राष्ट्रीय कोशिका विज्ञान केंद्र
NATIONAL CENTRE FOR CELL SCIENCE
(जैवप्रौद्योगिकी विभाग, भारत सरकार की स्वायत्त संस्था/
An Autonomous Institution of the Department of Biotechnology, Govt. of India)
सावित्रीबाई फुले पुणे विश्वविद्यालय परिसर, गणेशखिंड, पुणे-411007
Savitribai Phule Pune University Campus, Ganeshkhind Pune 411007.

भाग- I /PART- I (तकनीकी बिड/TECHNICAL BID)

SUPPLY, INSTALLATION, TESTING, COMMISSIONING, QUALIFICATION, AND VALIDATION OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY ON TURNKEY BASIS AT NCCS JIDNYASA BUILDING, KOTHRUD, PUNE-411038

प्रस्तुत करने की नियत तारीख/DUE DATE FOR SUBMISSION: 21/11/2023 @ 15 HRS

प्रेषित करने के लिए पता/ TO BE SUBMITTED TO:
निदेशक/The Director
राष्ट्रीय कोशिका विज्ञान केंद्र/National Centre For Cell Science
सावित्रीबाई फुले पुणे विश्वविद्यालय परिसर/ Savitribai Phule Pune University Campus,
गणेशखिंड/ Ganeshkhind, **पुणे/**Pune 411007 (**महाराष्ट्र, भारत/**Maharashtra, India)

बिडर का नाम एवं पता/NAME AND ADDRESS OF BIDDER:_____

TENDER COST: NIL

अनुक्रमणिका / INDEX

2. समाचार पत्रों में प्रकाशन हेतु जारी की जानेवाली मुद्रणालय सूचना/ PRESS NOTICE TO BE ISSUED FOR PUBLICATION IN NEWSPAPERS

राष्ट्रीयकोशिकाविज्ञानकेंद्र
NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, Ganeshkhind, Pune 411007

NOTICE INVITING TENDER

The Director NCCS, Pune invites sealed tenders in two bid system for following works

Sr. No.	NIT No.	Name of Work	Estimated Cost	EMD	Time of Completion
1	NCCS/MAINT/HT/454D/ 2023	SITC of 400 KVA Substation at Jidnyasa Bldg., Kothrud, Pune	Rs. 74 Lakh	Rs. 1.49 Lakh	Four Month
2	NCCS/MAINT/DG/454E/2023	SITC of 380 KVA DG Set at Jidnyasa Bldg., Kothrud, Pune	Rs.49 Lakh	Rs.0.98 Lakh	Four Month
3	NCCS/MAINT/GMP/454C/2023	SITC and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune	Rs.910 Lakh	Rs.18.20 Lakh	Six Month

Detail tender document can be downloaded from our website **www.nccs.res.in and https://eprocure.gov.in**. All further information, instructions, corrigendum/addendum or notices will be published on website only.

 SEAL AND SIGN. OF THE BIDDER

राष्ट्रीय कोशिका विज्ञान केंद्र
NATIONAL CENTRE FOR CELL SCIENCE
(जैवप्रौद्योगिकी विभाग, भारत सरकार की स्वायत्त संस्था/
An Autonomous Institution of the Department of Biotechnology, Govt. of India)
सावित्रीबाई फुले पुणे विश्वविद्यालय परिसर, गणेशखिंड, पुणे-411007
Savitribai Phule Pune University Campus, Ganeshkhind Pune 411007.

3. SHORT TENDER NOTICE

NCCS/MAINT/GMP/454C/2023-24 01/11/2023

National Centre for Cell Science is a Premier Research, an Autonomous Institute under Department of Biotechnology, Govt. of India having office at Savitribai Phule Pune University Campus, Ganeshkhind, Pune -411007 and another office at Survey No.85/2, Jidnyasa Bldg, near Vanaz Company Ltd, Kothrud, Pune-411038.

The Director NCCS. Pune invites sealed tender from interested, inline, experienced, reputed Individuals, firms, OEM, Pvt. Ltd., & Ownership Companies or registered contractors with C.P.W.D., Railways, M.E.S., B.S.N.L., P.S.U's etc having sound technical knowledge, expertise and experience in establishment of c-GMP Facilities/ BSL-1&2 laboratories for " **Supply, Installation, Testing, Commissioning, Qualification and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune-411038".**

Description of the Work	Estimated Cost (Rs.)	EMD (Rs.)	Time for Completion
Supply, Installation, Testing, Commissioning, Qualification, and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune-411038	**Rs.91014689/-**	**Rs.18.20 Lakh**	**180 days (Six months)**

3.1 IMPORTANT DATES OF TENDERING PROCESS:

1	Tender available on website for download	:	01/11/2023 to 21/11/2023
2	Pre-bid Meeting	:	10/11/2023 @ 14:30 Hrs
3	Tender Submission due date	:	21/11/2023 @ 15:00 Hrs
4	Opening of Technical Bid	:	21/11/2023 @ 15:15 Hrs
5	Opening of Commercial Bid	:	Will be communicated in due course of time

(Note-Pre-bid meeting will be in both online and offline mode. A web link will be displayed on our website www.nccs.res.in on one day before the pre-bid meeting)

3.2 **PREQUALIFICATION CRITERIA:** (Please attached self- attested documents)

3.2.1 Bidder should have registration for Shop Act, GST and PAN Number. Bidder should have legal status whether it will be a registered Proprietorship Firm/Partnership Firm/ Company under Companies Act having legal entity having all statutory licenses/registration for carrying out such activity.

3.2.2 The bidder should have satisfactory completed similar type of works for setting up of BSL-1/2 functional laboratories/facilities for Biologicals within last five years (upto last day of submission of tender). Similar type of works means complete turnkey project execution including but not limited to project management, designing, supplying, installing, commissioning, testing and validating Grade B, Grade C and Grade D cleanrooms, allied utilities, and integration of all relevant services in a turnkey manner as per cGMP standards of Schedule M/ FDA-US/ EMA-EU/ WHO for BSL-2 biologicals laboratories / facilities. The lab should have been made fully functional. Executing similar projects in government set-up would be an added advantage. The value of each work order should be not less than

One similar completed works consisting not less than Rs.728 Lakh
"OR"
Two similar completed works consisting not less than Rs.546 Lakh
"OR"
Three similar completed works consisting not less than Rs.364 Lakh

In each of the above case, documentary evidence in the form of Work Order/Agreement/Purchase order indicating the nature and value of along with reference/contact person & address, telephone/ E mail details should be submitted for verification. The Completion Certificate of the job issued by the respective client is necessary. The experience certificate and statement showing the value of existing commitments and on-going works as well as the stipulated period of completion, remaining for the each of the works listed shall be issued by the firm. The experience of completed works shall be in the name of Bidder Company. Experience of completed works in Subsidiary/Group Company, Joint Venture Company or as sub-contractor shall not be considered and accepted.

3.2.3 The bidder should have Average Annual Turnover of not less than **Rs.455 lakh** (Rupees Four Hundred Fifty Five Lakh only) for the last five years. The Bidder should not have financial loss for any consecutive two years during last five years ending 31st March 2023. The bidder should submit audited balance sheets and Profit & loss account duly attested by chartered accountant.

3.2.5. The Bidder should submit the Bank Solvency Certificate (as per attached format) of **Rs. 364 lakh** (Rupees Three Hundred Sixty Four Lakh only) from any Nationalized / Commercial/ Scheduled Bank

3.2.6. The Bidder should accompany a DD OR Bank Guarantee (BG) of **Rs.18,20,000/- (Rupee Eighteen Lakh Twenty Thousand only)** drawn on any Nationalized / Commercial/ Scheduled Bank in the favour of the Director, National Centre for Cell Science, Pune payable at Pune towards Earnest Money Deposit (EMD). BG should be valid for minimum of six months. The MSME firms registered in NSIC are not exempted from payment of EMD for this work.

3.2.7. The Bidder should submit undertaking that their firm / organization have never been blacklisted by any Govt/ Semi Govt Organizations/ Institutes/ PSU's etc as per attached format in the tender.

3.3. TECHNICAL EVALUATION / SHORTLISTING / SELECTION PROCESS:

The selection will be through competitive bidding which will be single submission and have 2 stages of evaluation process viz., Pre-qualification, Technical Scoring and Financial Proposal. The method of bid evaluation of the proposals/offers is detailed in the tender document.

Tender document of those bidders will be considered for technical evaluation who fulfill minimum prequalification (eligibility) criteria as mentioned S No.3.2, based on the documents submitted.

Tender document of those bidders would be considered for opening of price bids who obtain a minimum of total 75 marks in the technical evaluation of proposals as mentioned in Sr No. 5.6.3.

3.4 MODE OF BID ISSUE AND SUBMISSION:

The interested bidders can download the tender document from website **www.nccs.res.in** and **https://eprocure.gov.in** (CPPP) which is available at free of cost. However in case of downloading of tender documents from website, it will be the responsibility of bidders /applicants / firms to ensure that complete tender documents have been downloaded. Required documents dully sealed & signed as stated in the above shall be sent it by sealed envelope super-scribing "**Supply, Installation, Testing, Commissioning, Qualification and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune-411038**" and the envelope shall be submitted duly addressed to

The Director,
National Centre for Cell Science,
Savitribai Phule Pune University Campus,
Ganeshkhind, Pune 411007.

Technical bid:
The '**Technical bid**' should consist of the following documents:

a) Application form along with documents relating to eligibility pre-qualification criterion (Forms).
b) Bid Security (EMD)- DD or PBG.
c) Power of attorney of person authorized to sign the Bid
d) Complete Tender Document duly signed and stamped.
e) Technical Compliance Table & technical data sheet in tabular form comparing each specification of the quoted items with detail drawings / layouts with that given in tender document.
f) Technical Specifications with brands **/** makes offered by bidder.

Price bid:
The 'Price bid' should contain the following documents:
a) As per the prescribed format (Part-II: Commercial / Price bid).

The tender document should be submitted intact in a sealed cover either in person or by post without tampering with any of the pages and drawings thereof and duly filled in, signed and seal at the bottom of each page and drawings, by the Bidder or his / their authorized representative and it shall reach at NCCS, Pune as per scheduled date and time mentioned above. The tender received after the scheduled time on due date will not be considered. The bid should be valid and open for acceptance for a period of 90 days from the date of opening the technical bid.

The Director, NCCS, Pune reserves the right to amend or withdraw any of the terms and conditions contained in the tender document before accepting the tender or to reject any or all the tenders without giving any notice or assigning any reason. The decision of the Director, NCCS, Pune, in this regard shall be final and binding on all.

DIRECTOR
NCCS, Pune

4. DEFINITIONS AND TERMS:

In this document the following words and expressions have the meaning hereby assigned to them

4.1 ***Employer*** shall mean **National Centre for Cell Science, Pune** and shall include his successors and assign, as well as his authorized officers or representatives. National Centre for Cell Science shall be known as "NCCS."

4.2 ***Consultant*** shall mean **M/s. MJA Pharma Tech Private Limited, Bengaluru** appointed by NCCS for the said works and shall include their legal representatives, assigns and successors.

4.3 ***Bidder*** shall mean the Proprietor / Individual, Partnership firm, Company / Corporation, Society; they shall be, for the purpose of this contract.

4.4 ***Contractor*** shall mean the person or the persons, firm or company whose tender has been accepted by the NCCS and shall include his/their heirs, and legal representatives, the permitted assigns and successors.

4.5 ***Contract*** shall mean the Articles of Agreement, General and Special Terms & conditions, Schedule of Quantities and Specifications attached hereto and duly signed.

4.6 ***Site*** shall mean the site of the contracted works at **"Survey No.85/2, NCCS Jidnyasa Bldg, near Vanaz Company Ltd, Kothrud, Pune-411038"**.

4.7 ***Work*** shall mean the works to be executed and recorded in accordance with the Contract and shall include all extra or additional altered or substituted works as required and recorded for the performance of the Contract.

4.8 ***This Contract*** shall include the notice inviting Tenders, the Articles of Agreements, the General Conditions of Contract, the Special conditions of contract, the Schedule of Quantities, Specifications for Materials, Work-Sheet and mode of measurements and drawings pertaining to the work. All sections of this Contract Document are to be read together. Further such correspondence between the NCCS and Contractors as admitted by the NCCS before award of work and thereafter shall also form part of contract documents.

4.9 ***Drawings*** shall mean the drawings referred to in the specifications, description of items etc. and any modifications of such drawings approved in writing by the Consultant and such other drawings as may from time to time be furnished or approved in writing by the Consultant.

5. INSTRUCTIONS TO THE BIDDERS:

5.1. METHOD OF APPLICATION:

5.1.1. If the Bidder is an individual, the application shall be signed by him above his full type- written name and current address.

5.1.2. If the Bidder is a proprietary firm, the application shall be signed by the proprietor above his full typewritten name and the full name of his firm with its current address.

5.1.3. If the Bidder is a firm in partnership, the application shall be signed by all the partners of the firm above their full typewritten names and current addresses or alternatively by a partner holding power of attorney for the firm. In the latter case a certified copy of the power of attorney should accompany the application. In both cases, a certified copy of the partnership deed and current addresses of all the partners of the firm should accompany the application.

5.1.4. If the Bidder is a limited company or a corporation, the application shall be signed by a duly authorized person holding power of attorney for signing the application accompanied by a copy of the power of attorney. The Bidder should also furnish a copy of the Memorandum of Articles of Association duly attested by a Public Notary.

5.1.5. Joint Ventures are not allowed for this work.

5.1.6. Bidder should ensure that the essential documents are attached as per Technical Bid and Check list and all pages of documents are signed and stamped. Failure to do so shall lead to the rejection of bids.

5.1.7. Bidder should submit their details as per attached all Forms with self-attested documents.

5.1.8. Overwriting should be avoided. Correction, if any, should be made by neatly crossing out, initialing, dating and rewriting, Pages of the qualification document are numbered. Additional sheets, if any added by the Bidder, should also be numbered by him. They should be submitted as a package with signed letter of transmittal.

5.1.9. References, information, certificates and work completion reports from the respective clients certifying suitability, technical knowhow or capability of the Bidder should be signed by an authorized person or officer. It should be on client's letter head.

5.1.10. Any information furnished by the Bidder found to be incorrect either immediately or at a later date, would render him liable to be debarred from tendering /taking up of work in NCCS.

5.2. BIDDER TO VISIT SITE:

The bidder must visit/examine the site and it's surrounding on pre bid meeting for the proper assessment of prospective assignment (scope of works). No claims later on shall be entertained.

Intending Bidders are advised to inspect and examine the site and its surroundings and satisfy themselves before submitting their bids as to the nature of the ground and sub-soil (so far as is practicable), the form and nature of the site, the means of access to the site, the accommodation they may require and in general shall themselves obtain all necessary information as to risks, contingencies and other circumstances which may influence or affect their bid. A bidder shall be deemed to have full knowledge of the site whether he inspects it or not and no extra cost consequent on any misunderstanding or otherwise shall be allowed. The bidders shall be responsible for arranging and maintaining at his own cost all materials, tools & plants, water, electricity access, facilities for workers and all other services required for executing the work unless otherwise specifically provided for in the contract documents. Submission of a bid by a bidder implies that he has read this notice and all other contract documents and has made himself aware of the scope and specifications of the work to be done and of conditions and rates at which stores, tools and plant, etc. will be issued to him by the Government and local conditions and other factors having a bearing on the execution of the work.

The site shall be handed over in its present existing condition, to the successful bidder for execution of the works. The existing fittings/fixtures and items to be dismantled shall be handed over to NCCS.

5.3. PRICE:

5.3.1. Bidder must ensure to quote percentage rate against Total Project Cost put to tender.

5.3.2. The rate(s) and amounts are in Indian Rupees only. The total amount should be written both in figures and in words.

5.3.3. In addition to this, while selecting the cells a warning appears that if the cell is left blank the same shall be treated as "0". Therefore, if the cell is left blank and no rate is quoted by the bidder, rate shall be treated as "0" (ZERO).

5.3.4. However, if tenderer doesn't quote any percentage above or below on the total amount of the tender in percentage rate tender, the tender shall be treated as invalid and will not be consider as lowest tenderer.

5.3.5. The rates for all tendered items shall be inclusive of GST, all taxes, duties, levies, transportation, transit insurance, cost of the materials, equipment/item, stores, freight, transit insurance, loading unloading including mathadi charges, packing & forwarding, clearance charges for imported goods, inspection/inspective certificate charges any contingency charges etc. and including all other incidental charges whichever is applicable for the equipment/item supply, erection, installation, testing and commissioning with all men, material, tools & tackles complete in all respect..

5.4. CORRECTION OF ERRORS

Tenders determined to be substantially responsive will be checked by NCCS for any arithmetic errors. Errors will be corrected by the NCCS as follows:-

(a) Where there is a discrepancy between the rates in figures and in words, the lower of the two will govern; and
(b) Where there is a discrepancy between the unit rate and the line-item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern.
(c) The amount stated in the Tender will be adjusted by the NCCS in accordance with the above procedure for the correction of errors and, with the concurrence of the bidder, shall be considered as binding upon the bidder. If the bidder does not accept the corrected amount the bid is liable to be rejected, and the earnest money deposit may be forfeited.

5.5. CLARIFICATION OF BID:

5.5.1. To assist in the examination and comparison of Bids, the NCCS, Pune may, at its discretion, ask any Bidder for clarification of his Bids. The request for clarification and the response shall be in writing or by email / fax, but no change in the price or substance of the Bid shall be sought, offered, or permitted.

5.5.2. Any effort by the Bidder to influence the NCCS's Bid evaluation, bid comparison or contract award decisions, may result in the rejection of his bid.

5.5.3. Corrigendum/amendments etc., if any, will be notified only on the NCCS web site and no separate advertisement will be made for the same. All prospective bidders are therefore advised to regularly visit the NCCS web site (**www.nccs.res.in**) for any future information or update.

5.6. BID OPENING:

On the due date as specified in tender, NCCS Pune will first open technical bid of all bids received in the presence of the bidders/ their representatives who wish to attend.

5.7. DESCRIPTION OF SELECTION PROCESS

5.7.1. Initially bidders will be shortlisted as per Prequalification (eligibility) criteria laid down in the tender document. NCCS may at any time after opening of the technical bid or presentation, depute a team of its' officials to the site / work place / office of the Bidder to get the credentials of the information furnished by the Bidder and to verify the status, workmanship & quality of the work / services rendered by them. The tender of the bidder shall be liable for rejection in case of

i. Any information furnished by the Bidder is found incorrect.
ii. The quality of the work and workmanship is found unsatisfactory

5.7.2. The Evaluation of Bids will be based on the details and information submitted by the Bidder and the Compliance and conformance of their Technical Bid to the Technical Requirements and Specifications given in the Bid Documents. It may be

noted that merely copying the Tender Specifications as compliance shall not be accepted.

5.7.3. The Bidders will be called for a Technical Presentation to demonstrate the compliance of their Bid to the Technical Requirements and Specifications given in the Bid Documents and evaluated by the Internal Technical Committee.

5.7.4. **Evaluation of Technical Proposals**:

Sr No	Description	Criteria / Mark	Max Mark
1.0	No. of years of relevant experience in turnkey project for designing, supplying, installing, commissioning, testing and validating Grade B Grade C and Grade D Cleanrooms, allied utilities, process equipment and integration of all relevant services as per cGMP standards		
	Up to 5 years	10	15
	Above 5 years	15	
2.0	**Number of Projects i.e.** Established c-GMP Compliant Facility as specified in pre-qualification criteria having Project cost equivalent to Rs.728 Lakh X Single Work OR Rs.546 Lakh X Two Work OR Rs.364 Lakh X Three Works in the last 5 years		
	One Project	12	20
	Two Projects	15	
	Three or more Projects	20	
3.0	Financial Strength of the Bidder: Average Annual Turnover in last five years ending 31st March 2023-		10
	Above Rs.455 Lakh and up to Rs. 900 Lakh	8	
	Above Rs. 900 Lakh	10	
4.0	In-house available full time key experienced Team Leader/ Specialist/ Engineer-		5
	4.1. HVAC Expert – 1 No.		
	Graduate / Diploma in Mech/HVAC engineering with min 15 year experience	3	
	4.2. Team Leader/Specialist – 1 No.		
	Graduate in Mechanical/ Electrical Engineering with min 10 year experience	2	
5.0	Ongoing Operation and Maintenance Service Contract for a GMP Facility		
	At least 1	8	10
	More than 1	10	
7.0	**Technical Presentation**		
	i. Company profile & Details of technical team & experience necessary for the execution of the proposed project	5	40
	ii. Details of completed similar turnkey projects for BSL-2 biologicals laboratories / facilities in India OR abroad that are relevant for the proposed facility set-up with relevant facility accreditation.	20	
	iii. Relevant photos & videos for the completed projects.	5	
	iv. Project Implementation Strategy to demonstrate the compliance of the submitted Bid to the Technical Requirements and Specifications for the proposed facility establishment along with the BAR/PERT chart.	10	
	Total Mark		100

(Note- The presentation will be arranged at the risk and cost of the bidder at NCCS Pune and NCCS will not pay any charges for the same)

5.8. AWARD OF CONTRACT:

The NCCS, Pune shall award the Contract to the Bidder whose evaluated offer/Bid has been found to be the technically suitable with high quality standards, financially lowest considering Life Cycle Cost (project cost and CAMC Cost for part of Equipment/ instrument) and is substantially responsive to the bidding document, provided further that the Bidder is found to be qualified to execute the contract satisfactorily. The selected Bidder shall be called for technical and financial discussion if required.

The Director, NCCS reserves the right to accept or reject any bid or all the bids at any time, without thereby incurring any liability to the affected bidder or specifying the grounds for the same. The work to be carried out under the Contract shall, except as otherwise provided in these conditions, include all labour, materials, tools, plants, equipment and transport which may be required in preparation of and for and in the full and entire execution and completion of the works. The descriptions given in the Schedule of Quantities shall, unless otherwise stated, be held to include wastage on materials, carriage and cartage, carrying and return of empties, hoisting, setting, fitting and fixing in position and all other labour necessary in and for the full and entire execution and completion of the work as aforesaid in accordance with good practice and recognized principles.

On acceptance of the tender, the name of the accredited representative(s) of the contractor who would be responsible for taking instructions from the E-I-C shall be communicated in writing to the E-I-C. The Contractor shall prepare an BAR Chart for the execution of the work showing clearly all activities with sequence from the start of the work to the completion, with detailed of manpower, materials, equipments and machinery required for the fulfillment of the programme within the stipulated period or earlier and submit the same for approval of the E-I-C, NCCS within ten days of award of the contract /issue of LOI.

6. GENERAL CONDITIONS OF CONTRACT:

6.1 PRE-BID CONFERENCE-

6.1.1. The objective of PBC is to provide a platform for clarifying issues and clearing doubts, if any, about the specification and other allied technical/commercial details of the bid document. Bids should be submitted only after the PBC so as to take care of the change made in the bidding document. Bidders are requested to send their written queries, doubts, clarifications if any well in advance on following email, minimum two days before meeting.
Email: pmtamhane@nccs.res.in

6.1.2. The Minutes of the pre-bid meeting will be uploaded on the NCCS website. All Bidders are requested to formulate their bids accordingly.

6.2 VALIDITY OF OFFER:

Bidder/s shall keep his / their offer valid for a period of at least three months (90 days) from the date of opening of the Technical Bid. If any Bidder withdraws or amends impairs or derogates from the tender in any respect within the period of validity of his offer, the EMD is liable to be forfeited.

6.3 RIGHT TO ACCEPT OR REJECT TENDER:

The Director, NCCS. reserves the right to amend or withdraw any of the terms and conditions contained in the tender document before accepting the tender or to reject any or all the tenders without giving any notice or assigning any reason. The decision of the Director, NCCS in this regard shall be final and binding on all.

The Director NCCS reserves the right to delete items, reduce or increase the scope of work without the contractor claiming any compensation for the reduction in the scope of work. Contractor has bound to carry out the reduced or increased quantity of work at the quoted rates.

6.4. ABNORMALLY HIGH RATE (AHR) & ABNORMALLY LOW RATE (ALR) ITEM:

If the bid of the successful bidder is seriously unbalanced in relation to the estimate of the cost of work to be performed under the contract, the NCCS may require the bidder to produce detailed price analysis for any or all items of the Bill of quantities of demonstrate the internal consistency of these prices with the working method and the schedule proposed.

6.5. ESCALATION:

Escalation is not applicable for this work.

6.6. PERFORMANCE BANK GUARANTEE (PBG)-

- The Successful Bidder shall submit an irrevocable Performance Bank Guarantee of **5% (Five percent) of the contract amount** for his proper performance of the contract agreement, (not withstanding and/or without prejudice to any other provisions in the contract) within period of seven days from the date of issue of

letter of Intent as per attached format of any Nationalized / Commercial/ Scheduled Bank.

- After receipt of Performance Bank Guarantee from the successful Bidder, formal work order will be issued.

- If he / she / they decline/s or fail/s to submit the PBG within the stipulated time, without prejudice to NCCS's right to rescind the contract and other rights and remedies warranted by the law.

- In the event of refusal to carry out work within fifteen days by the successful Bidder on any grounds, its Performance Bank Guarantee shall be forfeited.

- The Performance Bank Guarantee shall be valid for the entire period of contract plus sixty days. In case the time for completion of work gets enlarged, the contractor shall get the validity of PBG extended to cover such enlarged time for completion of work. The original PBG will be returned to the contractor from the date of completion on written request by contractor, without any interest.

- The Engineer-in-Charge shall not make a claim under the PBG except for amounts to which NCCS is entitled under the contract (not withstanding and/or without prejudice to any other provisions in the contract agreement) in the event of:

  i) Failure by the contractor to extend the validity of the PBG as described herein above, in which event the Engineer-in-Charge may claim the full amount of the PBG.

  ii) In the event of the contract being determined or rescinded under provision of any of the Condition of the agreement, the PBG shall stand forfeited in full and shall be absolutely at the disposal of the NCCS.

6.7. SIGNING OF THE CONTRACT:

- The successful Bidder shall be required to execute an agreement with NCCS as per the General Conditions / Special conditions enumerated in the tender documents and as per attached format, on a Non-Judicial Stamp Paper of **Rs.500/- (Rupees Five Hundred only)** within 15 days from the date of receipt of the notice of acceptance of tender. In the event of failure on the part of the successful Bidder to sign the agreement within the above stipulated period. The NCCS reserves the right to forfeit the PBG and cancel the contract.

- Until the Agreement is formally signed, the Letter of Intent/ Work Order of Tender issued to the successful Bidder and accepted by him shall be operative and binding on the NCCS and the Contractor.

- No payment for the work done will be made unless contract is signed by the Contractor.

6.8. INDEMNITY BOND:

The Contractor shall at all times hold NCCS harmless and effectively indemnified as per attached format on a Non-Judicial Stamp Paper of **Rs.500/- (Rupees Five**

Hundred only) within 15 days from the date of receipt of the notice of acceptance of tender. This clause shall survive the termination of this contract.

The Contractor shall indemnify, protect and save NCCS against all claims, losses, costs, damages, expenses, action suits and other proceedings, resulting from infringement of any patent, trademarks, copyrights etc. or such other statutory Infringements in respect of all the cold room equipments etc. supplied by him.

6.9. PAYMENT TO CONTRACTOR:

6.9.1. No advance payment will be paid against this work order.

6.9.2. Payment in maximum three RA bills, subject to each RA bill raised shall not exceed 25% each as per actual work carried out at site and such RA bills amount will be certified for payment.

Final bill amount will be certified for payment after completion of tendered work in all respect including testing, commissioning, documentation and validation.

10% Security Deposit will be deducted from each bill payable to the contractor.

6.9.3. Payments will be made online by RTGS / NEFT.

6.9.4. TDS will be deducted as per Prevailing Rules.

6.10. SECURITY DEPOSIT:

Security Deposit (10%) will be refunded after twelve months of defect liability period from the date of completion of work. In case of unsatisfactory performance by the Contractor Security Deposit will be forfeited.

6.11. PERFORMANCE BANK GUARANTEE FOR AMC/CAMC PERIOD:

Contractor should submit fresh equal CAMC/AMC amount of the irrevocable Performance Bank Guarantee for his proper performance of the contract agreement, (not withstanding and/or without prejudice to any other provisions in the contract) within period of seven days from the date of issue of work order. The Performance Bank Guarantee shall be valid for the entire CAMC/AMC period of contract plus sixty days.

The original PBG will be returned to the contractor from the date of completion of CAMC/AMC period plus sixty days on written request by contractor, without any interest.

6.12. DISCIPLINE:

Contractor shall carry out the works hereunder with due diligence and in a safe and workman like manner according to good Contractor's employees and shall abide by and conform to all rules and regulations promulgated by the NCCS governing the operations.

6.13. SAFETY CODE:

The Contractor shall take adequate precautions to ensure that the tendered works not at all affects the working of the NCCS. He shall take adequate measures to barricade the work sites so that unauthorized persons do not enter the work site. All the safety codes and the preventive measures for this type of work shall be strictly followed. All the personnel and staff shall be under the Contractor's authority and it shall be the responsibility of the Contractor for all insurance, accident claims etc. at the site. The Contractor shall strictly abide by the labour laws in force from time to time and comply with the same and will co-ordinate directly with the concerned authorities. Contractor should follow CPWD safety code norms and IE norms applicable for this work at his own risk and cost.

6.14. QUALITY OF WORK:

The quality of work at all stages should be as per the standards laid down, as per NIT and explained to the Contractor by NCCS., Pune. It is made clear that there cannot be any compromise in the material quality and workmanship of work. It shall be the responsibility of the Contractor to ensure that the standards laid down from time to time are strictly maintained. Contractor should use approved brands of materials only and get approved sample of each material from Engineer in charge before use. In case of any deviation from the approved design, specifications, makes, model or inferior workmanship, the Contractor should replace at his own cost without impacting the timelines.

6.15. DATE OF COMPLETION:

- Time is the essence of the Contract.
- The entire work shall be completed within six month (180 days) in all respects including validation.
- In order to complete the work on top priority within the time limit, the contractor has permitted to work from day and night including all holidays.

6.16. DEFECT LIABILITY PERIOD:

The Defect Liability Period (Period of Maintenance) for the work is twelve month from the date of the completion of work. During the period of maintenance, the contractor will be responsible for rectifying any defects in working caused due to bad workmanship and poor quality of materials etc. This will be rectified by the contractor at his own expenses otherwise SD (10%) will be forfeited.

6.17. COMPENSATION FOR DELAY:

If the contractor fails to maintain the required progress or to complete the work and clear the site on or before the contract or extended date of completion, he shall, without prejudice to any other right or remedy available under the law to the NCCS on account of such breach, pay as agreed compensation the amount calculated at the rates stipulated below as the Engineer in Charge of NCCS (whose decision in writing shall be final and binding) may decide on the amount of tendered value of the work for every completed day/month (as applicable) that the progress remains below that specified in Clause- Time and Extension for Delay or that the work remains incomplete.

Compensation for delay of work @ 1 % per month of delay to be computed on per day basis provided always that the total amount of compensation for delay to be paid under this Condition shall not exceed 10% of the contract value of work. The amount of compensation may be adjusted or set-off against any sum payable to the Contractor under this contract with the NCCS or the security deposit will be forfeited.

6.18. WHEN CONTRACT CAN BE DETERMINED:

Subject to other provisions contained in this clause, the Engineer-in-Charge may, without prejudice to his any other rights or remedy against the contractor in respect of any delay, inferior workmanship, any claims for damages and/or any other provisions of this contract or otherwise, and whether the date of completion has or has not elapsed, by notice in writing absolutely determine the contract in any of the cases as mentioned or elaborated General condition of Contract, reference shall be made to CPWD Manual or Amended upto date .

6.19. TIME AND EXTENSION FOR DELAY:

The time allowed for execution of the Works as specified in the NIT or the extended time in accordance with these conditions shall be the essence of the Contract. The execution of the works shall commence from such time period as mentioned in NIT or from the date of handing over of the site whichever is later. If the Contractor commits default in commencing the execution of the work as aforesaid, Director NCCS shall without prejudice to any other right or remedy available in law, be at liberty to forfeit the earnest money & performance guarantee absolutely.

As soon as possible after the Contract is concluded, the Contractor shall submit a Time and Progress Chart for each mile stone and get it approved by the Engineer-in Charge. The Chart shall be prepared in direct relation to the time stated in the Contract documents for completion of the works. It shall indicate the forecast of the dates of commencement and completion of various trades of sections of the work and may be amended as necessary by agreement between the Engineer-in-Charge and the Contractor within the limitations of time imposed in the Contract documents, and further to ensure good progress during the execution of the work, the contractor shall in all cases in which the time allowed for any work, exceeds the time period to complete the work as per mile stones given in NIT.

6.19.1. IF THE WORK(S) BE DELAYED BY:-

- force majeure, or
- abnormally bad weather, or
- serious loss or damage by fire, or
- civil commotion, local commotion of workmen, strike or lockout, affecting any of the trades employed on the work, or
- delay on the part of other contractors or tradesmen engaged by Engineer-in-Charge in executing work not forming part of the Contract, or
- Any other cause which, in the absolute discretion of the Engineer-in-Charge is beyond the Contractor's control.

Then upon the happening of any such event causing delay, the Contractor shall immediately give notice thereof in writing to the Engineer-in Charge but shall nevertheless use constantly his best endeavors to prevent or make good the delay and shall do all that may be reasonably required to the satisfaction of the Engineer-in-Charge to proceed with the works.

6.19.2. Request for rescheduling of Milestones and extension of time, to be eligible for consideration, shall be made by the Contractor in writing of the happening of the event causing delay on the prescribed form to the Engineer-in Charge. The Contractor may also, if practicable, indicate in such a request the period for which extension is desired.

6.19.3. In any such case the Engineer-in Charge may give a fair and reasonable extension of time and reschedule the milestones for completion of work. Such extension shall be communicated to the Contractor by the Engineer-in Charge in writing after receipt of such written request. Non application by the contractor for extension of time shall not be a bar for giving a fair and reasonable extension by the Engineer-in Charge and this shall be binding on the contractor.

6.20. MEASUREMENTS OF WORK DONE:

All measurements shall be taken jointly by the Engineer-in-Charge/ Consultant or his authorized representative and by the contractor or his authorized representative after completion of the work and such measurements shall be signed and dated by the Engineer-in-Charge and the contractor or their representatives in token of their acceptance. The contractor shall submit all the bills in the shape of the computerized MB in pages of A4 size as per the standard format as instructed by EIC and shall act as per clause 6 of CPWD GCC.

6.21. CONTRACTOR TO KEEP SITE CLEAN:

On completion of the work, all rubbish materials related to contract works shall be removed by the contractor(s) at his/their own expenses and the site cleaned and handed over to the NCCS and shall intimate officially of having completed work as per contract.

If it is noticed that the Contractor does not clean the place of work, then NCCS. Pune reserves the right to get the area cleaned and unilaterally debit the cost of cleaning to the Contractor or deduct the cost incurred, from the Contract amount as deemed fit.

6.22. DISMANTLED MATERIAL NCCS PROPERTY:

The contractor shall treat all materials obtained during dismantling of a structure, excavation of the site for a work, etc. as NCCS property and such materials shall be handed over to NCCS after completion of work.

6.23. INCONVENIENCE TO NCCS ACTIVITIES:

The Contractor shall not deposit materials on any site which will seriously inconvenience to any of the NCCS activities. The Engineer in charge may instruct

the Contractor to remove such materials which are considered by him to him by the dangerous or inconvenient to the activities of the NCCS.

6.24. WORK TO BE EXECUTED IN ACCORDANCE WITH SPECIFICATIONS, DRAWINGS AND ORDERS ETC:

The contractor shall execute the whole and every part of the work in the most substantial and workmanlike manner both as regards materials and otherwise in every respect in strict accordance with the specifications. The contractor shall also conform exactly, fully and faithfully to the design, drawings and instructions in writing in respect of the work signed by the Engineer-in-Charge and the contractor shall be furnished free of charge copy of the contract documents together with specifications, designs, drawings and instructions as are NIT.

The contractor shall comply with the provisions of the contract and with the care and diligence execute and maintain the works and provide all labour and materials, tools and plants including for measurements and supervision of all works and other things of temporary or permanent nature required for such execution and maintenance in so far as the necessity for providing these, is specified or is reasonably inferred from the contract. The Contractor shall take full responsibility for adequacy, suitability and safety of all the works and methods for execution of the works.

6.25. DEVIATION / VARIATION – EXTENT & PRICING:

The Engineer-in-Charge shall have power to make any alterations in, omissions from, additions to or substitutions for, the original specifications, drawings, designs and instructions that may appear to him to be necessary during the progress of the work and the contractor shall carry out the work in accordance with any instructions which may be given to him in writing signed by the Engineer-in-Charge, and such alterations, omissions, additions or substitutions shall not invalidate the contract and any altered, additional or, substituted work which the contractor may be directed to do in the manner above specified as part of the work shall be carried out by the contractor on the same conditions in all respects on which he agreed to do the main work. The time for the completion of the work shall be extended in the proportion that the altered, additional or substituted work bears to the original contract work, and the certificate of the Engineer-in-Charge shall be conclusive as to such proportion. Over and above this, a further period to the extension shall be allowed to the contractor. The rates for such additional, altered or substituted work under this clause shall be worked out in accordance to the prevailing market rate analysis.

6.19. It shall be the responsibility of the Contractor to meet transportation, food, medical and any other requirements in respect of the workers engaged by him at NCCS. Pune and NCCS. shall have no liabilities in this regard.

6.20. The NCCS. will not be responsible for any damages, losses, theft, claims, financial or other injury to any workers deployed by service providing Bidder in the course of their performing the functions / duties, or for payment towards any compensation.

6.21. <u>For elaboration of any items of the General condition of Contract, reference shall be made to CPWD Manual or Amended upto date. The Contractor shall in advance seek clarification on any elaboration</u>.

7. SPECIAL CONDITIONS OF CONTRACT:

7.1. For Technical data and specifications if in doubt / unclear / mismatch, the same are to be clarified with the Engineer in Charge.

7.2. The bills of quantities indicated in this tender are approximate and are liable to change at the discretion of the NCCS. Any variation in quantities will not be applicable for change/modification in quoted rates.

7.3. The nomenclature of the item given in the schedule of quantities gives in general the work content but is not exhaustive i.e. does not mention all the incidental works required to be carried out for complete execution of the item of work. The work shall be carried out , all in accordance with true intent and meaning of the specifications and the drawings taken together, regardless of whether the same may or may not be particularly shown on the drawings and / or described in the specifications, provided that the same can be reasonably inferred there from. There may be several incidental works, which are not mentioned in the nomenclature of each item but will be necessary to complete the item in all respect. All these incidental works / costs which are not mentioned in item nomenclature but are necessary to complete the item shall be deemed to have been included in the rates quoted by the contractor for various items in the schedule of quantities. No adjustment of rates shall be made for any variation in quantum of incidental works due to variation / change in actual working drawings. Also, no adjustment of rates shall be made due to any change in incidental works or any other deviation in such element of work (which is incidental to the items of work and are necessary to complete such items in all respects) on account of the directions of Engineer-in-Charge. Nothing extra shall be payable on this account.

7.4. Unless otherwise provided in the Schedule of Quantities, the rates quoted by the Contractor shall be inclusive of carrying out the works at and / or upto all heights, lifts, leads and depths. The contractor shall make all arrangements for the same. Nothing extra shall be payable on this account.

7.5. All ancillary and incidental facilities required for execution of work like labour camp, stores, fabrication yard, offices for Contractor, watch and ward, temporary ramp, temporary structure for plants and machineries, installation and temporary electricity supply, telephone, water etc. if required for execution of the work, etc., protection works, barricading, testing facilities / laboratory at site of work, facilities for all field tests and for taking samples etc. during execution or any other activity which is necessary (for execution of work and as directed by Engineer-in-Charge), shall be deemed to be included in rates quoted by the Contractor, for various items in the schedule of quantities. Nothing extra shall be payable on these accounts.

7.6. PROCEDURE FOR APPROVAL OF MATERIALS, SHOP FLOOR DRAWINGS AND COMMENCEMENT OF WORK

Within prescribed time period as per the mile stone the contractor shall visit the site and submit following documents for approval

1. List of makes & Model numbers of all items of equipment and accessories.
2. Catalogues of the equipment to be supplied along with design details, technical specification, safety certifications etc. as required for each product.

3. Shop floor drawings of each package shall be submitted separately for approval. It is the responsibility of the tenderer to get the makes, models and shop floor drawings approved by the department. The makes and models offered should be as per the specification and BOQ of the NIT. The decision of Engineer-in –charge is final in this regard. The materials can be brought to site only after the due approval of drawings, makes, models from the department.

7.7. The Contractor shall be responsible for the due and proper execution of all the works as per the terms and conditions. The contracting agency should study the design details and understand clearly, prior to quoting. The responsibility of performance shall be with the Contractor.

7.8. The debris arisen during the period of work of execution will have to be cleared then and there to keep the site / surroundings clean and tidy. Such debris shall be cleared at Contractors risk and cost.

7.9. The contractor should use additional supports, scaffoldings, materials, accessories, equipments, crane for lifting & shifting loading & unloading, hardware, labour, insurance etc. for proper execution of the work and performance of the work. No additional cost will be paid for this.

7.10. The NCCS reserve the right to call explanations and rate analysis from any bidder, regarding the calculations / clarifications on any details. They may also visit the office of the bidder / various works carried out by him. The necessary co-operation in this regard is envisaged form the bidder.

7.11. The NCCS or their representatives shall have access to the workshop /Manufacturing facilities of the bidder and or successful contractor so as to assure themselves of the quality of the material and workmanship.

7.12. The Bidder should have adequate technical, quality control and quality assurance staff for the contract. Designation, Name of the Person and Total Years of relevant Experience in the current firm should be provided for the following posts:

Head - Execution,
Head Design – Technical,
Project manager – Technical,
Manager – Quality & Planning,
Project Engineers – Execution,
Safety Engineer,
Site Supervisor and Technicians,
Validation Engineers,
Documentation Engineer and Service Engineer.

