIES

S&H –coordinators:

In connection with (Indian Regulations and standards) the tasks and responsibilities of the S&H coordinator(s) as well as the design- as the construction phase, are as follows:

Design phase:

- Co-ordination of the general aspects with respect to Safety, Health and Welfare.
- Taking care of the set-up of a S&H-plan 'in draft'.
- Putting together the S&H-file.
- Keep up and actualize the S&H-plan 'in draft' -and file.
- Hand-over the S&H-plan 'in draft' -and file to the S&H-coordinator(s) for the construction phase.

Construction phase:

- Organizing and coordinating the cooperation between employers.
- Coordinating the Safety, Health and Welfare measures by the employers.
- Coordinating supervision to meet the joint facilities.
- Give indications to the .
- Coordinating the information to the employees.
- Take measures to assure that only persons which are entitled to can come in at the works.
- Keep up and actualize the S&H-plan 'in draft' -and file.
- Handover the S&H-file to the principal.

SECTION 25: COMMUNICATION

Kick-off meeting

The kick-off meeting should be seen as a start up meeting, preliminary to the general or project oriented activities. In the kick-off meeting, besides technical relevant information, pay attention to the aspects of safety and health in general sense. The Contractor will be required to provide their job site safety program either at kickoff meeting or within a time period as determined by Project Manager after the kickoff meeting along with other pre-start documentation.

Pre-job meeting

The Pre-job meeting is meant for consultation before the activities may start. A part of this meeting is reserved to make detail appointments for specific Plant or Location directed safety- and health matters and 'actual' deviations of the normal situation. This meeting is meant as a supplement to the general information which already has been handed over during the kick-off meeting. At this meeting the **Pre-job Checklist** should be handled and worked out with all persons involved.

Progress Meeting:

The progress meeting is meant to get an update from contractors on project progress and resolve any construction/ coordination issues. It is normally held on weekly basis. This meeting will have EHS component and following items shall be discussed under this head.

Major safety issues at site Actions being taken to resolve them

Toolbox meeting:

Toolbox meetings are company (contractor) internal matters. With this kind of meeting, employees supposed to execute the job are informed about the most actual state of the activities. This information can be appointments, instructions which arethe result of above mentioned meetings. A toolbox meeting is a medium to inform 'executing employees'. Copies of these toolbox meetings (incl. registration forms) should be attached to this chapter.

Safety Meeting:

Safety meetings shall be held on weekly basis to be attended by Project Manager's Safety representative and safety officer from all contractors as well as their subcontractors. The meeting shall be chaired by Project Manager's safety representative and Project Manager may also like to attend the meetings randomly. The topics to be covered shall broadly include:

a. Safety issues at job site
b. Review pre task plans
c. Discuss safety statistics
d. Review safety committee reports/ recommendations
e. Discuss safety training initiatives
f. Review overall job site safety

SECTION 26: INFORMATION

General S&H-instructions

Everyone, who is doing activities at the Client site, should be registered at the job site. After registration, everyone get a Contractor Safety Instruction (video presentation). This presentation shows an explanation on the S&H policy, the most important emergency measures (Fire and Gas alarms) and shows general behavior rules and procedures.

Site Specific S&H-instructions

These instructions can be given when the common interest is served (equal for all facilities and departments) and the necessity exists. Examples are: LoTo, shutdown, etc. Site specific, S&H instructions, needed for this project to follow are as under; _____.

SECTION 27: PRE TASK PLANS (PTP)/ JOB TASK HAZARD ANALYSIS (JTHA)

PTP/ JTHA is the process of systematic investigation of a task and its subtasks, ascertaining the risks associated with carrying out activities associated with those tasks, listing preventive measures to avoid potential hazards associated with executing that activity and developing contingency plan in case of emergencies. The Standard Operating Procedure of the Project

Manager will serve as reference guidelines for the tasks which require development of PTP/ JTHA. However, the listis not all inclusive and if the Project Manager/ Project Manager's safety representative/ 's safety representative determine that the PTP/ JTHA is

required for some other tasks too, the contractor will be obligated to provide that as per the procedure and in the format as indicated by Project Manager (copy of format attached with these guidelines. Subsequent to the kick-off meeting, within the specified time period, the contractor will also provide the list of tasks against which PTP/ JTHA shall be submitted along with the expected time, when it would be submitted. This listing shall be done on the format shown below;

LIST OF PRE-TASK PLANS TO BE SUBMITTED ON THE *Project Name*	
Contractor:	**Trade Package:**

TASK	TIME OF EXECUTION	TARGET PTP SUBMISSION DATE

SECTION 28: ENVIRONMENT

Waste Disposal

Waste originated from activities at the project site should be dumped at the designated location in the designated manner as indicated by / PM. Chemical waste (air-sprays, oil, paint etc.) should be collected separately and, if property of client, shall be offered to the facility / department. This in conjunction with the waste-coordinator of the department concerned, or the In &out Clean department. In case the waste coordinator does not require the chemical waste for re-usage, the contractor will dispose it off at its own expense at the designated location in the designated manner as directed by Project Manager and in accordance with all Indian Environmental Laws. Chemical waste which originates from Contractor's works should be collected and carried away by Contractor according to the legal regulations. The In & Out Clean department should be informed before carrying away the waste.

Material Safety Data Sheets (MSDS)

The Contractor is obligated to inform about the risks and dangers associated with handling of chemical and hazardous substances at site. Therefore, the information transfer in the form of Material Safety Data Sheets is necessary. The contractor shall list all materials to be used at project site that require submission of MSDS and submit those. The material shall be brought to the site only after obtaining prior approval from 's representatives on the MSDS.