7.13. The Contractor shall depute Site Engineers & skilled workers as required for the work. He shall submit organization chart along with details of Engineers and supervisory staff. It shall be ensured that all decision-making powers shall be available to the representatives of the Contractor at site itself to avoid any likely delays on this account. The Contractor shall also furnish list of persons for specialized works to be executed for various items of work. The Contractor shall identify and deploy key persons having qualifications and experience in the similar and other major works, as per the field of their expertise. If during the course of

execution of work, the Engineer-in-Charge is of the opinion that the deployed staff is not sufficient or not well experienced; the Contractor shall deploy more staff or better-experienced staff at site to complete the work with quality and in stipulated time limit.

7.14. The main Contractor has to associate approved specialized agencies for the Civil, strengthening, E&M components etc, as listed in tender documents

The contractor shall ensure that the all the specialized agencies under him shall fulfill all the conditions of previous clause (Supervision of work) for the entire period of the contract.

7.15. Necessary protective and safety equipment shall be provided to the Site Engineer, workers & Supervisory staff by the Contractor at his own cost for use at site.

7.16. The contractor shall execute the whole and every part of the work in the most sound and substantial and workmanlike manner, and in strict accordance with the specifications both as regards materials and workmanship. The contractor shall also conform exactly, fully and faithfully to the designs, drawings and instructions in writing relating to the work signed by the NCCS / Consultant.

7.17. In case of conflict in specifications or terms, between tender, general engineering practice, National and International Codes, more stringent among all will be applicable.

The order of preference in case of any discrepancy as indicated to be read as following:

a) Nomenclature of item as per Bill of Quantities.
b) Additional specifications, particular specifications & special conditions.
c) General Conditions.
d) Tender drawings and specifications mentioned in drawings.
e) Tender specifications.
f) Indian Standard specifications of BIS.
g) Sound engineering practice as per directions of NCCS / Consultant.
h) Manufactures specifications.

A reference made to any Indian Standard specifications in these documents reference to the latest version of that standard, including such revisions /amendments as issued by Bureau of Indian standards up to last date of receipt of tender. The contractor shall keep at his own cost all such publications of relevant Indian Standards applicable to the work at site.

7.18. The NCCS shall have a right to increase or delete any item of work from the scope of contract and contractor shall not make any extra claim on this account.

7.19. The time for supply of items is very important factor to the NCCS. Only those Tenderers, who are confident and willing to supply the requested items to NCCS within the prescribed time period after the receiving of confirm work order from NCCS are requested to participate in this Tender.

7.20. The submission of tender shall be deemed to be an admission on the part of the bidder that it has fully acquainted with the contract terms and no claim other than what stated in the tender shall be paid in the event of award of Contract.

7.21. For elaboration of any items of the General condition of Contract, reference shall be made to CPWD Manual amended upto date. The Contractor shall in advance seek clarification on any elaboration.

7.22. The successful tenderer is responsible to provide the required manpower with qualified persons to meet the requirements of the maintenance of the installation during the guarantee period or AMC. The contractor shall provide any materials required. Tools required for the maintenance shall be arranged by the contractor.

7.23. The staff to be engaged on this work shall have full knowledge and experience of the work in which they are engaged. The electrician shall have valid licenses for corresponding trades.

7.24. No subletting or subcontracting of the work will be permitted.

7.25. The contractor shall not assign the contract or any part thereof without the written consent of the NCCS / Consultant. The whole of the works included in the contract shall be executed by the contractor except where otherwise provided in the contract and he shall be responsible for the acts, defaults and neglects of sub-contractor.

7.26. SPECIALISED WORK

Specialized works for structural strengthening mentioned under clause no. 8.0 of NIT should be got executed only through agencies specialized in the field and the contractor shall be required to submit the details of such agencies to the NCCS / Consultant and obtain necessary approval.

The specialized agency should have an experience of minimum five years in its area of specialization. The specialized agency should have successfully completed:

1. One work of similar nature having a magnitude equal to at least 80% of the value of the specialized work provided in the tender **or**
2. Two works of similar nature having a magnitude equal to at least 60% of the value of the specialized work provided in the tender **or**
3. Three works of similar nature having a magnitude equal to at least 40% of the value of the specialized work provided in the tender.

The contractor shall submit the following details of the specialized agency along with the technical bid:

a. Proof of the agency in operation since last five years.
b. List of works carried out by the agency in last five years along with the name of work, name and address of clients, year of execution, value of work done and brief specification of the work.
c. In each of the above case, documentary evidence in the form of Work Order/Purchase order indicating the nature and value of along with reference/contact person & address, telephone/ Email details should be submitted for verification. The Completion Certificate of the job issued by the respective client is necessary.

7.27. SAFETY, HEALTH AND ENVIRONMENT

i. The Contractor(s) shall take all precautions to avoid accidents by exhibiting necessary caution boards. He shall be responsible for all damage and accidents caused to existing/new work due to negligence on his part. In case of any accident of labour / contractual staff the entire responsibility will rest on the contractor and any compensation under such circumstances if becomes payable shall be entirely borne by the contractor.

ii. Appropriate personnel protective equipments such as helmets, gloves, googles, aprons, safety belts etc. shall be provided to the workers employed at the work site.

iii. All hazardous materials shall be labeled with the name of the materials, the hazards associated with its use and necessary precaution to be taken.

iv. Contractor shall ensure that during the performance of the work, all hazard to the health of personnel, have been identified, assessed and eliminated.

v. The contractor has to keep a record of all the workers employed at site, mark daily attendance along with the location of the work. All the labour record shall be made available for inspection and verification as and when required.

7.28. QUALITY ASSURANCE:

i. The contractor shall establish, document and maintain an effective quality assurance system as outlined in the specifications and various codes and standards.
ii. The bidder shall understand scope of the work, drawing, specifications and standards etc. attached with the tender or to be followed and shall seek clarification, if any before submission of the tender
iii. The quality assurance system plans / procedures / method statement to be followed shall be furnished in the form of quality assurance manual. It should cover quality assurance, plan procedure, specifications, frequency of the inspection, testing, acceptance criteria, method of sampling, testing etc. to be followed for quality.
iv. The approval of quality assurance does not absolve the contractor of the contractual obligations towards executing the work as laid down in the specification of the work.
v. The contractor shall produce quality control records in the formats approved by Engineer-in-charge / Consultant in the quality assurance plan.
vi. The contractor shall ensure the enforcement of quality assurance plan by all his specialized agencies as approved. The NCCS reserves the right to inspect, witness, review any stage of the work at shop / site as deemed necessary for quality assurance and / or timely completion of work.
vii. The contractor shall procure required materials in advance so that there is sufficient time for testing of the materials and clearance of the same before use in the work. The contractor shall provide at his own cost suitable measuring arrangements at site for checking the dimensions as may be necessary for execution of work.

7.29. TESTING OF MATERIALS

All the required tests as per Technical Specification should be conducted at the cost of the contractor, unless specifically mentioned otherwise. All materials which are to be tested at the manufacturer's works shall satisfactorily pass the tests in the presence of the authorized representative of NCCS / Consultant before being used in the work. In case all requisite testing facilities are not available at the manufacturer's premises, such testing shall be conducted at the approved laboratory. The charges for such testing shall be borne by the contractor.

The contractor shall arrange carrying out all relevant field tests mentioned in the list of mandatory tests given in CPWD Specifications 2019 Vol. 1 & 2 through the laboratory as approved by the Engineer-in-Charge and shall bear all charges in connection therewith including charges for testing for all materials. Nothing extra shall be payable to him on this account.

Tests registers for tests to be carried out at construction site or in outside laboratories shall be maintained by the contractor.

7.30. WARRANTIES AND GUARANTEES:

The following Warranty will form part of the contract placed on the successful Bidder: -

a) Except as otherwise provided, the Contractor hereby declares that the services, stores articles sold / supplied to NCCS. under this contract shall be of the best quality and workmanship and new in all respects and shall be strictly in accordance with the specification and particulars contained/mentioned in contract. The Contractor hereby ensures Guarantee that the said service/goods would continue to conform to the description and quality aforesaid for a period of 12 months from the date of handing over of the said services/goods to the NCCS., if during the aforesaid period of 12 months the said services/stores be discovered not to conform to the description and quality aforesaid not giving satisfactory performance or have deteriorated, and the decision of the NCCS. in that behalf, shall be final and binding on the CONTRACTOR and the NCCS. shall be entitled to call upon the CONTRACTOR to rectify the services/stores or such portion thereof as is found to be defective by the NCCS. within 12 months, or such specified period as may be allowed by the NCCS. in his discretion on application made thereof by the CONTRACTOR, and in such an event, the above period shall apply to the services/stores rectified from the date of rectification mentioned in warranty thereof, otherwise the Contractor shall pay to the NCCS. such compensation as may arise by reason of the breach of the warranty therein contained.
b) NCCS. reserves the right to declare any defect/short comings as critical to the extent that Contractor will replace the item rather than rectifying.

7.31. MATERIALS AND WORKMANSHIP

Unless some special Warranty/Guarantee clause has been stipulated elsewhere in the invitation to the tender or any it's annexure, the following warranty shall form part of the contract placed on successful tender: -

a) Contractor shall fully warrant that all the equipment and components supplied under the order shall be new and of first quality according to the specifications and shall be free from defects (even concealed fault, deficiency in design, materials and workmanship).

b) Should any defects be noticed in design, material and/or workmanship within 15 months from the date of shipment/dispatch of last consignment or 12 months from the date of commissioning and handing over of the equipment whichever is later, NCCS shall inform Contractor and Contractor shall immediately on receipt of such intimation, depute their personnel as soon as practicable but use reasonable efforts to commence such work in no event later than 7 days to investigate the causes of defects and arrange rectification /replacement/modification of the defective equipment at site without any cost to NCCS. within a reasonable period. If the Contractor fails to take proper corrective action to repair/replace the defects satisfactorily within a reasonable period, this Organisation shall be free to take such corrective action as may be deemed necessary at Contractor risk and cost after giving notice to the Contractor.

c) If in an emergency warranty service situation exists, the Contractor and NCCS. determines On-site Technical assistance is necessary, the Contractor shall dispatch emergency service personnel to the site to attend to the problem and rectify the defect as promptly as practicable. The Contractor shall maintain a Technical assistance centre and shall have technical support available to NCCS. in accordance with the requirement.

d) If the Contractor subcontracts any part of the system or any of the services to a Third party the Contractor is still liable for the Warranty /guarantee of the equipment/services so subcontracted as per the above clauses.

e) Damage to the machinery and/or equipment due to incomplete and erroneous instructions issued by Contractor will be responsibility of the Contractor and will be treated according to the provisions of Warranty clause. Normal wear and tear shall not come under purview of this clause.

f) In case defects are of such nature that equipment shall have to be taken to Contractor works for rectification etc. Contractor shall take the equipment at his cost after giving necessary undertaking or security as may be required by NCCS.

g) Equipment or spare parts thereof replaced shall have further warranty for a period of 12 months from the date of putting into beneficial use.

h) The Contractor shall guarantee that they will supply spare parts if and when required on agreed price. The agreed price should include but without any limitation to agreed discount on the published catalogue price or on agreed percentage or profit on the landed cost.

i) The Contractor will Warranty that before going out of production for any of spare parts, they will give adequate advance notice to the purchaser so that the latter may undertake to procure, if necessary, the balance of the life time requirements.

j) If the repairs, replacement or modification referred are of such nature as may affect the efficiency of the equipment NCCS. shall have the right to give to the Contractor within one month of such replacement/renewal notice in writing to carry out test as may be required for acceptance of the equipment.

k) If the Contractor fails to honour his obligation to repair or replace defective goods/services within a reasonable period of time, or if Contractor refuses to carry out work under the guarantee clause and implied guarantee condition, if danger is anticipated or in case of severe urgency, NCCS shall be entitled to

carry out, at Contractor cost and risk, repair work or replacement deliveries or have it done by a third party. In case not all goods /services have been delivered by supplier, this Organisation is entitled to procure the remaining goods/services at Contractor cost and risk. This does not relieve Contractor of any of his guarantee obligations. Taxes and duties of any kind whatever imposed by the authorities of the country of the Contractor or his sub-Contractors until delivery shall be borne by Contractor.

7.32. PERFORMANCE GUARANTEE:

Contractor shall guarantee that the performance of the EQUIPMENT/MATERIAL supplied under the order shall be strictly in conformity with specification and shall perform the duties specified under the ORDER.

The Contractor shall guarantee that the materials/equipment that shall be purchased from the sub-Contractor(s) shall be such as to fulfil the requirements laid down above and shall undertake to ensure fulfilment of these requirements.

7.33. REJECTION

If the NCCS finds that the goods supplied are not in accordance with the specification and other condition stated in the order or its sample(s) are received in damaged conditions (of which matters NCCS will be the sole judge), NCCS shall be entitled to reject the whole of the goods or the part, as the case may be and intimate to the Contractor the rejection without prejudice to other rights and remedies to recover from the Contractor any loss which it may be put to, also reserving the right to forfeit the security deposit/performance bond if any made for the due fulfilment of the contract. The goods shall be removed by the Contractor and if not removed within 7 days of the date of communication of the rejection NCCS will be entitled to dispose-off the same on account and at the risk of the Contractor and after recovering the storage charges at the rate of 5% of the value of goods of each month or part of month and loss and expense if any caused to NCCS and pay balance to the Contractor.

7.34. INSPECTION/TESTING OF MATERIAL

The inspection of stores/services/works will be carried out by the authority specified in the purchase order. The stores/works will be accepted only after the same has been found satisfactory after inspections and duly marked and sealed by the inspection authority.

The Contractor shall ensure that the stores/services/works to be delivered against this order shall be individually inspected, tested and analyzed in terms of the specifications attached to the tender and the relevant codes and practices specified therein by expression or implication. Necessary test reports shall be provided as required.

The Contractor should make available to NCCS and any other individual/ agency authorised by them for the purpose of inspection all its record and results in respect of inspection, test and analysis conducted by it as part of their manufacturing and testing operation under the applicable codes and practices specified by expression or implication in the tender.

Inspection tests and analysis shall be carried out/conducted at the Contractor works by the authorised representative of NCCS and the cost of such inspection tests and analysis including the cost of to and fro fare and accommodation and cash allowances payable shall be borne by NCCS.

The Contractor shall provide and deliver free of charge for tests/analysis by an independent authority at any such place or places as NCCS or its authorised inspector may reasonably require, such raw material(s) used or intended to be used for the contracted work by the Contractor as the Organisation/Inspector shall consider necessary. The cost of such tests/analysis shall be borne by the Contractor.

NCCS shall be entitled at all times, whether prior to, during or after the completion or inspection by itself and/or through inspectors appointed by the Organisation at the Organisation's cost, to inspect, test and/or analyse and/or to direct the Contractor in all respect of any store(s) or materials processes used or proposed to be used in the fabrication of the product of any of them. The said inspection, tests and analysis as far as required, is to be conducted in the presence of the inspectors. The Contractor shall ensure that the inspecting personnel referred to above are given free access to all the required places and information connected with their work, besides working facilities to carry out their function.

Should the Contractor fail to comply with any of the provisions aforesaid relating to inspection, testing and analysis, NCCS shall be entitled by itself and/or through inspectors to conduct or have conducted the inspection, test and/or analysis at the risk and expense of the Contractor in all respects.

For false calls for the cases where material is rejected on inspection, the Contractor will bear the actual cost of inspection incurred/suffered by the Organisation.

No rejected raw materials shall be used for the contracted work or re-tendered for inspection and/or test except with the prior permission of concerned Inspectors.

Unless otherwise specifically authorized by NCCS in writing, the Contractor shall not ship or dispatch for shipment under the contract entered into, any material which has not been properly inspected/tested marked and in respect of which a certificate of quality has not been issued or signed by the inspectors.

In addition to the general conditions of the inspection stated above, the Contractor shall also satisfy all the specific conditions of inspection as enumerated in the specification attached.

7.35. SUB-STANDARD MATERIAL/REPLACEMENT OF REJECTED GOODS

If the NCCS finds that STORES/MATERIAL supplied/SITC/SETC executed are not of the correct quality or not according to specification required or otherwise not satisfactory owing to any reason of which the Organisation will be the sole judge, the Organisation will be entitled to reject materials/works, cancel the contract and buy its requirement of the Stores/SITC/SETC in the open market at the risk and cost of Contractor, reserving always to itself.

The right to forfeit the security deposit/performance bonds placed by the supplier for the due fulfillment of the contract.

Rejected goods should be removed and replaced within 14 days of the date of communication of rejection.

In case this tender document does not contain a provision or terms for dealing with a situation that may arise during the execution of the works, the relevant provisions contained in the CPWD manual amended upto date or any other laws/rules shall be followed in such cases and the same will be binding on the Contractor.

7.36. The contractor should arrange the power supply at his own cost if required. The contractor shall be given water free of cost at one point. The contractor has to make his own arrangement for taking it up to using place at his own expense. The contractor shall make further arrangements at his own cost, ensuring safety of instruments and persons at all time.

7.37. It shall be the responsibility of the Contractor to meet transportation, food, medical and any other requirements in respect of the workers engaged by him at NCCS Pune and NCCS shall have no liabilities in this regard.

7.38. The NCCS will not be responsible for any damages, losses, theft, claims, financial or other injury to any workers deployed by the service providing Bidder in the course of their performing the functions / duties, or for payment towards any compensation.

7.39. The Contractor should have the requisite license for running their own establishment from authorities such as Local Authority, State / Central Departments etc., at its' own cost. The NCCS. shall not be responsible in any way for any breach of these rules and regulations by the Contractor.

7.40. The Contractor shall comply with all the statutory requirement in respect of engaging the personnel, their service condition, rules and regulation and all liabilities under the various labour law and other statutory obligations like PF, ESIC, Bonus, workmen's compensation, gratuity and also comply with the provisions of Minimum Wages Act, Payment of Wages Act etc. shall be that of the Contractor, and NCCS., Pune shall in no way be responsible or liable in case of any dispute, prosecution or awards made by court of law or other authorities.

7.41. **RESOLUTION OF DISPUTES** :

Any dispute arising out of this contract including any clarification as to the intent or interpretation of any of the provisions of these terms and conditions, the same shall be first referred to /sought from the Director, NCCS, whose decision in the matters shall be final and binding on the Contractor. Any other matter relevant to but not covered in the contract shall also be decided by making reference to the Director, NCCS whose decision will be final and binding on the Contractor.

If the dispute is not resolved through the reference made to the Director, NCCS, a reference of the same shall be made to an Arbitrator to be appointed by the Director NCCS Pune for adjudication of the same in accordance with the provisions of Arbitration & Conciliation Act-1996 and any statutory modification there under from time to time. There shall be no objection if the Arbitrator to be appointed is a Competent Officer of NCCS in the discretion of the Director NCCS Pune.

LEGAL JURISDICTION: If any dispute is not resolved by Arbitration will be referred to the Court of Pune Jurisdiction only.

7.42. CERTIFICATE OF COMPLETION OF WORKS:

The Contractor shall report in writing to the Engineer in charge/ Consultant, as and when the works are completed in all respects. The Engineer in charge shall after the joint verification and measurement of the works with the Contractor/ Consultant. The defect liability period shall commence only from the date of final bill.

8.0. SCOPE OF WORK & TECHNICAL DETAILS:

National Centre for Cell Science (NCCS) is a premier autonomous research institute, under the Department of Biotechnology, Govt. of India located at Savitribai Phule Pune University Campus, Ganeshkhind, Pune 411007. Under the aegis of the National Biopharma Mission, NCCS has be entrusted with responsibility to establish a state-of-the-art National cGMP-compliant mammalian cell line repository in the existing building of NCCS at Jidnyasa, near Vanaz Engineers Ltd., S.No. 85/2, Paud Road, Kothrud, Pune – 411038.

The plot area of the site is approximately 14500 Sq. Ft. The existing building consists of a basement + 3 floors with a total built up area of approximately 9000 Sq. Ft. The approximate area available on average per floor is 2500 Sq. Ft. The building is a complete empty shell with no activities presently. The proposed repository would be required to be established in par with international cell repositories using global benchmarks, stringent quality control parameters in GMP as per national (DGCI-CDSCO-India) and International (FDA-US & EMA-EU) regulatory requirements along with compliance with Environmental norms.

For the purpose of understanding the scope of work, it is clarified that the broad scope of services under this contract shall be Supply, Installation, Testing, Commissioning, Qualification and Validation on Turnkey Basis.

The Proposed Turnkey Tender involves the following works.

PART 1 - CIVIL WORKS
PART 2 - ELECTRICAL LT WORKS
PART 3 - HVAC WORKS
PART 4 - VRF WORKS
PART 5 - SCRUBBER WORKS
PART 6 - BMS & EMS WORKS
PART 7 - ELV WORKS
PART 8 - NETWORKING WORKS
PART 9 - CLEAN ROOM PANEL WORKS
PART 10 - LAB FURNITURE WORKS
PART 11 - COLD ROOM WORKS
PART 12 - UTILITY PIPING & ETP DRAIN WORKS
PART 13 - FIRE PROTECTION SYSTEM

PART 1 – Civil Part of turnkey tender includes the following works.

- Structural strengthening works for existing civil building.
- Construction of new lift shaft and Air Compressor foundation.
- Vinyl Flooring works.
- Dismantling, retrofit works & finishing for main building for present requirement.
- Pre-fabricated security POTA cabin.
- Existing underground water tank restoration & existing 2nd floor toilet restoration.
- Structural drawings for Lift Shaft, MS Shed, MS Staircase and Strengthening work should be vet through COEP, Pune before start of the work, submission of report etc.

PART 2 – Electrical Part of turnkey tender includes the following works.

- Design Electrical panels like PCC panel, APFC panel, MVP, MCC panels, Main
- Lighting panel and Main UPS panel.
- Selection and specification of the UPS for Lab equipment, Office, Server and Emergency lighting.
- Design of the Lighting and Power distribution system.
- Design of the Earthing System.
- Design of the Lightning protection system.

PART 3 – HVAC Part of turnkey tender includes the following works.

- Design of Air Conditioning system for proposed Facility.
- Preparation of Area Classification Zoning Layout.
- Preparation of AHU Zoning Layout.
- Preparation of Pressure Gradient Zoning Layout.
- Calculation of Heat Loads.
- Preparation of HVAC Room Data Sheet (RDS).
- Preparation of HVAC Equipment Schedule Sheet.
- Preparation of Air Flow Diagrams.
- Preparation of AHU positioning layout.
- Preparation of Supply air Terminals, Grille & Return air Raiser positioning layout.

PART 4 – VRF Part of turnkey tender includes the following works.

- Design of VRF system for proposed HVAC system.
- Design of Cooling system for proposed AHU.
- Design of Heating system for proposed AHU.
- Selection of VRF Outdoor unit.
- Preparation of VRF Schematic drawing for AHU.
- Preparation of VRF Schematic drawing for Cassette & Hi wall unit.
- Preparation of VRF drawings (VRF location, Refrigerant piping drawing & control flow drawing).

PART 5 – Scrubber Exhaust Part of turnkey tender includes the following works.

- Design of Scrubber Exhaust system for proposed system.
- Selection of Dry Scrubber Unit.
- Selection of Exhaust Blower.
- Preparation of Scrubber & Exhaust blower positioning layout.

PART 6 – EMS & BMS Part of turnkey tender includes the following works.

- Design of Building Management system (BMS).
- Design of Environmental Management system (EMS).
- Preparation of schematic drawings.
- Preparation of Monitoring and Controlling schedules.
- Desing of control logic.
- Typical operation of sequence for AHU’s.

PART 7– ELV Works Part of turnkey tender includes the following works.

- Intelligent Addressable Fire alarm panel- Alarm and Detection as per NFPA-72.
- HID card reader-based type Access Control system.
- Standalone Door interlocking system with No touch (Contactless) switch.
- IP based Closed Circuit Surveillance system.
- Standalone type Gas detection System

PART 8– Networking Part of turnkey tender includes the following works.

- Scope shall include both Active & Passive part.
- Cabling works from end user points to floor Hub rack.
- Cabling works from Hub rack to server rack and also from server to Internet service provider (ISP).
- Design and Specifications of Passive rack, patch panels, port switch, face plate, power outlet etc.
- Design and Specifications of Split AC for Server/HUB rack (split AC shall be part of HVAC scope).
- Sizing and Specification of UPS for proposed Server and HUB rack. (UPS Shall be part of Electrical scope).
- IP Based CCTV shall be considered for proposed Server/HUB room. (CCTV shall be part of ELV system scope, and its cabling will be part of networking scope).
- Networking Work contractor scope is to design, engineering, supply, testing, loading, transfer to site, unloading, shifting to store, installation & commissioning of BOQ material to meet the successful operation & functional requirements as per Local norms, practices and local standards. Handing over and training to the client.
- Preparation of execution drawings with section details and as built drawings in Vendor scope only. Consultant will provide the basic Networking drawings. Networking contractor has to develop drawing further upto the equipment termination with sizing, support structure (From wall or ceiling) & submit the same for approval.
- Co-ordination with other service contractors with respect to the installation activity without affecting the project schedule is in Networking Contractor's scope.

PART 9– Clean Room Part of turnkey tender includes the following works.

- Design of Modular Wall Panel of Insulated Epoxy Powder Coated Galvanized Sheet Steel with rockwool foam as infill.
- Design of Modular False Ceiling made of Insulated Epoxy Powder Coated Galvanized Sheet Steel with rockwool foam as infill.
- Design of Pass boxes
- Design of Clean room furniture.

PART 10 – Lab Furniture Part of turnkey tender includes the following works.

- Design of Lab Furniture
- Design of SS Cross over bench
- Design of Storage cabinets
- Design of Anti vibration table
- Design of SS chairs

PART 11 – Cold Room Part of turnkey tender includes the following works.

- Design of Cold room (2 to 8 Deg C)
- Design of Condensing unit
- Design of Evaporator unit
- Design of Cold room panels
- Design of Cold room doors

PART 12 – Utility & Drain piping Part of turnkey tender includes the following works.

- Design of Gas distribution system
- Design of Portable water system
- Design of Compressed air distribution system

- Design of Liquid nitrogen distribution system
- Design of Process drain & condensate drain
- Design of Emergency pump for rain water trench

PART 13 – Fire Protection system Part of turnkey tender includes the following works.

- Design of Fire Pump
- Design of Hydrant system

a. Testing, Commissioning and Validation of the facility as per cGMP requirements (EU-GMP) in the presence of NCCS concerned staff.
b. The contractor has to prepare DQ, IQ, OQ and PQ protocols for validation of entire cleanroom/HVAC system as cGMP requirement (EU-GMP).
c. The Contractor shall prepare and submit Manual, SOP's for Engineering Installations & facility in consultation with Consultant and shall provide training to the NCCS end users on GMP compliant facility operation, maintenance and housekeeping.

THE FOLLOWING TENDER DOCUMENTS ARE ATTACHED AS A PART OF NIT REQUIREMENT: -

1.	**PART- A**	**:**	**TENDER SPECIFICATIONS & APPROVED BRANDS**
2.	**PART- B**	**:**	**TENDER DRAWINGS**

Material approval Sheet for all items including Technical Data Sheet, Catalogues and literatures will be provided by Contractor based on Tender Documents which will be scrutinized and approved by NCCS/Consultant.

Tender drawings will be provided by the consultant. Shop drawings including coordination for all the services mentioned above based on the site requirements will be prepared and submitted by the individual contractors which will be scrutinized and approved by NCCS/Consultant.

"AS BUILT DRAWINGS" will be prepared by contractor which is checked and approved by consultant submitting drawings and all the installation, systems and services provided in this facility for reference and records to NCCS both in hard copy drawings and digital mode.

The Contractor or his engineer shall attend project review meetings with NCCS/Experts/Consultants at site / online for the execution and completion of the project as per the instruction of NCCS / Consultant till the completion of the project and handing over.

Contractor shall prepare project planning upto level 2 on MS Project / Primavera and submit it to NCCS / Consultant. The Contractor shall prepare an integrated bar chart for the execution of work, showing clearly all activities from the start of work to completion, with details of manpower, material and equipment required for

the fulfillment of the contract within the stipulated period or earlier and submit the same for approval within ten days of award of the contract.
The programme chart should include the following:

1. Descriptive note explaining sequence of the various activities.
2. Network (PERT / CPM / BAR CHART).
3. Programme for procurement of materials / equipment / labour by the contractor.

If at any time, it appears that the actual progress of work does not conform to the approved programme referred above, the contractor shall produce a revised programme showing the modifications to the approved programme to ensure completion of the work. The modified schedule of programme shall be approved by the Engineer in charge.

The submission for approval of such programme or the furnishing of such particulars shall not relieve the contractor of any of the duties or responsibilities under the contract. This is without prejudice to the right of NCCS to take action against the contractor as per terms and conditions of the agreement.

All Liasioning work if required related to this project will be in the scope of Contractor. Also Structural drawings for Lift Shaft, MS Shed, MS Staircase and Strengthening work should be vet through COEP, Pune before start of the work, submission of report etc. at the quoted rates.

The Contractor should coordinate with NCCS/Experts/Consultants at all stages of the project as and when required.

The Contractor should supply all the drawings and documents to NCCS / Consultant for review and approval as listed below:-

Sr No	Description	No of Sets	
1	GMP-Compliant Facility approvals from Authorities, Accreditation/ Validation, reports etc.	2 Sets	Contractors
2	As Built Drawings (Hard & Soft copies)	2 Sets + USB	Contractors
3	Manual	1 Sets	Contractors
4	SOP's for engineering installations and manuals, SOP’s for operation of facility	2 Sets	Contractors

All drawings (Architectural and services) shall be prepared by using CAD software and the scale of the drawings shall be indicated above or as decided by NCCS.

9. FORMS AND ANNEXURES:

FORM –I

9.1. INFORMATION REGARDING ELIGIBILITY LETTER OF TRANSMITTAL

[Note: On the letterhead of the bidder including full postal address, email address, telephone no.]

To,
The Director
National Centre for Cell Science
Savitribai Phule Pune University Campus,
Ganeshkhind
Pune- 411007.

Subject: Submission of bids for the "Supply, Installation, Testing, Commissioning, Qualification and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune-411038".
Ref.: NIT No. NCCS/MAINT/GMP/454C/2023-24; dt. 01/11/2023.

Dear Sir,

Having examined the details given in tender notice and bid document for the above work, I/we hereby submit the relevant information.

1. I/we hereby certify that all the statement made and information supplied in the enclosed forms and accompanying statement are true and correct.

2. I/we have furnished all information and details necessary for eligibility and have no further pertinent information to supply.

3. I/we also authorize Officer of NCCS to approach individuals, employers, firms and corporation to verify our competence and general reputation.

4. I/we submit the following certificates in support of our suitability, technical knowledge and capability for having successfully completed the following works:

Name of work :
Certificate from :
Enclosures :
Seal of bidder
Date of submission :

Signature of Bidder.

FORM -II

9.2. GENERAL INFORMATION

1	Name of firm	:	
2	Head office address	:	
3	Name of Authorised Person		
4	Telephone No.	:	
5	Mobile No.	:	
6	Fax	:	
7	E-mail No.	:	
8	Place of incorporation/ registration Year of incorporation/ registration	:	
9	PAN Registration No.		
10	GST Registration No.		

Seal and sign of the bidder

FORM -III

9.3. FINANCIAL CAPABILITIES/ INFORMATION

Financial Analysis – Details to be furnished duly supported by figures in balance sheet/ profit & loss account for the last five years duly certified by the Chartered Accountant, as submitted by the Bidder to the Income Tax Department (Copies to be attached).

Sr. No.	Details	Financial Year				
		2018-19	2019-20	2020-21	2021-22	2022-23
1	Annual Turnover as per Audited Balance Sheet					
2	Net Profit					
3	Loss if any					

Note : The above data is to be supported by audited balance sheets.

Attach copies of audited balance sheets duly certified by the chartered accountant for all five years (2018-19 to2022-23). Audited Balance sheet should mention the membership number of chartered accountant issued by ICAI along with full address.

Signature of Chartered Accountant with Seal

FORM -IV

9.4. EXPERIENCE OF COMPLETION OF PROJECTS OF SIMILAR NATURE

(During last five years ending last day of month previous to the one in which applications are invited)

SR No	Name of work / project and location	Type of work, size and qty	Cost of Work (Rs.)	Date of Commencement	Stipulated date	Actual date	Name and Contact number of the Officer to whom reference may be made

Note: Please attach supporting documents (completion certificates along with order copies should be on client's letter head) for the above information.

SIMILAR WORKS IN HAND

SR No	Name of work / project and location	Type of work, size and qty	Cost of Work (Rs.)	Date of Commencement	Stipulated date	Name and Contact number of the Officer to whom reference may be made

Note: Please attach supporting documents (order copies) for the above information.

FORM -V

9.5. SOLVENCY CERTIFICATE FROM BANKERS

This is to certify that to the best of our knowledge and information M/s./Sri._____ having marginally noted address_____, a customer of our Bank are / is respectable and can be treated as good for any engagement upto a limit of Rs. ___ (Rupees ____ only).

This certificate is without any guarantee or responsibility on the Bank or any of the officers and valid for one year from date of issue.

(Authorized Signature)

For the Bank

NOTE –

(1) Banker's certificates should be on letter head of the Bank, sealed in cover addressed to tendering authority.

(2) In case of partnership firm, certificate should include names of all partners as recorded with the Bank.

FORM –VI

9.6. PROFORMA OF AFFIDAVIT FOR NON-BLACKLISTING

(Affidavit to be furnished on a "non-Judicial" stamp paper worth Rs.100/-)

Date.....

To,
The Director
National Centre for Cell Science,
Savitribai Phule Pune University Campus,
Pune 411007.

Dear Sir,

Subject: Submission of bids for "Supply, Installation, Testing, Commissioning, Qualification and Validation of c-GMP Compliant Mammalian Cell Line Repository on Turnkey Basis at NCCS Jidnyasa Building, Kothrud, Pune-411038".
Ref.: NIT No. NCCS/MAINT/GMP/454C/2023-24; dt. 01/11/2023

I / We ..... hereby confirm that our firm has not been banned or blacklisted by any Government organization/Financial institution/Court /Public sector Unit /Central Government.

In case the above statement made by us are found to be false or incorrect, you have right to reject our bid at any stage including forfeiture of our PBG and / or cancel the award of contract.

Signature of Bidder : Place :

Name : Date :

Designation :

Seal

FORM -VII

9.7. DETAILS OF TECHNICAL & ADMINISTRATIVE PERSONNEL

SR No	Name	Designation	Qualifications	Professional experience	How these would Be involved in this work
1	2	3	4	5	6

Signature of Bidder

FORM -VIII

9.8. DETAILS OF PLANT AND EQUIPMENT

SR. No	Name of equipment	Qty	Capacity or Type	Remark
1	2	3	4	5

Signature of Bidder

ANNEXURE- I

9.10. FORM OF BANK GUARANTEE

In consideration of the Director (herein after called “National Centre for Cell Science, Pune”) having offered to accept the terms and conditions of the proposed agreement between_____ and _____ (Hereinafter called “the said Contractor(s)”) for the work_____ (Hereafter called “the said agreement”) having agreed to production of an irrevocable Bank Guarantee for Rs.__. (Rupees_____ only) as a security/guarantee from the contractor(s) for compliance of his obligations in accordance with the terms and conditions in the said agreement.

1. We__(Hereinafter referred to as “the Bank”) hereby (Indicate the name of the Bank) undertake to pay to the National Centre for Cell Science, Pune an amount not exceeding Rs.__. (Rupees_____ only) on demand by the National Centre for Cell Science, Pune.

2. We__ do hereby undertake to pay the amounts due (indicate the name of the Bank) and payable under this Guarantee without any demure, merely on a demand from the National Centre for Cell Science, Pune stating that the amount claimed is required to meet the recoveries due or likely to be due from the said contractor(s). Any such demand made on the Bank shall be conclusive as regards the amount due and payable by the bank under this Guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs.__. (Rupees_____ only).

3. We, the said bank further undertake to pay to the National Centre for Cell Science, Pune any money so demanded notwithstanding any dispute or disputes raised by the contractor(s) in any suit or proceeding pending before any court or Tribunal relating thereto, our liability under this present being absolute and unequivocal. The payment so made by us under this bond shall be a valid discharge of our liability for payment there under and the contractor(s) shall have no claim against us for making such payment.

4. We __further agree that the guarantee herein (indicate the name of the bank) contained shall remain in full force and effect during the period that would be taken for the performance of the said agreement and that it shall continue to be enforceable till all the dues of the National Centre for Cell Science, Pune under or by virtue of the said agreement have been fully paid and its claims satisfied or discharged or till Engineer-in-Charge on behalf of the National Centre for Cell Science, Pune certified that the terms and conditions of the said agreement have been fully and properly carried out by the said contractor(s) and accordingly discharges this guarantee.

5. We__ further agree with the National Centre for Cell Science, Pune that (indicate the name of the bank) the National Centre for Cell Science, Pune shall have the fullest liberty without our consent and without effecting in any manner our obligations hereunder to vary any of the terms and conditions of the said agreement or to extend time of performance by the said contractor(s) from time

to time or to postpone for any time or from time to time any of the powers exercisable by the National Centre for Cell Science, Pune against the said contractor(s) and to for bear or enforce any of the terms and conditions relating to the said agreement and we shall not be relieved from our liability by reason of any such variation, or extension being granted to the said contractor(s) or for any forbearance, act of omission on the part of the National Centre for Cell Science, Pune or any indulgence by the National Centre for Cell Science, Pune to the said Contractor or by any such matter or thing whatsoever which under the law relating to sureties would, but for this provision, have effect of so relieving us.

6. This guarantee will not be discharged due to the change in the constitution of the Bank or the contractor(s).

7. We__ lastly undertake not to revoke this (indicate the name of the bank) guarantee except with the previous consent of the National Centre for Cell Science, Pune in writing.

8. This guarantee shall be valid upto__ unless extended on demand by National Centre for Cell Science, Pune. Notwithstanding anything mentioned above, our liability against this guarantee is restricted to Rs.__. (Rupees_____ only) and unless a claim in writing is lodged with us within six months of the date of expiry or the extended date of expiry of this guarantee all our liabilities under this guarantee shall stand discharged.

Dated the__ day of__ for__.

(Name of Bank)

ANNEXURE -II

9.11. ARTICLES OF AGREEMENT

(***ON NON-JUDICIAL STAMP PAPER OF RS. 500/-***)

This Contract Agreement made on this____day of___20__ w.e.f.___ day of _____20__ for the work of _____ Between

M/s._____ (refer note) in the town of _____hereinafter called "THE CONTRACTOR" (which term shall unless excluded by or repugnant to be subject or context include its successors and permitted assigns) of the ONE PART

AND

National Centre for Cell Science, a society registered under the Societies Registration Act and having its office at Savitribai Phule Pune University Campus, Ganeshkhind, Pune 411007 hereinafter called the "NCCS" (which term shall unless excluded by or repugnant to the subject or context include its successes and assigns) of the OTHER PART.

WHEREAS

a. The NCCS is desirous that the Works of _____NCCS, Pune (Tender Ref. No. _____dt._____) should be executed as mentioned, enumerated or referred to in the tender including Press Notice Inviting Tender, Detailed NIT, General Conditions of the Contract, Special Conditions of the Contract, Specifications, Drawings, Plans, Time Schedule of completion of jobs, Schedule of Quantities and Rates, Agreed Variations, other documents, Pre bid minutes, has called for Tender.

b. The contractor has inspected the site and surroundings of the work specified in the tender documents and has satisfied himself by carefully examination before submitting his tender as to the nature of the surface, strata, soil, sub-soil and grounds, the form and nature of the site and local conditions the quantities, nature and magnitude of the work the availability of labour and materials necessary for the execution of work, the means of access to site, the supply of power and water thereto and the accommodation he may require and has made local and independent enquiries and obtained complete information as to the matters and things referred to or implied in the tender documents or having any connection therewith, and has considered the nature and extent of all the probable and possible situations, delays, hindrances or interferences to or with the execution and completion of the work to be carried out under the contract, and has examined and considered all other matters, conditions and things and probable and possible contingencies, and generally all matters incidental thereto and ancillary thereof affecting the execution and completion of the work and which might have influenced him in making his tender.

c. The tender documents including the NCCS's Press Notice Inviting Tender, Detailed NIT, General conditions of contract, Special Conditions of Contract, Schedule of Quantities and rates, General obligations, Specifications, Drawings, plan, time schedule for completion of work, Pre bid minutes, TCD Negotiation if any. Letter of Acceptance of tender, Work order, all correspondence related this work and any statement of agreed variations with

its enclosures copies of which are hereto annexed form part of this contract though separately set out herein and are included in the expression Contract wherever herein used.

d. Contractor shall not claim any escalation in contract rate for rise in prices of materials/labour etc. during the completion of work and shall complete the work at contracted rate which shall be valid for period ___ month from the date of issue of Work Order. In case of extension in the time period for execution of the contract beyond period ____ month, for any reasons of delay, he shall not be eligible for escalation and the NCCS decision in this respect shall be final and binding on the contractor.

AND WHEREAS

The NCCS accepted the tender of M/s._____ (refer note__) (CONTRACTOR) for the Works of_____ at NCCS, Pune and issued work order letter Ref. No._____ dated ___at the total cost of Rs.__ (Rupees ____) as rates stated in the Schedule of quantities for the work and accepted by the NCCS (hereinafter called the Schedule of Rates) upon the terms and subject to the conditions of the contract.

NOW THIS AGREEMENT WITNESSTH & IT IS HEREBY AGREED AND DECLARED AS FOLLOWS.

1. In consideration of the payment to be made to the contract for the work to be executed by him, the contractor hereby convenient with the NCCS that the contractor shall and will duly provide, execute, complete and maintain the said work and shall do and perform all other acts and things in the contract mentioned or described or which are to be implied and there from or may be reasonably necessary for the completion of the said works and at the said times and in the manner and subject to the terms and conditions or stipulations mentioned in the contract, AND

2. In consideration of the due provisions execution, completion and maintenance of the said work, the NCCS does hereby agree with the contractor that the NCCS will pay to contractor the respective amounts for the work actually done by him and approved by the NCCS at the Schedule or Rates and such other sum payable to the contractor under provision of the contract, such payment to be made at such time in such manner as prescribed for in the contract.

3. It is specifically and distinctly understood and agreed between the NCCS and the contractor that the contractor shall have no right, title or interest in the site made available by the NCCS for execution of the works or in the building, structures or works executed on the said site by the contractor or in the goods, articles, materials, etc. brought on the said site (unless the same specifically belongs to the contractor) and the contractor shall not have or deemed to have any lien whatsoever charge for unpaid bills will not be entitled to assume or retain possession or control of the site or structures and the NCCS shall have an absolute and unfettered right to take full possession of site and to remove the contractor, their servants, agents and materials belonging to the contractor and lying on the site.

4. The dispute or difference if any, relating to this agreement or any document appended hereto shall be settled by arbitration under the provisions of Indian Arbitration & Conciliation Act, 1996 or any rules and regulations framed there under within the Jurisdiction of Pune and the Jurisdiction of Arbitration shall be the city of Pune only.

In Witness whereof the parties hereto have here-into set their respective hands and seals in the day and the year first above written.

Signed and delivered for and on behalf of NCCS	Signature and delivered for and on behalf of the contractor
NCCS, Pune	CONTRACTOR
Address : Date : Place :	Address : Date : Place :
In presence of following witnesses	
1 Signature : Name :	1. Signature : Name :
2 Signature : Name :	2. Signature : Name :

{NOTE:
FOR PROPRIETORY CONCERN
Shri……s/o……r/o……carrying on business under the name and style of……at…… (Hereinafter called the said Contractor which expression shall unless the context requires otherwise include his heirs, executors, administrators and legal representatives).

FOR PARTNERSHIP CONCERN
M/s ……a partnership firm having its registered office at …… (Hereinafter called the said Contractor which expression shall unless the context requires otherwise include his heirs, executors, administrators and legal representatives). The partners of the firms are:
i) Shri …….s/o……, And
ii) Shri ……s/o……etc.

FOR COMPANIES
M/s ……a company duly incorporated under the Indian Companies Act, 1956 and having its registered office at ……in the state of …… (Hereinafter called the said Contractor which expression shall unless the context requires otherwise include its successors and assign). }

ANNEXURE- III

9.12. INDEMNITY BOND

(ON NON-JUDICIAL STAMP PAPER OF Rs.500/-)

This deed of Indemnity is made this _____day of___20__ between

M/s._____, (hereinafter called "The Contractor" which expression shall unless repugnant to the context or meaning Thereof include its successors and assigns) of the FIRST PARTY and

Director, National Centre For Cell Science, Pune, an Institute having its Registered Office at Savitribai Phule Pune University Campus, Ganeshkhind, Pune 411007 (hereinafter called the "NCCS" which expression shall unless repugnant to the context or meaning thereof include its successors and assigns) of the SECOND PARTY.

WHEREAS the Contractor has, interalia, agreed with the Institute to execute the work _____on the Terms & Conditions contained in the Notice Inviting Tender No: ____between the Institute and the Contractor.

Whereas the Contractor has to furnish an Indemnity of the said Agreement. It is now agreed by and between the Parties hereto as follows:

1. In accordance with the said Agreement, on the Contractor furnishing this Indemnity, the Contractor hereby undertakes to indemnify the Institute and keep the Institute indemnified from time to time against any loss caused due to mishandling, mis- operating or improper maintenance etc. or damage caused to or suffered by the Institute by reason of any breach or breaches on the Contractor's art of any of the Terms & Conditions contained in the said Agreement and in the event the contractor shall make any default or defaults in carrying out any of the works under the said Agreement or otherwise in observance or performance of any of the Terms & Conditions relating thereto in accordance with the true intent and meaning thereof, the Contractor shall forthwith on demand and without demur pay to the Institute such sum or sums as may be claimed by the Institute as losses, damages, costs, charges or expenses by reason of such default or defaults on the Contractor's part.

2. Notwithstanding anything to the contrary in these presents or in the said Agreement The Institute's decision as to whether the Contractor has made any default or defaults or the amount or amounts to which the Institute is entitled by reason thereof will be binding on the Contractor for the purpose of this Indemnity and the Contractor shall not be entitled to ask the Institute to establish its claim or claims under this Indemnity but will pay the same on demand without any objection provided always the mutual rights under the said Agreement shall not in any way be prejudiced by reason of such demand by the Institute and payment by the Contractor under this Indemnity and the claims under the said Agreement (which Shall be settled in accordance with the said Agreement) without prejudice to the Institute's rights to demand immediately under this Indemnity and the Contractor's liability to pay the same.

3. This Indemnity shall continue and hold good until it is released by the Institute in writing on the Contractor's application after expiry of relative Guarantee period of the said Agreement and after the contractor has discharged all his obligations under the said Agreement and submitted a “NO DEMAND CERTIFICATE” from the Institute under the said Agreement. The Indemnity Bond shall be valid for a minimum period of CONTRACT PERIOD and renewable thereof (Claim Period).

4. The Institute will have the fullest liberty from time to time to enforce or forbear to enforce any of the Terms & Conditions of the said Agreement and the Contractor shall not be released from his / their liability under this Indemnity by the exercise of the Institute 's liberty with reference to the matters aforesaid or by reason of any time being given to the Contractor or any forbearance, act or omission on the Institute's part or any indulgence by the Institute to the Contractor or by any variations or modifications of the said Agreement or any other act, matter or thing whatsoever on the Institute's part.

5. This Indemnity and the powers and provisions herein contained are in addition to and not by way of limitation or substitution for any other guarantee, indemnities hereto before given to the Institute by the Contractor and this indemnity does not revoke or limit such indemnities or guarantee.

IN WITNESS WHEREOF the Parties hereto have executed these presents the day the year First hereinabove written.

Name and sign of the Contractor

Engineer in Charge
NCCS., Pune

In the presence of following Witness

1. _____

2._____

8. CHECK LIST OF DOCUMENTS SUBMITTED:

Sr No.	Particulars	Submitted (Yes No)	Remark
1	Two separate bids i.e. Technical and Commercial submitted in single envelope dully sealed.		
2	Earnest Money Deposit (EMD)		
3	Copy of Registration certificate of firm (Shop Act/ Company Registration)		
4	Copy of GST Registration		
5	Copy of PAN card		
6	Copies of IT return and balance sheets for last five years		
7	Copies of similar supporting work orders / Agreement with completion certificate		
8	List and clients indicating quantum of work executed with them		
9	Form- Letter of Transmittal		
10	Forms / Annexures		
11	Seal signed copy of Pre-bid meeting minutes		
12	Detailed tentative BAR Chart		

 SEAL AND SIGN. OF THE BIDDER

PART- A

TENDER SPECIFICATIONS

PART 1

CIVIL WORKS

CONTENTS

1.0 SCOPE OF WORK:

- Structural strengthening works for existing civil building including Civil works related to Strengthening like Foundation jacketing, Column & Slab Wrapping with **CFRP BAND**.
- Construction of new lift shaft, Transformer yard, DG foundation & Air Compressor foundation.
- Dismantling, retrofit works & finishing for main building for present requirement including removing existing False ceiling, Windows etc.
- Prefabricated security POTA cabin.
- Existing underground water tank restoration & existing 2nd floor toilet restoration.

2.0 TECHNICAL SPECIFICATION:

2.1 EARTH WORK AND ANTI-TERMITE TREATMENT WORKS:

Before the earth work started, the places where excavation is directed to be done shall be cleared of all shrubs, weeds, grass and vegetation, brush wood, trees and saplings of girth upto 30cm measured at height of 1mtr above ground and rubbish removed upto a distance of 50m outside the periphery of the area under clearance. The roots of the trees shall be removed to a minimum depth of 60cm below ground level, or a minimum of 30cm below formation level, whichever is lower, and the hollows filled up with earth, levelled and rammed.

The trees of girth above 30cm measured at height of 1 mtr above ground, shall be cut only after permission of the Project Manager, is obtained in writing. Payment for cutting and removing roots of such trees shall be made separately.

After site clearance and before commencement of excavation or filling, the contractor shall take levels at 3 mtr intervals in either directions or at lesser intervals as considered necessary at site for the entire plots of both pockets / sites. A record of these levels shall be signed jointly by Contractor / Project Manager and Architect. The recorded ground levels shall be plotted on plans to a scale of 5 mtr to 1cm or any other suitable scale as required by the Architects / Project Managers. North direction line and position of B.M shall invariably be shown on the plans. The plans shall be signed by the contractor, the Project Engineer /

Architect, before the earth work started. The labour required for this will be the contractor's account.

Concrete / Masonry pillars shall be erected in the area which are visible from the largest area to serve as benchmark for the execution of the work. This benchmark will be constructed as per standard drawing and connected standard B.M. as approved by the Project Manager. Necessary profiles with pegs, bamboos and string shall be made to show the correct formation levels, before the work is started.

The rate quoted shall include bailing or otherwise removing all water which may accumulate in the excavation from all causes, trimming of all sides plumber otherwise as directed. Dismantling, removing & stacking as directed existing water pipes & or soil pipes within the excavation portion.

Deep trenches of excavation, newly placed concrete work are required to be properly protected from rain, bad weather and accidents by adequate means at no extra cost to the Owner.

In the case of soft rock and hard rock, the excavated stuff shall be properly stacked for pre-record measurement and then disposed off in places as directed. The quantity of these stacks shall measured and payment will be based on net quantities after deducting voids from the measured quantities as per table below :

Soft Rock - 35%
Hard Rock - 40%

Excavation in hard rock : Rock which is in solid beds, which can only be removed either by blasting or by wedging or chiseling shall be treated as hard rock. A boulder or detached rock measuring one cubic metre or more, shall also be treated as hard rock if the same cannot be removed without blasting, wedging or chiseling.

Where hard rock is met with and blasting operations are considered necessary, the contractors shall intimate about the same to the Project Manager. The contractor shall obtain license from district / public authorities for carrying out blasting work as well as for obtaining transporting and storing explosives as per' explosive rules 1940 or as amended.

Blasting operations shall be carried out under supervision of a responsible licensed operator of the contractor during certain specified hours, preferably during lunch break as approved

in writing by the Architects / Project Managers. The operator shall be conversant with the rules of blasting.

The operator should have the valid blasting license. Proper precautions for safety of persons shall be taken. Red flags shall be prominently displayed around the area to be blasted and all people on work except those who actually light the fuses shall be withdrawn to a safe distance of not less than 300 metres from the blast. Blasting shall not be done within 100 metres of an existing masonry or any other kind of structure unless special precautions are taken by heavy blanketing etc., on the special approval of Architects / Project Managers.

Where blasting is not practicable or prohibited, excavation shall be done by wedging or chiseling and it shall be restricted to the quantity required to enable the necessary foundation etc. to be put in. In case, the dimension of trenches exceed those shown in drawings the excess quantity shall not be paid for.

Excavation shall be to the exact length, width and depth shown or figures in the drawing or as directed by the Architects / Project Managers. If excavated to greater length, width or depth than shown or required the extra work occasioned thereby shall be done at contractor's expenses. Extra depth shall be brought up by plain cement concrete filling 1:5:10 proportion or M7.5 controlled concrete and extra length and width filled in by rammed earth or murrum or if the Architects / Project Managers think it necessary for stability of the work by 1:5:10 concrete as directed at contractor's cost. Water accumulated within the trenches during the progress of work from whatever causes shall be bailed or pumped out at the contractor's own expenses. Foundations or trenches shall be kept free of water while masonry or concrete works are in progress.

Unless otherwise specified the mode of measurements and quantities will be in accordance with IS 1200.

Filling of loose pockets :

Any natural loose pockets filled with PCC 1:5:10 shall be measured and paid extra under relevant items at the discretion of the Project Manager if applicable.

The working space will be paid only in the retaining wall in the event of waterproof plastering takes place for the external surfaces. The rock excavation shall be payable on actual stack measurement after deducting the voids and No other conditioning are payable.

The quoted rate shall include the cost of shoring and strutting for protects the sides of excavation where it required. The extra excavation or working space/allowance beyond the dimensions to avoid the sliding / falling of earth in the trench will not be entertained for payment. Only the size of trenches indicated in drawings will be considered for payment.

Excavation over area shall comprise the following:-

a) Excavation exceeding 1:5mtr in width or / and 10 sq.mtr on plan and exceeding 30cm in depth.
b) Excavation for basement, water tanks etc.,
c) Excavation in trenches for foundations exceeding 1.5mtr in width or / and 10 sq.mtr on plan.

2.2 EARTH FILLING:

The earth used for filling shall be free from stone, shingle or bolder not larger than 75mm in any direction, salts, organic or other foreign matter. Normally excavated earth from the same area shall be used for filling. However if such earth contains deleterious material, salt-peta earth etc., the same shall not be used. All clods of earth shall be broken or removed.

Trench Filling: The space all-round the foundations , pipes and drains in trenches shall be cleared of all debris, brick bat etc., The filling shall be done in layers not exceeding 15cm in layer. Each layer shall be watered and consolidated before the succeeding one is laid. Each shall be rammed with iron rammers where feasible and with the butt-ends of crow bars where rammers cannot be used. Special care shall be taken that no damages caused to the pipes, drains and masonry in the trenches below. The volume of the consolidated filling shall be measured.

Plinth / basement under floor filling : Earth obtained from excavation (or approved earth brought from outside for which no extra payment shall be made) shall be filled in layers not more than 15cm in depth at a time, spread, leveled, watered and well consolidated around foundation, under floors and other locations. The earth used for filling shall be free from all grass, roots, debris etc.,

2.3 EARTH DISPOSAL:

The surplus earth after refilling the trenches, under floors of the building shall be disposed of either inside or outside premises (to place where non-objected by the civil / local authorities) as per direction of Project Manager.

2.4 SAND FILLING :

The sand used for filling shall be clean and free from dust, organic and foreign matters. The filling shall be done in manner similar to earth filling as specified in article above, except that

consolidation which shall be done flooding the area with water. The surface of consolidated sand shall be dressed to required level or slope.

RATE :

Earthwork rate includes the following;

- Excavation and depositing earth as specified.
- Setting out works, profiles etc.,
- Site clearance.
- Forming (or leaving) 'Deadman or' tell tales in borrow pits and their removal after measurements.
- Bailing out or pumping of water in excavation from rains, sub soils etc.,
- Protection and supporting of existing services i.e., pipes, watermains, cables met within the course of excavation.

2.5 ANTI-TERMITE TREATMENT (PRE-CONSTRUCTION):

All the buildings shall be adequately protected against attack by subterranean termites by suitable chemical treatment measures. The work shall be carried out by a specialist pest control agency approved by the architect.

The work shall be carried out by the approved specialist firm and shall be covered by a return guarantee on the stamp paper for the satisfactory performance of the treatment for a minimum period of ten (10) years. The treatment shall be carried out generally in accordance with the stipulations laid down by IS 6313 (part - II) - 1981 (code of practice for anti-termite measures in buildings - part II – pre-constructional chemical treatment measures) subject to the minimum requirements given in this specifications.

2.6 MINIMUM SPECIFICATION :

The earth filling immediately under the stone soling (under floors) bottom and side fills of all foundations (excepting foundations) and soil along external perimeter of all buildings shall be chemically treated against termites. The chemicals to be used for the treatment shall be Chloro Pyrifos conforming to the requirement and concentration laid down in IS 6313 (part II) - 1981.

2.7 APPLICATION:

The chemical solution shall be prepared by mixing the chemical with the appropriate quantity of water to obtain a chemical emulsion of the correct concentration as stipulated above. The prepared emulsion shall be applied as described below :

Column pits, wall trenches, etc.

The bottom surface and sides of the excavations (upto a height of 30cm from the bottom) made for column foundations, wall foundations etc. (excepting RCC foundations) shall be treated with the chemical emulsion at the rate of 5 litres per sqm of surface area.

Treatment to back-fill

After the column foundations, wall foundations etc. come up the back fill in immediate contact with the foundation structure shall be treated at the rate of 5 ltrs per sqm of the surface of the substructure for each side. If water is used for ramming operation is completely by roding earth at 15 cm centres close to the wall face and spraying the chemical with the above dose. The earth is to be returned in layers and the treatment shall also be carried out in similar stages. The chemical emulsion shall be directed towards the masonry wall surfaces so that the earth in contact with these surfaces is well treated with the chemicals.

In the case of RCC walls and columns, the treatment shall start at the depth of 50 cm below natural ground level. From this depth the back fill around the RCC columns, walls etc. shall be treated at the rate of 5 ltrs per sqm. of the surface.

2.8 TOP SURFACE OF PLINTH FILLING:

The top surface of the plinth fill (just below the stone soling) shall be treated with chemical emulsion at the rate of 5 ltrs per sqm of the surface before the stone laid. If the filled earth has been well consolidated and does not permit the emulsion to seep through, holes upto 50 to 75 mm deep at 150 mm centres both ways may be made with crowbars to facilitate saturation of the soil with the chemical emulsion.

2.9 JUNCTION OF WALL AND FLOOR:

A channel of size 3x3 cm shall be made at all the junctions of walls and columns with the floor (before laying the soling) and rod holes made in the channel upto the ground level at 45 cms centres. The solution is poured into the channel at the rate of 5 ltrs per linear meter of the vertical surface and allowed to soak through the holes fully so that the soil in

contact with the chemical. The soil shall be tamped back into the channel and consolidation to original conditions.

2.10 EXTERNAL PERIMETER OF BUILDING:

After the building is complete, holes shall be made along the external perimeter of the building at intervals 15 cms and depths of 30 cms and the emulsion shall be allowed to soak through these holes fully at the rate of 5 ltrs per running meter of the perimeter wall.

2.11 SOIL SURROUNDING PIPES:

Wherever any service pipes enter the soil inside the area of the foundation of any building, the soil surrounding the point of entry of each pipe at the foundation, floor etc. shall be fully soaked with the chemical solution for a distance of at least one meter from the point of such entry.

2.12 EXPANSION JOINTS:

Soil beneath expansion joints at ground floor level shall be specially treated as directed. The joint itself shall also be treated as directed by the Architect.

1. Treatment Under Apron:-

The soil below the concrete for stone aprons to be provided around the perimeter walls of all buildings shall also be treated with the chemical solution at the rate of 5 litters per sqm.

2. TREATMENT OVER DPC:-

Top of concrete damp proof course in external and internal walls shall be given a liberal coat of chemical solution when the concrete is still green.

3. SPRAYING EQUIPMENT :

To facilitate proper penetration of the chemical into the soil, a pressure pump of adequate capacity and sprayers shall be employed to apply the solution.

2 & 3. PCC, REINFORCED CONCRETE AND REINFORCEMENT STEEL WORKS :

CONCRETE SPECIFICATIONS :

All concrete works are to be controlled concrete (design mix) as specified in the Bill of Quantities.

GENERAL :

This section describes and specifies work required for plain and reinforced cement concrete including reinforcement and formwork. Unless otherwise specified or agreed in writing by the Consultants, all materials and methods used in the production, testing and handling of concrete shall comply with the latest editions or amendments of the relevant Indian Standards.

4. MATERIALS :

All materials shall be obtained from sources approved by the Structural Consultants. The agreed source or quality of any material shall not be changed during the course of the contract except with the approval of the Structural Consultants.

When requested by the Structural Consultants, the Contractor shall provide a certificate from the manufacturer, for each and every delivery of material, showing the source, quantity delivered and confirming that the material has been tested and conforms to the required Indian Standard.

5. TESTING OF CONCRETE MATERIALS:

Prior to the commencement of concrete work, the Contractor shall get all cement, aggregates and water tested in the laboratories approved by the Structural Consultants and shall keep approved samples in the site office for inspection of the Structural Consultants at any time of the concreting operation.

During construction also, the materials shall be sampled and tested as often as deemed necessary by the Structural Consultants. Samples shall be taken and tested in accordance with the latest revisions of relevant Indian Standard Specifications and the cost thereto shall be borne by the Contractor.

6. CEMENT :

The cement used throughout the work shall be to the approval of the Structural Consultants and Project Manager. A certificate shall be obtained from the manufacturers and produced to the Consultants for each delivery of cement and in case of Ordinary Portland Cement it shall comply with the requirements of IS : 269. The Contractor shall store the cement in sheds to be provided by him for this purpose at site. The Cement shall be delivered to the site in bags sealed with the manufacturer's seal and different types of cement shall be stored separately. The storage sheds with watertight walls and roof, shall be maintained in a perfectly dry and well ventilated condition, 30 cm above ground level and the cement shall be stored as per instructions issued in the booklet of the Associated Cement Company. It shall be turned over from the bottom as and when required by the Consultants. Any cement which has been deteriorated, caked or which has been damaged due to any reason whatsoever shall not be used. No cement shall be used for the works that has been stored at site for more than three months unless it is re-tested. Test samples of cement may be drawn from each consignment as delivered and tested by the Contractor. Should the result of such test show that any sample does not comply with the specified requirement, the whole consignment from which the sample was taken, shall be rejected and forthwith removed entirely from the site and replaced with cement of satisfactory quality.

7. SAND :

Sand to be used for concrete shall be well graded mixture from coarse to fine grains, complying with the requirements of IS 383 and 515. It shall be clean, hard and free from salt, earth, clay and other impurities. Fine sand of uniform size or silt shall not be used. It will comply with sieve analysis in accordance with IS: 2386 Part I & II. Unless initially clean, all sand shall be thoroughly and carefully cleaned by screening and washing in fresh and clean water. The screened and washed sand shall not contain more than 8% by volume of clay, dust and silt immediately after allowing it to settle for 3 hours in water.

Field tests shall be carried out regularly to ensure the suitability of sand.

Sample loads shall be available at site for the inspection of the Consultants and if approved by them all sand in the work shall be of similar quality.

In case of sand containing moisture the proportions of concrete materials shall be adjusted to give the correct mixture.

8. COARSE AGGREGATE :

The coarse aggregate for the reinforced concrete work shall consist of crushed gravel, black trap, granite or other stone to the approval of the Consultants and shall be free from dust. If considered necessary by the Consultants the aggregate shall be washed specially until an approved cleanliness is obtained. The use of laminated stone, flat or flaky material will not be permitted. The combined coarse aggregate shall in all respects be so graded as to allow 95% to 100% by weight to pass a 20 mm I.S. Sieve; 25% to 55% by weight to pass a 10 mm I.S. Sieve and 0% to 10% by weight to pass a 5 mm I.S. Sieve. The aggregates of different sizes shall be stored in separate stacks in clean state and free from all dirt.

The coarse aggregate where absorption of water after 24 hours immersion is more than 5% by weight shall not be used.

When required by the Consultants tests indicated in I.S. 383 shall be got carried out by Contractor at his cost to show the acceptability of the materials. Strong piles of aggregate shall have good drainage, preclude inclusion of foreign matter and preserve the gradation.

9. WATER :

Water used for all purposes in this contract shall be free from oil, acid, vegetable matter, salts or dirt of any kind which will have adverse effect on cement or steel in the case of reinforced concrete. Whenever called for the Contractor shall produce test results for water being used on work.

Average 28 days compressive strength of at least three 15 cm concrete cubes prepared with water proposed to be used shall not be less than 9O percent of the average strength of three similar concrete cubes prepared with distilled water. Sea water shall not be used.

10. ADMIXTURES :

Plasticiser may be used in the concrete work to achieve better workability Admixtures or Cements containing additives (such as accelerators, retarders, water proofing agents etc) shall not be used unless specified or otherwise directed or approved by the Structural Consultants.

STEEL REINFORCEMENT :

The following types of reinforcement shall be used.

1) Mild Steel round bars conforming to IS : 432 (Part-I)

2) Hot-rolled deformed bars conforming to IS : 1139 -
3) Cold-twisted bars conforming to IS : 1786 –

The contractor shall produce a test certificate of the manufacturer and additionally from an independent testing agency approved by the Architects / Project Managers for each consignment, Costs of these tests are deemed to be included in the contract.

Bars upto 25 mm diameter shall stand bending cold to an angle 180^0 round a diameter equal to that of the test piece without fracture of the outside skin of the bent portion. If independent tests are considered necessary they shall be carried out to IS : 223. No bar shall be more than 2½% over or under the areas specified. Immediately before deposition of the concrete, reinforcement shall be well cleaned and made perfectly free from dirt, loose rust, scales, paint, oil wash, grease or any other coatings which may destroy or reduce bond.

11. FABRICATION AND PLACEMENT OF REINFORCEMENT :

All steel reinforcement shall be fabricated and fixed in accordance with IS2502. Bars shall be firmly bound together with annealed steel wire not thinner than 16 SWG at all intersections to ensure that the network of rods will retain its original form and the mesh will be so temporarily supported as to retain its correct position in the formwork during the process of depositing the concrete. An adequate number of M.S. chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. All splices and lengths of overlaps in reinforcement shall be strictly in accordance with the drawings. The overlaps shall be staggered and their positions shall be approved by the Consultants. No welding of reinforcement is permitted unless approved by the Consultants in writing. The ends of wire ties must not project towards the face of the concrete, and all ends shall be cut off or bent inwards so that there is no risk of rust staining the surface of concrete. Off-cuts of binding wire must be removed from the inside of forms after the steel fixing operations are over.

Where reinforcement bars are bent aside at construction joints and afterwards bent back into their original positions, care shall be taken to ensure that at no time is the radius of the bend less than 4 bar diameters for deformed bars. Care shall also be taken when bending back bars, to ensure that the concrete around the bar is not damaged.

Where reinforcing bars are lapped with dowels provided in concrete work, if the lap length shown on the drawings is less than the minimum lap length specified on the drawings for development of full strength of the connection, bars shall be spliced by welding. Such

welding shall conform in all respects to the provisions given in Appendix 'A' of SP:34 (S&T) - 1987, Handbook on Concrete Reinforcement and Detailing, Bureau of Indian Standards. However, if the contractor has failed to provide sufficient lap length as shown on the drawings through his own fault, the bars shall be spliced by welding and such welded splice is deemed to be included in the contract price.

12. SPACER BLOCKS:

To maintain the specified amount of concrete cover to the reinforcement, **PVC cover blocks** shall be used.

a) At each end of reinforcing bar, not less than 25 mm, nor less than twice the diameter of bar.
b) For a longitudinal reinforcing bar in a beam, not less than 25 mm, nor less than the diameter of the bar.
c) For a longitudinal reinforcing bar in a column, not less then 4O mm nor less than the diameter of the bar.
d) For tensile, compressive, shear or other reinforcement in a slab, not less than 15 mm, nor less than the diameter of the bar.
e) For vertical or horizontal reinforcement in concrete walls not less 15 mm nor less than the diameter of the bar.
f) For reinforcement in footings, pile caps and raft foundations not less than 5O mm.

13. PREVENTION OF RUST STAINING:

Reinforcement left projecting above a concrete surface shall be cement washed if exposed in such a way that rust staining of concrete surfaces is likely. Any rust staining of exposed surfaces shall be cleaned immediately.

14. STORAGE AND HANDLING OF REINFORCEMENT :

Reinforcement shall be stacked off the ground in clean conditions and protected from contamination and excessive rusting. The reinforcement shall be clean and free from oil, grease, loose rust, loose mill scale, salt and chemical contaminants at the time of fixing in position and concreting. The reinforcement of different diameter shall be stored in separate stack in clean state.

MODE OF MEASUREMENT FOR STEEL REINFORCEMENT :

Basic rates indicated are inclusive of all taxes and duties and delivered at site.

a) Material supplied by the Owner shall not be considered as second sales in case the steel is supplied by the owner to contractor : Reinforcement including authorized overlaps as per drawing shall be measured in lengths of different diameters as actually used in the work nearest to a centimeter and their weight calculated on the basis of standard table. Wastages, chairs, spacers and unauthorized overlaps agreed in writing by the Structural Consultants/Architects / before concreting shall not be measured and paid for. Contractor has to include the same in his quoted rate. For reconciliation the allowable wastage in reinforcement shall be 3% (1% unaccountable & 2% accountable). Chairs, spacers and rolling margins shall be considered for reconciliation only but not for payment. All tests and test certificates shall be produced by the contractor as directed by Architects / Project Managers free of cost.

b) In case of steel procurement by the contractor : Contractor has to account in his quoted rate for all Wastages, cost of unauthorized overlaps, rolling margin, chairs, spacers, binding wire, tying and placing in position. Bar bending schedule and Bill of Quantities shall be approved by the Structural Consultant / Architects / Project Managers before concreting.

- **PROPORTIONS FOR CONCRETE :**

The Contractor shall design concrete mixes to produce concrete of the required strengths. The contractor must submit full designs of the mixes for approval of the Consultants and trial mixes will be prepared by the contractor in the presence of the Consultants, having workability, strength, minimum cement content and finish as criteria.

Concrete surfaces which are to be finished with cement rendering shall be thoroughly hacked with approved hand tools immediately after removal of formwork so as to bring about adequate bond between the concrete and cement rendering.

Notwithstanding the acceptance by the Consultants of any mix design and series of trial mixes, variations may be made to the proportions when considered necessary by the Consultants. Variations of this nature will not be allowed to affect the unit price of concrete.

For Design Mix concrete, the quantity of cement shall be determined by weight. Where standard bags of cement are used, their weight shall be checked at frequent intervals and any loss in weight due to leakage etc. shall be made good.

In the case of Controlled Concrete all aggregates and cement shall be measured by weight in approved weigh batching equipment. Mixing water shall be measured in graduated litre Cans.

While calculating the amount of mixing water, the moisture content of the aggregate shall be taken into account. The grades of concrete shall be in accordance with Table below. The cement content of the mixes specified shall not exceed the minimum content specified in Table by more than 5%

Grade of Concrete	Minimum Cement content Kg./Cum (for 43 grade cement)	Minimum Crushing strength Kgs./Sq.cm.		
		Preliminary	Working	
		Tests 28 days (in Kg/Sq.cm)	Test 7 days (in Kg/Sq.cm)	Test 28 days (in Kg/Sq.cm)
M 10	250	120	67	100
M 15	290	180	100	150
M 20	300	240	135	200
M 30	350	360	200	300

The above specified compressive strengths shall be for the use of ordinary Portland Cement in concrete. When rapid hardening Portland Cement is used, the 28 days compressive strength requirements specified in Table shall be met at 7 days. Where other cements are used, the Consultants shall specify the corresponding requirements preferably on the basis of preliminary tests.

In order to get a relatively quicker idea of the quality of concrete compressive strength tests at 7 days may be carried out in addition to 28 days compressive strength tests and it shall not be less than 67% of the 28 days Cube Strength. In all cases 28 days compressive strength shall alone be the criterion for acceptance or rejection of the concrete.

- **MIXING OF CONCRETE:**

The mixing of concrete shall continue until there is a uniform distribution of material and the concrete is uniform in color and consistency and shall be for at least two minutes.

Mixers and weigh batchers shall be maintained in first class condition throughout the contract and any mixer or plant which is faulty shall not be used. The drums on all mixers shall revolve at the speed recommended by the manufacturer. A mixer of any type which has been out of use for more than 20 minutes shall be thoroughly cleaned out before any fresh concrete is mixed. All equipments shall be maintained in a clean, serviceable condition and their accuracy periodically checked.

- **SLUMP TEST:**

The Contractor shall keep at the site of the works for the constant use of the Consultant's representative a standard slump test mould and shall provide facilities throughout the construction for tests to be made as and when the Consultants may require. The slump cannot be definitely stated until tests have been made using the materials adopted for the work, but it is anticipated that the slump of between 25 mm to 50 mm will be required.

- **COMPRESSIVE STRENGTH:**

The Contractor shall keep on site adequate number of moulds of minimum six standard 15 cm. test cube moulds and ancillary equipment for preparing test cubes. Before the Contractor commences any concrete construction, he shall make six cubes of mix concrete with the cement, sand, aggregate and water which he proposes using on the contract and shall have them tested at a Laboratory approved by the Consultants. Three cubes shall be tested at 7 days and three cubes at 28 days after casting and curing. In all cases the cubes shall give the minimum compressive strength for Preliminary Tests specified above. No concrete construction shall be commenced until Preliminary Tests on the six cubes referred above have been completed and result show the concrete to have the minimum compressive strength.

As construction proceeds samples from fresh concrete shall be taken as per IS : 1199 and cubes shall be made, cured and tested in accordance with IS : 516. Three test specimens shall be made for each sample for testing at 28 days. Additional cubes may be required for

various purposes such as to determine the strength of concrete at 7 days or at the time of striking formwork, or to determine the duration of curing, or to check the testing error. The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than + 15 percent of the average. Any part of the work from which the cubes fail to give the required minimum compressive strength shall be dealt with the Contractor as directed by the Consultants and at the expenses of the Contractor.

The concrete is also liable to be rejected or repaired as per the instructions of the Consultants if it is porous or honeycombed, its placing has been interrupted without providing a construction joint or the reinforcement has been disproportionately displaced.

The Contractor shall keep a daily record showing the date when each portion of concrete is poured in slab, beam, column, etc., curing period, removal of formwork and test cube results at 7 days and 28 days period. They shall be sent immediately to the Consultants .

- **TRANSPORTING PLACING AND COMPACTION OF CONCRETE :**

The concrete shall be transported maintaining required workability in a manner such as to avoid the segregation of the constituent materials, and loss of any of the ingredients. It shall be deposited as nearly as practicable in its final position to avoid rehandling. It shall be placed and compacted before setting commences and should not be subsequently disturbed. Methods of pouring should be such as to preclude segregation, and to avoid displacement of reinforcement and movement of formwork.

The concrete should be thoroughly compacted and fully worked around the reinforcement, around embedded fixtures and into the corner of the formwork without formation of honeycombing, pinholes or surface irregularities and any other defects whatsoever. The use of mechanical vibrators having capacity of producing vibrations at a rate not less than 5OOO cycles per minute is recommended. Over vibration or vibration of very wet concrete is harmful and should be avoided; under vibration is also harmful. In addition to mechanical vibration, sufficient hand tools must be used to ensure full consolidation around reinforcement and at edges and corners.

The deposition of concrete shall be carried out as continuously as possible to reduce to a minimum joints between new concrete which has set. Where construction joints are necessary they shall be formed at right angles to the axis of the member concerned by the insertion of rigid stopping off form, against which concrete can be properly rammed. No unset concrete shall be brought into contact with unset concrete containing cement of

different type. Special permission and instructions shall be obtained when concrete has to be deposited under water.

Accumulation of set concrete on the reinforcement shall be avoided. Before fresh concrete is deposited upon or against any concrete which has already hardened, the surface of hardened concrete shall be well roughened if necessary by chipping and all laitance removed. The surface shall then be swept clean with wire brushes, thoroughly wetted and covered with a thin layer of cement mortar.

- **PROTECTION OF CONCRETE :**

Newly placed concrete shall be protected by approved means from rain, sun and drying winds. Concrete placed below the ground shall be protected from falling earth during and after placing. Approved means shall be taken to protect immature concrete from damage by debris, excessive loading, vibration, abrasion, deleterious ground-water, mixing with earth or other materials that may impair the strength and durability of concrete.

- **CONSTRUCTION JOINTS :**

Before construction commences the Contractor shall submit to the Consultants, for their approval, sketches of layouts showing proposed positions of construction joints and pour sequences. These layouts must take into account the requirement that the casting of this part of the floor slab between axes ** and ** extending from axes ** to **, on all floors will be required to be delayed by a minimum 45 days after the most recent adjacent pour.

Each section of concrete shall be poured continuously between construction joints. Shuttering to all construction joints should be so made that it produces on the face of joints a suitable grooved or indented surface to act as a shear key or bond for the subsequent concrete. Inclined joints shall not be permitted.

If the concrete has been allowed to harden excessively, the surface shall be chipped over its whole surface to a depth of at least 10 mm and thereafter thoroughly washed. If the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire brushes to avoid dislodgment of particles of aggregate. Before fresh concrete is added to the other side of a construction joint the surface of the old concrete will be thoroughly wetted and then covered with a thin layer of cement mortar of the same quality as that in the concrete.

All construction joints shall be formed at right angles to the main axis of the member concerned and in position of minimum shear and as per the direction of Project Manager.

No distortion or displacement of reinforcement from the positions shown on the drawings shall be permitted at construction joints.

Maximum concreting dimensions are given below :

Retaining walls: The maximum dimension of a rectangular wall panel cast in one pour shall be the concurrence of the Structural Consultant.

STRUCTURAL JOINTS:

Expansion joints or other permanent structural joints shall be provided in positions and of the form described in the drawings or elsewhere.

In no case shall the reinforcement, corner protecting angles or other fixed metal items, embedded or bonded into concrete, run continuously through an expansion joint. The placing of concrete on either side of the expansion joint shall be done separately after an interval of at least seven days.

CUTTING INTO CONCRETE:

No concrete shall be cut into, nor shall it be interfered with in any way, without the prior approval in writing of the Consultants. Necessary holes shall be provided as required for plumbing work and for electrical pipes at the time of execution.

CURING OF CONCRETE:

Exposed surfaces of concrete shall be kept continuously in a damp or wet condition for at least seven days from the date of placing of concrete.

Approved curing compounds may be used in lieu of moist curing with the permission of the Consultants. Such compounds shall be applied to all exposed surfaces of the concrete as soon as possible after the concrete has set.

INSERTS:

The contractor shall fix all necessary steel plates, pipe holes, pockets, dowels etc. in the shuttering of concrete work, to enable subsequent fixing of supports, brackets, ceilings, precast members etc. as indicated in the drawings or as required by the Consultants.

FINISHING :

As soon as possible after the formwork has been struck holes left by clamping bolts, air and water holes and other rough patches, shall be filled in with cement and sand mortar 1 : 1

1/2 mix. Excess water shall be avoided The patched areas shall be kept moist for minimum 10 days.

The face of concrete for which shuttering is not provided shall be smoothed with wooden float. The floating shall be done so as not to bring an excess of mortar to the surface of the concrete. Indentations in the surface of concrete shall be formed by approved implements to the depth and patterns described.

If reinforcement is exposed or honeycombing occurs at points considered vulnerable by the Consultants, the member shall be treated as directed by the Consultants.

Loading in excess of design loading

No portion of the structure shall be subjected to any loading in excess of design loading except with the prior written permission of the Consultants and subject to such conditions as they may prescribe.

PRE-CAST CONCRETE:

All aforesaid specifications for concrete shall apply to precast concrete in addition to the following variations.

The concrete in one precast piece shall be placed in one operation. No piece shall be removed from the mould or erected until sufficiently matured to ensure that no damage shall be done to the piece.

All details of jointing, inserts, anchors and bearing widths shall be as shown on the drawings.

All precast concrete members shall be clearly marked to indicate the top of the member and its location.

Units shall be stored, transported and placed with due care so that they will not be overstressed or damaged.

Precast units shall be adequately braced and supported during erection to ensure proper alignment and safety, and such bracings and supports shall be maintained until there are adequate permanent connections.

PLUM CONCRETE COURSE (IF APPLICABLE):

The unevenness in the founding strata shall be leveled using plum concrete. The pockets in the founding strata shall be filled with plain cement concrete of lean mix. Plums above 160 mm and upto any reasonable size shall be embedded in the plain cement concrete layer

upto a maximum limit of 20 percent by volume of plain concrete when specifically permitted by the Engineer-in-charge. The plums shall be distributed evenly and shall be not closer than 150 mm from the surface.

LEVELLING COURSE:

It shall be plain cement concrete of leaner mix which shall be proportional as stipulated and placed in position conforming to line and level shown on the drawing and compacted by approved means and cured.

SUPERVISION:

Constant and strict supervision at all items of the construction is necessary during the progress of the work, including the proportioning and mixing of the concrete. Supervision is also of extreme importance to check the reinforcement and its placing before being covered. Before any important operation, such as concreting or striking off the formwork is started, adequate notice shall be given to the Consultants.

FORM WORK:

The Form Work shall be designed for rigidity and durability, strength, watertightness, easy removal, surface finish required for concrete in contact with shuttering and economy.

Material used in form work shall be 12 mm thick film faced shuttering plywoods, steel props, steel plates, or specially designed and manufactured moulds out of plastic or reinforced fibber glass or steel.

Use shall depend upon its location, type of finish specified subject to acceptability by Project Manager. Form work designed with proposed material in use should be able to retain its shape, lines, and dimensions, shown in the drawings. It should safely carry the full load of concrete together with any live and impact load likely to occur during concreting.

Material used shall conform to relevant IS Codes. It is the contractor's responsibility to entirely achieve the standard expected to the satisfaction of the Project Manager.

WORKMANSHIP:

Erection of form work may be from pre-moulded, pre-fabricated, pre-assembled plates or forms reasonable enough to transport and erect at site to correct line and level as set out at site. Supports shall be firm and maintained in position by nails, cross bracings, tie rods, locking bolts and nuts. It shall be rigid and stiff so as to retain its shape during and after concreting.

Joints shall be water-tight and no cement slurry shall be allowed to slip through. Pre-fabricated or site fabricated forms shall be assembled, so as to deshutter without any jerk to the green concrete. For this double wedges shall be used. Wedges shall be nailed, the heads reasonably left out, allowing easy removal while deshuttering.

Pre-fabricated or site fabricated forms shall be of sufficient thickness and with the required supporting runners in either direction. Supporting runners shall be standardized in size for easy replacement and universal use at site.

Props shall be of steel only. Size and verticality shall be approved by the Project Manager. Its spacing shall be as per design. It shall be vertical and plumbed. Base shall be a proper steel plate or timber plank, for equal distribution of load. The concreting of the upper floor shall be done only after 14 days of concreting of lower floor.

Beams and slabs shall have camber of 4 mm per metre or as directed by the Project Manager.

All angles and corners shall be sharp and well defined in places where concrete edges are permanently exposed and require no further treatment, they shall be chamfered in a triangle of 25 x 25 mm. Props of steel or timber shall be provided with adequate horizontal and cross-bracing. Steel props shall use steel pipes and steel couplers.

At the design and erection stage, the following additional points shall be considered and incorporated into the shutters.

The contractor shall submit the scheme of shuttering and its design get it approved by the consultants.

a) Openings for clearing prior to start of concreting.
b) Pouring points shall avoid high drops and provide easy access to vibrator needles.

Surfaces shall be treated with mould releasing oil or emulsion as approved by the Project Manager prior to reinforcement laying.