Contractor is required to provide Material Safety Data sheets (MSDSs) for any chemical brought on site. An index of MSDSs for all products proposed to be used on site must be provided. In so far as possible, "environmentally friendly" products should be used (e.g. detergent or citrus based cleaners rather than solvent based cleaners). Low-Volatile Organic Compound (VOC) products should be used at all times. Chlorinated solvents should not be brought on site except on a pre-approved case-by-case basis. The Client/ reserves the right to reject any chemical proposed to be brought on site. Any regulated wastes generated on site (e.g. hazardous, residual or special waste, including regulated wastewaters, waste oil, waste paint), in must be disposed of by Contractor in strict accordance with federal, provincial and municipal or and local standards. No wastes may be disposed of down the drain or in the Client installed dumpster without prior written consent. Contractor must have appropriate training for the work to be done. Training records must be produced upon demand. Contractors must bring appropriate tools, equipment, safety devices and clothing to the job site. No tools or equipment maybe borrowed from the Client without prior written consent.

Material	MSDS sheet to be submitted by

SECTION 29: REPORTING

The contractor will submit the Monthly man-hour & safety report on the format enclosed in EHS guidelines. The report will be submitted by__ hrs. on_day of every month. In addition, should the Project Manager require any interim man-hourreports on weekly basis or any other frequency determined by Project Manager, those will also be submitted by the contractor. Safety reports submitted are in no way linked with the requirement for submission of Daily report on the part of contractor.

CONTRACTOR HEALTH AND SAFETY Sl. No…… Date……
General information (To be Completed by Safety officer)
Contractor Name : Project Name : On site contractor Representative / Supervisor / Safety
Location of Infraction : Description of Infraction: Observed By : Date : Time :
Status of Project : Project Stopped until correctionProject Continuing W/infraction Corrective Actions Required by (Date/time)
CORRECTIVE ACTION (To be Completed by the Contractor)
Corrective Action : Corrective Action Performed by :Date / time : Name : Signature :
Return to GU
CORRECTIVE ACTION FOLLOW UP (To be completed by Project Manager)
Received / Certified By : GU Date : Remarks :

EHS DECLARATION

From:

Name of the Contractor
Name of the organizationTo:

Project Manager

Location – Pin code

Subject: EHS Declaration

I/ we hereby declare to accept the responsibility to carry out the work safely. I/ we have understood the hazards associated with site activity and developed the relevant safety procedures, trained the man power and provided required PPE and equipment. I/ we or the workers working under my/our control will adhere to the site safety rules and EHS

guidelines as stated in this document. The following are the safety practices that will be followed in addition to any other requirements as recommended by Project Manager's EHS Manager/ Site safety officer to work safely at site.

1. Wear safety helmet, safety shoes, eye protection with side shields.
2. Wear safety harness and hooking to the life line rope.
3. Wear appropriate hand gloves like cotton, leather, PVC, rubber or surgical hand gloves.
4. Proper tools will be used and checked for defects and replaced whenever required.
5. Welding torch with ring guard, welding shield, leather hand gloves required.
6. No steel rod will be used as earthing on to the welding machine.
7. Proper working platform with hand rail will be used while working at heights.
8. a) Housekeeping will be done on daily basis and the debris, sand, concrete materials and mortar will be removed andstored at identified place.
9. b) Papers, plastic sheets, rubber materials and wooden pieces have to be put in recycle bin from the work place and thiswill be sent outside the site.
10. I/ we will be appointing one safety officer, safety stewards and group leader of safety.
11. My/ our workmen and I/ we will not create any problem, quarreling with other agents.
12. I/ we will be providing fire extinguishers, fire buckets with water and sand in work place.
13. First aid facility and hospital facility will be provided to my/ our workman.
14. I/ we will be conducting the safety training programs for my/ our workmen, like first aid, fire fighting and safety.
15. I/ we will obtain work permits to work for hazardous area.
16. As per the contract document, we agree with imposition of penalty on us should we violate
17. any safety norms/ practices at the project site, which can be deducted from our invoices.
18. I/ we will submit all the required insurance policies as per the contract documents.

Signature of the contractor

PERSONAL PROTECTIVE EQUIPMENTS CHECKLIST

SL.NO PARTICULARS YES / NO

1 Do the Workers Wear Helmet in such a way to protect their head?

2 Are they wearing hand gloves, Rubber gloves (IS 4770 for electrical purpose), Leather hand gloves of required quality forthe job

3 Do the workers using appropriate Footwear?

4 Is there any need for Safety harness (IS 3521-1965) use? If so, are they hooked property?

5 Is there any need for Ear protection? If so, are they using the device external or internal type?

6 Are the workers wearing Safety glasses / Safety screens /Safety goggles for the work being done? If so, are they usingappropriate equipment?

7 Do the Workers have respirator/ protection from inhalation hazards?8 Are the helpers also using proper PPE or not?

9 Have the Workers been briefed about the Hazards associated with the job and the emergency action to be followed whenever there is requirement?

EHS Manager/ Site Safety Officer Contractor's Site In-charge/ Safety In-charge

GALGOTIAS UNIVERSITY

PERMIT FOR WORKING AT HEIGHTS

Permit No.: Date:

Project Name: Location:

Contractor: Sub-contractor:

Job description: Area/ location:

A	**SCAFFOLDING & RELATED PROTECTION**	Y	N	N/A
A.1	Scaffolding good construction, adequate strength with 50 cm clear walk ways toeboards with wide screens,			
A.2	Scaffold well secured with stair ways, hand rails. Should be wide enough to pass two persons at a time			
A.3	Maintained good Housekeeping at work location / site			
B	**OVERHEAD CLEARANCE**			
B.1	Required clearance available from all overhead electrical cables			
B.2	**LADDERS**			
B.3	Strong material, well maintained ladders			
B.4	Ladder not placed against loose boxes materials, sound objects, near electricalinstallation.			
B.5	Ladder of sufficient height used, on top tied down and man positioned at the foot at ladder.			
B.6	Safety Footwear provided			
B.7	Ladder placed at an angle of 70 to 75 degrees			
B.8	Area of work barricaded so no person can walk under the ladder.			
C	**PERSONAL PROTECTION EQUIPMENT**			
C.1	Safety harness provided and worn			
C,2	Safety helmet, safety shoes and any other PPE required to perform the job at hand is provided and worn properly			

A. Permission:

Permission granted from _____to_____hrs.on_____

Time_____Date_____Signature of permit issuing authority

B. Receipt:

I hereby declare that I accept the responsibility for carrying out the work as detailed on this permit and no attempt will bemade by me or men under my control to carryout any other work.

Time_____Date _____Signature of Person Receiving Permit

C. Clearance certificate:

Work completed by taking all precautionary steps as approved by permit issuing authority.

Time_____Date _____Signature of Person completing jobs

D. Cancellation:

This permit to work is hereby cancelled.

Time_____Date _____Signature of permit issuing authority/Shift in-charge

GALGOTIAS UNIVERSITY

HOT WORK PERMIT

Permit No.: Date:

Name of the Project: Location:

Name of the Contractor: Sub-Contractor:

A) Person taking permit /permittee to fill up:

1) Exact location where hot work is being planned_____

2) Approximate duration of work From: Date:_____Start Time_____ Finish Time_

Revalidated To: Date:_____ Start Time_____Finish Time_

3) Description of work:

4) Tools & Tackles used:

Points to be checked

SL No	Details	Y	N	N/A
1	Has the area immediately below and adjacent to the work spot been cleared/removed of oil, grease and waste cotton etc?			
2	In case of Gas welding, proper hose pipes and pressure gauges are used?			
3	Have fire extinguishers been kept handy at site?			
4	Has tin sheet / wet gunny bag / fire retardant cloth/ sheet been placed to prevent sparks from causing fire?			
5	Have fire sand buckets been kept handy at site?			
6	Whether cylinders are kept in upright positions?			
7	Whether Proper PPE's are available?			
8	In Electrical Welding whether proper Earthing is provided.			

The above points have been complied with and conditions rendered safe / hazards innocuous to undertake the hot work.

Name of_____Signature _____

Designation_____

Permitee (Site engineer)

Name & Signature of Safety Officer _____

B) The person giving permit (Issuing Authority) to fill up:

After checking all the above precautions the hot work can be carried out in the above area.

1. Date:_____Time:_____Signature of safety Officer_____Permit is revalidated for the Period
2. Date:_____Time:_____Signature of Safety Officer _____

C) Time _____ Date: _ at which the permit closed & filed

DISPOSAL PERMIT FORM

PERMIT NO.: DATE:

Mr._____ Foreman, is authorized to dispose of the followingmaterials in the manner indicated:

MATERIAL METHOD LOCATION

The procedures posted at the burning ground and disposal area must be followed in detail during these operations.

Personnel Authorized _____

Time: _____ Date: _____

_____

(Supervisor)

GALGOTIAS UNIVERSITY

EXCAVATION PERMIT

Permit No:_____Date: _____
Project Name:_____Location: _____

Contractor:_____Sub-contractor:_____

Excavation details:

Purpose:

_____

Area/ Location:_____
Proposed date and time for start of work: _____
Proposed date and time for completion of work:_____
Tools and equipment involved: _____

_____
_____

Length_____m Width _____m Depth_____m

Preparation

1. Underground cables, pipelines, electrical lines etc checked Yes/No
2. Personnel protective equipments to be used to include;

A. Safety Shoe Yes/No
B. Safety Helmet Yes/No
C. Gloves Yes/No
D. Eye Protection Yes/No
E. Ear Protection Yes/No
F. Nose Mask Yes/No

Safety Precautions

1. The proper approach arrangement to be made with required no. of exit points
2. Wear proper PPEs
3. Barricade area and Display Warning boards
4. Ensure good housekeeping before and after the work
5. Ensure the presence of supervisor during the execution of work
6. Use certified machinery
7. Check for possible interference with any underground utilities
8. Check reverse horn for vehicles and driver license
9. Any special safety precautions (specify)_____

Checked By:
Contractor's Safety Officer Signature Date

PERMIT ISSUING AUTHORITY (Permit is granted & valid up to)

1. Date:_____Time:_____Signature of Safety Officer _____ Permit is revalidated for the Period
2. Date:_____Time:_____Signature of Safety Officer _____

NIGHT WORK PERMIT FORM

PERMIT NO.: _____DATE: _____

Project name:_____ Location: _____
Contractor name:_____Trade Package:_____
Activities scheduled for night work with location:

_____

Reason for conducting these activities at night:

_____

Name of the Supervisor:

Name of workers and designation:

S.No NAME DESIGNATION

Sufficient lighting provided: YES/NO Area
to be cleaned after work: YES/NO

Emergency vehicle available: YES/NO Vehicle No.:

Any other special precautions:

Signature:_____Signature:_____Signature: _____

Supervisor (Contractor) Site In charge (Main Contractor) EHS Manager

Note: CONCERNED AGENCIES ARE RESPONSIBLE FOR ANY UNSAFE ACT/
CONDITIONS

GALGOTIAS UNIVERSITY

PERMIT FOR WORKING IN AHU/ ELECT/ UPS/ SERVER/ BATTERY ROOMS

A.

Date:_____ Permit number:_____

Project:_____Location:_____
Agency requesting permit: _____
Location of work: _____
Permit to work on (date):_____From: _____To:_____
Description of work:_____

_____

Names of Individuals who will work in the area along with the name of supervisor:

_____
_____

LOTO required or not? _____
Hot work/ Height work permit taken, if required. _____
Any other precautions, if required: _____

_____

Signatures of requestor

B.

Permit granted to work on_____from_____to_____.
Signatures of authorized representative

C.

Area cleared after work: _____
Signature of rep of agency which Signatures of representative

Performed work

Copy to: 1. Workers working at site

2. representative
3. Contractor records

CONFINED SPACE ENTRY PERMIT

A.

Date:_____Permit no.: _____

Project Name and Location: _____

Permit Requested by:_____

Confined space location:_____Confined space description: _____

Purpose of entry and description of work:_____

_____

_____

Duration of permit: From: _____To: _____

Potential hazards (Mark all that apply):

Oxygen deficiency/ Toxic gases Fire/ explosion /Mechanical hazards

B.