The following points shall be observed very carefully:

a) Joints of moulds shall be water-tight. It is easy to check from the bottom and make sure that no light is visible.
b) Props shall be on solid base, plumbed, in one straight line and braced horizontally & cross.

c) Tie bars in beams, walls and columns shall be at the correct place and fully tight.
d) Wedges shall be fully secured and nailed with heads left out for easy removal.
e) All saw dust, dirt, shavings & any other unwanted materials shall be cleaned & hosed out.
f) Provisions shall be made for watching form work while concreting and any other platform needed for movement of workers without any disturbance to reinforcement.

Form work shall be erected in accordance with:

a) IS 3696 Safety Code of scaffolds and ladders.
b) IS 4014 Code of Practice for Steel tubular scaffolding I & II. Part 2 Safety regulation for scaffolding.
c) IS 8989 Safety Code for erection of concrete framed structures.

SPECIAL FAIR FACED FINISH:

Where special fair faced finish is specified, the contractor shall be responsible for producing a perfectly smooth surface to the concrete, free from projections or imperfections of any description. Arises must be clean, sharp and perfectly sound. The formwork must be designed so that it can be erected and maintained perfectly plumb and all surfaces must be true planes free from winding or other deformities throughout. Typing wires through the concrete to hold the formwork together will not be permitted and either exterior bracing or through bolts are to be employed. If the latter are used the bolts shall subsequently be removed and the boles plugged with cement mortar. The pattern of holes has to be to the approval of the Consultants. No part of any metal tie or spacer remaining permanently embedded in the concrete shall be nearer than 50 mm to the finished surface of the concrete. Concrete faces must be protected at all times during and after construction against accidental damage or disfiguration and the Contractor will be responsible for taking all necessary measures to ensure that the work is perfectly sound and free from blemishes, stains, etc when finally handed over.

REMOVAL OF FORM WORK :

Under normal circumstances and where O.P Cement is used, forms shall be removed after expiry of the following periods:

a) Walls, columns and vertical faces - 24 to 48 hours
b) Slabs (props left under) - 3 days
c) Beams-soffits (props left under) - 7 days

d) Removal of props under slabs
   i) Spanning upto 4.5 m - 7 days
   ii) Spanning over 4.5 m - 14 days
e) e) Removal of props under beams and arches
   i) Spanning upto 6 m - 14 days
   ii) Spanning over 6 m - 21 days

For other cements, the stripping time shall be suitably modified in consultation with the Project Manager.

Where the shape of elements is such that the form work has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage or cracking that might occur due to the restraint imposed. For precast moulds, the stripping time shall be 24 hours. The mould may be lifted and stored in the yard within 24 hours to 48 hours as approved by the Project Manager.

OPENINGS / INSERTS:

All required openings and pockets shall be provided as detailed in the drawing. The contractor shall provide for the required material, labour, for fixing and supporting during concreting, in his quoted price. It is imperative that all openings and pockets be de-shuttered with care and all corners of openings shall be preserved. All openings/pockets shall be in the correct line and level. After concreting, the openings shall be secured against any accident by proper covering and guard rail and warning notice, if any.

The contractor shall clean and grout the pocket at a later date with a non-shrinking compound added to the grout mix or non- shrinking cement shall be used. It shall be well-cured and protected to correct line and level till handing over.

Inserts are material such as timber, steel, plastic, dowels, bolts, locks, brackets, pipes etc. left in concrete partly or fully embedded to receive connection with foreign member at a later date. These may be fabricated by the contractor or provided by the owner as received from specialist, manufacturer, etc. These shall be protected from weathering and damage in course of the construction. The cleaning required after concerting and any treatment such as oiling, greasing or covering with paint etc. shall be carried out by the contractor at his cost.

It is very important that the providing and fixing as contemplated in the Contract shall be carried out with the "utmost precision" and to the entire satisfaction of the Project

Manager. Any deviation from that as shown in the drawings or instructions shall be rectified by the contractor at his own cost and responsibility.

MASONRY WORKS :

Masonry mortar : Mortar shall be of mix as indicated. The mixing specified are by volume. Mixing shall be done in mechanical mixture. The mortar shall be mixed for at least three minutes after addition of water. Cement mortar shall be freshly mixed for immediate use. Any mortar which has commenced to set shall be discarded and removed from the site.

SIZE STONE MASONRY

Size stones shall be of hard granite, basalt or trap stone obtainable from approved quarry. The stones shall be clean and wetted before they are used.

Height of course shall not be less than 15 cms and all courses shall be of uniform height. Unless otherwise instructed the depth of higher courses should not be more than the depth of lower courses. Bed and sides shall be hammer or chisel dressed from the face 75 mm and 35 mm respectively.

No face stone shall be less in depth than in height or shall tail into the work to a length less than the height. Stones shall break joints at least half the height of the course. Faces of stones shall be hammer dressed and bushing not be more than 25 mm. Thickness of joints shall not be more than 20 mm. edges of face stones of exposed faces shall be chiseled true to both longitudinal and vertical lines. Exposed faces of corner stones to be 2 line dressed 50 mm wide. Bond or through stones shall be provided not exceeding 2.00 mtr apart in each course and shall be staggered. Bond stone shall be from the front to the back of the walls. For wall upto 60 cms thick under, bond stones shall be in one piece and for walls over 60 cms thick they shall either be in one piece (if available locally) or be in the series of headers; each header overlapping the adjoining one by not less than 150 mm bond or through stones shall be marked as directed to enable their being easily detected even after having been built in position. The interior or filling shall be with flat bedded stones laid in mortar, chips, spells shall be used to avoid thick mortar joints and shall not exceed 10% of the quantity of stone masonry. Care is to be taken that no dry work or hollow spaces shall be left anywhere in the masonry.

RANDOM RUBBLE MASONRY

The face stone shall be laid absolutely without pinnings on the face. Every stone shall be carefully fitted so as to form neat and close joints and if necessary, the edges shall be dressed with chisel so as to ensure close joints work. The thickness of joint will be as specified for each work and in no case more than 20 mm. The thickness of joint should be uniform on the face variation being within 25%. Mortar in joints should be scraped 12

mm deep for pointing.

The stones shall be roughly chisel dressed to ensure equal size on face as far as possible. They shall be of uniform colour and they shall be carefully laid and solidly bedded in mortar and shall tail back and bond well into the backing and shall not be of greater than either breadth of face or length of tail into the work.

One header or through stone shall be inserted for every square metre of face & shall run right through the wall if it is not more than 600 mm thick. If more than 600 mm a line of headers shall be laid from face to back which shall overlap each other at least 150 mm stones shall be arranged to break joints as much as possible & long vertical lines of joining shall be avoided in face work. The quoins, unless otherwise specified shall be of selected stones neatly dressed with hammer chisel to form required angle & laid header and stretcher alternatively. The masonry has to be kept wet for 10 days.

In the case of cement mortar, the proportion specified is on volume basis. But cement shall be weighed on the assumption that one cubic metre of cement weighs 1440 kgs.

Architects / Project Managers may also require the cement to be measured by volume but on the same assumption.

BRICK WORK GENERAL :

A. All brick work should be carried out as shown on the drawings with set backs, projections, cuttings, toothings etc. Wherever the proportion of cement mortar has not been specifically mentioned, cement mortar in the proportion of 1:6 shall be used. Flat brick arches shall be provided wherever required without any extra cost. Brick work shall be kept wet while in progress till mortar has properly set. On holidays or when the work is stopped, top of all unfinished masonry shall be kept wet. Should the mortar be dry, white or powdery, for want of curing, work shall be pulled down & rebuilt at the contractor's expense.

B. Table moulded bricks shall conform to IS 1077. Country bricks shall be of the best quality and approved by the Architects / Project Managers. Bricks shall be thoroughly cleaned and well wetted. Table moulded bricks shall be soaked for at least 12 hours in fresh water before being used on the work. Country bricks shall be thoroughly soaked in water till the bubbles cease to come.

C. Unless otherwise specified, brickwork shall be done in English bond with frog upwards. The bricks shall be bedded & joined with mortar in such a manner as not to leave voids. Each brick shall be correctly bedded into position by tapping with the handle of the trowel, grouting of mortar slurry will not be allowed, except where necessary for special reasons and in such cases, prior permission of the Architects / Project Managers shall be obtained.

D. Care shall be taken that each course of brick work is truly horizontal and perfect in bond and the face of the wall is straight, plumb and even. The mortar joints shall be 10 mm in thickness, except where extra thickness is required for the purpose of bringing the brick work to the required height or level. Half bricks or bats shall not be used except for obtaining the bond and where absolutely necessary.

E. Brick work in 230 mm wall : In the case of 230 mm thick walls, if bricks are of size such that the width of the header course does not come equal to the width of the stretcher course. The difference shall be made up during construction of brick work itself by same mortar as used for construction of masonry to provide a plane vertical surface. The surface should also be scarified to receive plaster.

F. All junctions of walls and cross walls shall be carefully bonded into the main walls. The rate of laying masonry will be upto a height of 100 cm per day if cement mortar is used. Greater heights may be built only if permitted by the Architects / Project Managers.

G. During rains, the work shall be carefully covered to prevent mortar from being washed away, should any mortar or cement be washed away, the work shall be removed and rebuilt at the contractor's expense.

HALF BRICK WORK :

This shall be set in cement mortar as specified. Unless otherwise specified the walls be reinforced with 2 nos. of 6 mm mild steel bars at every fifth course, with PCC 1:3:6 of 75mm thick band for the full length of wall and with tie bars at 1 metre interval and on top of the first course and at every fourth course thereafter. The cost of half brick work shall include the cost of reinforcement where reinforcement of half brick walls is specified.

CEMENT CONCRETE BLOCK MASONRY :

General :

Extent and Intent : The Contractor shall furnish all materials, labour, operations, equipment and incidentals necessary and required for providing solid and hollow concrete block walls as called for on the drawings.

All blocks shall be manufactured in a factory using appropriate block making machine. If the blocks are to be manufactured at site, the contractor shall furnish the Project Manager full details of the equipment to be deployed, along with the sequence of operations, curing, storing arrangement, space requirements etc. Only after obtaining the Project Manager's permission, the contractor can put up the block making unit at the site.

Whether manufacturer at a fully equipped factory or at the site, the blocks shall fully meet the requirements laid down in IS : 2185 – Part I – 1979 (Grade 'D' for solid blocks), cement for manufacturing blocks shall be provided by the contractor at his own cost. If manufactured at the site, proper account of cement used for the manufacture of blocks shall be maintained by the contractor and provided to Architect whenever called for.

Testing: Samples of blocks shall be tested at intervals and in accordance with IS : 2185 (Part I). Acceptance criteria shall be as laid down in above standards.

CONCRETE BLOCKS (SOLID & HOLLOW) :

Concrete blocks shall conform to requirements stipulated in IS : 2185 – Part I – 1979 cement, aggregates, sand and water shall conform to requirements laid down under concrete work. The size of the blocks shall be 400 mm x 200 mm x 200 mm, 400 mm x 200 mm x 150 mm and 400 mm x 200 mm x 100 mm as called for.

The blocks shall be of the exact dimensions called for, with clean, sharp edges and sides. Blocks shall fully match the specimens to be got approved by the Architect. The blocks shall be free from broken edges, cracks and other defects. They shall be stockpiled in an approved manner to protect from any damage. The blocks shall be handled with care. Damaged blocks shall be removed from the site and replaced by good ones. Minimum average compressive strength shall be as mentioned in the detailed specification of schedule of quantities.

Mortar : The block shall be laid in cement mortar proportion as mentioned in the detailed specification of schedule of quantities. All mortar shall be prepared in accordance with IS :

2250 – 1965. Mortar shall be mixed and used as stipulated under mortar mixing in the section “brick work”.

Laying : The blocks shall be laid as stipulated in IS : 2572 – 1963. The blocks need not be wetted before use. Mark the courses on columns and adjust the first course so as to avoid any gap at beam bottom. The first course shall be laid with the greatest care to ensure that it is properly aligned, leveled and plumbed. Subsequent courses shall be laid over this course true to line and levels. Each block and each course shall be carefully checked for alignment, level and plumb so that the wall is truly straight and vertical. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of block. The mortar joints shall be struck off flush with wall surface and when the mortar has started stiffening, it shall be compressed with a rounded or “ U “ shaped tool to obtain a watertight joint. The joints both horizontal and vertical, shall not be more than 10 mm thick. They shall be uniform and straight and truly horizontal and vertical, staggered vertically. The jambs at openings for doors, windows, etc. shall be built truly vertical and to correct dimensions, The top course at cills, roof levels etc., shall be made truly horizontal and to correct heights and dimensions. All walls wherever they meet or intersect shall be bonded or tied securely in an approved manner. Where two walls meet or intersect, the courses in the two walls shall be, as far as possible, laid up at the same time with a true masonry bond between at least 50% of the units at the intersection. Where the two walls cannot be laid simultaneously, toothing or pockets with 20 cms maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built with these toothing or pockets as the case may be.

The intersection of hollow block wall and brick wall shall also be bonded as described above.

Filling Hollows with Concrete : The Hollows of blocks (in the case of hollow blocks) at jambs of doors and windows shall be filled with cement concrete 1:2:4 (1 Cement : 2 coarse sand: 4 crushed graded stone aggregate 20 mm and down gauge). Hollows of blocks shall be similarly filled with concrete at other locations also as called for.

Joints : The joints shall be full of mortar. The face joints shall be raked to a minimum depth of 8 mm by a raking tool during the progress of the work when the mortar is still green so as to provide key for the plaster to be done. The face of the wall shall be cleaned daily and mortar droppings removed.

Reinforced Concrete Block wall : All concrete block walls 100 mm thick shall be reinforced with 2 Nos of 6 mm mild steel bars at every fifth course with PCC 1:3:6, 75mm thick band for the full length of the wall.

Scaffolding & curing etc : The specification clauses for 'curing' , 'scaffolding' , 'openings' and 'caulking' as given under 'Brick work' shall apply for "Concrete Blocks" walls also.

FLOORING WORKS :

GRANOLITHIC FLOORING – 50mm thick :

General :

The flooring shall consist of 1:2:4 concrete base 38 mm thick and 12 mm thick granolithic wearing coat. The granolithic flooring shall be laid in alternate panels. The size of panels shall be as decided by the Architects / Project Managers .

LAYING OF 1:2:4 CONCRETE BASE:

The 1:2:4 concrete base shall be of graded course aggregate of maximum size 10 mm course sand and cement. The ingredients shall be thoroughly mixed with sufficient water to obtain the required plasticity.

The free water on the surface of the base shall be removed and a coat of cement slurry of the consistency of thick cream shall be brushed on the surface.

The prepared 1:2:4 concrete shall be laid immediately after mixing on the fresh grouted base. The concrete shall be spread evenly & levelled carefully. Low places shall be filled, humps removed & the whole surface again levelled. The layer shall be compacted by ramming and trowelled and allowed to set.

MIXING AND LAYING OF WEARING COAT:

One part of cement in dry state shall be mixed with 1.5 parts by volume of well graded / crushed granite chips of 6 mm maximum size. The ingredients shall be then mixed with sufficient water as for ordinary concrete. The wearing coat shall be laid 12 mm thick over 1:2:4 cement concrete base immediately after it has set compacted and leveled with a steel trowel. Just sufficient trowelling shall be made to give a level surface. The surface should not be over trowelled as excessive trowelling will bring the cement to the surface which shall be strictly avoided. When the initial set takes place further compaction by steel trowelling shall be done & final brushing shall be made before the topping becomes too hard.

POWER FLOATED AND FINISHED M25 CONTROLLED CONCRETE FLOORING - 75MM THICK :

Providing and laying 75mm thick Power floated and finished M25 controlled concrete flooring with necessary shuttering, consolidation curing etc., as detailed below :

1. Providing and laying 75 mm thick M25 concrete over the prepared surface.
2. Supplying & mixing high strength super plasticizer in concrete as per the manufacturers specification.
3. Providing and running surface vibrator on pre-laid concrete and leveling the concrete between the form work of angles or MS channels and finished smoothly using Power trowels only.
4. The floor has to be laid in panels of specified size by the alternative bay method. During the laying of concrete the construction joints have to be de-marketed for the next operation of shrinkage joint treatment.
5. The finished surface shall be within the allowable tolerance of + (or) - 2mm only with an area of 9 Sq.mtr
6. Incase variation in levels exceeding the allowable tolerance of 2mm, the same shall be made up by using Nitoflor ML manufactured by FOSROC Chemicals India Ltd., or any other approved equivalent at the contractors cost.
7. The floor has to be laid in panels of Maximum size 3 mtrs x 3 mtrs panels by the alternative bay method. The construction joint shall be cut using diamond bit wheel for a width of 3 to 4mm and a depth of 30mm within 20 to 30 hours of concreting. No delay shall be acceptable.
8. On curing and drying of the concrete the construction joints have to be filled with non-shrink material conbextra GPI manufactured by FOSROC Chemicals (India) Pvt. Ltd.,

The rate shall include for all materials, labour form work moulds and machineries etc., complete.

PROVIDING AND LAYING 75MM THICK POWER FLOATED AND FINISHED WITH FLOOR HARDNER NITOFLOR HARD TOP STANDARD MANUFACTURED BY M/s. FOSROC CHEMICALS INDIA PVT LTD BY USING M20 CONTROLLED CONCRETE FLOORING WITH THE APPROVED WATER CEMENT RATIO AND AS DETAILED BELOW:

1. Providing and laying 75mm thick M25 Controlled concrete over the prepared surface brought casting with Nitflor hard top standard.

2. Supplying & mixing high strength super plasticizer as per the manufacturers specification.

3. Providing and running surface vibrator on pre-laid concrete and leveling the concrete between the form work of angles or MS channels and finished smoothly using Power trowels only.

4. The finished surface shall be within the allowable tolerance of + (or) - 2mm only with an area of 9 Sq.mtr

5. The floor has to be laid in panels of Maximum size 3 mtrs x 3 mtrs panels by the alternative bay method. The construction joint shall be cut using diamond bit wheel for a width of 3 to 4mm and a depth of 30mm within 20 to 30 hours of concreting. No delay shall be acceptable.

6. On curing and drying of the concrete the construction joints have to be filled with non-shrink material conbextra GPI manufactured by FOSROC Chemicals (India) Pvt. Ltd.,

The rate shall include for all materials, labour form work moulds and machineries etc., complete. If the plasticizer is cancelled during construction which will be deducted at the rate quoted in the appropriate item.

PROVIDING AND LAYING M25 CONTROLLED CONCRETE VACUUM DEWATERED FLOORING (TREMIX PROCESS) WITH AN APPROVED WATER CEMENT RATIO AND AS DETAILED IN BELOW :

1. Providing and laying 150mm thick M25 grade controlled concrete over the prepared surface.

2. Supplying & mixing high strength super plasticizer in concrete as per the manufactures specification.

3. Providing and running surface vibrator on prelaid concrete and leveling the concrete between the form work of angles or MS channels and finished smoothly using Power Trowels only.

4. Providing and laying suction mats and tops spread and dewatred the concreting with help of vacuum pump.

5. Power floating the dewatred concrete with skim floater till a desired top smooth finish obtained.

6. Immediately after dewatering, the surface should be broad casted with using Nitoflor hard top standard manufactured by FOSROC Chemicals India Ltd., or any other approved equivalent at the contractors cost. The concrete hardener should be used at 3 kgs/ sq.mtr or as per manufacturers instructions depending upon abrasion resistant required over the Trimix vacuum dewatered floor.

7. The finished surface shall be within the allowable tolerance of + (or) - 2mm only with an area of 9 Sq.mtr.

8. Incase variation in levels exceeding the allowable tolerance of 2mm, the same shall be made up by using Nitoflor ML manufactured by FOSROC Chemicals India Ltd., or any other approved equivalent at the contractors cost.

9. The floor has to be laid in panels of Maximum size 3 mtrs x 3 mtrs panels by the alternative bay method. The construction joint shall be cut using diamond bit wheel for a width of 3 to 4mm and a depth of 30mm within 20 to 30 hours of concreting. No delay shall be acceptable.

10. On curing and drying of the concrete the construction joints have to be filled with non-shrink material conbextra GPI manufactured by FOSROC Chemicals (India) Pvt. Ltd.,

11. The rate shall include for all materials, labour form work moulds and machineries etc., complete. If the plasticizer is cancelled during construction which will be deducted at the rate quoted in the appropriate item.

PROVIDING AND LAYING 150MM THICK POWER FLOATED AND FINISHED M25 CONTROLLED CONCRETE FLOORING FOR GRADE SLAB WITH AN APPROVED WATER CEMENT RATIO AND AS DETAILED BELOW :

1. Providing and laying 150 mm thick M25 concrete over the prepared surface.

2. Supplying & mixing high strength super plasticizer in concrete as per the manufacturers specification.

3. Providing and running surface vibrator on pre-laid concrete and leveling the concrete between the form work of angles or MS channels and finished smoothly using Power trowels only.

4. The finished surface shall be within the allowable tolerance of + (or) - 2mm only with an area of 9 Sq.mtr

5. Incase variation in levels exceeding the allowable tolerance of 2mm, the same shall be made up by using Nitoflor ML manufactured by FOSROC Chemicals India Ltd., or any other approved equivalent at the contractors cost.

6. The floor has to be laid in panels of Maximum size 3 mtrs x 3 mtrs panels by the alternative bay method. The construction joint shall be cut using diamond bit wheel for a width of 3 to 4mm and a depth of 30mm within 20 to 30 hours of concreting. No delay shall be acceptable.

7. On curing and drying of the concrete the construction joints have to be filled with non-shrink material conbextra GPI manufactured by FOSROC Chemicals (India) Pvt. Ltd.,

The rate shall include for all materials, labour form work moulds and machineries etc., complete. If the plasticizer is cancelled during construction which will be deducted at the rate quoted in the appropriate item.

CURING :

As soon as the surface is hard enough, it shall be covered with sacking or sand and kept continuously wet for a period of atleast one week.

TERRAZO / MOSAIC FLOORING

The tiles shall conform to IS : 1237 having the colour and chips approved by the Architects / Project Managers . The mosaic topping of lighter shade tiles shall be made of white cement with an approved shade pigment and natural shade tiles shall be of grey cement with an approved shade pigment. The type of tiles shall be as specified in respective items.

A bed of cement mortar consisting of one part of cement & 6 parts of sand shall be laid & properly leveled to an average thickness of 20 mm and the surface shall be kept slightly rough to form a satisfactory key for tiles. Neat cement paste of honey like consistency shall be spread over mortar bed, over such area at a time as would accommodate about 20 tiles. Tiles shall be soaked in water for atleast 15 minutes and allowed to dry for the same duration. Tiles shall then be fixed with a thin coat of cement paste on back of each tile and then each tile gently tapped with a wooden mallet till it is properly bedded & in level with adjoining tiles. Joints shall be fine & as imperceptible as possible (not more than 1.5 mm wide).

After tiles have been laid in a room or a day's fixing work is completed, surplus cement grout that may have come out of the joints may be wiped off gently and joints cleaned. A thick slurry of coloured cement matching the colour of tiles shall be spread over it and

rubbed so as to seal even the thinnest joint between the tiles and make it impervious & the flooring cured for 14 days. The floor shall be polished and finished according to IS:1443.

SHAHABAD, TANDUR, GRANITE, KOTAH AND CUDDAPAH FLOORING

The slabs shall be of selected quality, hard sound, dense, homogenous intexture, free from cracks, decay, weathering and flaws and of thickness as specified. The top exposed faces should have been roughly polished before bringing it to site. Unless otherwise specified the slabs should be cut to the required shape and size, by hand using fine chisel or machine cut as specified. All pieces should be of uniform size.

A bed of cement mortar 1:6 shall be laid and properly leveled to an average thickness of 20 mm and the surface should be kept slightly rough to form a satisfactory key for the tiles. Neat cement paste of honey like consistency shall be spread over mortar bed over such an area so that the paste will not harden before laying tiles. Slabs shall be soaked in water for 15 minutes and allowed to dry. The slabs shall then be fixed as per approved pattern with thin coat of cement paste on back of each slab. They will be tapped with a wooden mallet till it is properly bedded in level with adjoining slabs. Joints shall not be more than 1.5 mm wide. The surplus cement grout that may have come out of the joints has to be wiped off gently and joints cleaned. The joints shall be filled up with grey or white cement with an admixture of pigments to match the shade of the slab. The flooring shall be cured for 14 days. Then it shall be polished according to IS : 1443, except that 1) first polishing with course grade carborandum shall not be done. 2) Cement slurry with or without pigment shall not be applied before polishing.

CERAMIC TILES / GLAZED TILES FLOORING , DADO & SKIRTING :-

Glazed tiles from an approved manufacturer conforming to IS : 777 shall be of specified size and thickness and colour All specials viz. coves, internal and external angles, corners, beads etc. shall be used wherever directed. Under layer of 12 mm average thickness of cement mortar 1:3 proportion shall be laid. Tiles shall be well soaked in water washed clean and set in cement grout and each tile being gently tapped with a wooden mallet till it is properly bedded and in level with the adjoining tiles. The joints shall be kept as thin as possible and in straight lines or to suit the required pattern. After the tiles have been laid, surplus cement grout shall be cleaned off. The joints shall be cleaned off the grey cement grout with a wire brush or trowel to a depth of 5 mm and all dust and loose mortar removed. Joints shall then be flush pointed with white cement if necessary mixed with colour to match the colour of the tile. The floor/dado shall then be kept wet for 14 days. After curing, the surface shall be washed with mild hydrochloric acid and clean

water. The finished floor / dado shall not sound hollow when tapped with a wooden mallet. The rate will include the cost of under layer of cement mortar.

PLASTERING WORKS :

GENERAL :

EXTENT AND INTENT;

The contractor shall furnish all materials labour scaffolding equipments tools plant and incidentals necessary and required for the completion of all plaster and wall finishes, subject to approval by Architect.

GENERAL :

Plaster as herein specified shall be applied to all internal and external surfaces where called for. Glazed tile dado, terrazzo dado and other wall finishes shall be provided where indicated on drawings and schedule of finishes. Areas called for on drawings and typical shall be considered to apply to appropriate adjoining areas whether shown on same drawings or not and whether indicated or not.

All plaster work and other wall finished shall be executed by skilled workmen in a workmanlike manner and shall be of the of the best workmanship and in strict accordance with the dimensions on drawings subject to the approval of the Architect.

PLASTER WORK :

The primary requirement of plaster work shall be to provide absolutely water tight enclosure, dense, smooth and hard and devoid of any cracks on the interior and/or exterior. The contractor shall do all that is necessary to ensure that this objective is achieved. All plastering shall be finished to true plane, without any imperfections and shall be square with adjoining work and form proper foundation for finishing materials such as paint etc.

Masonry and concrete surfaces which call for applications of plaster shall be clean, free from efflorescence, damp and sufficiently rough and keyed to ensure proper bond, subject to the approval of the Architects / Project Managers .

Wherever directed by the Architect, all joints between concrete frames and masonry in filling shall be expressed by a groove cut in the plaster. The said groove shall coincide with the joints beneath as directed. Where grooves are not called for, the joints between concrete members and masonry in filling shall be covered by plaster mesh manufactured

from galvanized steel strip of 7" width, 0.35 mm nominal thickness and of approximate weight of 0.095Kgs per Rmt of approved make.

CHASING & BREAKAGES :

All chasings, installations of conduits, inserts boxes etc., shall be completed before any plastering or other wall finish is commenced on a surface. No chasing or cutting of plaster or other finish on a surface shall be permitted. Broken corners shall be cut back not less than 150 mm on both sides and patched with plaster of Paris as directed. All corners shall be rounded to a radius of 8 mm or as directed by the Architects / Project Managers .

SAMPLES :

Samples of each type of plaster & other wall finish shall be prepared well in advance of undertaking the work for approval by the Architects / Project Managers .

MATERIALS:

CEMENT	: As specified under concrete work
WATER	: As specified under concrete work
SAND	: For internal plaster - sieved sand
WATER PROOFING COMPOUND	: CICO No.1 or approved quality

PROPORTIONS;

The materials used for plastering shall be proportioned by volume by means of gauge boxes.

PREPARATIONS OF SURFACES;

The joints in all walls, both existing and freshly built shall be raked to a depth of 15 mm, brush cleaned with wire brushes, dusted & thoroughly wetted before starting plastering work. The concrete surfaces to receive plaster shall be roughened by hacking over the entire surface so that the skin of the concrete is completely removed, as approved by the Architects / Project Managers to ensure proper key for the plaster.

PLASTER TO WALLS :

Plaster to internal faces of walls shall be 20 mm thick comprising of one part cement and six part clean fine sand. The external surfaces of external wall shall have plaster of 20 mm thickness comprising of one part of cement & 6 parts of clean fine sand.

WATER PROOF PLASTER TO RCC WALL SURFACES:

Waterproofing the RCC bottom, side walls etc. in two courses, the first in cement mortar 1:4, mixed with CICO No. 1 at 3 % by weight of cement and immediately there on fix 20 mm granite aggregate as close as possible. The second coat of plaster shall be carried out on subsequent day same as in first coat and finished smooth. The second coat will not have granite aggregate.

MORTAR MIXING :

Mortar shall be prepared as specified under 'brick work'. It shall be made in small quantities, as required and applied within 15 minutes of mixing.

APPLICATIONS;

Plaster application shall be commenced only after the preparatory work is approved by the Project Manager. Correct thickness of plaster shall be obtained by laying plaster screads (gauges) at intervals of 1.5 mtrs. as directed.

Mortar shall be firmly applied, well pressed into the joints, rubbed, and finished as approved by the Architects / Project Managers to give a smooth and even surface.

CURING;

Finished plaster shall be kept wet for at least 10 days after completion. In hot weather, walls exposed to such shall be screened with matting kept constantly wet or by any other approved means.

CEILING PLASTER :

Plaster to ceilings, soffits or stairs flight slabs and similar locations, where called for, shall be 12 mm thick & comprise of one part cement & four parts of clean fine sand.

PREPARATION OF SURFACE :

The surfaces to be plastered shall be prepared as called for earlier. The surface shall be brushed, swept clean and thoroughly wetted before plastering.

APPLICATIONS :

Mortar shall be applied firmly, pressed to the surface rubbed & finished to a smooth & even surface subject to the approval of the Architects / Project Managers .

PLASTER MESH TO WALL, CONCRETE JUNCTIONS, ALL CHASING OF CONDUIT INSTALLATION AND INSERT BOXES ETC., :

Plaster mesh manufactured from galvanized steel strip of 0’ 7” width, 0.35 mm nominal thickness and of approximate weight of 0.095 kgs per Rmt of approved make shall be provided at junctions of brick masonry / block masonry and concrete members, to be

plastered and other locations properly stretched and nailed, ensuring equal thickness of plaster on both sides of the mesh.

CEMENT MORTAR :

Cement mortar shall be of proportion specified for each type of work. It shall be composed of Portland cement & sand. The ingredients shall be accurately gauged & shall be evenly mixed together in a mechanical mixer. Care should be taken not to add more water than necessary. If hand mix is allowed it shall be done on pucca water proof platform. The gauged materials shall be put on platform, & thoroughly mixed dry. Water shall then be added & the whole mixed thoroughly until the mix is homogenous and of uniform colour, quantity of mortar mixed should not be more than what can be consumed within half an hour of mixing.

Cement mortar mix are specified as 1:2, 1:3, 1:4, 1:5 etc. The first figure will mean one part of portland cement by volume, the second figure will mean so many parts of sand by volume. For example, cement mortar 1:4 would mean one part of cement and four parts of sand.

Cement & sand must conform to relevant I.S specification.

POINTING ON SIZE STONE MASONRY, BRICK WORK AND TILES WORKS :

Type : The type of pointing shall be as specified.

Scaffolding, staging : For all exposed brick work / stonework or to the surface of pointing to be done, double scaffolding having to sets of vertical supports shall be provided. The support shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Surface Preparation shall be as specified in the article of 'Plastering Work.'

The joints shall be raked to such a depth the minimum depth of the new mortar measured from either the sunk surface of the finished pointing or from the edge of the brick shall not be less than 12mm.

Mortar of specified mix shall be used.

Application and finishing : The mortar shall be pressed into the raked out joints, with a pointing trowel, either flush, sunk or raised, according to the type of pointing of required. The mortar shall not spread over the corner, edges or surface of the masonry. The pointing shall then be finished with the proper tool, in the manner described below :

Flush Pointing : The mortar shall be pressed into the joints and shall be finished off flush and level with the edges of the bricks, tiles or stones so as to give a smooth appearance. The edges shall be neatly trimmed with a forwarded and straight edge.

Cut or weather struck pointing : The mortar shall first be pressed into the joints. The top of the horizontal joints shall then be nearly pressed back about 3mm or as directed, with the pointing tool so that the joints are slopping from top to bottom. The vertical joints shall be rule pointing. The junctions of vertical joints with the horizontal joints shall be at true right angles.

Rules Pointing : The joints shall be initially formed as for flush pointing and then while the mortar is still green, a groove of shape and size as given in the drawing or as directed, shall be formed by running a forming tool, straight along the centre line of the joints. This operation shall be continued till a smooth and hard surface is obtained. The vertical joints shall also be finished in a similar way. The vertical lines shall make true right angles at their junctions with the horizontal lines and shall not project beyond the same.

Raised and Cut pointing shall project from the wall facing with its edges cut parallel as to have a uniformly raised band about 6mm raised width 10mm more as directed. The superfluous mortar shall be cut off from the edge of the lines and the surface of the masonry shall also be cleaned off all mortar. Lines of joints from different directions should meet nearly at the junctions instead of crossing beyond.

Rate shall include the cost of all materials and labour involved in all the operations described above.

PAINTING WORK:

General :

The specification covers the various types of painting and finishing of all surfaces throughout the interior & exterior of the building. The number of coats required in various situations and also the types of finish required for the several items of work such as cement based paint, plastic emulsion paint, oil bound distemper etc., are specified in the schedule of quantities and specifications.

Before the commencement of the work the contractor shall provide sample panels of painting at his own cost for the approval of the Architects / Project Managers to enable him to keep an accurate check on the materials supplied & final shade to be painted. It is

however the express responsibility of the contractor to provide any deviations & defects shall have to be rectified by the contractor at his own cost.

Contractor shall protect not only his own work at all times but also all the adjacent work and materials by suitable covering, protection or other methods acceptable to the Architects / Project Managers during progress of painting. It is the responsibility of the contractor upon completion of painting work to remove all paint and varnish spots from floors, walls, glass panes and other surfaces and restore them to the original conditions. The work generally to be touched up shall be attended to after all other workmen have left. All accumulated material, rubbish etc. have to be cleared and the premises left in clean, orderly and acceptable conditions.

Contractor shall provide scaffolding wherever necessary erected on double supports tied together by horizontals, no ballies, bamboo's or planks shall rest on or touch the surface which is being painted. Contractor is deemed to have considered the following while tendering and no extra claim on account of these will be entertained.

A) Supplying the paint and other materials required of approved color and brand.

B) Preparing the surfaces to be painted.

C) Providing and erecting scaffolding and removing the same after completion of the work.

D) Lifting of materials to any height and painting at all levels.

E) Application of paint as per the specification and to manufactures instructions.

F) Curing, protecting the painted surface, adjacent work and thoroughly cleaning of the premises.

G) A list of approved brand of manufacture is appended.

MATERIAL :

The paint shall generally conform to the chemical composition and other characteristics laid down in the relevant Indian standard specification. The entire materials required for painting work shall be obtained direct from approved manufacturers or their authorized agents and brought to site in original manufacturer's containers with seals unbroken.

Paint shall be ready mixed and of 1st quality of the approved brand and manufacture. Mixing of paint by the contractor at site will not be allowed, except with preparation

of ingredients and their quality shall be strictly maintained as per manufacturer's instructions and all as directed by the Architects / Project Managers . All the materials shall be kept properly protected when not actually in use. Lids of containers shall be kept closed. Materials which have become stale or flat (in the opinion of the Architects / Project Managers) shall not be permitted to be used on the works and shall be removed from site forthwith. Wherever the works `approved' occurs in these specifications it shall mean that the competent authority for such approval are the Architects / Project Managers . Any materials found not conforming to the relevant specification shall have to be removed by the contractor from the site at his own expenses.

The manner of taking measurements will be in accordance with ISI 1200.

WHITE WASHING WALLS AND CEILINGS :-

White wash shall be prepared from fat lime or shell lime slaked on site mixed with just enough water to make a thick paste and allowed to remain for atleast 7 days before use. At the time of using, the paste shall be diluted with just sufficient water and strained through cloth. Four kgs. of gum dissolved in hot water shall be added to each metre of the cream (1.5 gms. per cft). Ultra marine blue shall be added to give required whiteness. The number of coats shall be specified in the bill of quantities and shall be applied by using flat brushes or spray pumps, on surface prepared. Each coat shall be allowed to dry before next coat is applied.

COLOUR WASH

Colour wash shall be prepared by adding mineral colours or approved pigments not affected by lime or light. Colour wash shall be applied as specified under `white wash'. Approval of the Architects / Project Managers shall be obtained in regard to exact shade before applying colour wash.

COLOURLESS LACQUER POLISH

Polish :- Nitro cellulose lacquer polish of approved brand manufacture and finish shall be used.

PREPARATION OF SURFACE :-

The surface shall be cleaned and all unevenness shall be rubbed down smooth with suitable grade sand paper and well dusted. Knots if visible shall be made good as per the direction of the Architects / Project Managers . Holes and indentation on the surface shall be stopped with glaziers putty. The surface then shall be given a coat of ready made ragging wood filler and allowed to dry for maximum 4 hours. The surface again shall be

rubbed down perfectly smooth with suitable emery paper and wiped clean. There after a finishing touch up with ragging wood filler is to be given and allowed to dry. To receive the polishing the surface is again rubbed down smooth.

APPLICATION :

Nitro cellulose sealer coat of approved manufacturer shall be applied strictly as per the manufacturers specification. The polish shall be applied with a sprayer at suitable pressure and viscosity as recommended by the manufacturer, and allowed to dry for 4 to 6 hours and rubbed down with suitable grade emery. The surface shall be again sprayed with 3 coats of NC lacquer (3 wet on wet coat). Finally the surface shall be given wax polishing by using rubbing compound.

CEMENT PAINT :

Material : The cement paint shall conform to IS : 5410 – 1969 of approved brand and manufactures.

Surface preparation : In case of new work, the surface shall be thoroughly cleaned of all water dropping, dirt, dust, edge, grease and other foreign matter by proper washing and brushing. The surface shall be thoroughly wetted with clean water before the application of the cement paint. In case of old work, all loose pieces and scales shall be removed and the surface shall be cleaned of all dirt, dust, edge, oil etc., by brushing and washing. Pitting in the plaster if any shall be made good and a coat of waterproof cement paint shall be applied over patches after their proper wetting with clean water.

Preparation of Mix : Cement paint shall be mixed in such quantities as can be used up within an hour of its mixing, as otherwise the mixture will set and thicken, affecting flow and finish. This paint shall be mixed with water in two stages. The first stage shall comprise of 2 parts of cement paint and one part of water stirred thoroughly and allowed to stand for 5 minutes. Care shall be taken while first mixing, that the cement paint is to be gradually added to the water and not vice versa. In the second stage the water is added to the liquid prepared in the first stage and stirring thoroughly to obtain a liquid of workable and uniform consistency. In the preparation of the mix, the manufacturer's instructions shall be followed. The lids of the cement paint drums shall be kept tightly closed when not in use, as by exposure to atmosphere, the cement paint will rapidly air set.

Application : The mix prepared shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so

that the direct heat of the sun on the surface is avoided. The application method shall be as per instructions of the manufacturer. The completed surface shall be watered after the day's work.

The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted. In case of old work, the treatment shall be with one or more coats as necessary to get a uniform shade. In case of new work, the surface shall be treated with three or more coats of water-proof cement paint and metal surfaces.

Precaution : Water cement paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, paints etc. It shall not be applied on gypsum, wood and metal surfaces.

SYNTHETIC ENAMEL PAINT

Providing two coats of synthetic enamel paint of approved make colour over one coat of primer on plastered surfaces, wooden surfaces, and steel surfaces. A filles putty coating has to be given after primer coat in the case of wooden surfaces. The putty shall be made from pure white mixed to the proper consisting with new linseed oil. A little white lead is being mixed to help hardening of putty. On no account putty is to be used before primary coat.

Primers to be used shall be according to the manufacturers specification.

STRUCTURAL & OTHER STEEL WORKS:

STEEL WINDOW, DOORS AND VENTILATORS:

Unless otherwise specified the rates will include :

1. Work at all heights.
2. The rate will include painting with two coats of synthetic enamel paint of approved colour and make over one coat of primer.
3. Fusion welding quality of steel (ST 42 W) section conforming to I.S 2062 and IS 1038 to be used.
4. For glazing 4 mm clear plane glass shall be used where the unsupported glazing area is 1.5 sqmm and less. Where the unsupported area is more than 1.5 sqmm 5.5 mm clear plane glass shall be used.
5. Glass putty rubber beadings, hinges, tower bolts, stays teak wood or aluminium beadings as may be specified.

STRUCTURAL STEEL WORK

GENERAL :

This specification covers the supply, fabrication, transportation to site and erection on prepared foundations, structural steel work consisting of beams, columns vertical trusses, bracings shear connections etc.

Fabrication, erection and approval of steel structures shall be in compliance with :

These general specifications and IS:800-1962, IS:806, IS:1161 and supplementary drawings to be supplied to the contractors during execution of the work.

Providing shop primer coat for steel structures. Grouting complete satisfaction of the Engineer-in-charge / Architects / Project Managers / Consulting Engineer.

FABRICATION DRAWINGS :

The contractor shall prepare all fabrication and erection drawings on the basis of design drawings supplied to him and submit the same in triplicate to the Engineer-in-charge/ Architect/Consulting Engineer for review, the Engineer-incharge / Architects / Project Managers / Consulting Engineer, shall review and comment, if any of the same. Such review, if any, by the Engineer-in-charge / Architects / Project Managers does not relieve the contractor of any of his required guarantees / responsibilities. The contractor shall however be responsible to fabricate the structural strictly conforming to specifications & revised drawings.

Fabrication drawings shall include the following :

- member sizes and details

- types and dimensions of welds and bolts

- shapes and sizes of edge preparation for welding.