No. Item Yes Not Required1
Proper lighting provided

2 Proper ventilation provided (natural/ artificial)3
Full body harness with lifeline provided

4 Proper access for exit provided5
Entrance barrier provided

6 Method of isolation/ control, purge, flush, etc.7
Lockout provided

8 Respiratory protection provided
9 Rescue team with devices put on stand
by10 Proper PPE provided

11 Tests required (Attach reports):

Oxygen level (19.5% - 23%) Carbon
Monoxide level (<25 ppm)

Name of Entrants Name of Attendants (stand by team)

I have checked the above points and found the conditions compliant to undertake the abovementioned work.

_____ _____ _____

Name of permitee Signature of permitee Designation

C.

The precautions and safe conditions mentioned above have been verified and the work can be started.

_____ _____ _____

Name of Issuing authority Signatures of Issuing authority Designation

D.

Time_____ Date_____Permit closed and filed.

Signature of safety supervisor: _____

GALGOTIAS UNIVERSITY

SHAFT WORK PERMIT

Date:_____ Permit no.: _____

Project name and Location: _____

Name of the agency requesting permit: _____

Location of work: Shaft number:_____Floor:_____

Task to be performed: _____

Start date and time:_____Finish date and time: _____

Safety Precautions required:

No. Item Yes Not required

1 All personnel are wearing proper PPE
2 Workers have been briefed about hazards3 Safe access to shaft available
4 Safe working platform erected
5 Safety harness with lifeline provided
6 Fire extinguisher provided for hot work7 Shaft appropriately barricaded

Names of workmen entering shaft: _____

_____
_____

I have ensured that the safety precautions as listed above for the task to be performed have been taken for this shaft work.

_____ _____

Name of permitee Signature of permitee Designation

_____

Name of Issuing authority Signature of Issuing authority Designation Notes:

1. Separate permit required for work in each shaft.
2. Work permit is valid for the prescribed date, time and in prescribed location only.Time____Date _____Permit is closed.

Name and Signature of the Issuing authority: _____

GALGOTIAS UNIVERSITY

CONTRACTOR INCIDENT/ NEAR MISS REPORTING FORMAT

Project:_____Location: _____
Name of Contractor: _____
Name of Contractor Employee: _____Age:_____Sex:_____
Incident Date:_____ Incident Time:_____Incident Location: _____
Injuries:_____
Treated by:_____Treated at: _____
Type of Incident (First aid/ Recordable/ Lost Work day/ Fatal/ Near Miss): _____
Task assigned to person at the time of incident:_____

_____

Description of the Incident: _____

_____
_____
_____

Primary Root cause for the Incident:_____

_____
_____

Contributory factors: _____

_____
_____

Date when latest safety training was given to employee: _____
Subject of training:_____Given by: _____
Was a Pre task plan required/ submitted for this task:_____
Is there a standard procedure developed to perform this task?_____
If yes, was it reviewed with the worker and when? _____
Preventive measures proposed to avoid recurrence in future:_____

_____
_____
_____
_____

Contractor Site In-Charge Contractor Safety In-Charge

GALGOTIAS UNIVERSITY

PEP TALK REPORT FORM

(To be filled by the person conducting pep talk)

Project:_____ Location: _____
Name of Contractor:_____ Trade: _____
Name of Site In-Charge: _____
Name of Contractor Safety coordinator:_____
Number of Workmen present in Pep talk:_____
Date and Time of Pep talk: _____
Topics discussed: _____

_____
_____

Any significant problems/ issues identified:_____

_____
_____

Remarks (if any):_____

_____

Contractor Safety Representative Safety Representative

MONTHLY EHS STATISTICS REPORT – *Month, Year*

(To be filled and submitted by contractor)

Project:_____Report No:_____Date: _____
Name of Contractor:_____Trade:_____

S.No Description Status

1 No. of Man-hours worked over last month2
Cumulative Man-hours worked till date

3 No. of Reportable Accidents on project4
No. of Near Misses

5 No. of Lost Work Day (LWD) cases6
No. of Safety Pep talks conducted

7 Infraction Notices/ Safety Inspection Reports received8
Infraction Notices/ Safety Inspection Reports closed

9 No. of Fire extinguishers available at site (all types)a Foam Type (Last serviced on____)
b CO2 Type (Last refilled on_____)
c Others

10 No. of Training sessions conducted
a Fire fighting training
b First Aid training

c PPE Usage trainingd
Others

11 Safety Permits Issued
12 No. of Safety sign boards displayed at site
13 Housekeeping practices (Excellent/ V Good/ Good/ Average/ Poor)14 No. of times Equipment, Machinery and Tools inspected
15 Physical condition of the PPE in usage (Good/ Average/ Poor)16
License and vehicle documents available (if applicable)

17 Percentage compliance on the usage of PPE by workers
Submitted by:

Contractor Safety Representative/ Site In-Charge
Safety Representative Comments (if any):

_____

_____

Reviewed by:

Safety Representative Copy
to: Project Manager

MONTHLY EHS STATISTICS REPORT – *Month, Year*

(To be prepared by contractor for submission to Client)

Project:_____Report No:_____Date: _____

Sl# Description Status

1 No. of Man-hours worked over last month2
Cumulative Man-hours worked till date

3 No. of Reportable Accidents on project4
No. of Near Misses

5 No. of Lost Work Day (LWD) cases 6 No.
of Safety Inspections conducted7 No. of
Safety Audits conducted

8 No. of Safety Infraction Notices/ Inspection Reports issued9
No. of Fire extinguishers available at site (all types)

a Foam Type (Last serviced on_____)
b CO2 Type (Last refilled on_____)
c Others

10 No. of Training sessions conducted
a Fire fighting training
b First Aid training

c PPE Usage trainingd
Others

11 No. of Safety pep talks conducted
12 Total number of Safety Permits Issued
13 No. of Safety sign boards displayed at site
14 Housekeeping practices (Excellent/ V Good/ Good/ Average/
Poor)15 Equipment, Machinery & Tools inspection (Satisfactory/
Not)
16 Physical condition of the PPE in usage (Good/ Average/ Poor)17
License and vehicle documents available (if applicable)

18 Percentage compliance on the usage of PPE by workers
19 Overall EHS implementation ((Excellent/ V Good/ Good/ Average/
Poor)Additional Comments (if any):

_____

_____

_____

Safety Representative

MONTHLY EHS REPORT – *Month, Year*

A. MAN-HOUR LOG

Sl#	Contractor	Up to Last report	Man-hoursthis report	CumulativeManhours
1				
2				
3				
4				
5				
Grand Total:				

B. INCIDENT REPORT

Sl#	Description	Up to Last report	This report	Cumulative	Remarks
	1 Near Misses				
	2 Recordable Incidents				
	3 Lost Work Day cases				

Sl#	Safety inspection conducted on	No. of Non conformances	No. of Open Non conformances	Remarks

Sl#	Safety Audit Conducted on	Safety Rating/ Score

Average Safety Score:

E. OVERALL JOB SITE SAFETY AND COMPLIANCE WITH EHS STANDARDS

EHS representative to indicate whether Excellent/ V Good/ Good/ Average/ Poor, as the over job site safety and compliancewith EHS Standards and also provide comments (if any).

Attachments: Monthly EHS statistics report

PENALTY FOR NON COMPLIANCE WITH EHS GUIDELINES

A.

Project:_____Location:_____Date: _____

Penalty notice issued to: _____

Contractor Site In-charge:_____

Contractor Safety representative: _____

Description of Non-compliance: _____

_____

_____

_____

Location of non-compliance:_____

Have there been similar non-compliances in the past? _____

Have any Safety Infraction Notices been issued in the past? If yes, provide details

_____

S. No.	Degree of violation	Type of violation	Penalty for violation	No. of violations	Penalty Amount
				Total Penalty Amount	

Signature of the Safety Officer/ representative generating this notice

B.

Billing department to proceed with deduction of INR_____ as penalty amount from contractor's next running bill, fornon-compliance with EHS guidelines, duly accepted by contractor as part of tender document as well as through acceptance on EHS Declaration

form.

Signatures of Project ManagerCC
to: Client Project Manager

GALGOTIAS UNIVERSITY

CHECKLIST FOR BUILDING HOIST/ WINCH

Project:_____Location: _____

Name of Contracting agency:_____

S. No Description OK/ Not OK Remarks

A. SUPPORTING STRUCTURE:

1 Condition of steel tubes2
Condition of the Base

3 Bracing (diagonal/horizontal)4
Anchorage with structure

5 Any obstructions to the movement of rope?

B. WINCH MACHINE:

1 Condition of brakes and accessories2
Functioning of brake with load

3 Oil level and condition4
Gear box and motor

5 Coupling bolts and nuts6
Condition of wire rope

7 Anchorage of drum and wire rope8
Pawl arrangement for locking

9 Condition of diversion pulleys, idlers pulleys and fleet angle10
Limit Switches

11 Electrical connection, earthing and insulation

C. UNLOADING PLATFORM:

1 Area Barricaded
2 Stability
3 Sagging
4 Any Overloading
5 Hand 5railing
6 Staging

D. OTHERS

1 Is the person authorized/experienced to Operate?
2 Does the person at unloading point use Safety belt?
3 Is the bucket overloaded?
4 Is the Signaling Man present?
5 Is the work permit Obtained?

Signature of Contractor Site In-charge Signatures of Safety Officer/ Rep.
Print Name:_____Print Name: _____

GALGOTIAS UNIVERSITY

CHECKLIST FOR SCAFFOLDING

Project:_____ Project number:_____

Name of Contractor:_____Trade: _____

S. N.	Description	Observation	Yes/ NO/ NA	Remarks / Recommend ation
1	Does the site has a practice of providing suitable and sufficient scaffolds so that the work could be safely done at a height?			
2	Is site engaging suitable/ properly trained/ experienced workmen for constructing / dismantling / shifting scaffolding works?			
3	Are scaffold platforms designed / constructed with aminimum safety factor of four?			
4	Is there a safe means of access to the workingplatform?			
5	Are scaffold structures on a solid base avoiding pavements& manhole covers?			
6	Is the scaffolding structure free from excavation pit / proper distance is maintained?			
7	Is verticality of the structure being properly maintained?			
8	Are ties for scaffold structure properly maintained (vertical as well as horizontal position)?			
9	Is there a provision of toe boards/guard rails and arethey secured?			
10	Whether planks used for working platforms are wooden /metallic?			
11	If wooden plank, whether thickness is maintained asper standard or not, viz.			
12	a. For 1.5 M span -1.5” thick			
13	b. For 2.6 M span -2.0” thick			
14	Is there a system of inspecting scaffolds by a competent person at least once a week and also afterevery prolonged interruption in the work?			
15	Is there a system of inspecting materials of scaffolds oneach occasion before erection?			
16	Is there a system of inspecting scaffolds at every spellof bad weather/ heavy wind condition?			
17	Is over hang of the working platform restricted to lessthan 50 mm/ four times the thickness of the board?			
18	Is their awareness among workmen on the importanceof load distribution on a given working platform?			
19	Is there a check for the condition and correct usage of fittings for scaffolds?			

20	Is the width of a working platform properly maintainedaccording to usage, viz.			
21	a) Minimum 600 mm for footing and not for deposit ofmaterials.			
22	b) Minimum 800 mm for footing and deposit ofmaterials.			
23	c) Minimum 1050 mm when used for heavier loads orto support higher platforms.			
24	Are all the materials stored on the platforms properlysecured or not?			
25	Whether planks are tied using proper binding wires?			
26	Are openings in working platform kept safely covered / fenced?			
27	Are the scaffolds being erected on firm and levelsurface?			
28	Does the height of mobile scaffolds exceed four timesthe smaller base dimension?			
29	Are all materials stacked on platform properly securedwhile in motion?			
30	Is the safety rule: Not to ride on a scaffold while inmotion, violated.			
31	Is there a system of checking for obstructions beforethe tower is moved?			
32	Are suitable / correct lifting tackles (wire rope/ chains/ shackles) selected for suspension & used?			
33	Are all the suspension gears correctly spaced andconnected?			
34	Is there a system of using manila rope/coir rope for suspension at any place where such rope would beliable to damage by heat/flames/sharp edges etc.			
35	Are all precautionary measures taken to prevent contact between arc welding apparatus and suspension ropes?			
36	Is there a provision of guardrails and toe boards?			
37	Is hanging platform secured?			
38	Is there a provision of anchoring safety belt. Lanyardsto be tied to guy ropes?			