- details of shop & field joints, splices including sub-assemblies.

BILL OF MATERIALS :

Quality of structural steels, welding electrodes, bolts, nuts and washers etc. to be used.

Erection assemblies, identifying all transportable parts and sub-assemblies, associated with special erection instructions if required.

Calculations, splices etc. other details not specifically detailed in design drawings shall be suitably given on fabrication drawings considering normal detailing practices & developing full member strengths. Where asked for calculations for the same it shall be submitted for approval.

Any alternate design or in section is allowed when approved in writing by Architects / Project Managers .

However, if any variation in the scheme is found necessary later, the contractor will be supplied with revised drawings. The contractors shall incorporate these changes in his drawings at no extra cost and resubmit for review.

Architects / Project Managers /consultants review shall not absolve the contractor of his responsibility for the correctness of dimension, adequacy of details and connections. One copy will be returned reviewed with or without comments to the contractor for necessary action. In the former case further three copies of amended drawings shall be submitted by the contractor for final review.

The contractor shall supply three prints each of the final reviewed drawings to the Architects / Project Managers within a week since final review, at no extra cost for reference and records.

The Architects / Project Managers will verify the correct interpretation of their requirements.

If any modification is made in the design drawing during the course of execution of the job, revised design drawings will be issued to the contractor. Further changes arising out of these shall be incorporated by the contractor in the fabrication drawings already prepared at no extra cost and the revised fabrication drawings shall be duly got reviewed as per the above clauses.

MATERIALS :

ROLLED SECTIONS :

The following grades of steel shall be used for steel structures :

Structural steel will generally be of standard quality conforming to IS : 226. Whenever welded construction is specified plates of more than 200 mm thickness will generally conform to IS : 2062. Steel tubes for tubular structure shall conform to IS:1161.

WELDING MATERIALS :

Welding electrodes shall conform to IS : 814. Approval of welding procedures shall be as per IS : 823.

BOLTS, NUTS AND WASHERS :

Bolts and nuts shall be as per IS : 1367 and tested as per IS : 1608. It shall have a minimum tensile strength of 44 kg/sqmm and minimum elongation of 23% on a gauge length of 5.6 mm (an original cross sectional area of the gauge length). Washers shall be as per IS : 2016.

All materials shall conform to their respective specifications. The use of equivalent or higher grades or alternate materials will be considered only in very special cases subject to the approval of the Engineer-in-charge/Architect/Consulting Engineer in writing.

RECEIPT & STORING OF MATERIALS :

Steel materials supplied by the contractor must be marked for identification and each lot should be accompanied by manufacturers quality certificate, conforming chemical analysis and mechanical characteristics.

All steel parts furnished & supplied shall be checked, sorted out, straightened & arranged by grades & qualities in stores. Structurals with surface defects such as pitting, cracks, laminations etc. shall be rejected if the defects exceed the allowable tolerances specified in relevant standards or as directed by the Engineer-in-charge/Architects / Project Managers / Consulting Engineer.

Welding wire and electrodes shall be stored separately by qualities and lots inside a dry and enclosed room in compliance with IS : 816-1968 and as per instructions given by the Engineer-in-charge / Architects / Project Managers /Consulting Engineer. Electrodes shall be perfectly dry and drawn from an electrode even, if required. Checking of quality bolts of any kind as well as storage of same shall be made conforming to relevant standards.

Each lot of electrodes, bolts, nuts etc. shall be accompanied by manufacturer's test certificate.

The contractor may use alternative materials as compared to the design specification only with the written approval of the Engineer-in-charge / Architects / Project Managers / Consulting Engineer.

MATERIAL TESTS :-

The contractor shall be required to produce manufacturer's quality certificates for materials supplied by the contractor. Notwithstanding the manufacturer's certificates the Engineer-in-charge/ Architects / Project Managers / Consulting Engineer may ask for testing of materials in approved test houses. The test results shall satisfy the requirements of the relevant Indian Standards.

Whenever quality certificates are missing or incomplete or when material quality differs from standard specifications the contractor shall conduct all appropriate tests as directed by the Engineer-in-charge/Architects / Project Managers /Consulting Engineer at no extra cost.

Materials for which test certificates are not available or for which test results do not tally with the relevant standards specifications, shall not be used.

FABRICATION :

Fabrication shall be accordance with IS: 800 section V & IS:806 in addition to the following :
Fabrication shall be done as per approved fabrication drawings adhering strictly to work points and work lines on the same. The connections shall be welded or bolted as per design drawing. The work shall also include fabricating built up sections.

Any defective material used shall be replaced by the contractor at his own expenses, care being taken to prevent any damage to the structure during removal.

All the fabricated and delivered items shall be suitably packed to be protected from any damage during transportation & handling. Any damage caused at any time shall be made good by the contractor at his own cost.

Any faulty fabrication pointed out at any stage of work shall be made good by the contractor at his own cost.

PREPARATION OF MATERIALS :

Prior to release for fabrication, all rolled sections warped beyond allowable limit shall be pressed or rolled straight & freed from twists, taking care that an uniform pressure is applied. Minor wrappings, corrugations etc. in rolled sections shall be rectified by cold working.

The sections shall be straightened by hot working where the Architects / Project Managers so direct and shall be cooled slowly after straightening.

Warped members like plates and flats may be used as such only if wave like deformation does not exceed l/1000 but limited to 10 mm (l-length).

Surface of members that are to be joined by lap or fillet welding or bolting shall be even so that there is no gap between over lapping surfaces.

MARKING :

Marking of members shall be made on horizontal pads of an appropriate racks or supports in order to ensure horizontal and straight placement of such members. Marking accuracy shall be atleast + or -1 mm.

CUTTING :

Members shall be cut mechanically (by saw or shear) or by oxyacetylene flame. However, all tubes for structural purposes shall be cut by saw only.

All sharp, rough or broken edges, & all edges of joints which are subjected to tensile or oscillating stresses, shall be ground.

No electric metal arc cutting shall be allowed.

All edges cut by oxyacetylene shall be cleaned off impurities prior to assembly.

Cutting tolerance shall be as follows :-

A) For members connected at both ends + or -1 mm.

B) Elsewhere + or -3 mm.

The edge preparation for welding of members more than 12 mm thick shall be done by flame cutting and grinding. Cut faces shall not have cracks or be rough.

Edge preparation shall be as per IS : 823.

DRILLING :

Bolt holes shall be drilled.

Drillings shall be made to the diameter specified in drawings.

No enlarging of holes filling, by mandrelling or oxyacetylene flame shall be allowed.

Allowed variations for holes (out of roundness, accentricity plumbline deviation)shall be as per IS : 800.

- Maximum deviation for spacing of two holes on the same axis shall be + or - 1 mm.

- Two perpendicular diameters of any oval hole shall not differ by any more than 1 mm.

Drilling faults in holes may be rectified by reaming holes to the next upper diameter, provided that spacing of new hole centres and distances of hole centres to the edges of members are not less than allowed and that the increase of hole diameter does not impair the structural strength. Hole reaming shall be allowed if the number of faulty holes does not exceed 15% of the total number of holes for one joint.

PREPARATION OF MEMBERS FOR WELDING :

Assembly of structural members shall be made with proper jigs and fixtures to ensure correct positioning of members (angles, nodes etc.)

Sharp edges, rust of cut edges, notches, irregularities fissures due to faulty cutting shall be chipped or ground or filled over the length of the affected area, deep enough to remove faults completely. All steel tubes required for fabrication shall be cut only by a hacksaw/handsaw and shall not be gas cut except where permitted by the Engineer-in-charge.

Edge preparation for welding shall be carefully and accurately made so as to facilitate a good joint.

Generally no special edge preparation shall be required for members under 8 mm thick.

Edge preparation beveling denotes cutting of the same so as to result in V, X, K or U seam shapes as per IS 823.

The members to be assembled shall be clean and dry on the welding edges. Under no circumstances shall wet, greasy rust or dirt covered parts be assembled. Joints shall be kept free from any foreign matter, likely to get into the gaps between members to be welded.

Before assembly the edges to be welded as well as areas extending for atleast 20 mm shall be cleaned (until metallic polish is achieved).

When assembling members, proper care shall be taken of welding shrinkage and distortions, as the drawing dimensions cover finished dimensions of the structure.

The elements shall be got checked & approved by the Architects / Project Managers or their authorised representative before assembly.

The permissible tolerance for assembly of members preparatory to welding shall be as per IS : 823-1964. After the assembly has been checked, temporary tack welding in position shall be done by electric welding keeping in view finished dimension of the structure.

WELDING PROCEDURE :-

Welding shall be carried out only by full trained and experienced welders as tested and approved by the Architects / Project Managers . Any test carried out either by the Architects / Project Managers or their representative or the inspectors shall constitute a right by them for such tests & the cost involved thereon shall be borned by the contractor himself.

Qualification tests for welders as well as tests for approval of electrodes will be carried out as per IS : 823. The nature of test for performance qualification of welders shall be commensurate with the quality of welding required on this job as judged by the Engineer-in-charge/Architects / Project Managers / Consulting Engineer.

The steel structures shall be automatically semi-automatically or manually welded.

Welding shall begin only after the checks mentioned under preparation of materials, marking, cutting, drilling and preparation of members for welding have been carried out. Welding procedures and tests for welder's skill have been conducted as per IS : 823 and approved by the Engineer-incharge/ Architect/Consulting Engineer.

The welder shall mark with his identification on each element welded by him.

When welding is carried out on open air, steps shall be taken to protect the place of welding against wind or rain. The electrodes wire and parts being welded shall be dry.

Before beginning the welding operation, each joining shall be checked to assure the parts to be welded are clean and root gaps provided as per IS : 823.

For continuing the welding of seams discontinued due to some reason, the end of the discounted seam shall be melted in order to obtain a good continuity. Before resuming the welding operation, the groove as well as the adjacent parts shall be well cleaned for a length of approximately 50 mm.

For single butt welds (in V, 1/2 V or U) and double butt welds (in K, double U etc.) the rewelding of the root is mandatory but only the metal deposit of the root has been cleaned by back guaging or chipping.

The welding seams shall be left to cool slowly. The contractor shall not be allowed to cool the welds quickly by any other method.

For multi-layer welding, before welding the following layer, the formerly welded layer shall be cleaned metal bright by light chipping and wire brushing. Packing strips shall not be allowed.

The order and method of welding shall be so that :

No unacceptable deformation appears in the welded parts. Due margin is provided to compensate for contraction due to welding in order to avoid any high permanent stresses.

The defect in welds must be rectified according to IS : 823 & as per instruction of Engineer-in-charge/Architects / Project Managers /Consulting Engineer.

WELD INSPECTION :

The weld seems shall satisfy the following :

shall correspond to design shapes and dimensions.

shall not have any defects such as cracks, incomplete penetration & fusion, under-cuts, rough surfaces, burns, blow holes and porosity etc. beyond permissible limits.

During the welding operations and approval of finished elements, inspections and tests shall be made as shown in Annexure B.

The mechanical characteristics of the welded joints shall be as in IS : 823.

PREPARATION OF MEMBERS FOR BOLTING :

The members shall be assembled for bolting with proper jigs and fixtures to sustain the assemblies without deformation and bending.

Before assembly all sharp edges, shavings, rust, dirt etc. shall be removed.

Before assembly the contacting surfaces of the members shall be cleaned & given a coat of primer as per IS:2074.

The members which are bolt assembled shall be set according to drawings and temporarily fastened with erection bolts (minimum 4 pieces) to check the coaxiality of the holes.

The members shall be finally bolted after the deviations have been corrected, After which there shall not be gaps. Before assemblies, the members shall be checked and got approved by the Engineer-in-charge/Architect/Consulting Engineer.

The difference in thickness of the sections that are but assembled shall not be more than 3% or maximum 0.8 mm whichever is less. If the difference is larger, it shall be corrected by grinding or filling.

Reaming or holes to final diameter or cleaning of these shall be done only after the parts have been check assembled.

As each hole is finished to final dimensions (reamed if necessary) it shall be set and bolted up. Erection bolts shall not be removed before other bolts are set.

BOLTING UP :

Final bolting of the members shall be done after the defects have been rectified & approval of the joints obtained.

The bolts shall be tightened starting from the centre of joint towards the edge.

PLANNING OF ENDS :

Planning of ends of members like column ends shall be done by grinding when so specified in the design.

Planning of butt welded members shall be done after these have been assembled, the spare edges shall be removed with grinding machine or files.

The following tolerance shall be permitted on member that have been planed :

On the length of the member having both ends planed, maximum + or - 2 mm with respect to design.

Level differences of planed surface, maximum 0.3mm deviation between planed surface and member's axis maximum 1/1500.

HOLES FOR FIELD JOINTS :

Holes for field joints shall be drilled in the shop to final diameters and tested in the shop with trial assemblies.

When three dimensional assembly is not possible in the shop, the holes for field joints may be drilled in shop & reamed on site after erection on approval by the Architects / Project Managers .

For bolted steel structures, trial assembly in shop is mandatory.

The tolerance for spacing of holes shall be + or - 1 mm.

TOLERANCES :

All tolerances regarding dimensions, geometrical shapes and sections of steel structures shall be as per annexure 'C' if not specified in the drawing.

MARKING FOR IDENTIFICATION :

All elements and members prior to dispatch for erection shall be shop marked.

The members shall be visibly marked with a weather proof light colored paint. The size & thickness of the numbers shall be chosen as to facilitate the identification of members.

For the small members that are delivered in bundles or crates the required marking shall be done on small metal tags securely tied to bundle while the crates shall be marked directly.

Each bundle or crate shall be packed with members for one & same assembly in the same bundle or crate general utility members such as bolts, guests etc. may be packed.

All bill of materials showing weight, quality and dimensions of contents shall be placed in the crates.

The members shall be marked with a durable paint, in visible location, preferably at one end of the member so that these may be easily checked during storage & erection.

All members shall be marked in the shop before inspection and acceptance.

When the member is being painted, the marking area shall not be painted out bordered with white paint.

The marking & job symbol shall be registered in all shop delivery documents (transportation, for erection etc).

SHOP TEST PRE-ASSEMBLY :

For steel structures that have the same type of welding the shop test pre-assembly shall be performed on one cut of every 10 members minimum.

For bolted steel structures, shop test pre-assembly is mandatory for all elements as well as for the entire structure in conformity with 'holes for field joints'.

SHOP INSPECTION AND APPROVAL :

GENERAL :

The Architects / Project Managers or their representative shall have free access at all responsible times to the contractor's fabrication shop & shall be afforded all reasonable facilities for satisfying himself that the fabrication is being undertaken in accordance with drawings & specification

Technical approval of the steel structure in the shop by the Architects / Project Managers is mandatory.

The contractor shall not limit the number and kinds of tests, final as well as intermediate once, or extra tests required by the Architects / Project Managers .

The contractor shall furnish necessary tools, gauges, instruments etc. and technical and non-technical personnel for shop tests by the Architects / Project Managers , free of cost.

SHOP ACCEPTANCE :

The Architects / Project Managers shall inspect and approve at the following stages.

The following approval may be given in the shop.

- Immediate approval of work that cannot be inspected later.
  - Partial approvals.
  - Final approval.

Intermediate approval of work shall be given when a part of the work is performed later.

- Cannot be inspected later.

- Inspection would be difficult to perform and results would not be satisfactory.

Partial approval in the shop is given on members and assemblies of steel structures before the primer coat is applied and includes:-

Approval of materials

Approval of filed joints

Approval of parts with planed surfaces. Test erection.

Approval of members.

Approval of markings.

Inspection and approval of special features like rollers, loading, platform mechanism etc.

During the partial approval, intermediate approvals as well as all former approvals, shall be taken into consideration.

FINAL APPROVAL IN THE SHOP :

The final approval refers to all elements and assemblies of the steel structures, with shop primer coat, ready for delivery from shop to be loaded for transportation or stores.

The final approval comprises of:

Partial approvals

Approval of shop primer coat.

Approval of mode of loading and transport.

Approval of storage (for materials stored).

PAINTING & DELIVERY :

PREPARATION OF PARTS FOR SHOP PAINTING :

Painting shall consist of providing one coat of red oxide zinc chromate primer or equivalent primer as approved to steel members before dispatch from shop. Final painting shall be done with two coats of approved brand of enamel paint of required shade prior to erection.

Primer coat shall not be applied unless :

Surface have been wire brushed, cleaned of dust oil, rust etc.

Erection gap between members, spots that can not be painted or where moisture of other aggressive agents may penetrate have been filled with approved type of oil and putty.

The surface to be painted are completely dry.

The parts where water of aggressive agents may collect (during transportation, storage, erection & operation are filled with putty & provided with holes for drainage of water).

Members and parts have been inspected and accepted.

Welds have been accepted.

The following are not to be painted or protected by any other product :

Surfaces which are in vicinity of joints to be welded at site.

Surfaces bearing markings.

Other surfaces indicated in the design.

The following shall be given a coat of hot oil or any approved resistant lubricant only.

Planned surfaces.

Holes for links.

The surfaces that are to be embedded or in contact with the concrete shall be given a coat of cement wash.

The surfaces which are in contact with the ground, gravel or brickwork and subject to moisture, shall be given bituminous coat.

The other surfaces shall be given a primer coating.

Special attention shall be given to locations not easily accessible, where water can collect and which after assembly and erection cannot be inspected, painted and maintained. Holes shall be provided for water drainage and inaccessible box type sections shall be hermetically sealed by welds.

If specified elsewhere in the schedule of quantities the contractor shall paint further course of red oxide after erection and placing in position of the steel structures.

PACKING, TRANSPORTATION, DELIVERY :

After final shop acceptance and marking, the items shall be packed and loaded for transportation.

Packing must be adequate to protect item against warping during loading and unloading.

After lifting devices shall be used for loading in order to protect item against warping.

Slender projecting parts shall be braced with additional steel bars, before loading, for protecting against warping during transportation.

Loading and transportation shall be done in compliance with transportation rules.

If certain parts cannot be transported in the lengths stipulated in the design, the position & type of additional splice joints shall be approved by the Architects / Project Managers .

Items must be carefully loaded on platforms of transportation means to prevent warping, bending or falling, during transportation.

The small parts such as fish plates, plates gussets etc. shall be securely tied with wire to their respective parts.

Bolts, nuts and washers shall be packed and transported in crates.

The parts shall be delivered in the order stipulated by the Architects / Project Managers and shall be accompanied by document showing :

- Quality and quantity of structure or members.

- Position of members in the structure.

- Particulars of structure.

- Identification number/job symbol.

FIELD ERECTION :

The erection work shall be permitted only after the foundation or other structure over which the steel work will be erected is approved and is ready for erection.

The contractor shall satisfy himself about the levels, alignment etc. for the foundations well in advance, before starting the erection. Minor corrections shall be carried out by the contractor on his own expense.

Any faulty erection done by the contractor shall be made good at his own cost.

Approval by the Architects / Project Managers or their representatives at any stages of work does not relieve the contractor of any of his required guarantees of the contract.

STORAGE AND PREPARATION OF PARTS PRIOR TO ERECTION :

The storage place for steel parts shall be prepared in advance and got approved by the Architects / Project Managers before the steel structures start arriving from the shop.

Platform shall be provided by the contractor near the erection site for preliminary erection work.

The contractor shall make the following verifications upto receipt of material at site :-

- For quality certificates regarding materials and workmanship according to these general specifications and drawings.
- Whether parts received are complete without defects due to transportation loading and unloading defects, if any are well within the admissible limit.

For the above work sufficient space must be allotted in the storage area.

Steps shall be taken to prevent warping of items during unloading.

The parts shall be stored according to construction symbol & markings so that these may be taken out in order of erection.

The parts shall be atleast 150 mm clear from round on wooden or steel locks for protection against direct contact with ground and to permit drainage of water.

If the rectification of members like straightening etc. are required these shall be done in a special place allotted which shall be adequately equipped.

The parts shall be clean when delivered for erection.

ERECTION AND TOLERANCES :

Erection in general shall be carried out as required and approved by Architects / Project Managers .

Positioning and leveling of the structure alignment and plumbing of the stanchion and fixing every member of the surfecture shall be in accordance with the relevant drawings and to complete satisfaction of the Architects / Project Managers .

The following checks and inspection shall be carried out before, during and after erection.

- Damage during transportation.

- Accuracy of alignment of structure

- Erection according to drawings & specifications

- Progress and workmanship.

In case there by any deviations regarding positions of foundations or anchor bolts, which would lead to erection deviations, the Architects / Project Managers shall be informed immediately. Minor rectification's in foundations, orientation of bolts holes etc. shall be carried out as a part of the work at no extra cost.

The various parts of the steel structure shall be so erected as to ensure stability against inherent weight wind and erection stresses.

The structure shall be anchored and final erection joints completed after plan and elevation positions of the structural members have been verified with corresponding drawings and approved by the Architects / Project Managers .

The bolted joints shall be tightened so that the entire surface of the bolt heads and nuts shall rest on the member. For parts with slopping surfaces tapered washers shall be used.

FINAL ACCEPTANCE AND HANDING OVER THE STRUCTURE :

At acceptance, the contractor shall submit the following documents

- Shop and erection drawings - either in tracings or reproducibles.

- 4 copies of each of the following :

Shop acceptance documents

Quality certificate for structural, plates, etc. (electrodes, welding wire, bolts, nuts, washers etc.)

List of certified welders who worked on erection of structures.

Acceptance and intermediate control procedure of erection operation.

Approval by the Architect at any stage of work does not relieve the contractor of any of his required guarantees of contract.

METHOD OF PAYMENT :

Payment for steel work shall be made on basis of admissible weight of the structure accepted, the weight being determined as described below :

The rate for supply, fabrication and erection shall include cost of all handling and transportation to owner's store/ site of work where supply and fabrication only are involved, trimming, straightening, edge preparation, preparation and getting reviewed of fabrication drawings & providing one coat of red oxide zinc chromate primer and two coats of enamel painting.

In case, owner supplies materials, the rate shall include the cost of steel materials, taking delivery of the materials from owner's store, all handling rehandling, loading and unloading, transport to site of work, returning of surplus materials to owner's stores etc. complete as well as the cost of all handling and transport, scaffolding, temporary supports, tools and tackles, touching up primer coat, grouting etc.

The weight for payment will be assessed from the approved fabrication drawings and the respective bill of material prepared by the contractor and approved by the Architects / Project Managers . The weight of structural materials/plate shall be calculated wherever necessary on the basis of IS handbook. If sections are different from IS section, then manufacturers handbook shall be adopted. No allowance in weights shall be made for rolling tolerance.

Sections built out of plates structural shall be paid on the actual weight incorporated except for gussets which will be paid on the weight of the smallest rectangle enclosing the shape. No deductions shall be made for skew cuts in rolled steel sections.

Welds, bolts, nuts, washers etc. shall not be measured. Rates for structural steel work shall be deemed to include the same.

No other payment either for temporary works connected with this contract or for any other item such as welds, shims, racing plates, etc. shall be made. Such item shall be deemed to have been allowed for in the rate quoted for steel work.

GROUTING OF POCKETS :

Grouting of pockets and under base plates will be done only after the steel work has been leveled and plumbed and the base of stanchions are supported by steel shims. The space below the base plate and pockets shall be thoroughly cleaned

The mortar used for grouting shall not be lesser than 1:2 (1 cement : 2 sand) grade 300 in case of concrete) and shall be mixed to the minimum consistence required, it shall be poured under a suitable head and tammed until the space has been completely filled.

Tolerances allowed in the erection of plant building Without Cranes :-

The maximum tolerances for line and level of the steel work shall be + or - 3.00 mm on any part of the structure. The structure shall not be out of plumb more than 3.5 mm on each 10 m section of height and got more than 7.00 mm per 30 m section.

The tolerances shall apply to all parts of the structure unless the drawings issued for erection purposes state otherwise.

ANNEXURE - A

Inspection or Test	Coverage	Procedure	Evaluation findings & Remedy of defect
Inspection of weld Seam	All welds	Naked eye of lens	All faulty welds shall be rectified
Checking of Sizes	Atleast one for each Weld	Ordinary measuring instruments (rule, templates)	Should faulty weld be found all welds shall be checked & all defects shall be rectified.
Mechanical tests for Welding procedure performance & Electrodes		As per IS:823	As per IS : 823

A N N E X U R E - B

INADMISSIBLE WELD DEFECTS AND TOLERANCE ALLOWED FOR WELDS

Defects	Detailing of sketching of Defect	Allowed tolerances & remedy of defects	Cause of defects	Mode of finding Defects
Unsatis-factory appearance	Uneven width rugged seam	At discretion Cut weld & reweld	Uneven welding progress, voltage fluctuations, varying arc length, negligence, inexperienced welder	External (visual) inspection.
Unsatis-factory shape	Shallow or jutting welds	no variance from design shape shall be allowed	negligence	Visual inspection template checking
Incomplete Weld		Not allowed fill in weld		Template checking
Molten metal flow		Not allowed fill in weld	Excessive melting, wrong handling of electrodes.	Visual inspection.
Pits		Not allowed cut & Reweld	Wrong welding technique	Visual inspection
Surface cracks		Not allowed cut and reweld	Great stresses, sudden cooling, wrong type of electrodes	Visual inspection.
Incorrect Sectional dimensions A) Depth		B1= +/-2mm B2= +/-2mm b = +/-1mm c= +/- 1mm	Negligence	Template checking
Weld		Chisel & Grind		

Defects	Detailing of sketching of Defect	Allowed tolerances & remedy of defects	Cause of defects	Mode of finding Defects
Insufficient	For weld lengths 11+5 mm for 12+10 mm for shorter seams cut & reweld. or complete to length		Negligence	Rule Checking
Back cuts	If 0.5 mm for 10 mm and c 1 mm for 10 mm replace relevant members		Burnt material, excessive. melting	Visual inspection
Surface Porosities	max. 5% of seam area cut and reweld		Frequent inter-ruptions or welding electrodes inade-quately covered	Visual inspection

Inadequate appearance of weld may be allowed if no other defects that might diminish weld strength are present. Sectional weld shape must comply with design indications. No concave welds shall be allowed for specified convex welds, or vice versa. Tolerance for concavity or convexity of welds shall be 1 x A ("A" being the height of the triangle within the section shown), but more than 0.6mm.

MISCELLANEOUS WORKS :

RAIN WATER PIPES

P.V.C. PIPES

General

P.V.C. Pipes shall conform to the relevant specification of I.S. 4985 or they should be of SWR type pipes. They shall be made of polyvinyl chloride (PVC) and shall be sound with good surface finish, mechanical strength and capacity. During manufacture only those additives may be added to produce and above characteristics. No additives shall be added separately or together in quantities sufficient to constitute a toxic hazard, or impair the fabrication or welding properties of the pipe or impair its physical or chemical properties. Addition of the manufactures own rework material during manufacture is permissible only upto 10%. All pipes shall be spigot and socket type (bell and type).

RAINWATER ROOF OUTLETS

Rainwater outlets shall be through flow cast iron body with aluminum ring and aluminum dome with stainless steel screws. Outlet sizes shall be equal to the nominal bore of the rain water pipes. Adaptors with threaded connection for rain water outlets and solvent welded connection for rain water pipes shall be provided for each rainwater outlets.

Balcony or side inlet roof outlets shall be with full flat grating with solvent socket.

Pipe Sizes and Wall Thickness:

Pipe Dia (mm)	Wall Thickness (mm)
4Kg/cm2	
110 mm	2.2 mm
75 mm	1.8 mm
6Kg/cm2	
As per IS code	

Tolerances:

Tolerances on diameters and wall thickness shall be as per IS 4985.

Fittings:

All fittings shall be injection moulded socket fittings with or without inspection doors as specified and shall be in accordance with the requirements of IS 7834.

Pressure ratings and tolerances shall be as per IS 4985.

Laying and Jointing:

Pipes shall be cut to length required including the portion to be inserted in the socket with a hacksaw. The pipe shall be cut square. Pipes and sockets shall be clean and dry and burrs removed both inside and outside with a file. The surface of the surfaces to be in contact shall be roughened with emery paper, and dry fit checked.

A thick coat of solvent cement shall be applied to the outer surface of the pipe and a thin coat on the inside surface of the socket by means of a brush. Solvent cement shall be of approved made and turned for 90 degree to ensure even distribution of cement. Excess cement shall be wiped off. G.I clamps shall be used for clamping to walls etc. pipe shall be clamped at least 50mm away from the wa ll surface using G.I clamps screwed to the wooden plugs, not more than 1 meter apart.

Connecting C.I. pipe to P.V.C. pipes:

A connector socket shall be used for such connections. A rubber ring is to be placed over the spigot. Which is then inserted into the socket connector, gentle, even heat is applied to the connector socket by means of a blowlamp. The connector socket will shrink making a watertight airtight joint.

Connecting P.V.C. to G.I pipes:

Standard threaded couplers shall be used for this purpose.

WATER / WEATHER PROOFING TREATMENT

PROVIDING TERRACE WEATHER / WATER PROOFING TREATMENT OVER THE ROOF SLAB WITH FOLLOWING OPERATIONS:

Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.**

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non acceptable standard the same will be rejected by our Architects / Project Managers with out any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.**

VI. **All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor.**

VII. **The specifications given in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.**

PART 1 : WATERPROOFING LAYER

1. After curing of the slab, the surface shall be cleaned thoroughly and any mortar droppings, debris etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, dirt and foreign materials before starting the treatment.

2. Before starting the grouting process, a 100mm depth water ponding for 15 days shall be carried out to identify the location of leakage, dampness in the roof slab.

3. All construction joints, honey combed concrete, leakage / dampness portion in the slab shall be treated with pressure grouting using cement slurry mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning / water ponding of the surface. The grouting shall be carried out with 10 PSI pump at the appropriate location as required.

4. Thereafter, the slab surface shall be applied with two coats NI-O-POL (acrylic polymer) mixed with cement in the ratio of 1:1 pbw

5. After the above four steps of primary treatment, the slab surface shall be applied with primer coat consisting of cement slurry and PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement. The primer coat shall be neatly filled to seal all voids, pores, undulation in the surface to make the surface water repellent.

6. Over the primer coat, CM 1:4 mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement shall be laid before the primer coat gets dried.

7. Soon after the mortar is laid, a layer of brick bat coba consisting of various sizes of brick bats to an average thickness of 130mm shall be laid over the green mortar bed to the required gradient. The brick bat coba layer shall not be less than 65mm at kurras or any other locations of the treatment. The brick bat coba shall be laid to the required gradient 1:100 or as directed and the drains shall be maintained at 1:80 gradient. Curing shall be carried out for a minimum period of 3 days.

8. On curing of the brick bat coba, all joints / space between the brick bats shall be grouted with CM 1:4 mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement. Necessary curing shall be followed till to start of further treatment.

9. On completion of curing period, a layer of 25mm thick M20 cement concrete using 6mm and down size graded granite aggregate mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement and fibre mesh HARBOURITE 12mm polypropylene fibre manufactured by Synthetic Ind. Inc. USA at 125 gram per bag of cement shall be laid over the brick bat coba layer. The concrete layer shall be carried out using alternative bay panel method. The size of concrete panels shall 3m x 3m. The finish surface shall have the broom finish to receive the further china mosaic treatment.

During laying of the adjacent concrete panel the bond coat of NI-O-POL acrylic polymer mixed with cement in ratio of 1:1 pbw shall be applied on the cold joint between adjacent panels.

10. At the junction of parapet wall and roof slab, necessary wattas consisting of brick bats in CM 1:4 mixed with PROOFSOL at 1 Kg per bag of cement and HARBOURITE polypropylene fibres at 125 gm per bag of cement and the parapet treatment shall be carried out upto 300 to 450mm with drip moulds in CM 1:4 for easy and immediate dropping of rain water from the parapet.

11. On completion of entire treatment including kurras treatment, the terrace shall be ponded with water for a minimum period of 15 days for the purpose of curing and testing of the treatment. During this period, leakage, dampness etc., shall be observed and if any defects found shall be arrested immediately before starting the protective layer treatment

PART 2 : RAIN WATER DOWN TAKE PIPE KURRAS

1. The opening left out to fix the rain water down take pipe during concreting of the roof slab shall be cleaned and chased to the required size, profile as directed. Only core cutting technique shall be used for any openings not provided during concreting.

2. The rain water pipes kurras shall be fixed to the required location and the gap between rain water pipe kurra and slab shall be grouted with M30 concrete mixed with PROOFSOL integral waterproofing compound at 1 Kg per bag of cement and HARBOURITE polypropylene fibre at 125 gm per bag of cement.

3. A further treatment shall be carried out around the rain water pipe kurra with 50 x 50mm grooves and remove the loose concrete thoroughly washed with water.

4. The sockets / grooves shall be pressure grouted with cement slurry mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement.

5. A groove of 20 x 10mm shall be neatly cut around the pipe and filled with epoxy putty made out of ARALDITE GY 251 and hardener HY 840 mixed with Silica flour in proportion 1:½:4 of make CIBA, so that to take care of any moisture movement along the pipes.

6. A PVC flashing between RCC surface and waterproofing treatment of concrete shall be fixed as further waterproofing treatment.

PART 3 : PROTECTIVE LAYER

1. After successful waterproofing treatment, the surface shall be cleaned thoroughly free from dust, dirt and foreign materials using wire brush before starting the treatment.

2. Over the clean surface, CM 1:4, 25mm thick mixed with PROOFSOL integral waterproofing compound at the rate of 1 Kg per bag of cement shall be laid in slope as directed. On the green mortar layer, cement slurry with PROOFSOL shall be spread over to fix the broken ceramic tiles. Broken ceramic tiles shall be placed over green slurry at the proportion 30% with Cobalt blue tiles and balance with off white colour ceramic tiles. The broken pieces shall be 10 to 40mm size and pressed in slurry with wooden rammer gently till squeezing of the mortar into the joints.

3. After final setting of the tiles, the surface shall be cleaned with saw dust or any other approved method.

4. Curing shall be carried out to minimum period of 10 days by ponding over the treated terrace.

5. The final finished surface of the broken ceramic tile layer shall be cleaned with approved detergent. No acid to be used.

TOILET WATER PROOFING TREATMENT
Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of**

water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non-acceptable standard the same will be rejected by our Architects / Project Managers without any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.**

VI. **All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor.**

VII. **The specifications given in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.**

All pre-work's like grooves, electrical / GI piping conduit, holes made to connect nahani trap, P-trap, Floor trap etc., should be completed before starting the waterproofing process.

PART A : PRIMARY TREATMENT

1. On completion of curing and all pre-work's stated above, the surface shall be cleaned thoroughly and any mortar droppings, debris etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, dirt and foreign materials before starting the treatment.

2. Before starting the grouting process, a 100mm depth water ponding for 10 days shall be carried out after plugging the trap hole to identify any loose pockets which have potential for leakage and create water ingress in the floor slab.

3. All construction joints, honey combed concrete, leakage / damp areas in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 or an approved equivalent grout admixture at the rate of 0.45 Kg per bag of cement. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, vertical surfaces, columns and wherever leakages are expected during cleaning / water ponding of the surface. The junction of vertical and horizontal surface shall have the CANTS at 45^0 using NITO BOND SBR modified mortar CM 1:3 as detailed in drawings.

4. All water supply and sanitary lines in the toilets shall be sealed with WINSIL 20 silicone sealant or an approved silicone sealant all-round the pipes including grouting with cement slurry mixed with CONBEX 100 as detailed in drawings.

5. After the above said steps of primary treatment, the slab surface shall be applied with primer coat consisting of cement slurry admixed with CONBEX 100 or an approved equivalent grout admixture at the rate of 225 gms per bag of cement. The primer coat shall be neatly filled to seal all voids, pores, undulation in the surface to make the surface watertight.

PART B : WATERPROOFING TREATMENT

1. After completion of the primary treatment a layer of two coats of Fosroc's BRUSH BOND RFX to a total thickness of 1mm or an approved equivalent cementitious acrylic waterproofing coats shall be carried out on horizontal and vertical surfaces of the toilet as shown in the drawings. The coated surface should be water cured for a minimum period of three days.

2. On completion of curing process, a layer of CM 1:4, 20 to 25 mm thick water proofing plaster admixture with CONPLAST X 421 IC or an approved equivalent integral waterproofing compound at the rate of 130 ml per bag of cement shall be carried out in 2 layers. Broken jelly may be placed on the 1st coat of plaster for 2nd coat plaster work. The necessary slopes from entrance door towards water escape pipe shall be made in accordance to the site requirement as detailed in drawing. The waterproofing treatment shall be carried out on all side walls upto 450 mm above toilet finished floor level and all beam tops, junction etc.,

3. The treated surface shall be flooded with water upto slab drop for a minimum period of 4 days for curing cum testing purposes. After 4 days, get the same checked and certified before proceeding for further activity. During this period, leakage, dampness etc., shall be observed and if any defects found shall be arrested immediately before starting further activities.

PART C : FILLING OF TOILET SUNKEN PORTION

Case 1 : If the depth of sinking is more than 50mm the same shall be made up by using well burnt selected brick bats free from over and under burnt brick bats shall be laid to the require slope. Admixture with CONPLAST 421 IC or an approved integral waterproofing compound including the gap between the brick bats to also be grouted with the same mortar. A layer of 50mm thick M20 screed concrete to the required level and gradient admixture with

CONPLAST 421 IC or an approved integral waterproofing compound shall be carried out before tiling layer taken up.

Case 2 : If when the depth of sinking is less than 50mm shall be made up by 50mm thick M20 screed concrete to the required level and gradient admixture with CONPLAST 421 IC or an approved integral waterproofing compound before tiling layer taken up.

The necessary curing shall be taken up for a minimum period of 7 days.

SLOPING SUNSHADE / PORTICO SLAB WATER PROOFING TREATMENT

Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.**

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non acceptable standard the same will be rejected by our Architects / Project Managers with out any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.**

VI. **All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor.**

VII. The specification give in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.

All pre-work's like grooves, electrical / GI piping conduit, holes made to connect khurra, Floor trap etc., should be completed before starting the waterproofing process

PART A : PRIMARY TREATMENT

1. On completion of curing and all pre-work's stated above, shall be cleaned thoroughly and any mortar droppings, debris etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, dirt, and foreign materials before starting the treatment.

2. Before starting the grouting process, a 100mm depth water ponding for 10 days shall be carried out after plugging the trap hole to identify the loose pockets which have potential for leakage and create water ingress (if applicable), leakage in the slab.
3. All construction joints, honey combed concrete, leakage / damp areas in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 or an approved equivalent grout admixture at the rate of 225 gm per bag of cement. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, vertical surfaces, columns and wherever leakages are expected during cleaning / water ponding of the surface. The junction of vertical and horizontal surface shall have the CANTS at right angles using NITO BOND SBR modified mortar CM 1:3 as detailed in drawings.

4. If there are service pipelines in the chajja the same shall be sealed with WINSIL 20 silicone sealant or an approved silicone sealant all-round the pipes including grouting with cement slurry mixed with CONBEX 100 as detailed in drawings.

5. After the above said steps of primary treatment, the chajja surface shall be applied with primer coat consisting of cement slurry admixed with CONBEX 100 or an approved equivalent grout admixture at the rate of 225 gm per bag of cement. The primer coat shall be neatly filled to seal all voids, pores, undulation in the surface to make the surface watertight.

PART B : WATERPROOFING TREATMENT

1. Over the primary treatment, a layer of two coats of Fosroc's BRUSH BOND RFX to a total thickness of 1mm or an approved equivalent cementitious acrylic waterproofing coat shall be carried out on horizontal and vertical surface of wall / fascia of chajja as indicated in the drawings. The coated surface should water cured for a minimum period of three days.

2. On completion of curing process, a layer of CM 1:4, 25 mm thick water proofing plaster admixture with CONPLAST X 421 IC or an approved equivalent integral waterproofing compound at the rate of 130 ml per bag of cement, Microsilica Conplast MS shall be carried out in 2 layers. Broken jelly may be placed on the 1st coat of plaster for 2nd coat plaster work. The necessary slopes from entrance door towards water escape pipe shall be made in accordance to the site requirement as detailed in drawing. The waterproofing treatment shall be carried out on all side walls upto 300mm above chajja finished floor level and all beam tops, junction etc.

3. The treated surface shall be flooded with water for a minimum period of 4 days for curing cum testing purposes. After 4 days, get the same checked and certified before proceeding for further activities. During this period, leakage, dampness etc., shall be observed and if any defects found shall be arrested immediately before starting further activities.

The necessary curing shall be taken up for a minimum period of 7 days. The texture paint finish may be taken up on the finished surface after the treatment gets fully dried.

UNDER GROUND SUMP TANK WATERPROOFING TREATMENT - INTERNAL SURFACE
Note :

I. The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.

II. A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,

III. The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.

IV. The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.

V. If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non-acceptable standard the same will be rejected by our Architects / Project Managers without any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.

VI. All services requirements for successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor.

VII. The specifications give in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.

All pre-work's like grooves, GI piping conduit, holes made to connect service lines etc., should be completed before starting the waterproofing process.

PART A: PRIMARY TREATMENT :

After curing of the tank, the internal surface of the tank shall be cleaned thoroughly and shall be pressure grouted for the entire surface of the tank.

Before starting the grouting process, water shall be filled for 10 days in the tank to identify loose pockets which have potential for leakage and create water ingress, leakage in the tank side walls / slab.

All internal concrete surface of the tank shall be grouted in a grid pattern of 600 x 600mm using pneumatic drill. 18mm dia holes shall be drilled in the concrete surface upto half of the thickness of wall / slab at the above said spacing of grid pattern. PVC / MS nozzles shall be fixed in the drilled holes using a single component rapid setting compound like Renderoc plug or approved equivalent. The tank surface shall be treated with pressure grouting using cement slurry mixed with a expansive and plasticizing admixture like CONBEX 100 at the rate of 225 gm per bag of cement or an approved equivalent grout admixture with the required consistency. The prepared cement slurry shall be injected through the prefixed nozzles under pressure using a 10 PSI grout pump to fill all the pores / gaps / construction

joints / wherever leakages are expected in the tank surface. On completion of grouting, the nozzles shall be sealed with a quick setting waterproofing agent like Renderoc plug. After the grout sets, the grouting holes shall be treated by removing the nozzles and finishing flush with the surface.