EHS Manager/ Site Safety Officer

Contractor Site Safety In-charge

GALGOTIAS UNIVERSITY

SAFETY INSPECTION REPORT

Project:_____Report No.:_____ Date: _____

Name of Contractor: _____

Number of non-conformities observed (as per details below): _____

Details of Non-Conformities observed:

The following non-conformances with reference to project EHS guidelines were observed during routine EHS round of the project site;

Sl. #	Description of non-conformity	Target date
1		
2		
3		
4		

Note:

Please take serious note of the above listed non-conformities and initiate corrective action immediately, so as to remove the non-conformity by the Target dates indicated above, failing which shall proceed with imposition of penalty for the observed non-conformities.

Safety Representative

Contractor's Corrective Action Response (*To be filled by contractor*):

All the above listed non-conformities have been rectified. The work is now being executed in compliance with EHS guidelines and applicable Safety Standards. The disposition of the non conformances is listed as under;

S.No	Disposition Description	Status
1		
2		
3		
4		

Contractor's Site In-Charge Contractor's Safety Representative

Dated: _____

Copy to: Project Manager

PRE-TASK PLAN FORMAT

PROJECT NAME AND LOCATION: **PTP No.:**
CONTRACTOR: **TASK:** **SCHEDULED ON:** **SUBMITTED ON:**

S.N o	Activity Description	Potential Hazard	Preventive Action	Contingency Plan
				Briefly describe the contingency plan in case the preventive actions associated with potential hazards fail to yield results and Accident/ Incident still happens. Contingency plan must list the immediate contact number of Security, Emergency, and Safety representative.

☐ To be resubmitted

☐ Reviewed

Prepared By:

Safety officer (Contractor)

Approved By: Signature: Safety Officer

Schedule I

Performance Bank Guarantee

(On non-judicial paper of appropriate value)

(By any Nationalized Indian Bank or else obtain confirmation from ARG Outlier Media Pvt. Ltd.)

THIS GUARANTEE made on this [__] day [__] of [__] between [__] ("**Bank**") which expression shall, unless repugnant to the context or contrary to the meaning thereof, include its successors and assigns on the one part and [__], a Company incorporated in India and having its registered office at [__] ("**Client**") which expression shall, unless repugnant to the context or contrary to the meaning thereof, include its successors and assigns, of the other part.

WHEREAS Client has entered into a contract agreement ("**Contract**") at a total value of Rs. [__] with M/s. [__] (hereinafter called Contractor) which expression shall, unless repugnant to the context or contrary to the meaning thereof, includes its successors and assigns.

AND WHEREAS one of the conditions of Contract entered into, is that the Contractor make a payment of Rs. [__] being [5% (five percent)] of Contract Price in the form of a bank guarantee from a bank and in a form acceptable to the Client.

AND WHEREAS THE Contractor has requested the Bank to issue a guarantee of Rs. [__] and the Bank, through its branch at [__], has agreed to furnish this Guarantee in the manner hereunder.

NOW THIS GUARANTEE WITNESSETH that,

1. In consideration of Client, at the request of the Contractor, advancing a sum of Rs. [__], to the Contractor as and by way of Performance Guarantee, the Bank hereby unconditionally and irrevocably guarantees to the Client for due performance of the Contractor's obligations under the Contract and indemnifies the Client in respect of the amount of the Rs. [__] ("**Guarantee Amount**"). The Bank hereby undertakes, without recourse to Contractor and notwithstanding any dispute between the Client and the Contractor under the Contract or any objection by the Contractor, to pay the Client, on its mere demand in the enclosed format a sum upto and not exceeding the Guarantee Amount, being the amount of the 100% (hundred percent) of the payment or such other unadjusted amount of the said Performance Guarantee. If the Client notifies to the Bank that the Contractor has failed to observe, perform and fulfill the terms of the said Contract then the Bank shall immediately pay to the Client, on Client's mere demand in the enclosed format, such sum or sums of money to the extent of Rs. [__] being 5% (five percent) of the value of the Contract Price (as defined in the Contract) as may be claimed by the Client by reason of non-fulfillment by the Contractor of his obligations under the Contract as aforesaid / and shall also indemnify the Client against all losses and damages which may be suffered by the Client as aforesaid and against all costs, charges, expenses which may be incurred by the Client in connection herewith. The Bank shall pay the said amount without demur or protest or without recourse

to the Contractor. Any such demand placed in the enclosed format on the Bank shall be conclusive proof with respect to the amount due and payable by the Bank under this Guarantee. The decision of Client as to whether the terms and conditions of this Guarantee or Contract have been observed or not shall be final and binding on Bank and the Bank will not have the discretion to withhold payment to the Client if letter in enclosed format is delivered by the Client to the Bank on or before [__] ("**Claim Period**").

2. This Guarantee is a continuing Guarantee and not revocable except with the previous written consent of the Client and as aforesaid, it will continue in force until the Contractor has maintained the schedule of delivery of the said work under the Contract and observed and fulfilled the terms and conditions of the Contract. The Client has an irrevocable and unconditional right to claim under the Guarantee in case the Guarantee required to be extended in its opinion is not extended by the Contractor or the Bank within the time frames and for the time frames stipulated by the Client.

3. The Client may, without affecting Bank's liabilities and obligations hereunder and without reference to the Bank grant time or other indulgence to or compound with the Contractor or enter into any agreement or agree to forbear to enforce any of the terms and conditions of the Contract.