On completion of the grouting process, water shall be filled again for 10 days in the tank to identify the water leakage / dampness in the tank.

After water test, the surface shall be cleaned thoroughly and any mortar droppings, debris etc., shall be mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, dirt and foreign materials before starting the waterproofing treatment.

All water supply and sanitary lines in the tank shall be sealed with WINSIL 20 silicone sealant or an approved silicone sealant all-round the pipes including grouting with cement slurry mixed with CONBEX 100 as detailed in drawings.

PART B: WATERPROOFING TREATMENT

1. Over the primary treatment, a layer of two coats of BRUSH BOND RFX or an approved equivalent cementitious acrylic waterproofing coat shall be carried out on horizontal and vertical surfaces of tank. The coated surface should be water cured for a minimum period of three days.

2. On completion of curing process, a layer of CM 1:4, 25 mm thick water proofing plaster admixture with CONPLAST X 421 IC or an approved equivalent integral waterproofing compound at the rate of 130 ml per bag of cement, Microsilica Conplast MS at 1% by weight of cement, fiber mesh HARBOURITE fine fibrillated 100% virgin polypropylene fibers manufactured by Synthetic Inc., USA in the cement mortar at 125gm per bag of cement shall be carried out in 2 layers. Broken jelly may be placed on the 1st coat of plaster for 2nd coat plaster work. The necessary slopes fin the tank floor towards water escape pipe shall be made in accordance to the site requirement as detailed in drawing. The waterproofing treatment shall be carried out on all sides walls upto soffit of cover slab.

3. The treated surface shall be flooded with water for a minimum period of 4 days for curing cum testing purpose. After 4 days, get the same checked and certified before proceeding for further activity. During this period, leakage, dampness etc., shall be observed and if any defects are found the same shall be arrested immediately before starting further activities.

The necessary curing shall be taken up for a minimum period of 7 days. The food grade epoxy coating or glazed tile cladding may be taken up after the floor gets fully dry.

WATERPROOFING TREATMENT OVER UNDER GROUND SUMP (WHERE TERRACE GARDEN IS PLANNED)

Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.**

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non-acceptable standard the same will be rejected by our Architects / Project Managers without any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.**

VI. **All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor**

VII. **The specifications given in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.**

All pre-works like grooves, electrical / GI piping conduit should be completed before starting the waterproofing process

PART A: PRIMARY TREATMENT -

After curing of the slab, the surface shall be cleaned thoroughly and any mortar droppings, debris etc. The surface shall be free from dust, dirt and foreign materials before starting the treatment. The surface shall be mechanically abraded with carborandum stone, wire brush and washed with plenty of water.

Before starting the grouting process, 100mm depth water ponding for 10 days shall be carried out to identify loose pockets which have potential for leakage and create water ingress, leakage in the roof slab.
All construction joints, honey combed concrete, leakage / damp portions in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 at dosages of 225gm per bag of cement or an approved equivalent grout admixture. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning / water ponding of the surface.

If any water supply and sanitary pipelines in the slab shall be sealed and grouted with WINSIL 20 manufactured by M/s. GE Bayer or an approved equivalent silicone sealant.

PART B: WATERPROOFING TREATMENT

M20 screed concrete mixed with CONPLAST X 421 IC or an approved equivalent integral waterproofing compound at the rate 130 ml per bag of cement may be used to get the required gradient over the slab where required per drawings.

After curing of the concrete, the surface shall be prepared by removing dust, latience using wire brush and applied with polymer based spray applied membrane Proofex SM, 2mm thick as per manufacturer's (Fosroc) specification. Over the membrane treatment, geo-textile fabric manufactured by M/s. Fosroc Chemicals India Ltd., shall be laid immediately after application of Proofex SM membrane treatment. Geo-textile fabric per Fosroc's specification shall be applied to the surface of Proofex SM membrane treatment within 5 minutes of application and whilst the surface is till wet so that the geo-textile can get fused to the membrane.

Over the geo-textile membrane a layer of 600 x 600 mm Shahbad stone slab of 25 to 30 mm thick with machine cut edges shall be laid over CM 1:4 mixed with CONPLAST X 421 IC or an approved integral waterproofing liquid at a dosage of 130ml per bag of cement. The joints of natural stone shall left open at the time of laying the Shahbad stone slab and it shall be

filled after 2 to 3 days with a mixture of sand cement mortar having a ratio 1:3 mixed with above said integral waterproofing liquid. The bedding thickness and the joint width shall be 20mm and 5 to 10mm respectively. The top surface of treatment shall be finished with CM 1:4, 20mm thick water proofing plaster admixture with Micro silica conplast MS 1% by weight of cement, graded fibrillated 100% virgin polyproplythene fibres manufactured by Synthetic Inc., USA in the structural concrete parapet at 0.9 Kgs per Cmt of concrete.

On completion of entire waterproofing treatment, a layer of NON WOVEN geo-textile fabric like Terram B20 (200g/m Sqm) or approved equivalent shall be laid. A layer of coarse aggregate of 20 to 40mm filtration bed of 150mm shall be carried out as detailed in drawings.

Further landscape gardening process may be taken up with approved good quality sweet earth as per the landscape tender specification.

UNDERGROUND SUMP WATER PROOFING TREATMENT - FOR OUTSIDE SIDE AND OUTER BOTTOM OF TANK

Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.**

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non-acceptable standard the same will be rejected by our Architects / Project Managers without any liability whatsoever and no payment will be made for the entire waterproofing system and same**

will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.

VI. All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor

VII. The specification give in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.

PRE-WORKS

Over the levelled and compacted soil, rubble packing shall be carried out in accordance to the specification FW064

LDPE film of 500 micron thickness shall be laid over the finished rubble packing and sandwich the film by a layer of 30mm thick river sand such as 15mm over and below the film as per the specifications FW065. The overlapped joints shall be properly jointed either by heat sealing or by pressure sensitive tapes

Providing and laying M10 control cement concrete by using 20mm jelly over the sandwiched LDPE film upto 75mm thick to the required level including necessary compaction as directed. Curing shall be carried out to a minimum period of 4 days.

OPTION 1 : BOX TYPE WATERPROOFING TREATMENT

PART A - PRIMARY TREATMENT

Below raft : The surface of waterproofing treatment to be carried out under the raft slab shall be cleaned thoroughly and all pre-works stated above / compaction shall be completed before starting the treatment. A layer of CM 1:4 plaster admixture with Conplast X 421 IC at 130ml per bag of cement or an approved integral waterproofing compound shall be carried out as a protective layer. The plaster shall be cured for a minimum period of 5 days.

Peripheral external wall : After curing of the tank, the peripheral external wall surface shall be cleaned thoroughly and any mortar droppings, debris of water etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, foreign material before starting of the treatment.
The surface shall be observed for leakage, water ingress in the side wall during the water filling test.

All construction joints, honey combed concrete, leakage / damp portions in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 at dosages of 225gm per bag of cement or an approved equivalent grout admixture. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning / water ponding of the surface.

All water supply and sanitary pipe lines in the slab (if any) shall be sealed and grouted with WINSIL 20 manufactured by M/s. GE Bayer or an approved silicone sealant

PART B : WATERPROOFING TREATMENT

Below raft : After curing of the concrete / bedding plaster, the surface shall be coated with two coats of BRUSH BOND RFX as per M/s. Fosroc Chemicals India Ltd., specification. The coated surface should be water cured for a minimum period of 3 days

After curing, a layer of 600 x 600mm Shahabad stone slab of 25 to 30mm thick with machine cut edges shall be laid over CM 1:4 mixed with CONPLAST X 421 IC, an integral waterproofing liquid at a dosage of 130ml per bag of cement. The joints of natural stone shall be left open at the time of laying the Shahbad stone slab and it shall be filled after 2 to 3 days with a mixture of sand cement mortar having a ratio 1:3 mixed with the above said integral waterproofing liquid at the same dosage. The bedding thickness and the joint width shall be 20mm and 5 to 10mm respectively.

The Shahbad stone slab layer shall be finished with CM 1:4, 10 to 15mm thick mixed with CONPLAST X 421 IC integral waterproofing liquid at a dosage of 130ml per bag of cement. Curing shall be carried out to a minimum period of 3 days before casting the raft / grade slab.

After the curing period, raft / grade slab may be carried out to the required thickness and designs along with steel reinforcement per structural drawings.

Peripheral external wall : On completion of primary treatment, the peripheral external vertical wall shall be treated as same as the process stipulated for below raft.

OPTION 2 : MEMBRANE TREATMENT

PART A - PRIMARY TREATMENT

Below raft : The surface of waterproofing treatment to be carried out under the raft slab shall be cleaned thoroughly and all pre-works stated above / compaction shall be completed before starting the treatment. A layer of CM 1:4 plaster admixture with Conplast

X 421 IC at 130ml per bag of cement or an approved integral waterproofing compound shall be carried out as a protective layer. The plaster shall be cured for a minimum period of 5 days.

Peripheral external wall : After curing of the tank, the peripheral external wall surface shall be cleaned thoroughly and any mortar droppings, debris of water etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, foreign material before starting of the treatment.

The surface shall be observed for leakage, water ingress in the side wall during the water filling test.

All construction joints, honey combed concrete, leakage / damp portions in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 at dosages of 225gm per bag of cement or an approved equivalent grout admixture. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning / water ponding of the surface.

All water supply and sanitary pipe lines in the slab (if any) shall be sealed and grouted with WINSIL 20 manufactured by M/s. GE Bayer or an approved silicone sealant

PART B - WATERPROOFING TREATMENT

Below raft : After curing of the concrete / bedding plaster, the surface shall be spray applied membrane Proofex SM 2mm thick as per manuacturer M/s.Fosroc Chemicals India Ltd., specification. Over the membrane treatment, geo-textile fabric manufactured and approved by M/s. Fosroc Chemicals India Ltd., shall be laid immediately after application of Proofex SM membrane treatment geo-textile fabric. The geo-textile fabric shall be applied to the surface of Proofex SM membrane treatment within 5 minutes of application and whilst the surface is till wet and the geo-textile can fuse with the membrane. The coated surface should be water cured for minimum period of 3 days

After curing, a layer of 600 x 600mm Shahabad stone slab of 25 to 30mm thick with machine cut edges shall be laid over CM 1:4 mixed with CONPLAST X 421 IC, an integral waterproofing liquid at a dosage of 130ml per bag of cement. The joints of natural stone shall left open at the time of laying the Shahbad stone slab and it shall be filled after 2 to 3 days with a mixture of sand cement mortar having a ratio 1:3 mixed with above said integral waterproofing liquid at the same dosage. The bedding thickness and the joint width shall be 20mm and 5 to 10mm respectively.

The Shahbad stone slab layer shall be finished with CM 1:4, 10 to 15mm thick mixed with CONPLAST X 421 IC integral waterproofing liquid at a dosage of 130ml per bag of cement. Curing shall be carried out to a minimum period of 3 days before casting the raft / grade slab.

After the curing period, raft / grade slab may be carried out to the required thickness and designs along with steel reinforcement per structural drawings.

Peripheral external wall : On completion of primary treatment, the peripheral external vertical wall shall be treated as follows :

A layer of polymer based spray applied membrane Proofex SM, 2mm thick shall be applied as per manufacturer M/s.Fosroc Chemicals India Ltd., specification. Over the membrane treatment, geo-textile fabric shall be laid immediately after application of Proofex SM membrane treatment geo-textile fabric manfctured by M/s.Fosroc Chemicals India Ltd. The geo-textile fabric shall be applied to the surface of Proofex SM membrane treatment within 5 minutes of application and whilst the surface is till wet and the geo-textile can fuse with the membrane.

On completion of entire waterproofing treatment, a filtration system may be carried out as detailed in the succeeding process.

PART C : FILTRATION SYSTEM [COMMON TO BOTH OPTION 1 & 2]

A filtration system shall be carried out all-round the sump tank after completion of entire waterproofing treatment box type waterproofing treatment as follows

Perforated PVC at 6 Kg / Sq.cm pressure pipe shall be laid to the slope all-round the tank as detailed in drawing with perforation in the pipe to receive the filtered water from the filter media.

Over the perforated pipe, a layer of filtration media with coarse aggregate free from dust and dirt, silt shall be laid to the width of 200 to 300mm as detailed in drawing.

A separation layer between earth and filtration layer shall be provided with geo-textile fabric Terram B20 (200g/m Sqm) as shown in the drawings.

Further landscape gardening earth filling process may be taken up as per the landscape and civil works specifications.

BELOW RAFT SLAB AND RETAINING WALL SIDES OF THE BASEMENT FLOOR
Note :

I. **The work shall be carried out by the approved specialized waterproofing agency who has a minimum of 10 years experience in the proposed waterproofing system and covered by a written guarantee for their treatment for a minimum period of 10 years.**

II. **A working shop drawing shall be submitted for review before executing the treatment with all relevant details of rain water down take pipes, flashing, coving, ridge, valley, drip moulds, etc.,**

III. **The main civil contractor shall submit in writing the quality assurance statement of their responsibilities of the treatment before commencing the work and confirming acceptance of these specifications and approved water proofing vendor.**

IV. **The main civil contractor has to take responsibility for waterproofing all areas which have service lines puncturing through the roof, walls etc., including cables, pipes, ducts, trays etc., which are installed by other contractors at all potential areas of water ingress into the building including through vertical surfaces of the structure except at structural glazing areas which is not in the scope of the main civil contractor.**

V. **If cracks are found on the concreted surfaces and water ingress into the structure takes place or if the quality of finished work is found to be of non acceptable standard the same will be rejected by our Architects / Project Managers with out any liability whatsoever and no payment will be made for the entire waterproofing system and same will have to be rectified free of cost by the main civil contractor using an alternative approved method by the Architects.**

VI. **All services requirements for the successful treatment needs to be identified and the clearance for the same shall be the responsibility of the main civil contractor**

VII. **The specification give in the section are generic in nature. The main civil contractor has to study and submit his final proposal for review which includes detailed specifications, method statement and shop drawings.**

PRE-WORKS

Over the levelled and compacted soil, rubble packing shall be carried out in accordance to the specification FW064

LDPE film of 500-micron thickness shall be laid over the finished rubble packing and sandwich the film by a layer of 30mm thick river sand such as 15mm over and below the film as per the specifications FW065. The overlapped joints shall be properly jointed either by heat sealing or by pressure sensitive tapes.

Providing and laying M10 control cement concrete by using 20mm jelly over the sandwiched LDPE film upto 75mm thick to the required level including necessary compaction as directed. Curing shall be carried out to a minimum period of 4 days.

OPTION 1 : BOX TYPE WATERPROOFING TREATMENT

PART A - PRIMARY TREATMENT

Below raft : The surface of waterproofing treatment to be carried out under the raft slab shall be cleaned thoroughly and all pre-works stated above / compaction shall be completed before starting the treatment. A layer of CM 1:4 plaster admixture with Conplast X 421 IC at 130ml per bag of cement or an approved integral waterproofing compound shall be carried out as a protective layer. The plaster shall be cured for a minimum period of 5 days.

Peripheral external wall : After curing of the retaining wall, the peripheral external wall surface shall be cleaned thoroughly and any mortar droppings, debris of water etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, foreign material before starting of the treatment.

All construction joints, honey combed concrete, leakage / damp portions in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 at dosages of 225gm per bag of cement or an approved equivalent grout admixture. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning of the surface.

All service pipe lines in the slab / side walls (if any) shall be sealed and grouted with WINSIL 20 manufactured by M/s. GE Bayer or an approved silicone sealant

PART B : WATERPROOFING TREATMENT

Below raft : After curing of the concrete / bedding plaster, the surface shall be coated with two coats of BRUSH BOND RFX as per Fosroc Chemicals India Ltd., specification. The coated surface should be water cured for a minimum period of 3 days

After curing, a layer of 600 x 600mm Shahabad stone slab of 25 to 30mm thick with machine cut edges shall be laid over CM 1:4 mixed with CONPLAST X 421 IC, an integral waterproofing liquid at a dosage of 130ml per bag of cement. The joints of natural stone shall be left open at the time of laying the Shahbad stone slab and it shall be filled after 2 to 3 days with a mixture of sand cement mortar having a ratio 1:3 mixed with the above said integral waterproofing liquid at the same dosage. The bedding thickness and the joint width shall be 20mm and 5 to 10mm respectively.

The Shahbad stone slab layer shall be finished with CM 1:4, 10 to 15mm thick mixed with CONPLAST X 421 IC integral waterproofing liquid at a dosage of 130ml per bag of cement. Curing shall be carried out to a minimum period of 3 days before casting the raft / grade slab.
After the curing period, raft / grade slab may be carried out to the required thickness and designs along with steel reinforcement per structural drawings.

Peripheral external wall : On completion of primary treatment, the peripheral external vertical wall shall be treated as same as the process stipulated for below raft.

OPTION 2 : MEMBRANE TREATMENT

PART A - PRIMARY TREATMENT

Below raft : The surface of waterproofing treatment to be carried out under the raft slab shall be cleaned thoroughly and all pre-works stated above / compaction shall be completed before starting the treatment. A layer of CM 1:4 plaster admixture with Conplast X 421 IC at 130ml per bag of cement or an approved integral waterproofing compound shall be carried out as a protective layer. The plaster shall be cured for a minimum period of 5 days.

Peripheral external wall : After curing of the peripheral wall, the peripheral external wall surface shall be cleaned thoroughly and any mortar droppings, debris of water etc., mechanically abraded with carborandum stone, wire brush and washed with plenty of water. The surface shall be free from dust, foreign material before starting of the treatment.

All construction joints, honey combed concrete, leakage / damp portions in the slab shall be treated with pressure grouting using cement slurry mixed with CONBEX 100 at dosages of 225gm per bag of cement or an approved equivalent grout admixture. The pressure grouting shall be done through sockets to fill the pores in the concrete at construction joints, columns and wherever leakages expected during cleaning of the surface.

All water supply and sanitary pipe lines in the slab (if any) shall be sealed and grouted with WINSIL 20 manufactured by M/s. GE Bayer or an approved silicone sealant

PART B - WATERPROOFING TREATMENT

Below raft : After curing of the concrete / bedding plaster, the surface shall be spray applied membrane Proofex SM 2mm thick as per manufacturer M/s.Fosroc Chemicals India Ltd., specification. Over the membrane treatment, geo-textile fabric manufactured and approved by M/s. Fosroc Chemicals India Ltd., shall be laid immediately after application of Proofex SM membrane treatment geo-textile fabric. The geo-textile fabric shall be applied to the surface of Proofex SM membrane treatment within 5 minutes of application and whilst the surface is till wet and the geo-textile can fuse with the membrane. The coated surface should be water cured for minimum period of 3 days.

After curing, a layer of 600 x 600mm Shahabad stone slab of 25 to 30mm thick with machine cut edges shall be laid over CM 1:4 mixed with CONPLAST X 421 IC, an integral waterproofing liquid at a dosage of 130ml per bag of cement. The joints of natural stone shall left open at the time of laying the Shahbad stone slab and it shall be filled after 2 to 3 days with a mixture of sand cement mortar having a ratio 1:3 mixed with above said integral waterproofing liquid at the same dosage. The bedding thickness and the joint width shall be 20mm and 5 to 10mm respectively.

The Shahbad stone slab layer shall be finished with CM 1:4, 10 to 15mm thick mixed with CONPLAST X 421 IC integral waterproofing liquid at a dosage of 130ml per bag of cement. Curing shall be carried out to a minimum period of 3 days before casting the raft / grade slab.

After the curing period, raft / grade slab may be carried out to the required thickness and designs along with steel reinforcement per structural drawings.

Peripheral external wall: On completion of primary treatment, the peripheral external vertical wall shall be treated as follows :

A layer of polymer-based spray applied membrane Proofex SM, 2mm thick shall be applied as per manufacturer M/s.Fosroc Chemicals India Ltd., specification. Over the membrane treatment, geo-textile fabric shall be laid immediately after application of Proofex SM membrane treatment geo-textile fabric manufactured by M/s. Fosroc Chemicals India Ltd. The geo-textile fabric shall be applied to the surface of Proofex SM membrane treatment within 5 minutes of application and whilst the surface is still wet, and the geo-textile can fuse with the membrane.

On completion of entire waterproofing treatment, a filtration system may be carried out as detailed in the succeeding process.

PART C : FILTRATION SYSTEM [COMMON TO BOTH OPTION 1 & 2]

A filtration system shall be carried out all-round / along the peripheral wall after completion of entire waterproofing treatment / box type waterproofing treatment as follows.

Perforated PVC at 6 Kg / Sq.cm pressure pipe shall be laid to the slope all-round the peripheral wall as detailed in drawing with perforation in the pipe to receive the filtered water from the filter media.

Over the perforated pipe, a layer of filtration media with coarse aggregate free from dust and dirt, silt shall be laid to the width of 200 to 300mm as detailed in drawing.

A separation layer between earth and filtration layer shall be provided with geo-textile fabric Terram B20 (200g/m Sqm) as shown in the drawings.

Further landscape gardening earth filling process may be taken up as per the landscape and civil works specifications.

11.0 METHODOLGY FOR REPAIRING OF BEAM AND COLUMN

a) SURFACE PREPARATION

Preparing the substrate surface (concrete, brick, steel, or timber) for effective bonding of the overlay. It includes various tasks like.

1. Scraping the loose/non-structural layers such as CM plaster or Putty layers etc,
2. Cleaning foreign deposited on the surface
3. Levelling the undulations in the surface etc.

b) REINFORCEMENT TREATMENT

Thoroughly clean the exposed rebar by wire brush. Apply chemical rust remover over the reinforcement surface thoroughly all around the circumference and along the full length of rusted reinforcement. Apply two coats of anticorrosive chemical on the exposed rebar.

c) **CRACK TREATMENT**

Cracks can be treated by Grouting. For that Insert 12mm diameter Teflon nozzles in holes drilled along the cracks and fix them by sealing only its sides with epoxy putty. Inject the approved and specified grout into these cracks by means of suitable gun or pump. The

process shall be repeated until the whole of the crack has been sealed. As soon as the systemis cured, the nozzle shall be cut.

d) APPLICATION OF POLYMER MODIFIED MORTAR

The section can be restored with polymer modified cementitious mortar (P.M.M.). Applicationof P.M.M. shall preferably be in coats of approximately 10 mm thickness since trowelling withgreater thickness can lead to collapse/delamination of the mortar. Moist cure the P.M.M. surface for 7 to 10 days followed by air - curing in ambient temperature as per manufacturers specification. The main objective of PMM application is to provide evenness and nominal strength to member at surface and to recover thickness lost by loose and damaged concrete.

12.0 STRENGTHENING OF SLAB.

Based On NDT Report Done, Building Strengthening For Additional Imposing Loading Is Proposed. Vendor To Refer NDT Report & Detailed BOQ , Quote For Strengthening Works.

METHODOLOGY FOR STRENGTHENING OF SLAB USING CFRP BAND

a) SURFACE PREPARATION

Preparing the substrate surface (concrete, brick, steel, or timber) for effective bonding of the overlay is an important step in the methodology of CFRP Application. It includes various tasks like: -

1. Scraping the loose/nonstructural layers such as CM plaster or Putty layers etc,
2. Cleaning foreign deposited on the surface
3. Leveling the undulation in the surface etc.

b) MARKING SURFACE FOR PLACING CFRP BAND

The marking should be done as per the design drawings provided on repaired surface. Before marking the surface, ensuring the surface is clean and dust free is a must. Sometimes it is performed before surface preparation where only part of the structural member participates instrengthening.

c) APPLYING R&M PRIMER COATING

R&M Primer is a resin-based material it is applied by brush or roller to the marked surface. Primer provides a compatible surface for the overlay and thus improves the bonding of the strengthening material.

R&M Primer is a 2-component-based material, Mixing Proportion:

1) Base: 4kg.

2) Hardener: 2kg.

These two components have to be mixed in a specified ratio and need to be stirred well with the help of a stirrer machine for at least 2-3 minutes till it gets properly mixed. Fine mixing gives better results.

d) APPLICATION OF R&M RESIN PUTTY

The surface is well prepared with putty / leveling mortar to fill the undulations or unevenness at both the top and bottom. It should be overseen that the surface of the member to be strengthened is smooth, even, and free from undulations for the efficient working of the CFRPLaminates.

e) CUTTING AND PLACING OF R&M CARBON BAND AT BOTTOM

In a clean area away from the resins, the fabric (**R&M Carbon Fiber**) is carefully measured and cut by the specifications. Care should be taken so that there isn't any damage to the carbon fabric.

f) APPLICATION OF CARBON FIBRE BAND AT SLAB BOTTOM

R&M SATURANT is a bonding agent for the fibers and it is a 2-component-based material. Base: 3.7kg - Hardener: 1.3kg. These 2 components require proper mixing with the help of the Stirrer machine for at least 2-3 minutes for accurate merging which gives an output of superior bonding. Immediately after stirring it should be applied on the surface without any time gap with the help of a brush application. Apply **R&M Fiber** immediately after applying the **R &M SATURANT** layer.

We must start doing fiber wrapping around the surface as per the guidelines of the manufacturer concerning the design given. While wrapping roller application with nominal hand pressure is a must so that the fiber should get properly embedded in the epoxy for

superior bonding with concrete which results in developing better strength. After the application of Carbon fiber, seal it with another layer of saturant.

g) FIXING OF R&M FIBER ANCHORS, TOPCOAT

After completing the wrapping work fiber anchors are applied at specified spacing on the slab. The anchor is inserted in the drilled hole and then protruding fibers are Manually spread in a circular shape so that it should give a locking effect from all 360°. A finalcoat of Saturant is applied to the fiber after fixing carbon anchors. It should be applied on the surface with the help of brush application uniformly so that a thick layer is coated on the surface.

CONDITIONS OF CONTRACT - IMPORTANT POINTS
1) Quoted rate shall be at all levels and at all floors including necessary, staging, scaffolding, curing and all works as per IS standards etc, complete.
2) Quantity Indicated may vary to any extent with respect to G.F.C drawings.
3) The necessary protection for flooring till handover, to be included in quoted rate.If any damages occurred shall be rectified / replaced till hand over as many times for client satisfaction.
4) The quoted rate for concrete shall be for SMC (or) RMC with 100% pure cement only (fly ash / GGBS not accepted)
5) Contractor shall quote separately in covering letter the percentage of ESI and PF for the labours -if not applicable then contractor to indemnify the same to client.
6) Contractor shall include All Insurances , CAR policy and work-men ship compensation percentage in the quote.
7) Client shall provide power and water required for construction free of cost to contractor at one point. The necessary safety extension shall be contractor's cost.
8) Basic rates means, Landing cost till unloading and stocking.
9) Any executed work which is deviated from drawing or as per instruction by client/Architect/Engg-in-charge shall not be paid. Contractor to re-execute at free of cost.
10) Any legal issue's related to contractor like labour insurance, labour welfare , labour licence shall be contractor's responsibility.
11) Actual site executed measurement shall be measured and paid for.. Wastage shall be contractor's scope.
12) All paid receipts (like ESI, GST, Labour insurance, CAR policy, Workmanship policy, Labour licence, paid receipts etc) shall be enclosed along with RAB for verification before making certification for payment.
13) In Running account Bill : the claimed value shall be minimum 100 lakhs . Less than this shall not be accepted.
14) only the approved material shall be used for construction else amount shall not be paid.

15) No Labour stay at the premises. Contractor shall plan outside premises the labour hutment at his cost and shall include in his quoted rates.
16) ID card for labour is compulsory with ESI No's. Else the labour will not be allowed inside premises. ID card shall have information of Name of labour, Age, Blood group, permanent address /copy of Aadhar-card etc
17) Safety in execution of civil works is must as per standards of SHE plan. Any unsafe works will be stopped. Contractor to appoint dedicated qualified safety manager approved by PMC/Client representative. With-out safety manager, work shall not be allowed for execution.
18) Contractor to study the drawing Plan, section & elevation properly before quote for shuttering work. To consider necessary scaffolding work accordingly. No extra charges will be paid for staging works.
19) All shuttering to be considered for ply wood. For curves necessary flexible ply shall be considered. Plywood repetition shall not be more than 4 times and all the repetitions should be approved by PMC / client representative. NO honeycomb/ undulation concrete surface is accepted. if found has to be dismantled and redo at contractor's own cost.
20) Priority of work : Footing /retaining wall to start first including sump tank and complete, then later grading of soil, soil filling and consolidation work to carried out including water ponding in each layer as per Technical spec etc complete. Then Basement roof slab with subgrade preparation along with PCC.
21) All the works shall be executed and curing to be done as per IS standards. Any deviation found shall be re-worked to the satisfaction of PMC/Architect / client representatives by dismantling and rework at no extra cost.
22) The quoted rates shall include for contractor's site office with toilet facility for staff and labours. The Site office & Toilet shall be hygienic and shall be maintained on daily basis. If hygienic found not maintained then the entire work will be stopped till cleaning is done. The toilet shall be cladded with tiles including flooring for easy maintenance.
23) Contractor quoted rate shall include : to study the location of debris disposal outside the premises not objected by civic authorities and quote accordingly based on distance. Contractor to indemnify the same to client that any complaints received from Civic Authorities for illegal debris deposition is responsibility of contractor to solve the legal notice.
24) Contractor quoted rate shall include : Before Execution, all Construction material (random samples) to be tested for its properties as per BOQ/tender requirement. If any failure material found will be rejected the entire supply lot and will not be considered for the payment.
25) Contractor quoted rate shall include : Maintenance of client office and toilet for the entire duration of project.
26) Contractor quoted rate shall include : Required quality and quantity test at his own lab or 3rd party consultants as required by PMC/Architect/Client

27) Contractor quoted rate shall include : Required capacity of DG including fuel & maintenance to achieve the target. NO delay of scheduled work is accepted due to power failure. It is contractor responsibility to plan accordingly.
28) Housekeeping is contractor's scope .Maintaining the site clean without debris on regular basis. The housekeeping shall be included as part of all items in quoted rate. No extra will be paid. Any debris /house keeping removed for other agency shall be taken JMR from client/Architect/PMC and shall be claimed in respective item in BOQ.
29) quoted rate should include for grouting the water-proofing chemical to RCC wall at the junction of two concrete lifts. Contractor is responsible to avoid water leakage in RCC retaining structure. No extra claims will be made to retain the water leakages.
Note :
No increase in rates for any items using any of the materials listed will be allowed throughout the duration of the project, however the difference in cost for Cement , Reinforcement Steel, & RMC only will be considered for differential payment against submission of purchase bill copies. Variation of rates of other materials will not attract any additional cost.
Contractor shall submit the bills of the above items immediately upon purchase and delivery to site for reconciliation of difference of cost - (both upwards or downward).

PART 2

ELECTRICAL LT WORKS

CONTENTS

1.0 SCOPE OF WORK

- Electrical contractor scope is to design, engineering, and supply, testing, loading, transfer to site, unloading, shifting to store, installation & commissioning of as per BOQ to meet the successful operation & functional requirements as per Electrical norms, practices and local standards. Handing over and training to the client.
- Preparation of execution drawings with section details and as built drawings in Vendor scope only. Consultant will provide the basic Electrical drawings. Electrical contractor has to develop drawing further up to the equipment termination with sizing, support structure & submit the same for approval.
- Preparation of panel GA drawings, control wiring details, Bill of Materials, Short circuit calculation and panel location drawings in Vendor scope only & submit the same for approval. Consultant will provide the basic Electrical SLD.
- Co-ordination with other service contractors with respect to the installation activity without affecting the project schedule is in Electrical Contractor's scope.
- Certification of equipment and materials for duty, rating, hazardous area use, etc., shall be obtained from recognized National or International testing authorities. Evidence of the appropriate certification shall be obtained prior to commitment to purchase.
- Equipment of Indian origin selected for installation in hazardous areas shall have a test certificate from the Central Mining Research Institute (CMRI) or equivalent certifying authority and approval certificates from the Chief Controller of Explosives (CCE).
- Billing shall be considered for actual installed quantity only. Contractor has to be returned the balance quantity.

2.0 DESIGN BRIEF

The Electrical system design covers the following: -

- Design of the IEC 60439 form 3B standard Electrical panels like PCC panel, APFC panel, MVP, MCC panels, Main Lighting panel and Main UPS panel.
- Selection and specification of the UPS for Lab equipment, Office, Server and Emergency lighting.

- Design of the Lighting and Power distribution system.
- Design of the Earthing System.
- Design of the Lightning protection system.

2.1. Electrical load summary list: -

ELECTRICAL LOAD SUMMARY						
SL.No.	**Description**	**Load in kW**	**Load factor**	**Load in kW after DF**	**Load in kVA**	**Power Factor (PF)**
1	Lab Equipment	168	40%	67	84	0.80
2	Utility Equipment	30	70%	21	26	0.80
3	HVAC Equipment	171	70%	120	149	0.80
4	Lighting load	6	100%	6	6	1.00
5	ELV System	14	100%	14	14	1.00
6	Miscellaneous Load	10	80%	8	8	1.00
	Total Power Load (kW)	**399**		**236**	**288**	
	CONSIDERING ABOVE LOAD AND CONSIDERING TRANSFORMER BEING LOADED MAXIMUM 80%, REQUIRED TRANSFORMER IN KVA	**360**				
	SUGGESTED TRANSFORMER CAPACITY IN KVA	**1 X 400KVA**				
	CONSIDERING ABOVE LOAD AND CONSIDERING DG SET BEING LOADED MAXIMUM 85%, REQUIRED DG IN KVA	**360**				
	SUGGESTED D.G SET RATING IN KVA	**1 X 380KVA**				

	CONTRACT DEMAND		
	CONVERTING KW TO KVA AT 0.95 PF	**248**	

UPS LOAD SUMMARY							
SL. NO.	**DESCRIPTION**	**LOAD IN KW**	**LOAD FACTOR**	**LOAD IN KW AFTER LF**	**LOAD IN KVA**	**SUGGESTED UPS IN KVA**	**BATTERY BACKUP TIME**
1	LAB EQUIPMENT	40	40%	16	20	1 x 40kVA Conventional UPS with Isolation transformer	15 mins
2	LV SYSTEM & EMS	8.65	100%	8.65	9		
3	NETWORKING SYSTEM - ACTIVE SWITCHES	5.18	100%	5.18	5		
4	EMERGENCY LIGHTING LOAD	2	100%	2	2	1 x 3kVA Conventional UPS with Isolation transformer	90 mins
	TOTAL LOAD	**56**		**32**	**36**		

2.2. Power distribution scheme: -

- We have proposed 22kV / 0.433kV, 400kVA Distribution Transformer with Off Load Tap Changer as per the equipment load list.
- 1x380kVA, 415V DG set of 100% back up shall be considered for plant load.
- Distribution Transformer, DG set, and UPS selection and specifications are based on the equipment power load list considering load factor as follows:
    - Lab equipment- 40%
    - Utility Equipment – 70%
    - HVAC Equipment – 70%

- Lighting - 100%
- LV system & BMS - 100%

- 22kV HT cable routing is proposed from the VCB Panel to the Distribution Transformer.
- LT Cables are proposed from Transformer to LTKIOS Panel and from LTKIOS Panel to Main LT Panel.
- LT Cables are proposed from DG set to Main LT panel.
- Main LT Panel shall be designed for Electrical interlock between DG set and Transformer breakers.
- Main LT Panel shall feed the power to APFC panel, Medium voltage panel, MCC Panel.
- APFC panel is proposed with 7% detuned reactor with 480V and designed to take care of reactive power management and 20% active harmonic filter of full load is proposed.
- Main Lighting Panel shall serve the power to all lighting distribution boards and to emergency lighting UPS. This UPS power feeds the Emergency Lighting Distribution Boards.
- MCC Panel shall feed the power to Utility equipment like Air compressor, HVAC AHU Starter panels, Fire Hydrant Pump starter panel, HVAC-VRF Units and STP Pump Skid.
- Medium Voltage Panel shall feed power to 40kVA UPS, All RPDB'S, Main Lighting Panel and emergency lighting UPS.
- Following UPS rating is proposed:
  - ✓ 1x40kVA UPS with Isolation transformer & 15minutes battery backup for Lab equipment's & Office area.
  - ✓ 1x3kVA UPS with 90minutes battery backup for Emergency lighting.
- For all Electrical Power DBs, incoming breaker shall be MCB/MCCB with 300mA RCCB & outgoing circuits with MCB is proposed for power circuits.
- For all Electrical Lighting DBs incoming breaker shall be MCB with 30mA RCCB & outgoing breakers MCB is proposed for lighting circuits.
- SPDs (Surge Protection Device) are proposed for all DBs and Electrical panels.
- Motor protection circuit breakers are proposed upto 15kW and 18.5kW and above Motor duty type MCCBs are proposed for starter feeders only and remaining feeders shall be MCCBs with thermal magnetic type protections are proposed.
- All AHU motors, Scrubbers are provided with VFD. Bypass starters are not considered for motors.
- The philosophy for breakers consideration:
  - ✓ All Panel incomers - Microprocessor based protection MCCB & EDO type ACB.
  - ✓ Panel outgoings – Thermal magnetic MCCB & MDO type ACB

- ✓ Starter Feeders – Motor Protection Circuit Breaker / Motor Duty MCCB.
- ✓ Up to 630A – MCCB.
- ✓ 800A and above –ACB.

- For all HVAC equipment's motors Starter panels are proposed with VFD, Starter panels are proposed near HVAC- AHU Units.
- 1.1KV grade Multistrand XLPE insulated PVC outer sheathed Armoured cables are used for equipment power connection and motors.

a) Power Sockets: -

- Based on equipment load list, the raw power and UPS power socket quantities are arrived.
- Industrial type 1phase of 20A,32A and 3phase of 30A power sockets controlled by DP/4P MCB with powder coated enclosures are considered.
- Modular type 6/16A Multi pin power sockets with safety shutters, controlled by SP switch with polycarbonate enclosure are considered.
- Modular type 6A power sockets controlled by SP switch with polycarbonate enclosure are considered for Office areas.
- All power sockets shall be mounted at a height of 900 mm from FFL except corridor power sockets. Corridor power sockets shall be mounted at a height of 300mm from FFL.

2.3. Lighting System: -

- Following levels of illumination are considered for lighting design as per IS:6665
  - Production area. : 300 - 350 LUX
  - Office, stores etc. : 250 - 300 LUX
  - General corridors, airlocks & change rooms : 200 - 250 LUX
  - Service area & Technical areas : 150 - 200 LUX

- LED light fixtures suitable of minimum 100lumens per watt are considered as given below:
  - ✓ 25W 1'X1' clean room, 36W 2'X2' clean room light fixture suitable for clean rooms shall be considered inside Ground floor and first floor Lab areas.

- ✓ 36W 2'X2' Non clean room Recessed mounted suitable light fixture shall be considered inside office area, stores, Material-in & out, IT HUB room, BMS room, Battery room and UPS room.
- ✓ 40W LED Batten type (IP65) fixtures for Technical area, Internal satire case shall be considered.

- 1.1KV grade Multistrand PVC copper FRLS wires are used for Light fixture.
- All lighting switches shall be mounted at a height of 1200 mm from FFL.

Cable tray:

- We have proposed Hot dip galvanized cable trays with not less than 500 microns thick coating for outdoor applications.
- GI cable trays with 90 GSM are proposed for indoor applications.
- GI perforated Cable trays are proposed.
- Cable tray shall run above the false ceiling area and exposed cable tray shall run in the technical area and Service area.
- The cable tray below 300mm wide shall be supported with anchor bolt & threaded rod support, 450mm & above cable tray shall be supported with the MS supports.
- Cable tray laying shall be with considering reducers, bends, up & down frames etc., for smooth laying of the cables.
- The cable tray shall consist of 2 runs of earth strip along the length of the tray.
- Powder coated raceways are proposed for DBs droppers for cable routing.

2.4. Earthing System: -

Following type of earthing are considered as per IS 3043.

- Dedicated Copper plate earthing for DG Neutral earthing.
- Dedicated GI Plate Earthing for DG Body earthing.
- Dedicated GI Plate Earthing for RMU earthing.
- Dedicated GI Plate Earthing for Metering cubical panel Body earthing.
- Dedicated GI Plate Earthing for VCB panel Body earthing.
- Dedicated GI Plate Earthing for Transformer Body earthing.
- Dedicated GI Plate Earthing for LTKIOS Body earthing.
- Dedicated Copper Plate Earthing for Transformer Neutral earthing.

- Dedicated Copper Plate earthing for UPS isolation transformer neutral.
- GI Grid Earthing for utility equipment, panels and DB's.
  - ✓ Two run GI earth strips are run below the floor up to the building and raised wall and run along with electrical cable tray.
  - ✓ Two run Copper earth strips with PVC sleeves are run below the floor up to the building and raised on wall with proper insulator supports and run along with electrical cable tray with proper insulation supports.
  - ✓ From cable tray to respective equipment copper wire/GI wire shall be run and end terminated.
- Dedicated maintenance free copper rod earthing for early streamer lightning arrestor.
  - ✓ Copper strips shall be run along the vertical wall from lightning arrestor to earth pits.

2.5. Lightning arrestor System: -

- **Level I Early streamer lightning arrestor system** is considered for protection against lightning strikes.
- A lightning arrestor shall be installed in the top point of the building.
- The type of Earth pits is specified in the Earthing system.

3.0 CODES AND STANDARDS

- All equipment shall generally comply with the updated issues of:

✓ Applicable Indian Standards.
✓ Indian Electricity Act.
✓ Indian Electricity Rules.
✓ Electricity Bill.
✓ National Electrical Code by BIS.

Equipment complying with any other authoritative / internationally recognized standards such as IEC, British, U.S.A and German etc. will also be considered subject to its performance being equivalent or superior to Indian Standards. In such case the bidder shall clearly indicate the standard adopted and furnish the copy of latest English version of the same along with the bid and bring out the salient features for comparison.

All Standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as published one month prior to the date of opening the bids. A list of some of the major standards applicable is given below:

IS: 13947 Part-1 to Part-5 LV Switchgear and Control gear

IEC/BS EN 60947-4-1 Specification for low-voltage switchgear and control gear. Contactors and motor-starters. Electromechanical contactors and motor-starters.

IS: 2705 Current Transformers

IS: 3156 Voltage Transformers

IS: 3231 Electrical relays for power system protection

IS: 1248 Electrical indicating instruments

IS: 2834-1986 & 133409 part 1-1996 & IEC: 60831 -1/2 Specification for Capacitors

IS: 3043 Earthing stations.

IS: 9537 part 3-1983 Conduits for Electrical Purposes - Outside Diameters of Conduits.

IEC: 309 Part-3 Plugs, socket outlet, connectors, and appliance inlets for use in explosive gas atmosphere.

IS 5780: 2002 Electrical Apparatus for Explosive Gas Atmospheres - Intrinsic Safety "I" – Specification.

IS: 6381 Construction and testing of electrical apparatus with type of protection's'.

IS 2206 (pt.1) 1984 Specification for Flameproof electric lighting fittings (well glass and bulkhead type, fittings using glass tubes).

IS 6665: 1972 Code of practice for industrial lighting

IS: 7098 (Part1&2) specification for cross linked polyethylene insulated PVC sheathed cables

IS: 8130 specifications for conductors for insulated Electric Cables

IS: 3975 specifications for mild steel wires, strips and for armoring of cables.

IS: 10810 specifications for test on cables (Part 1 to 55/I)

IS: 5831 specifications for PVC insulation and sheath of electric cables

IS: 10418 specifications for drums for electric cables

IS: 10462 Fictitious calculation (Part-I) method for determination of dimensions of protective covering of cables: Part-I Elastomeric and thermoplastic insulated cables.

IS: 694 PVC insulated cables for working voltages up to and including 1100 V.

IS 732: 1989 Code of Practice for Electrical Wiring Installations

IS 8544: Part 1: 1977 Motor starters for voltages not exceeding 1000 V: Part 1 Direction line ac starters & Part 2 Star-delta starters

IS 8828: Specifications for Miniature Air brake circuit breakers for voltages not exceeding 1000 volts.

IS: 15652: General requirements for electrical High voltage insulating Mats.

IS 8623/ 1993 Part I & II: Particular requirements of busbar trunking System

IEC: 60529 Classification of degrees of protection provided by enclosures

IS: 13118 High Voltage A.C Circuit Breakers

IS: 8130 1984 Specification for conductors for insulated Electric Cables

IS: 3975 1979 Specification for mild steel wires, strips and for armoring of cables.

IS: 10810 1984 Specification for test on cables (Part 1 to 55\ I)

IS: 10462 1983 Fictitious calculation (Part-I) method for determination of dimensions of protective covering of cables: Part-I Elastomeric and thermoplastic insulated cables.

IEC-529 : Degree of protection provided by enclosures.

IEC/EN 61439-6 : Particular requirements for Bus Bar Trunking.

DIN IEC 68 Part 2-3 : Suitable for Constant/ cyclic Warm, Humid Climates.

EN 60695-2-1 : Incandescent Wire test for all plastic Parts.

UL 94 : Self-extinguishing Property for all plastic parts.

4.0 TECHNICAL SPECIFICATION

4.1 SPECIFICATIONS FOR PANELS & SWITCHGEARS:

- This specification covers the covers design, manufacture, testing and supply and installation of All Panels up-to 1000 V.
- Adequate arrangements for air circulation shall be made within each compartment of the Electrical Panels. The Contractor shall ensure that the internal temperature of the Electrical Panels will be well within the operating ranges as specified by IEC 60437-1 of all electric components including switchgear, control gear, bus bars, relays, wiring and timers inside the Electrical Panels.
- This specification shall be read in conjunction with the enclosed particular specifications (if any) which will give more details about the project/site conditions. In case of any contradictions between this and the particular specifications, the details of particular specifications shall prevail.
- Unless otherwise specified all Control Panels shall be suitable for continuous operation on 415 Volts, 3 phase 4 wire, 50 Hz AC supply, suitable of withstanding fault levels & duty conditions stated in the particular specifications.
- All breakers shall be considered as per discrimination chart.
- Panel builder and Switchgear Manufacturer must ensure total selectivity between Upstream and Downstream Breakers (ACB, MCCB, MPCB and MCBs) for entire electrical distribution network. Switchgear manufacturer shall submit Total Discrimination report along with techno-commercial offer.
- Preparation of panel GA drawings, control wiring details, Bill of Materials, Short circuit calculation and panel location drawings in Vendor scope only & submit the same for approval. Consultant will provide the basic Electrical SLD.

4.2 GENERAL REQUIREMENTS:

- The requirements, conditions, appendices etc. in any other bid documents shall apply to and shall be considered a part of this specification as of bound together. In case of any discrepancy between conditions specified in any other volume and this volume, the requirements, specified in this volume shall prevail.
- The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification, but which is necessary for trouble free operation of the equipment and accessories specified in this specification shall be

deemed to be included unless specifically excluded. All such equipment /accessories shall be supplied without any extra cost. Also, all similar components shall be interchangeable and shall be of the same type and rating for easy maintenance and low spare inventory.

- All drawings, schedules and annexure appended to this specification shall form part of the specification, Specific reference in this specification and documents to any material by trade name make or catalogue number shall be construed as establishing standard of quality and performance and not as limiting competition. The bidder may offer any similar equipment provided it meets the specified standard design and performance requirements, based on client approvals only.
- The bidders shall refer the BOQ and drawing for incoming feeders, outgoing-feeders, indications, metering and protection details along with quantity and type of each.

4.3 CONSTRUCTION:

- All panels shall be fully metal-clad, of compartmentalized dust and vermin proof of All panels shall be fully metal-clad, of compartmentalized dust and vermin proof and suitable for duty application as given in the particular specification. Each compartment shall house all the components connected with the particular circuit and with feeders with multi-tier formation. And all panels / feeder must possess the LOTO facility.
- The design shall be aimed at ensuring total safety (to equipment and operating personnel) during connections, operation, testing, inspection, and maintenance without any need for special precautions and without any need for disturbing the adjacent equipment's or de-energization of the panel / system.
- All Switchboard frames and load bearing members shall be fabricated using suitable mild steel structural sections or pressed and shaped cold-rolled sheet steel of thickness not less than 1.6/2.0 mm. Frames shall be enclosed in cold-rolled sheet steel of thickness not less than 1.6 mm. doors and covers shall also be of cold-rolled sheet steel of thickness not less than 1.6 mm. Stiffeners shall be provided wherever necessary. The internal parts shall be of unpainted / GI parts to ensure effectively earthing connection. The construction shall be standard design which can be ordered separately as loose kits for future expansion. The gland plate thickness shall be of 3.0 mm (minimum) for hot / cold-rolled sheet steel and 4.0 mm (minimum) for non-magnetic material. The panels may be of Projection or Flush type design. All the doors should be of identical sizes and in complete alignment with each other. The door gaps shall be uniform all-round the panel. Doors for rear side and alleys shall be of bolted type. All other doors shall be hinged type (LHS hinging preferred) using sturdy hinges.

- All panel edges and cover / door edges shall be reinforced against distortion by rolling, bending or by the addition of welded reinforcement members or as per type tested design. The top covers of the panels should be designed such that they do not bulge / bend by the weight of maintenance personnel on it. All cut outs shall be straight and free of burrs. Holes / round cutouts shall be punched and neatly filed / ground. All these shall be done prior to painting to avoid exposure of bear metal after painting.
- The complete structures shall be rigid, self-supporting, and free from flaws, twists and bends. All cutouts shall be true in shape and devoid of sharp edges.
- All Switchboards shall be of dust-proof and vermin-proof construction and shall be provided with a degree of protection of IP: 52 as per IS: 13947 / IEC 60439. All cutouts shall be provided with synthetic rubber gaskets. The Switchboards which are meant for outdoor duty shall be provided with degree of protection of IP: 55 as per IS: 13947.
- The Panel shall be designed for normal air-ventilated cooling without exceeding temperature limits stipulated in the Standards / Codes. Ventilation Louvers if at all necessary shall be provided with metallic screen and dust filters. The louvers shall be of uniform size and spacing.
- Switchboard shall be supplied with base frames made of structural steel sections, along with all necessary mounting hardware required for welding down the base frame to the foundation / steel insert plates. The base frame height shall be such that floor finishing (75 mm thick) to be done by Owner after erection of the Switchboards does not obstruct the movement of doors, covers, withdrawable modules etc.
- The Panels shall be extensible on either side without any structural modifications. The bus bars, for this purpose, shall be brought upto the end of the Panel with fixing holes pre-drilled.
- The panel height shall not exceed 2175 mm for all the Busbar ratings and type of switchboards and all the Panels within any particular room shall be of uniform height. Panel should have integral base frame of 75/100mm, The height of the operating handle, push buttons etc shall be restricted between 300 mm and 1800 mm from finished floor level (unless otherwise approved).
- The Panels shall be designed in shipping sections of width not more than 2000 mm (unless otherwise approved) and shall have lifting eye-bolts of suitable size to withstand the weight of the switchboard.
- Sheet steel barriers shall be provided between two adjacent vertical panels running to the full height of the switchboard, except for the horizontal busbar compartment. Form 4 / 3b segregation arrangement shall be provided in cable alley. Synthetic rubber gasket

shall be provided between the panel sections to avoid ingress of dust into panels. Each shipping section has full metal sheets at both ends for transport and storage.

- All hardware used shall be non-corroding, plated and the joints secured using plated nuts / washers & spring washers. For all connections for busbars, cables, supports, high tensile steel bolts alone shall be used of specified makes only.
- The Panel shall be provided with doors / covers on all the four sides. All equipment's / components shall be accessible from front. Rear side doors shall provide access only for cables / busbars. However, these shall also be accessible from front, particularly in cases where the Panels are installed adjoining the walls of the room.
- Gaskets of neoprene rubber or other similar compressible but non-ageing / non-deforming materials shall be provided for all openings.
- **All Switchboards shall be provided into distinct vertical sections (panels). Each comprising of the following compartments:**

4.3.1 BUSBAR COMPARTMENT:

- A completely enclosed busbar compartment shall be provided for the horizontal and vertical busbars. Bolted covers shall be provided for access to horizontal and vertical busbars and all joints for repair and maintenance, which shall be feasible without disturbing any feeder compartment. Auxiliary and power busbars shall be in separate compartments.
- Busbar compartments shall be provided with thick insulated shrouding sheets such that the conductors are not directly accessible even on removal of the main door.

4.3.2 SWITCHGEAR / FEEDER COMPARTMENT:

- All equipment associated with an incomer or outgoing feeder shall be housed in a separate compartment of the vertical section. The compartment shall be sheet steel enclosed on all sides with the withdrawable units in position or removed. Insulating sheet at the rear of the compartment is also acceptable. The front of the compartment shall be provided with the hinged single leaf door with captive screws for positive closure.
- The internal structures on which components such as Circuit Breakers or Switches or other such heavy items are mounted shall be of 6 mm thick M.S angles. Documentary proof shall be provided during inspection of panel.
- Internal sheets used for mounting of components shall be of minimum 1.6/2 mm thickness and mounting of components on these sheets shall be by using rivetted nuts / self-threaded screws to have better rigidity. Sheets used as barriers or compartment

partitions can be of 18 gauge CRCA sheets provided there is no other load on them and provided they do not buckle / have dents.

- Form 4B separation for ACB feeders and Form 3B for MCCB feeders.

4.3.3 CABLE ALLEY / CABLE COMPARTMENT:

- A full height vertical cable alley of minimum 300/400 mm width shall be provided for power and control cables with sufficient cable ladders / supporting arrangement. Cable alley shall have no exposed live parts and shall have no communication with busbar compartment. Cable terminations located in the cable alley shall be suitably shrouded to prevent accidental contact by falling of tools etc. For circuit breaker external cable connections, a separately enclosed cable compartment shall also be acceptable. The contractor shall furnish suitable plugs to cover the cable openings in the partition between the feeder compartment and cable alley. Cable alley shall be hinged.
- All the terminals shall be suitable for termination of cables as specified in the Specifications / drawings / Particular Specifications for aluminium/copper cables / lugs. The terminals shall be finger-proof / touch-proof to avoid any accidental contact. The tentative power and control cable entries (top / bottom) required are indicated in the "Bill of Materials". However, the Owner reserves the right to alter the cable entries, if required during detailed engineering, without any additional commercial implication.
- Each switchboard shall be provided with undrilled, removable type gland plate which shall cover the entire cable alley. Bidder shall ensure that sufficient cable glanding space is available for all the cables coming in a particular section through gland plate. For all single core cables, gland plate shall be of non-magnetic material. The gland plate shall preferably be provided in two distinct parts for the easy and terminating addition cables in future. The gland plate of removable type shall be provided with gasket ensure enclosure protection. Recommended drilling chart of gland plate for all power and control cables in the vertical panels shall be indicated by the Contractor in the respective G.A drawings of the boards.
- The layout of individual feeders shall provide easy & safe accessibility to the auxiliary / control Circuits without the danger of coming in contact with the live 4 parts / busbars. Surrounding shall be provided contractor shall submit a detailed drawing for approval prior to commencement of manufacture.
- All Incomer / Feeder doors shall be provided with door interlocks with defeat facilities.
- All Draw-out ACB compartments shall be provided with safety shutters.

- Access to auxiliary / Control terminals shall be free and safe and located such that the power terminals or any other live terminals / connections do not come in the way and any accidental contact is avoided. Terminals of different voltage classes shall be AC/DC segregated. All component terminals shall be shrouded and finger touch proof.
- The compartment sizes shall be standardized and in multiples of the basic size. Equipment's in compartments of same size shall be interchangeable.
- All doors / covers shall be removable only by use of special tools / keys to prevent un-authorized access to the Panel interiors. Suitable Caution / Danger boards shall be provided on each such door / cover which leads to possibilities of coming in contact with live conductors / terminals. The Panel shall have clearly identified and marked Incoming and Outgoing terminals.
- All components / circuit breakers / switches shall have proper labels to identify their control points and ease in study of the drawings.
- The Panel shall be provided with an earth bus running throughout the panel and all switches, non- current carrying metal parts / components shall be connected to this earth bus. The earth bus shall be extended on both sides to facilitate connection of the panel to the earthing grid. All hinged doors shall be also earthed.
- Suitable cable size terminal block (one stage higher as cable size mentioned in SLD) need to be provided up to 63A. 80A and above busbar to be provided up to cable alley.
- Panel manufactures shall provide the required termination and interface detail for BMS work. In case of requirement of supervision and guidance during BMS commissioning, same shall be inclusive to the panel manufacture's scope of work. It is the responsible of panel manufactures to provide necessary interface detail such as data point register address during BMS commissioning or supervise as appropriate during installation and testing of BMS system.

4.3.4 BUSBARS

- All Bus bar / panel shall be cut/bend using CNC machines only.
- The Busbar sizes shall be determined taking into consideration the continuous rating without exceeding the final temperature as permitted by IS/IEC 60439 when carrying rated current and must be suitable for a fault level as per SLD & BOQ (1 sec).
- Busbars shall be of high conductivity electrolytic aluminum / copper as per the Particular Specifications, supported on insulators at regular intervals of 500 mm made of non-hygroscopic, non-inflammable material i.e. epoxy / SMC / DMC / FRP such that there is no stress on the busbar / terminal. The Phase Busbars shall be of uniform current rating

throughout their length and the current rating of neutral shall be at least half that of phase busbars. Maximum current density employed for busbar cross sectional area calculations shall not exceed 0.7 Amp (PCC panels) and 0.8 Amp. Per sq. mm for aluminum. 1.4 Amp (PCC panels) and 1.6 Amps per sq. mm for copper busbars.

- The cross-section of the busbar shall be uniform throughout the length of the switchboard and shall be adequately supported and braced to withstand the stresses due to the short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.
- The bus bars carrying full current of Switchboard shall be supported on non-breakable, non-hygroscopic epoxy resin or glass fiber reinforced polymer insulated supports that are Thermoset in nature, so as to able to withstand high operating temperature of 135 deg C and mechanical forces, arising from a severe fault level as stipulated in schedule of quantities. The busbar insulator shall be supported on the main structure.
- All busbar joints shall be connected with high tensile steel bolts (8.8 grade), Belleville / spring washers and nuts, so as to ensure good contacts at the joints. Non-silver-plated busbar joints shall be thoroughly cleaned at the jointed locations and suitable contact grease shall be applied just before making a joint. All bolts shall be tightened by the torque spanner to the recommended value.
- Zinc passivated or cadmium plated high tensile strength steel bolts, nuts & washers shall be used for all busbar joints / supports. At the joints, the overlap should be equal to or greater than the width of the busbar or 10 times the bar thickness, whichever is greater. The joints shall be treated by grease to ensure the joints moisture proof and shall be smeared by petroleum jelly to increase the efficiency of the joint. Minimum clearance between phases / live parts shall be 20 mm and phases / live parts / neutral to ground shall be 19 mm except on the equipment terminals. For horizontal and vertical busbars the clearance specified above should be maintained even when the busbars are sleeved or insulated. All connections from the busbars upto switch / fuses shall be fully shrouded / insulated and securely bolted to minimize the risk of phase to phase and phase to earth short circuit.
- The interconnections between the main busbars & individual units shall be made by using copper / aluminium busbar strips of adequate rating and shall be shrouded.
- Busbars shall be provided with colour code PVC sleeve. Busbar have to be designed to withstand dynamic force of short circuit as specified in the Electrical SLD.
- All copper to aluminium joints shall be provided with suitable bimetallic washers.
- Whenever the busbars are painted with black matt paint, the same should be suitable for temperature encountered in the switchboard under normal operating conditions.

- The bidder shall furnish calculations establishing the adequacy of the busbar sizes for specified current ratings.
- An Earth Bus of required cross sectional area shall be provided throughout the length of the switchboard. Provision shall be made to connect the earth busbar to the Plant earthing grid at two ends. The earth bus and inter-connecting earth wire shall be colour-coded in Green. All non-current carrying metal parts in the panel shall be connected to the earth bus.
- Vertical earth bus shall be provided in each vertical section which shall in turn be bolted / welded to main horizontal earth bus.
- The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current to earth, without exceeding the allowable temperature rise.
- Suitable arrangement shall be provided to each end of the horizontal earth bus for bolting the Owner's earthing conductors. The horizontal earth bus shall project out of the switchboard ends and shall have predrilled holes for this connection. All joint splices to earth bus shall be made through at least two bolts, and taps by proper lug and bolt connection.
- All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus. Electrical conductivity of the whole switchgear enclosure framework shall be maintained even after painting.

4.3.5 WIRING

- Wiring for power, control signalling, protection and instrument circuit in the switchboard shall be done with PVC FRLSH insulated copper conductors of 1.1 kV grade. All control wiring shall be enclosed in fire-retardant FRLS channels. A minimum 1.5 sq.mm size FRLSH wire with stranded copper conductors or FRLSH wire shall be used for circuit ratings of up to 6 Amps. For CT circuits 2.5 sq.mm FRLSH wire shall be used. The cables and control wires shall be suitable for withstanding 105 deg C. Shorting links shall be provided for all CT terminals. Each wire shall be identified at both ends by ferrules and provided with tinned copper lugs firmly crimped. Cable entry to the switchgear shall be from bottom / top as specified and supporting facilities shall be provided for clamping the cables in the cabling compartment. Inter-panel wiring within each shipping section shall be in the scope of Contractor and inter-linking using terminal blocks on adjoining shipping sections to facilitate the same along with suitable jumping wires. Internal wiring shall be taken through PVC sleeves or rubber grommets. All terminal blocks and wires shall be tagged for identification in accordance with IS 11353. All wiring for external connections shall be

brought out to the individual terminals on a readily accessible. Terminal block; all terminal block shall be shrouded or provided with transparent covers. Clamp type control terminal blocks shall be provided for outgoing control cables. Minimum 10% spare Terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

4.3.6 SPACE HEATERS

- Anti-condensation heaters shall be fitted in each cubicle together with an ON/OFF isolating switch suitable for electrical operation at 230 volts A.C 50 Hz single phase of sufficient capacity to raise the internal ambient temperature by 50deg C. The electrical apparatus so protected shall be designed so that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the switchboard is in operation. As a rule, the heaters shall be placed at the bottom of the cubicle.

4.3.7 PAINTING

- The panels shall be powder coated as per specified colour. All metal surfaces shall be thoroughly cleaned and degreased to remove oil, grease and dirt. Rust and scales shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline water and drying. After phosphating, thorough rinsing shall be done with clean water followed by final rinsing with dilute dichromate solution and oven drying. The final finished thickness of paint film on steel shall not be less than 60 to 80 microns (Powder coated). Finished painted appearance of equipment shall present an aesthetically pleasing appearance free from dents and uneven surfaces. The required colour for the panels shall be as per the particular specification. Panels meant for Outdoor locations shall have double doors with water-tight gaskets and epoxy paint, and that for interior shall be white. All unpainted steel parts shall be plated or suitably treated to prevent rust and corrosion.

4.3.8 NAME PLATE/LABELS

- Name plates shall be of anodized aluminum with white engraving on black background and shall be properly secured with fasteners. Name plate shall be provided for each feeder and equipment i.e. indicating lamps, push buttons, switches, relays, auxiliary contactors etc. mounted on the switchboard. Special warning labels shall be provided wherever necessary. A name plate with switchgear designation shall be fixed at the top

of the Panel. Name plate giving feeder details shall be provided for each compartment and a separate name plate giving details of bus section shall also be provided. As mentioned in GA drawing, name must be printed; any changes in the names of the feeder shall be recorded by the panel manufacturers/consultants.

4.4 COMPONENTS

4.4.1 AIR CIRCUIT BREAKERS:

a. GENERAL:

The ACBs shall conform to IS 13947-1 / IEC 60947-1 for general rules and IS 13947-2/IEC 60947-2 for Circuit Breakers. The ACBs shall be suitable for 3 phases 415 Volts. Air Circuit Breakers shall be provided in fully drawn-out cubicles, unless otherwise stated. These cubicles shall be such that drawout is possible without disconnection of the wires and cables. The power and control circuits shall have self-aligning and self-isolating contacts. Mechanical latches shall be integrated in ACB at service, test and isolated position to ensure that Breaker is firmly latched in respective position. It shall not be possible to move the breaker from the position unless latch is manually operated. ACBs shall meet the following minimum parameters, ACBs must be considered with a provision to integrate with EMS System of communication models (RS 485) and all ACBs should have a provision for LOTO facility. And The Main incomer for Transformer, DG ACB and all panel incomers must display the THDI and 4th pole is 100 % Netural.

• Rated operational Voltage		• 690V
• Rated insulation Voltage		• 1000V
• Rated impulse withstands Voltage		• 12 Kv
• Protection		• ANSI, 49, 51, 51TD, 50, 51 N, 51N TD, 51G, Zone Selectivity 68, undervoltage – 27, Over Voltage 59, Residual Current 64. Applicable only wherever specified in SLD & BOQ.
• Trip history with time stampings		• 30

• Event history with time stampings		• 100
• Communication Type		• Modbus TCP or TCP/IP
• Password Protection		• For settings changes to prevent unauthorized access
• No. of mechanical operations		• 20,000(up to 2000A)
		• 15,000(above 2000A, up to 4000A)
• No. of electrical operations		• 10,000(up to 2000A)
		• 5,000(above 2000A, up to 4000A)

b. CONSTRUCTION:

The Breaker shall be suitable for load and line reversibility.

The draw out type breaker shall be with service-test-isolated positions.

The ACB shall have front face with Insulation Class II IA for safety as per IEC 60947-2 allowing class II installations with breaker control from outside.

- ACB shall be of 3pole or 4pole (as per BOQ), air break longer life along with less maintenance requirement.
- All ACBs shall be with Icu=Ics=Icw (1Sec)
- There shall be 3 distinct and separate positions of Test/Isolated/Service on circuit breakers on cradles which are self-lockable at each position:
- ACB shall have Safety Shutter as standard with provision for locking for safety.
- ACB shall conform to stringent environmental directives i.e. ROHS and WEEE norms.
- ACB front must be with IP54 protection.
- ACB shall be provided with Arc Chute Cover and stainless-steel filters to absorb all gases which are released in the event of Short circuit which ensures better safety
- All accessories like Shunt trip/Under voltage/Closing Coils shall be common for all Breakers. Shunt trip shall be continuous rated coil
- Draw-out ACBs shall preferably be provided with a mechanical latch on chassis which latches the ACB at Connected-Test-Disconnected positions while racking in and racking out the circuit breaker. This feature will help the operator in placing the circuit breaker at right position inside the chassis and can help in avoiding the accident.

All ACBs shall be provided with Ready to Close Contacts as standard feature to check in the event of Closing under the following conditions:

- ACB is in OFF position
- Spring Mechanism is charged
- Opening order is not present
- Device not completely racked in

c. CONTROL UNITS / PROTECTIONS:

The Control Units shall be housed in a separate enclosure and there shall be total insulation of the control unit with respect to the power unit.

The Control Unit shall be of Microprocessor type & suitable to provide short circuit, overload and earth fault protection, which should be self-powered type without the need of any auxiliary power supply during normal operation of the breaker.

The protection release shall have following protections as standard: -

- Adjustable overload current (Ir) settings from 40% to 100% of rating of ACB (In). Overload 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 400ms.

Separately powered, individual fault trip indication LEDs (For overload, short circuit, earth fault and trip unit failure) shall be available on the trip unit which shall function even if the display fails.

ON / OFF options shall be available for short-circuit & earth fault protections which can be used to ensure discrimination with upstream circuit breaker or fuse.

The trip unit shall have integral test facility to verify the healthiness and to avoid external calibration.

It shall be possible to change the protection settings online and the circuit breaker need not be switched off while adjusting the settings.

All ACBs in PCC panel shall be provided with zone selective interlocking which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate between incomer breaker and outgoing breakers enabling zone selective interlocking.

It shall be possible to view the percentage loading of three phases at once on trip unit via LEDs or LCD display to help the user in identifying the current load balancing of the network. This will help in preventing the deterioration of loads affected by load balancing by identification of the balancing related issue.

ACB shall be provided with Energy Release (wherever specified) and will measure the following with class 1 accuracy:

- Current – Phase and Neutral
- Voltage – Phase to Phase and Phase to Neutral
- Power- KW, KVAR, KVARH for all phase individually and total 3 phases.
- Energy- KWH
- Power Factor

The above parameters along with the status of breaker shall be displayed on front door of the panel. Also, trip unit shall provide last 20 trip histories which include date and time stampings.

It shall be possible to upgrade the breakers with Communication feature at Site to Ethernet connectivity.

d. ACCESSORIES:

The connection for the auxiliary shall be accessible from the front.

ACB shall be provided with following accessories, in addition to the item specified in Bill of Quantities. Further these devices shall be fit table at site from the front and common for all ratings.

- Under Voltage trip coil.
- Shunt trip coil.
- Closing coil,
- 4NO + 4NC auxiliary switches.
- Fault indicator/Reset unit.
- The closing time shall be less than or equal to 70ms, and of fast opening type with break time of breaker should be <30ms to ensure higher life of distribution cables.

e. INTERLOCKING:

ACBs shall be provided with the following interlocking: -

- Pad lock to prevent unnecessary manipulations of the breaker.
- Electrical interlock shall be done by using breaker aux-contacts only
- Al the ACBs of EDO and MDO modules must have a provision for all type of interlocking.
- The features like COM port with RS 485 communication port, measurement functions (DLM), IDMTL settings, interrupted current values, rating plugs etc. shall be provided in the breakers as feature.

4.4.2 MOULDED CASE CIRCUIT BREAKER:

- MCCBs shall comply with standards IS/IEC 60947-1 & 2. The breaking capacity performance certificates shall be available for category A to the above-mentioned standards.
- MCCB shall have a rated operational voltage (Ue) of 415V, insulation voltage (Ui) of 690 V (AC 50/60 Hz) & impulse voltage (Uimp) of not less than 8kV.
- MCCBs rating up to 630Amp shall be current limiting type preferably having an encapsulated double break design having two fixed contacts, one moving contact and two arc chutes per pole. The design is required to minimize the effects of short circuit currents i.e. limit the let through energy and improve the life of cables.
- MCCB shall comply with the environmental directives like RoHS and WEEE.

Performance:

- The MCCBs shall have a rated service breaking capacity (Ics) equal to the ultimate breaking capacity (Icu) at 415V. MCCB's Manufactures can optimize breaking capacity of outgoing MCCB's by using cascading technique.
- The limiting capacity of a circuit breaker is expressed by two curves which are a function of the prospective short-circuit current (the current which would flow if no protection devices were installed): The thermal stress (A2s), i.e. the energy dissipated by MCCB during fault should be as low as possible. Cable selection to be done as per Maximum permissible cable stresses for which manufacture should produce current limiting and energy limiting curves of MCCB's.

Safety:

- For maximum safety, the power contacts shall be insulated in an enclosure made of a thermosetting material from other functions such as the operating mechanism, the case, the trip unit and auxiliaries (ON/OFF/Trip Contact, Shunt, Under Voltage etc.). All poles shall operate simultaneously for circuit breaker opening, closing, and tripping. MCCBs shall be actuated by a toggle or rotary handle that clearly indicates the three distinctive positions: ON, OFF and TRIPPED. MCCB shall clearly indicate the suitability for isolation in the name plate identified by the symbol  . MCCBs shall be equipped with a "push to trip" button in front to test operation and simultaneous opening of all poles together.
- MCCBs shall be designed to prevent access to live parts when the cover is removed, means main current path of the circuit breaker should be isolated from auxiliary section i.e. MCCB shall offer class –II front face as per IEC standards 61140 and 60664-1.
- The electrical life of MCCBs shall be 8,000 operations up to 250A & 4000 operations up to 630A.
- All MCCBs shall have cross bolted type termination where bus bars or cable lugs can be terminated by crossing the bolt between the lugs/bus bars and MCCB connections, to enhance safety and reliability of the terminations. In case spreaders/rear connectors are used in between MCCB and bus bar/lugs then the spreaders shall be cross bolted with the MCCB connectors.
- Separate Field installable auxiliary contacts for signalizing ON/OFF indication shall be provided with all MCCBs.
- Rotary handle shall ensure IP40 for direct type and IP 55 for extended Rotary handle.
- MCCB shall have provision for Rear connection - MCCB mounting on a back plate with suitable holes enables rear connection. The rear connections are simply fitted to the device connection terminals.

Protection's requirements:

- All MCCBs shall be thermal magnetic type and microprocessor based as per the SLD & BOQ.
- For Thermal Magnetic MCCB shall be adjustable overload settings from 0.6 to 1 time In and fixed magnetic settings.
- For shall be self-powered microprocessor-based type to have wide range of settings and advanced information over and above thermal magnetic trip units
    a. LED indication on trip unit shall be there for trip unit ON indication.

b. Test port on trip unit shall be there for testing the trip unit.
c. Overload alarm indication LED shall be there on trip unit.
d. Overload settings adjustment from 40% to 100% shall be possible
e. It shall be possible to set the overload time delay from 0.5 to 16 secs at 6xIr.
f. Short circuit settings shall be adjustable from 1.5 to 10 times Ir. Fine adjustment of settings shall also be possible. Short circuit time delay shall be adjustable from 0.1 to 0.4 secs. It shall be possible to switch the I2t protection ON or OFF to achieve discrimination between upstream fuse or circuit breaker.
g. Instantaneous settings shall be adjustable from 1.5 In to 10 In.
h. Earth fault protection shall be adjustable from 20% to 100% or OFF. It shall be possible to switch the I2t protection ON or OFF to achieve discrimination between upstream fuse or circuit breaker.

- In case of 4 pole microprocessor based MCCBs neutral shall be protected & adjustable as a Neutral unprotected / Neutral protected at 0.5 In/ Neutral protected at In.
- All MCCBs in PCC panels with inbuilt earth fault protection shall also be provided with zone selective interlocking feature, which helps in reducing the thermal and dynamic stress on installation during short circuit and ground faults. The releases shall be suitable to communicate with upstream ACBs enabling zone selective interlocking.
- All MCCBs with earth fault shall display the type of fault (overload, short circuit, earth fault, instantaneous tripping), the phase concerned and interrupted current value, on occurrence of fault.
- All MCCBs with earth fault protection shall store last trip record. The record shall be viewable on display modules or communication or shall be downloadable using MCCB test port.

Communication specifications:

All Incoming MCCB's (Microprocessor based LSIG release) shall have communication provision with the following features.

- It shall be possible to communicate ON, OFF and Trip status of all Incomer MCCBs over modbus TCP/ Ethernet port (with at least 10mbps speed on Ethernet network).
- Incomer MCCB's shall provide following information which shall be displayed on inbuilt webpages/software
  - MCCB ON/OFF/Trip status indication

- Total number of ON/OFF and trip operations
- Total number of operating hours & % Contact wear for all MCCBs where LSIG protection is asked
- Last trip record of the circuit breaker with interrupted current value and phase in which the fault occurred for all MCCBs where LSIG protection is asked.

4.4.3 MINIATURE CIRCUIT BREAKERS:

The breaking capacity of the MCBs shall be 10 kA in accordance with IEC 60947 & IS 13947 / 8828 - 1996 and with tripping characteristics to suit the type of load it is feeding. They shall be suitable for 35mm DIN rail mounting in any plane without derating. The terminals should be protected against finger contact to IP 20 degree of protection with no restriction for line and load.

- Number of poles: single-pole, double-pole, triple-pole or four-pole as specified in the BOQ or Drawings
- Protection against external influences: Enclosed-type.
- Method of connection: Bolted type or clip-on type,
- Rated operational voltage and frequency 240 / 415 V AC and 50 Hz.
- Range of instantaneous tripping current: MCB's shall be current limiting Type Class 3 with range of instantaneous tripping current B, C or D type as appropriate or as specified,
- Rated short-circuit breaking capacity: not less than 10 kA (M3) unless otherwise specified in BOQ
- I2t characteristic: suitable for load and circuit being protected,
- Degree of protection: IP-20 for MCB's
- Reference ambient temperature: as per IEC 60898.

4.4.4 SURGE PROTECTIVE DEVICES (SPD)

The work required under this section shall include all material, labour and auxiliaries required to furnish and install complete Surge Protection Devices at main LT Panel incoming feeders Class 1 (Spark Gap) & Sub Distribution Boards Type 1+2 and the DB level Type 2+3 for the protection of Building electrical and Electronics system from the effect of Lightning discharges, line induced transient surge voltage or switching surges.

a. Main Electrical panels (Transformer and DG Incomer's)

According to IEC 61643-11 and EN 61643-11, in order to avoid oscillations and magnetic coupling phenomena, equipment must be protected against direct surges with din rail Type 1 (10/350µs) surge arresters. And all the SPD must be with backup protection of Isolator.

- Surge Protector at Type 1 (L T Panel Protection):-

The Surge Protection Device (SPD) manufacturer shall offer a complete line of Surge Protection Devices to support the requirements for Main LT Panel Incoming feeders. The surge protector at this stage shall be provided to protect the downstream electrical and electronics against any lightning discharges surges that may enter into the system through Mains panel.

The Protection unit shall be based on single arc spark gap technology and shall be able to withstand 10/350 microsecond surge currents associated with external lightning discharges.

- Type - 1 SPD Spark gap techno of
- Nominal voltage U n (L - N / L - L)- 230/440 V
- Maximal continuous operating voltage U c (L - N / L - L) – 255/440
- Voltage protection level Up at In (L - N / N - P E / L - P E) ,<2.5 KV
- Nominal discharge current In (8 / 2 0) – 25 KA
- Maximum discharge current In (8 / 2 0) – 60 KA
- Impulse current Iimp (10/350) (L-N / N - P E) -25/100 KA
- Total current- 100 KA
- Response time <100ns
- Operating current Ic -<1mA
- Short circuit withstand Icc 7 KA

b. Sub electrical switchboards protection with type 1+2 Surge Protective Devices

According to IEC 61643-11:2012 and EN 61 643-11:2012 electrical installations must be protected against direct lightning and surge impulses with din rail class. And all the SPD must be with backup protection of Isolator.

- I+II/Type 1+2 (10/350µs) surge arresters:-

SPDs use MOV technology to allow for high lightning discharge currents, pluggable types avoid ejection of the cartridge during the discharge of the current and non-blow out technology avoids fire risks.

The SPD must provide either common protection in TNC network or common and differential mode protection in TT and TNS networks according to IEC 61643-11:2012 recommendations.

Supply, install and connect Surge Protective Devices with the following technical characteristics:

- Technology: Metal oxide varistors
- Impulse current wave form 10/350 μs: I imp = 25 kA
- Maximal discharge current wave form 8/20μs: Imax = 60 kA
- Nominal discharge current wave form 8/20 μs: In = 25 kA
- Voltage protection level: Up ≤ 1.5 kV
- Nominal voltage: UN = 230 V
- Maximum continuous operating voltage: Uc = 255 V
- Short circuit withstand = 50 kA
- Integrated thermal disconnector
- Pluggable cartridge for an easy and quick intervention
- Visual state indicator
- Safety system
- Auxiliary contact
- No electrical consumption on visual state indicator
- Back up protection with Fuse or Circuit breaker: ≤ 125 A
- Certified standard IEC 61643-11 and EN 61643-11.

4.4.5 CURRENT TRANFORMER (CTs) AND VOLTAGE TRANSFORMER (VTs)

CTs and VTs shall comply with IEC 61869/BSEN 61869 and CTs shall be of the epoxy resin encapsulated ring type. The ratings specified on the Drawings are indicative only and it shall be contractor/manufacturer's responsibility to ensure that the ratings offered are adequate for the relays/meters provided considering lead resistance, etc.

Current transformers shall comply with approved standard and shall be compatible with and provide the necessary accuracy, over current factors, characteristics, performance and VA rating for the satisfactory operation of the relevant protection devices, instruments and meters.

All CTs shall have a short-time current rating as specified in IEC 60044-1.

CTs for protection shall be compatible with the protection relays to ensure that the CTs will not be saturated up to the maximum prospective fault current.

CTs designed for unit protection schemes shall be able to withstand a stability of not less than the maximum through-fault of the units.

In balanced circuits, the spill current with maximum stability conditions shall not exceed one quarter of the operating current of the relay.

CTs for use in conjunction with protection relays shall be of class 5P accuracy or better. CTs for use in conjunction with measuring instruments shall be of Class 1 accuracy. The product of rated accuracy limit factor and rated output of the protection CTs shall not be less than 20 times the total rated burden of the trip circuit including the relay, connection leads and O/C release where applicable.

All CTs shall have output ratings adequate to cater for the burden connected to them. The Contractor shall demonstrate to the satisfaction of the Employer representative. By calculation or by test, that each group of the CTs, when installed and having the secondary burden connected, is capable of operating the relays and other measuring instruments in accordance with the manufacturer's published characteristics and the requirements of the system, with a reasonable margin of safety.

4.4.6 SELECTOR SWITCHES:

All control switches shall be 16 Amps. Rated, back connected, rotary type having a cam operated contact mechanism. Type and the number of ways shall be clearly mentioned on the switches. Ammeter selector switches shall have made before break feature on its contacts. Selector switches for the motor feeders shall be lockable in OFF position.

4.4.7 PROTECTIVE RELAYS:

All protective relays used shall conform to the relevant Indian Standards and meant for the specific type of protection envisaged. Static type/microprocessor-based relays shall be preferred. The relays shall have a minimum of one NO and one NC alarm/trip contacts of rating not less than 5 amperes at 230 V AC supply. Wherever relay inputs are from current transformers, protection type CTs Class 5P10/Class PS shall be used. All relays shall be suitably calibrated / compensated for the site conditions and with variable settings adjustable at site.

4.4.8 MEASURING INSTRUMENTS:

All measuring instruments shall be of 96 sq.mm/144 sq.mm as per Particular Specification and shall be flush mounting type and complete with all auxiliary equipment's such as shunts, transducers, current and voltage transformers as required.

Electrical meters shall conform to IS 13779 / IEC - 1036, 687, 1286 suitable for single phase /three phase supply system in all respects. Accuracy of meters shall be of class as specified in BOQ.

All meters shall be digital type and multifunction Meters with RS 485 connectivity to suit BMS system wherever mentioned in BOQ. Suitable memory and software for logging the information along with real time metering information must be available. The meters must have required level of protection and sufficient number of auxiliary contacts.

Meter shall be suitable for 3 phase, 4 wire systems, and balanced as well as unbalanced load. All instruments and associated apparatus shall be capable of carrying their full-load current without undue heating. They shall not be damaged by the passage of fault currents up to the rating of the associated switchgear through the primaries of their associated instrument transformers. The instrument meter shall be earthed by a conductor of not less than 2.5 mm2 cross-sectional area.

Selector switches shall be inbuilt in voltmeters such that voltmeter can read voltages between phase and phase and between phase and neutral.

Ammeters shall normally be suitable for 5 A secondary of current transformers

Voltmeter circuits shall be provided with protection through MCB as required Separate current transformers for feeder shall be provided for protection device and for instrumentation.

4.4.9 INDICATING LAMPS AND PUSH BUTTONS:

Indicating lamps shall be of LED type and of low watt consumption, easily replaceable from the front. Lamps shall be uniformly bright and provided with translucent covers of appropriate colors. Push buttons shall have a minimum of 1 set of NO/NC contacts. As per IEC/NFPA standard Color coding for Indicating Lamps and Push-buttons shall be as follows:

- STOP/OPEN/EMERGENCY TRIP : RED
- START/CLOSE : GREEN
- RESET/TEST/HEALTHY : YELLOW / BLACK / WHITE.

- TRIP : AMBER

Emergency lock and key type push buttons shall be installed wherever required or specified in BOQ to de-energize the Electrical Panels in the event of an emergency. The Emergency Push Button shall be button type with flat surface protection guard ring and pressed-in design with key reset so that accidental triggering and vandalism shall be avoided as far as possible. Transparent hinged cover shall be provided in front.

4.4.10 INSPECTION & TESTING:

Routine tests as per Indian Standards shall be carried out on the panel. This shall comprise physical inspection of panel including wiring and fittings, and operational and functional tests where necessary. The routine rests to be carried will be as follows:

- High Voltage Test: To test high voltage withstands capacity for power and control circuits. Test certificate to be submitted along with the panels.
- Megger test: To check the insulation resistance between pole and neutral, pole and pole and all secondary wiring between phase and earth. These should be recorded and submitted.
- Phase sequence test: To check phase configuration.
- Bill of materials check
- Functional tests
- Design ambient temp: For all the switch gear shall be considered 45Deg C.