4. This Guarantee shall not be affected by any change in the Constitution of the Bank, Contractor or the Client or by absorption / merger of the Client, Contractor or the Bank with any other body or corporation or otherwise and this Guarantee will be available to or enforceable by such body or corporation.

5. All composition and payments received by the Client from or on behalf of the Contractor shall be regarded as payments in gross and in the event of the Contractor being wound-up, the Client will be entitled to prove against the properties of the Contractor in respect of the whole of the contractor's indebtedness to the Client without any right on the part of the Bank to stand in the Client's place in respect of or to claim the benefits of such composition and payment or any security held by the Client until the Client shall have received the full amount of the claims against the Contractor.

6. In order to give effect to this Guarantee, the Client will be entitled to act as if the Bank were the principal debtor and the Bank hereby waives all and any of its rights of surety ship.

7. It shall not be necessary, and the Bank hereby waives any necessity, for the Client to proceed against the Contractor before presenting to the Bank its demand under this Guarantee.

8. The Guarantee herein contained is unconditional and irrevocable during its currency and will remain in full force for a period of [__] years from the date hereof ("**Expiry Date**"), or if full payment has been made to the Client by BANK, which is earlier. The Bank's liability under this Guarantee is restricted to the Guarantee Amount, i.e. Rs. [__] (Rupees [__]). The Client may claim the full or part of the amount under the Guarantee entirely at its sole discretion and make this claim at one or more times before the expiry of the Claim Period under this Guarantee. The total amount of claims is restricted to the Bank's liability under the Guarantee. The Bank is required to make a payment immediately on receipt of the claim in the enclosed format.

9. This Guarantee shall continue to be in force notwithstanding the discharge of Contractor by operation of law and shall cease only on payment of the full amount by Bank to Client of the amount hereby secured and on the claim of Client against Contractor in respect of Contract being satisfied.

10. This Guarantee shall be in addition to and not in substitution for any other guarantee or security for the Contractor given or to be given to the Client in respect of the Contract by the Bank whether alone or jointly with others.

11. In the event of force majeure, according to the Contract, the validity of the present guarantee shall be extended for a period to be mutually agreed upon by the Client and the Contractor.

12. Unless demand or claim under this Guarantee is made within the Claim Period of this Guarantee, or unless the Guarantee is renewed, or extended in writing by the Bank, all the rights of the Client hereunder shall be forfeited and the Bank shall be relieved and discharged of all liabilities.

13. Any notice by way of request, demand or otherwise hereunder may be sent by post to the Bank, addressed as aforesaid, and if sent by post, it shall be deemed to have been given at the time when it would be delivered in due course of post, and in proving such notice, when given by post, it shall be sufficient to prove that the envelope containing the notice was posted and a certificate of posting from postal Authorities / Agencies, to the effect that the envelope was so posted shall be conclusive.

14. These presents shall be governed by and construed in accordance with Indian Law as applicable.

15. The Bank hereby declares that it has the power to issue this Guarantee and the undersigned has full power to do so.

Notwithstanding anything contained hereinabove our liability under this guarantee is restricted to the Guarantee Amount i.e. Rs. [__] (Rupees [__]). This guarantee is valid upto the Expiry Date i.e. [__]. Any claim arising out of the guarantee must be lodged with the bank at its office at [__] on or before the Claim Period i.e. [__], after which the liability of the bank would be extinguished.

In witness thereof the Bank has executed these present the day and year first above written.

Signed and delivered for and on behalf of the above named.

IMPORTANT NOTE

Following points shall be taken care of while submitting the Bank Guarantee: -

1. The Bank Guarantee shall be on non-judicial stamp paper having a value of Rs. 200/- or as per requirement stamp paper should be purchased in the name of the Bank, who gives the guarantee and not in the name of the supplier/ sub-contractor.

2. The Bank Guarantee shall be strictly as per the pro-forma.

3. Bank Guarantee should be from any of the Nationalized Banks or its subsidiaries only.
4. Correction made on the Guarantee should be endorsed by the Bank with it official seal.

NOTE: The BG format shall not be modified or changed

Schedule II

Contract Agreement

[*To be executed on a stamp paper of appropriate value*]

This Contract agreement ("**Agreement**") is entered into on this [__] day of [__] month, 2023 ("**Execution Date**") at Noida, by and among:

A. **Galgotias University, located at Plot No. 2, Sector 17A, Yamuna Expressway, Gr. Noida, Gautam Buddh Nagar, UP, India running under Smt. Shakuntla Educational & Welfare Society**, a society incorporated under the societies Act, 1860 and having its registered office at 4405/6, Prakash Appt. – 2, 5, Ansari Road, Daryaganj, New Delhi - 110002 (hereinafter referred to as the "**Client**" which expression shall unless repugnant to the meaning or context, be deemed to mean and include, its successors and permitted assignees);

B. **[__]**, a company incorporated under the Companies Act, [1956/2013] and having its registered office at [__] (hereinafter referred to as the "**Contractor**" which expression shall, where the context so admits, include its successors in office and assignees.

The Client and the Contractor are collectively referred to as the "**Parties**" and individually as "**Party**".

WHEREAS:

A. The Client had invited Bidders (as defined in the Instruction to Bidders ("**ITB**")) with requisite technical capability and sound financial position to bid for Works (as defined in the ITB) required to be undertaken for building the New admin. & Engg. Block (as defined in the ITB) including but not limited to construction activities required to be undertaken for building the New admin. & Engg. Block including but not limited to ELECTRICAL AND ELV activities required for development of the Project (as defined in the ITB).

B. The Client is desirous of having provided and executed certain Works mentioned, enumerated or referred to in the Bidding Documents (as defined in the ITB).

C. The Contractor is the successful bidder in respect of the Works to be undertaken pursuant to the Tender issued by the Client.

D. In accordance with the process agreed in the Bidding Documents, the successful bidder will undertake the Works at the Site in accordance with the terms and conditions set out in this Agreement. Accordingly, the Parties have agreed to enter into this Agreement for undertaking the Works for ELECTRICAL AND ELV of the New admin. & Engg. Block at the Site.