4.4.11 PARTICULAR SPECIFICATIONS FOR PANELS:

- Paint / Color of Panels : Powder coated to shade RAL 7032.
- Busbar Material : Aluminium (minimum current density 0.7Ampere per sq mm)
- Location of Panels / Duty : Indoor and Outdoor (refer the SLD and BOQ).
- Sheet Steel thickness : 14 SWG (2 mm) CRCA (Cold Rolled Cold Annealed) sheet Steel
- Minimum thickness of FRP barriers shall be 3 mm.
- Neutral Bus bars shall be rated at minimum 60% of the capacity of the Phase Busbars.
- All CTs shall be of resin-cast type.
- All measuring instruments shall be of digital type.

4.4.12 M.C.C. SPECIFICATIONS

- M.C.C. shall be generally of single front execution unless specified to be of double front execution.
- M.C.C. shall have bottom or top cable entries. Each shall have separate cable alley. Cable alleys shall be provided with suitable doors. Sheet metal barrier shall be provided between individual compartments and cable alleys. Bus tie feeders with MCCB will be of fixed type.
- All switches other than rotary switches shall be lockable in both ON & OFF positions. The switches / MCCB's shall be interlocked with compartment door to prevent opening of door when switch / MCCB is ON. A defeat mechanism for this interlock shall also be provided.
- The maximum height of operating handles/switches shall not exceed 1800mm and minimum height not below 350mm.
- The contactors shall be air break type, equipped with three main contacts and minimum 2 no. + 2no. Auxiliary contacts. The main contacts shall be rated for AC 3 Duty. The auxiliary contacts shall be rated for 5A at 240 V A.C.
- The coil of contactor shall be suitable for operation in 240V the drop off Voltage of contactor coil shall be between 15% to 65% of rated coil voltage.
- Thermal overload relays shall be of three elements, positive acting, ambient temperature compensated with adjustable range. Relays shall be of manually reset type. Relay shall be provided with minimum 1 no. + 1no having rating of 5 amps at 240 volts A.C.
- MCCB's shall provide with tripping device having inverse time characteristic for over load protection and instantaneous characteristic for short circuit protection. MCCB's operating handle ON & OFF position shall be clearly and handle shall be mounted on door of MCCB compartment.
- In case single phase preventer must be used, it shall be of current operated type and shall have provision of 2NO and 2NC contact, shall operate on the principle of sensing negative sequence component of current. SPP used shall be suitable for protection of non – reversing and reversing motors. The relay operation shall be independent of loading and rpm of the motor prior to occurrence of single phasing. And 1phase preventer must be integrated panel incomers to trip the breakers in case of phase failure.
- Over load relays/earth fault relays for MCC panel shall be have back connected draw out type, suitable for flush mounting and fitted with dust tight covers. The relay cases shall have provision for inserting of test plug at the front for testing and calibration. It shall be possible to test relays without disconnection of wirings. It should be provided

with hand reset type build in flag indicators to reset the flag without opening of relay case.

- All push buttons shall be of spring return & flush type. All push buttons shall be with minimum 1NO+1NC contacts.
- Emergency stop PB shall be mushroom head, stay put type with turn to release feature. All Mushroom PB shall be with minimum 2NO+2NC contacts.
- All illuminated PBs shall be with LED type lamps & 22.5mm dia in size with minimum 1NO+1NC contacts.
- Rating of all Push Button contacts shall be 10A AC 230V OR 3A 110V DC and Push button used shall follow these color codes:
  - Emergency Stop / stop : Red
  - Start / Close : Green
  - Trip : Amber
- Auxiliary relays / Contactors shall be used for interlocking and multiplying contacts. Their ratings must not be less than 5A for 240 Volts A.C. at PF of 0.8 to 1.0
- Timers used for star delta starters 10HP & above shall be of Electronic type and shall have adjusting time of 0-60 secs.
- The outgoing feeders shall be interlocked in auto / manual mode as per logic of interlocking mentioned in the SLD. a)Necessary wiring has to be done up to cable alley for interlock of AHU door, AHU motor and AHU lighting, in case the AHU door is opened while running lighting should ON, AHU motor should be OFF. b) Necessary wiring has to be done up to cable alley for interlock from Fire damper micro switch to AHU motor and for interlocking between panel Push button and remote push button near the units. c) Interlocking of the respective AHU's / VAU's and with its EAU's to be included.
- 2set of Potential free contactors to be considered for all starters and VFD for BMS operation.
- Successful bidder for LV switch boards will have to supply the following drawings for approval to the Consultant.
  - G.A drawing
  - Single line diagram
  - Bill of quantities with makes.
  - Technical specification/catalogues/datasheet/specification sheet of all the used switch gear/materials.
  - Only on approval by the Architect/Consultant/ Electrical Consultant/Client, supplier can commence fabrication and procurement

4.4.13 PARTICULAR SPECIFICATIONS OF STARTERS

a. DOL STARTERS (SHOULD FOLLLOW TYPE-2 COORDINATION)

- 1HP STARTERS

Full load current	:	1.8 Amps
Incomer MPCB	:	1.8- 2.2A TP
Contactor	:	12A 3 pole with auxiliary contacts
Illuminated Push buttons	:	On and off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	4Nos of 10sqmm Elmex for power, 3Nos of 2.5Sqmm for remote operation
MCB	:	16 A

- 2 HP STARTERS

Full load current	:	3.5 Amps
Incomer MPCB	:	3.5- 4.5A TP
Contactor	:	12A 3 pole with auxiliary contacts
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	4Nos of 10sqmm Elmex for power, 3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 3 HP STARTERS

Full load current	:	4.7 Amps
Incomer MPCB	:	4.5-5.5A TP
Contactor	:	12A 3 pole with auxiliary contacts
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	4Nos of 10sqmm Elmex for power,3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 5HP STARTERS

Full load current	:	8.2 Amps
Incomer MPCB	:	5.5-7A TP
Contactor	:	18A 3 pole with auxiliary contacts
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	4Nos of 10sqmm Elmex for power, 3Nos of 2.5sqm Elmex for remote operation
MCB	:	16 A

- 7.5 HP STARTERS

Full load current	:	11.1 Amps
Incomer MPCB	:	9-10A TP
Contactor	:	18A 3 pole with auxiliary contact
Illuminated Push buttons	:	On and Off

Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	4Nos of 10sqmm Elmex for power,3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

b. STAR DELTA STARTERS (SHOULD FOLLLOW TYPE-2 COORDINATION)

- 10 HP STARTERS

Full load current	:	14 Amps
Incomer MPCB	:	7-10A TP
Contactor	:	2 nos 18 A & 1 no. 12 A 3 pole with auxiliary contacts 1 no Electronic timer 0-60 SEC
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	8Nos of 10sqmm Elmex for power, 3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 12.5 & 15 HP STARTERS

Full load current	:	18 & 21 Amps respectively
Incomer MPCB	:	11-16A TP
Contactor	:	2 nos 18A & 1no 12A 3 pole with auxiliary contacts 1 No electronic timer
Illuminated Push buttons	:	On and Off

Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	8Nos of 25sqmm Elmex for power, 3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 20 HP STARTERS

Full load current	:	28 Amps
Incomer MPCB	:	14-20A TP
Contactor	:	2 nos 25A & 1no 18An 3 pole with auxiliary contacts 1No electronic timer
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	8 Nos of 25sqmm Elmex for power 3 Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 25 HP STARTERS

Full load current	:	35 Amps
Incomer Motor Duty MCCB	:	125A TP & N
MCCB	:	50A (Type-II Co-ordination full protection)
Contactor	:	2 nos 32A & 1no 25A 3 pole with auxiliary contacts 1No electronic timer
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)

Terminals	:	8Nos of 35sqmm Elmex for power, 3Nos of 2.5sqmm Elmex for remote operation
MCB	:	16 A

- 30 HP STARTERS

Full load current	:	40 Amps
Incomer Motor Duty MCCB	:	125A TP & N
MCCB	:	63A (Type-II Co-ordination full protection)
Contactor	:	2 nos 40A & 1no 25A 3pole with auxiliary contacts 1No electronic timer
Over load relay	:	20 to 33A with single phase protection
Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	8Nos of 50sqmm Elmex for power, 3Nos of 2.5sqmm Elmex for remote operation or busbar
MCB	:	16 A

- 40 HP STARTERS

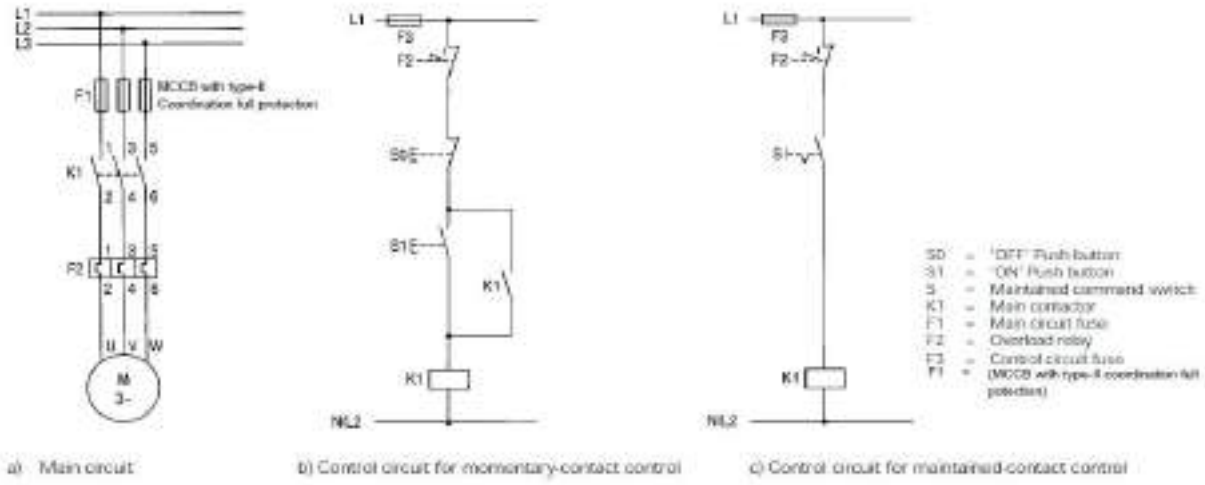
Full load current	:	55 Amps
Incomer Motor Duty MCCB	:	160A TP & N
MCCB	:	63A (Type-II Co-ordination full protection)
Contactor	:	2 nos 70A & 1no 40A 3pole with auxiliary contacts 1No electronic timer
Over load relay	:	30 to 50A with single phase protection

Illuminated Push buttons	:	On and Off
Indicating lamps	:	On (Green) off (Red) & Trip (Amber)
Terminals	:	8Nos of 50sqmm Elmer for power, 3Nos of 2.5sqmm Elmex for remote operation or busbar.
MCB	:	16 A

NOTE:

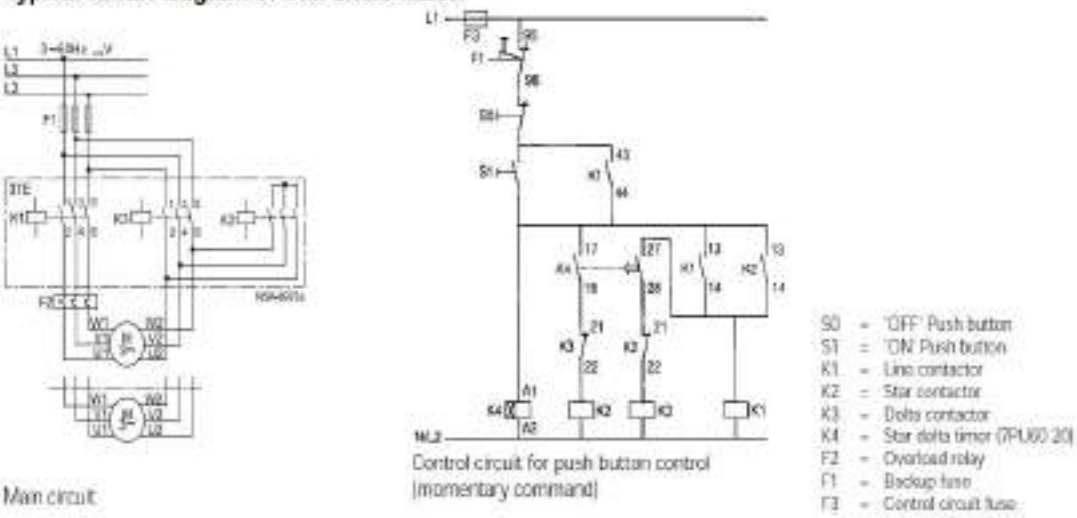
Upto 7.5 HP motor rating DOL starter has to be considered.
10HP and above motor rating Star Delta starters has to be considered.
Single line diagram has to be followed for detailed panel design.
Refer Single Line diagram for incomer type, it can be either MCCB, ACB, MCB

Typical circuit diagram of Direct On Line starter



a) Main circuit b) Control circuit for momentary-contact control c) Control circuit for maintained-contact control

Typical circuit diagram of Star Delta starter



4.5 PARTICULAR SPECIFICATIONS OF VARIABLE FREQUENCY DRIVES

- The VFD shall be of the type suitable for operation on a 3 phase, 415 V, 50 Hz input power supply at the following conditions:
  - ✓ Input supply voltage variations : ± 10 %
  - ✓ Input supply frequency variations : 50Hz/60Hz ±3%
  - ✓ Ambient temperature : 0 - 50 deg C, without derating.
  - ✓ Maximum relative humidity : 95% non-condensing
  - ✓ Vibration : 0.7 g RMS in 3 directions
  - ✓ Minimum efficiency at full load : 96%
- The VFDs will be mounted in the Electrical panel. Hence the VFDs shall have integrated; factory built metallic enclosures of IP 20 rating, without any de-rating. These VFD's shall be housed in a enclosed panel with minimum IP54 enclosure protection.
- VFDs shall conform to the recognized international standards like IEC and manufactured according to ISO 9001, BS 5750 part 1 & 2 and shall be UL listed. It shall carry the CE mark on EMC compliance.
- The VFD shall be capable of providing a starting torque of 160% for 0.5 sec and an overload torque of 110% torque for 1 minute.

- The VFD shall maintain full output voltage during main's variations of ±10% to prevent loss of torque and speed variations occurring during motor operation.
- The VFD shall comply with Electro Magnetic Compatibility (EMC) product standard EN61800-3, First Environment, Unrestricted distribution with minimum 50 meters of output cabling. The supplier of drives shall include additional filters needed, if any, to meet this compliance.
- The VFDs shall allow connecting shielded / screened 3 cores plus earth motor cable for all power sizes, without any restriction.
- For Pumps & Chillers - The VFD shall be employed with suitable technology limiting the total harmonic current distortion (THDi) and total harmonic voltage distortion (THDv) to less than 5% at the drive input terminals. External filters for harmonic reduction less than 5% are not allowed as it will cause voltage drop to VFD and motor
- For AHU & Ventilation Fans & Other applications - The VFD shall contain a standard built-in DC reactor of minimum 5% impedance on both positive and negative limbs of the DC Bus to reduce current harmonics less than 35% (THDi<35%). Voltage harmonics shall be limited to less than 5% (THDv<5%).
- For easier maintenance and to reduce inventory, the VFD shall allow connection of motors one frame size larger and 4 sizes smaller than its nominal rating.
- The VFD shall have the following protective functions: Electronic motor overload, Protection to motor and VFD against input transients, phase loss, short circuit, under voltage, over voltage, phase imbalance, motor over temp., and phase to phase short circuit or earth fault at motor terminals.
- The U-peak of the VFD shall be below 1000 Volts (when measured with a cable length of 50 meters) to prevent damage to motor insulation. Manufacturer of the VFD shall submit data sheet to verify this requirement in order to permit the usage of standard motors for the applications specified.
- The VFD shall be capable of having an output motor cable length of at least 150 meters (armoured cabling) without any need of additional equipment like output chokes. This is essential for applications like chilled water pumps and cooling towers where the motors are located far away from the control center.
- The VFDs shall incorporate a surge protection circuit as standard to protect the VFD from transients and spikes in the incoming power supply.
- 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 and switching back ON with VFD in on mode.

- The VFD shall monitor the belt (AHU etc.) or coupling etc.), and it shall display a warning signal if it detects a broken coupling / belt. There shall be provision to export this warning signal to the BMS system through RS 485, without any need of I/Os.
- The display of the VFD shall be Alpha numeric type. Display of all messages and faults shall be in English text format. Codes are not acceptable the display shall show the following operating parameters:
  - ✓ Power consumed by motor in kW
  - ✓ Run time of motor in Hours
  - ✓ Current drawn by motor in Amps.
  - ✓ Output frequency in Hz.
  - ✓ Motor speed in RPM
  - ✓ Set point in process units
  - ✓ Feedback in process units
- It shall be possible to see at least 4 of the above operating parameters in the VFD display, simultaneously.
- A parameter lock shall be available in the VFD local display panel to prevent unauthorized resetting of parameters.
- The VFDs shall have internal galvanic isolation (PELV) to avoid damage to BMS / PLC / DDC system when interconnected. If PELV is not available, the VFD vendor should offer opto-isolators for all the inputs and outputs in the VFD.
- The VFD shall automatically adjust the switching frequency based on motor current demand rather than motor speed so that the best possible switching frequency is provided, to match both performance and to maintain silent operation all speeds. The switching frequency range shall be from 4-10 kHz for VFDs.
- The VFD shall monitor the relationship between voltage and current in the motor and adjust the output voltage to minimize current and maximize motor and drive efficiency. VFDs offering fixed settings of V/f ratios are not permitted.
- The VFD shall have Auto / OFF / Manual switch on the keypad itself. It shall be possible to manually change the speed of the AHUs from the keypad of the VFD, if required, without the need of an external potentiometer. In manual mode the speed reference signal shall be from keypad of VFD and in auto mode, the reference shall be from the remote – either BMS or transmitter.
- The VFD shall have self-adjustable ramp times to prevent tripping / VFD damage in case inappropriate ramp times are set with respect to application requirement.
- The VFDs shall have the provision to program a minimum and maximum speed of operations, through the VFD programming itself.

- In case of a power failure, the VFD shall be capable of automatically restarting after a programmable time delay, without the need of an operator having switch on the unit.
- To prevent damage to the VFDs due to pre-rotating fans, the VFD shall have the capability to detect such spinning fans and adjust its frequency to its spinning speed before it starts controlling the fan. If the fan is running in the opposite direction, the VFD should brake the fan by sending a DC current, before starting the fan in the right direction.
- If a temperature / pressure / flow feedback signal is given to the VFD, it shall use its PID controller to modulate the speed in such a way that the set point of temperature or pressure is accurately maintained.
- The VFD shall be capable of accepting two such feedback signals simultaneously and be able to do a speed control based on average / sum / difference / minimum / maximum / 2 zone control of the above 2 signals.
- The feedback signal shall be monitored by the VFD and should provide a warning signal if the feedback goes above or below the programmed high and low limits. It shall be possible to transfer this signal to the BMS system as well.
- If the VFD loses the feedback signal or reference signal in auto mode, the VFD shall be capable of maintaining the speed at which it is running or to go to maximum speed or to trip.
- The VFD shall have the provision to automatically stop the motor when the feedback signal remains at the low level for a predetermined time.
- The PID controller shall be capable of programming the set points and incoming signals in any of the flowing units: : RPM, l/s, l/m, l/h, m3/h, m3/s, bar, Pa, kPa, GPM, lb/s, lb/h, CFM, in3/h, inwg, ft wg, PSI, kW, HP, oC, oF as required by the application, and be able to display the same while in operation.
- The VFD shall enable the motor to step over speeds that cause mechanical vibration / resonance in duct work / pipelines which can potentially damage the mechanical components in the system.
- The VFD shall have an auto de-rating facility by operating at a lower capacity in case of a phase loss or higher ambient temperature so that minimum air conditioning can be maintained. VFDs that trip on a phase loss or high ambient temperature are not suitable for this application and hence not permitted.
- The VFDs shall have the provision of 4 parameter set ups, which can be activated by the IBMS or by digital inputs.

- The VFD shall have the provision to generate a warning signal, if the operating frequency is above or below programmed the high and low limits, to stage on /off other devices.
- The variable frequency drives (VFD) shall have the provision to integrate into a BMS system, utilizing a serial communication through Modbus RTU protocol that enables a full "read & write" seamless interface between the VFD & IBMS. The VFD manufacturer shall be responsible for technical support to the IBMS Vendor in the implementation of a serial interface to the BMS System. The BMS Vendor shall be responsible for the complete "integration and interoperability" of the VFD through the IBMS via the serial interface.
- The VFD shall have an alpha-numeric digital display which shall display the following minimum information & The VFD shall provide to IBMS, via serial communication (by RS-485, 2 wire), access to the following VFD parameters as a minimum:
    - Frequency in Hz
    - Feedback signal in HVAC units (WC, PSI, GPM, °F, ft3/min, m3/h, L/h, L/s, bar, Pa, °C, M, ft., L/min, m3/min, "Hg, kPa, %)
    - Current in A
    - Output Voltage in V
    - Power in kW
    - Energy in kWh
    - Run time in hours
    - PID Monitors
    - Input and Output Terminal Status Indication
    - Fault Log History (Min Last 10 with Time stamp)

4.6 POWER FACTOR IMPROVEMENT CAPACITORS

4.6.1. CAPACITOR BANK:

Capacitor voltage shall be with minimum shall be 480V/525V, 50Hz when used with 7% de-tuned reactors. The capacitor element used in unit shall have metalized polypropylene film (MPP) having low loss dielectric and impregnated with semi dry biodegradable resin, which shall have high dielectric constant, low viscosity and high chemical stability. Capacitors shall be stacked winding to form three phases for effective heat dissipation. The Polypropylene film should be in wavy cut and heavy edge design, so that higher current carrying capabilities

can be achieved. The capacitor unit shall have over pressure dis-connector protection and Self-healing type.

- General specifications: 3 phase, delta connected, 50 Hz
- Overvoltage +10% (08h / 24h), + 15% (30m / 24h), + 20% (5m), +30% (1m) as per Clause 6.1 of IS 13340-1993.
- Overcurrent: 1.6 to 4.0 x In
- Capacitor banks shall be suitable for operation at 110% of rated RMS voltage and 150% of rated RMS current.
- Peak Inrush current withstand: 500 x In
- Life expectancy: 1,80,000 Hrs
- Capacitors shall have ISI and CE Marking.
- Total watt-losses excluding discharge resistors: < 0.45 W / kVAr
- Temperature category: -40 deg.C to 77 deg.C
- The Dielectric losses at ambient temperature and rated voltage shall be less than 0.2 Watt/KVAR
- Material for the capacitor casings shall be Aluminium extruded type, rustproof, non-inflammable and shall allow the capacitors to be installed in areas with strong atmospheric pollution without suffering any of the deterioration.
- The design shall be modular with an IP 40 protection level.
- The Capacitor should offer 15,000 switching operations per year.

4.6.2. DETUNED FILTER

Detuned harmonic filter reactors shall be used along with power capacitors to mitigate harmonics amplification and to avoid electrical resonance in LV electrical networks.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class H.

The reactors shall be made of high-grade copper windings, having a three phase, iron core construction suitable for indoor use. The reactor is air cooled and the layout shall be in accordance with IEC 60076 / IS 5553. Reactor should be designed, low temperature rise, low losses, high linearity of 200% (L> 0.95 x Ln).

The permitted tolerance of inductance is ± 3% of rated inductance value.

Reactor tuning factor shall be 7 % (189 Hz) and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

The limit of linearity of inductance of the filter reactor is: 1.73*In with L>=0.95*LN.

The detuning reactor shall be supplied with a normally closed thermostat contact to be connected in series with the power factor regulator step switching relay. When the reactor iron core has overheated above 155 deg. C, the thermostat contact will open and thus cut off that particular step, this will prevent thermal runaway of the reactors.

The input/output connections should be made through tinned copper bars. The coil windings should be provided with ventilation space for allowing adequate heat evacuation even hot ambience. The reactor should be vacuum impregnated with a varnish having high insulation properties.

4.6.3. CONTACTORS

Capacitor duty Contactors with appropriate KVAR ratings and utilization category shall be selected for reactive capacitor switching. The contactors for this application shall conform to IEC 60947-4-1.

The Capacitor duty contactor shall be with pre-charging resistor as to limit the inrush current. The pre charging resistors shall be closed through auxiliary contacts, which shall open within few cycles of closing of main contact through a magnetic detaching arrangement so as to ensure longevity of the Contactors.

The Contactors should have been Type tested to IEC 60947.
The Contactors shall be UL approved.

4.6.4. APFC CONTROLLER

Controller technology should be intelligent with digital signal processor (DSP). Controller should be capable of switching Banks in Real Time through static outputs. It should be of

(144x144 mm with IP54 on front) frame size and have clear backlit LCD graphic display wherein each phase data can be seen separately for eg. Power factor of all the 3 phases can be viewed at the same time. In order to have complete system and network control with analysis, it should have 7 input channels, 4 voltages inputs for L-1, L-2, L-3 and Neutral, 3 current inputs from 3 CT's of L-1, L2, L-3. Controller should have inbuilt Load and Power Quality Manager to view all electrical parameters on its graphic display like Currents, Voltages, Power Factor, Cos Phi, Active Power, Reactive Power, Apparent Power, THD-I (%), THD-V (%), Individual Current and Voltage Harmonics upto 31st, Current & Voltage Waveforms, Bar Chart for various parameters & harmonics. Controller should have operational voltage measurement range of 100V to 750V to withstand low and high peaks. Controller should have Dual PF setting for maintaining different target power factor on Mains and DG supply. It should have programmable option for taking inputs from …/5A or …/1A CT's. It should have communication port on front panel for connecting and analyzing controller data through cable on laptop or through Wi-Fi module for mobile app without opening the Panel door. Controller shall have expandable feature to expand the stages at later date to 16 or through Master-Slave combination up to 32 stages. Controller to give working hours and no. of operation of each banks details on display. It should have various programmable / default Alarms for protection of Capacitor Banks and complete System.

4.7 METHOD OF TESTING

Routine test:-

- Insulation resistance test with megger before HV test.
  - Between Phases
  - Between Phase / Neutral & Earth.
- HV test at 2.5Kv for 60sec.
  - Between R, Y, B, N shorted & Earth.
- Insulation resistance test with megger after HV test.
  - Between Phases
  - Between Phase / Neutral & Earth.
- Dimensional Check as per approved GA drawing.
- Function Check.

5.0 TECHNICAL SPECIFICATIONS FOR POWER DISTRIBUTION BOARD:

5.1 SCOPE

- This specification covers the design, manufacture, assembly, testing at works and supply of Distribution Boards. Complete with all accessories for efficient and trouble-free operation. As per specification and makes in tender.
- The enclosure should be of special grade CRCA sheets or thermoplastics, in case of metal enclosures, they should be subjected to seven tank phosphating and rust retardant process final finish to be powder coated and scratch resistant.
- Enclosure to be of weatherproof construction, IP 42 for indoor use, and IP55 for outdoor use. Distribution boards to be designed to conform to IS 8623
- Suitable knockouts should be provided for different size of cables and cable glands.
- Adequate clearance to be provided between DIN rails. DIN rails to be designed for easy mounting of MCB's, RCCB's, RCBO, load insulators, etc.
- Current carrying parts should be of electrolytic grade copper.
- Neutral bars to be of brass with insulation and separate earth bars to be provided.
- MCB's should have breaking capacity of 10KA (IEC 898) and should meet the requirements of IS:8828 BS 3871, VDE 0641 and IEC: 898
- Circuit identification stickers, ferrules or charts to be provided.

5.2 CONSTRUCTION

The distribution boards shall be fabricated out of 1.2 / 1.6mm thick CRCA sheet steel and shall be totally enclosed, dust and vermin proof, dead front, with hinged door with double sided hinged door type of bolted / welded construction suitable for wall mounting.

Each DB shall have individual hinged/bolted gasketed doors with cam lock. Removable gland plates shall be provided at top and bottom of the DB to facilitate drilling the holes at site to suit individual requirements or knockout shall be provided.

All boards shall be meggered phase to phase and phase to neutral using 1000/500V megger with all switches in closed position. The megger value should not be less than 2.5 M Ohm between phases and 1.5 M Ohm between phase and neutral. Testing of minimum 10 kA short circuit current otherwise specified in BOQ required.

Distribution boards shall be wall mounted and shall, where specified, incorporate double pole or triple pole all insulated switches as appropriate, which shall be front of panel operated with an "ON/OFF" indicator and capable of being padlocked in the "OFF" position. Distribution boards shall incorporate combinations of single pole, double pole, triple pole and four pole miniature circuit-breakers (MCBs/MCCBs) as specified.

Protective insulated cover plate shall be provided inside the DB to shroud all the live parts. Only the operating handle of the switch and the operating knobs of the miniature circuit breakers shall be projecting outside the cover plate. The unused holes of the DB shall be suitably blanked. The incoming switch terminals should be suitably shrouded to avoid accidental contact. Each bank of MCB's shall be clearly identified with its appropriate phase colours code and Each phase or way shall also be suitably shrouded with DMC / SMC. The boards shall be factory wired and assembled. Circuit identification labels shall be provided on the cover.

All three phase Lighting distribution board shall be provided with Double Door arrangements. They shall be of Phase segregated type. All components in the Distribution boards shall be same make. All the live part of the distribution shall be suitably shrouded.

5.3 BUSBARS

The bus bars shall be air insulated and made of high conductivity high strength copper bus bars liberally sized with high safety factor for the required rating (both short circuit and continuous currents). The neutral bus bar shall have adequate number of terminals for all outgoing single-phase circuits. A copper earth bus of suitable size shall be provided in each DB for earthing of the power, lighting circuits and earthing of DB.

5.4 MINIATURE CIRCUIT BREAKERS

The breaking capacity of the MCBs shall be 10 kA in accordance with IEC 60947 & IS 13947 / 8828 - 1996 and with tripping characteristics to suit the type of load it is feeding. They shall be suitable for 35mm DIN rail mounting in any plane without derating. The terminals should be protected against finger contact to IP 20 degree of protection with no restriction for line and load.

- Number of poles: single-pole, double-pole, triple-pole or four-pole as specified in the BOQ or Drawings
- Protection against external influences: Enclosed-type,

- Method of connection: Bolted type or clip-on type,
- Rated operational voltage and frequency 240 / 415 V AC and 50 Hz.
- Range of instantaneous tripping current: MCB's shall be current limiting Type Class 3 with range of instantaneous tripping current B, C or D type as appropriate or as specified.
- B/C Curve for lighting, C Curve for Motor loads and D curve MCB's for UPS loads
- Rated short-circuit breaking capacity: not less than 10 kA (M3) unless otherwise specified in BOQ
- I2t characteristic: suitable for load and circuit being protected,
- Degree of protection: IP-20 for MCB's
- Reference ambient temperature: as per IEC 60898.

5.5 RESIDUAL CURRENT CIRCUIT BREAKER (RCCB)

RCCBs shall be double pole or four-pole current-operated, housed in a totally enclosed moulded case, manufactured and tested in compliance with IEC 61008 or EN 61008.

RCCBs shall meet the following requirements:

- Number of poles: double-pole or four-pole as specified on the Drawings,
- Rated current (In): as shown on the Drawings,
- Rated residual operating current: 30 mA or 100 mA or 300 mA as shown on drawings or as per approval of the Engineer.
- Rated voltage: 240/415 V AC,
- Rated frequency: 50 Hz,
- Rated impulse withstand voltage (1.2/50) Uimp = 4 KV
- Surge current resistance (wave 8/20) = 250 A
- Rated short-circuit capacity: not less than 1.5 kA unless otherwise specified in BOQ
- Operating characteristics in case of residual currents with DC components: as specified,
- Method of mounting: distribution board type,
- Method of connection: connection shall be made with proper size of thimbles and number ferruling for circuit identification,
- I2t characteristic: suitable for equipment and circuit being protected
- Degree of protection: IP 3X to IEC 60529 or EN 60529, and
- Reference ambient temperature: As per IEC.
- The tripping mechanism shall be of trip-free so that the unit cannot be held closed against an earth fault. Tripping devices utilizing electronic amplifiers or rectifiers are not acceptable.

- Rated conditional short-circuit current Inc=Iδc = 10KA (with a SPD)
- And all the RCCB must able to connect the auxiliary contact at any time.
- Provision shall be made for testing the automatic earth - leakage tripping by an integral test device. A device shall be fitted for prevention against reclosing after the device has tripped on earth leakage.

5.6 RESIDUAL CURRENT CIRCUIT BREAKER WITH OVER –CURRENT PROTECTION (RCBO)

RCBOs shall be double pole or four-pole current-operated, housed in a totally enclosed moulded case, manufactured and tested in compliance with IEC 61009 -1, IS 12640(part 2) 2008 and ISI marked.

RCBOs shall meet the following requirements:

- Number of poles: two pole two module or four-pole as specified on the Drawings,
- Rated current (In): as shown on the Drawings,
- Rated residual operating current: 30 mA or 100 mA or 300 mA as shown on drawings or as per approval of the Engineer.
- Rated voltage: 230/415 V AC,
- Rated frequency: 50 Hz,
- Rated short-circuit capacity: 10kA
- Operating characteristics in case of residual currents with DC components: as specified,
- Method of mounting: distribution board type,
- Method of connection: connection shall be made with proper size of thimbles and number ferruling for circuit identification,
- I2t characteristic: suitable for equipment and circuit being protected
- Degree of protection: IP 2X, and
- Reference ambient temperature: As per IS 12640-1
- The tripping mechanism shall be of trip-free so that the unit cannot be held closed against an earth fault. Tripping devices utilizing electronic amplifiers or rectifiers are not acceptable.
- Provision shall be made for testing the automatic earth - leakage tripping by an integral test device. A device shall be fitted for prevention against reclosing after the device has tripped on earth leakage
- A mechanical flag indicator on RCBO for faster identification of fault trip condition i.e. in case of earth leakage current flag appears on the toggles thus immediate showing the cause of the trip of the device it's for preventive measures.

5.7 SURGE PROTECTIVE DEVICES (SPD) TYPE-2 FOR DISTRIBUTION

According to IEC 61643-11 and EN 61643-11, in order to avoid oscillations and magnetic coupling phenomena, equipment must be protected against indirect surges with din rail Class 2 / Type 2 (8/20µs) surge arresters. And all the SPD must be with backup protection of isolator.

The SPD should have a safety reserve system and be pluggable for preventive and easy maintenance. It should provide either common protection in TNC network or common and differential mode protection in TNS and TT network according to IEC 61643-11 and EN 61643-.

In the case of common and differential mode protection the SPD should use a combination of MOV and GDT technologies in order to provide isolation to ground and a low protection level for all protection modes. The associated circuit breaker (MCB) (to ensure a safe end of life) should be the same brand as the SPD to provide good coordination.

Supply, install and connect Surge Protective Devices with the following technical characteristics:

- Technology: Metal oxide varistors
- Pluggable cartridge for an easy and quick intervention
- Maximal discharge current wave form 8/20µs: Imax = 40 or 80 kA
- Nominal discharge current wave form 8/20 µs: In = 20 or 30 kA
- Voltage protection level: Up ≤ 1.25 kV (for 275 V) or 2.4 kB (for 440 V),
- Nominal voltage: UN = 230/400/600 V,
- Maximum continuous operating voltage: Uc = 275/350/440/600 V,
- Short circuit withstand = 100 kA
- Integrated thermal disconnector
- Visual state indicator
- Safety system
- Auxiliary contact
- No electrical consumption on visual state indicator

5.8 GROUNDING

The DB's shall be provided with two No's brass earthing stud terminals with suitable nuts, washers etc for connection to earth bus outside the DB.

5.9 PAINTING

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or highly humid conditions. The DB shall be prepared, primed, filled and painted to the highest standards. All items shall be cleaned and de burred after fabrication and welding is complete. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface free from blemishes and imperfections and the entire DB shall be powder coated with epoxy paint and the shade shall be indicated later.

5.10 TESTS

All necessary routine tests shall be performed on the equipment to demonstrate satisfactory performance to owner / consultant at works without any extra cost. Equipment shall not be dispatched without obtaining approval of test certificates for type, routine and acceptance tests. Inspection of the panels / switch gear shall be done by client at the vendor premises.

5.11 DRAWING & INSTRUCTION MANUALS

- Along with the offer, the bidder shall submit the following documents, in Triplicate.
- General arrangement of DB
- Technical leaflets on DB, MCB, MCCB, isolator etc.
- Type test reports as per IS 8828
- Tripping characteristic curves for MCB/MCCB.
- After award of the order, the contractor shall submit the following documents for approval, in six copies.
- General arrangement drawing showing the constructional features, dimensions, installation details etc.
- Complete technical particulars of Distribution boards, MCB, RCCB,RCBO, isolators etc.
- Before taking up manufacturing of the equipment the Bidder shall have to take the approval of for design and drawing. Any manufacturing done prior to approval shall be rectified by the bidder at his own cost and the equipment shall also be supplied within the stipulated period.

6.0 TECHNICAL SPECIFICATION OF LIGHT FIXTURES

This specification is intended to cover the design, fabrication, assembly & testing at manufacturer's works, properly packed for transportation, supply and delivery at site complete in all respects with all components, fittings and accessories for efficient and trouble-free operation and supervision of erection of Light fittings & accessories.

The electrical arrangement of the system shall be indicated in the data sheet. All components of the equipment's shall be rated for the electrical system characteristics shown on Data sheet.
The Equipment shall be suitable for operation with system voltage and frequency variations

- Voltage: 230 V 1 Phase 50 Hz Neutral solidly grounded.
- Voltage variation: ± 10%
- Frequency variation: ± 2%

The lumen maintenance of the LED fittings (of the system not chip) shall not be less than 70% after 5000 hrs. i.e. (L70; B10). It shall have a warranty of 5 years after delivery and warranty of the replaced item shall restart from the date of replacement.

The product should be latest state of art and compliant to relevant IEC 60598-1, 2, 3, IEC 62031and IEC/PAS 62612 or their latest edition depending on the type of luminaire. In addition to the above luminaire shall adhere to relevant BIS standards IS 15885, 16101, 16102, 16103, 16104, 16105, 16106, 16107 (Part I & II) as per the application. The product shall be of proven design should possess type test certificate/performance certificate from the accredited laboratory. The product and is major components shall be state of art and of proven design.

6.1 RECOMMENDED ILLUMINATION (LUX LEVELS):

The following Table gives the recommended illuminance range for different tasks and activities for chemical / lab sector. The values are related to the visual requirements of the task, to user's satisfaction, to practical experience and to the need for cost effective use of energy. Illuminations values considered are equal to higher than for lighting design shall be as per the IS 6665-1972 Table -2 page 21-32 and IS 3646 standards

Manufacturing & Lab area	300 -350 Lux
Office, meeting rooms	300 Lux

Stores, corridor, toilets, airlock	200 Lux
Technical areas	150 - 200 Lux

6.2 LED LIGHT FIXTURES:

LED technology is evolving continuously, and today it provides a perfect replacement for conventional luminaires in modern workspaces and industrial applications.

The LED advantage is LEDs offer energy efficient lighting solutions for primary applications, ensuring high energy savings and reducing carbon footprints. With latest development in LED technology, high power LEDs are now available with better light efficiency (greater than 100 lumens per watt) that provides good quality lighting for workspaces. LEDs are point sources, which help create compact luminaires. LEDs with 70% lumen maintenance (LM) at 50000 burning hours ascertain maintenance free long service life for the luminaire. LEDs are a green lighting solution with no mercury content.

6.3 LED - CLEAN ROOM LUMINAIRE:

Recessed/surface mounted LED 600x600mm/300mmx300mm/300mmx1200mm luminaire made of epoxy powder coated CRCA steel sheet housing. Opal acrylic Diffuser sealed with epoxy white powder coated bottom frame (unless specified during light fixture approval) to ensure fool proof dust/particle protection and Screw less with diffused acrylic cover, construction of the housing with Engineering push back mounting arrangement system (Interlocking System). All the LED CHIPS are mounted on PCB'S with separate aluminum Heat sink for better Life and heat dissipation. System luminaire efficacy greater than 100 Lum/W. Correlated color temperature (CCT) of 5700K (WH). The luminaire should have Color Rendering Index (CRI) >80, Power Factor >0.95. Power will be supplied with Constant current output driver operating range from 150 – 265 V AC supply voltage. The THDi < 10% and IP65 rated (from front side). It should have 50000 burning hours at LM 70.

LED drivers are supplied with CRCA Powered coated MS encloser, to ensure proper passage of Leakage current and heat dissipation and driver is having 2.5KV inbuilt surge protection and THDi < 10%. The driver should comply to BIS standards and should be of reputed makes.

6.4 LED - NON CLEAN ROOM LUMINAIRE:

Recessed LED 600x600mm/300mmx300mm/300mmx1200mm luminaire made of CRCA steel sheet with opal acrylic Diffuser fixed in separate steel frame. System luminaire efficacy greater than 120 lum/W. Correlated color temperature (CCT) of 5700K (WH) and 4000K(NW). The luminaire should have Color Rendering Index (CRI) >80, Power Factor >0.95. Power will be supplied with Constant current output driver operating range from 150 – 265 V AC supply voltage. The THDi < 10% and IP20 protected. It should have 50000 burning hours at LM 70.

LED drivers are supplied with CRCA Powered coated MS encloser, to ensure proper passage of Leakage current and heat dissipation and driver is having 3KV inbuilt surge protection and THDi < 10%. The driver should comply to BIS standards and should be of reputed makes.

6.5 LED – DOWN LIGHT:

Round / square LED Recessed Downlighter made up of CRCA or aluminum body with high efficiency opal diffuser. It should have system efficacy of 90 lm/W. The luminaire has color temperature of 5700K(WH) / 4000K(NW) and the luminaire should have Color Rendering Index (CRI) >80, Power Factor >0.95. Power will be supplied with Constant current output driver operating range from 150 – 265 V AC supply voltage. The THDi < 10% and IP20 protected. It should have 50000 burning hours at LM 70.

LED drivers are supplied with CRCA Powered coated MS encloser, to ensure proper passage of Leakage current and heat dissipation and driver is having 2kV inbuilt surge protection and THDi < 10