NOW THEREFORE THE PARTIES AGREE AS FOLLOWS:

1. **DEFINITIONS & INTERPRETATIONS**

1.1. **Definitions**

All capitalized terms used in this Agreement, but not defined herein shall have the meaning given to it in Clause 1 of the General Conditions of Contract ("**GCC**") which have been attached hereto as **Schedule A**.

The rules of interpretation as set forth in Clause 1 of the GCC shall apply *mutatis- mutandis* to this Agreement.

2. **SCOPE OF WORK**

The Works to be carried out by the Contractor, as part of its scope of work with regard to the ELECTRICAL AND ELV of the New admin. & Engg. Block shall be as specified in Clause 2 of the GCC, Schedule I (*Scope of Works*) of the GCC (attached separately as detailed BOQ), and the Technical Specifications.

3. **CONTRACTOR PERFORMANCE BANK GUARANTEE**

The Contractor Performance Bank Guarantee to be submitted to the Client by the Contractor shall be as specified in Clause 3 of the GCC.

4. **Construction of NEW ADMIN. & ENGG. BLOCK**

The ELECTRICAL AND ELV of New admin. & Engg. Block by the Contractor shall be as specified in Clause 4 of the GCC.

5. **CONTRACTOR'S OBLIGATIONS**

The Contractor's Obligations shall be as specified in Clause 5 of the GCC.

6. **CLIENT'S OBLIGATIONS**

The Client's Obligations shall be as specified in Clause 6 of the GCC.

7. **TIME FOR COMMENCEMENT AND COMPLETION**

The time for Commencement and Completion of the Works shall be as specified in Clause 7 of the GCC.

8. **MATERIALS AND WORKMANSHIP**

The Materials and Workmanship to be provided by the Contractor shall be as specified in Clause 8 of the GCC.

9. **PERFORMANCE PARAMETERS**

The Performance Parameters to be conducted by the Contractor in the presence of Client in order to ensure the operation of the New admin. & Engg. Block shall be as specified in Clause 9 of the GCC.

10. **LIQUIDATED DAMAGES**

The Liquidated Damages to be paid by the Contractor shall be as specified in Clause 10 of the GCC.

11. **COMPLETION AND ACCEPTANCE OF WORKS**

The Completion and Acceptance of Works to the satisfaction of the Client shall be as specified in Clause 11 of the GCC.

12. **PROJECT MANAGER**

The obligations of the Project Manager shall be as specified in Clause 12 of the GCC.

13. **ARCHITECT**

The obligations of the Architect shall be as specified in Clause 13 of the GCC.

14. **DOCUMENTS**

The Documents to be provided by the Contractor shall be as specified in Clause 14 of the GCC.

15. **CONTRACTOR TO INFORM ITSELF FULLY**

The obligation of the Contractor to inform itself fully shall be as specified in Clause 15 of the GCC.

16. **SUB-CONTRACTORS**

The engagement of Sub-Contractors shall be as specified in Clause 16 of the GCC.

17. **TRANSFER OF OWNERSHIP**

The transfer of ownership of the New admin. & Engg. Block shall be as specified in Clause 17 of the GCC.

18. **REPRESENTATIONS AND WARRANTIES**

The representations and warranties of the Parties shall be as specified in Clause 18 of the GCC.

19. **CONTRACTOR'S WARRANTIES**

The Contractor's Warranties shall be as specified in Clause 19 of the GCC.

20. **INSURANCE**

The Insurance to be obtained by the Contractor shall be as specified in Clause 20 of the GCC.

21. **DEFECT LIABILITY PERIOD**

The Defect Liability Period shall be as specified in Clause 21 of the GCC.

22. **VARIATION AND CHANGE IN CONTRACT ELEMENTS**

The Variation and Change in Contract Elements shall be as specified in Clause 22 of the GCC.

23. **CONTRACT PRICE AND INVOICING**

The Contract Price and Invoicing shall be as specified in Clause 23 of the GCC.

24. **TERMS OF PAYMENT**

The Terms of Payment shall be as specified in Clause 24 of the GCC.

25. **SITE OFFICE, SECURITY AND FACILITIES**

The obligation of the Contractor with respect to the Site Office, Security and Facilities shall be as specified in Clause 25 of the GCC.

26. **SAFETY REQUIREMENTS**

The Safety Requirements to be adhered to by the Contractor shall be as specified in Clause 26 of the GCC.

27. **LIMITATION OF LIABILITY**

The Limitation of Liability shall be as specified in Clause 27 of the GCC.

28. **INDEMNITY**

The Indemnification and payment of indemnities shall be as specified in Clause 28 of the GCC.

29. **CONFIDENTIAL INFORMATION**

The obligations of the Parties with respect to the Confidential Information shall be as specified in Clause 29 of the GCC.

30. **INTELLECTUAL PROPERTY RIGHTS**

The ownership of the Intellectual Property Rights shall be as specified in Clause 30 of the GCC.

31. **FORCE MAJEURE**

The Force Majeure event shall be as specified in Clause 31 of the GCC.

32. **CHANGE IN LAW**

The occurrence of events comprising Change in Law shall be as specified in Clause 32 of the GCC.

33. **SUSPENSION**

The Suspension of Works shall be as specified in Clause 33 of the GCC.

34. **TERMINATION**

The right of Parties to terminate the Agreement shall be as specified in Clause 34 of the GCC.

35. **GOVERNING LAW AND DISPUTE RESOLUTION**

The Governing Law and Dispute Resolution mechanism shall be as specified in Clause 35 of the GCC.

36. **MISCELLANEOUS**

The miscellaneous provisions of the Agreement shall be as specified in Clause 36 of the GCC.

[signature page follows]

IN WITNESS WHEREOF the parties have executed this Contract as of the date first recorded above.

CLIENT

SHAKUNTALA EDUCATIONAL & WELFARE SOCIETY

_____
Name:
Title:

CONTRACTOR

[__]

_____
Name:
Title: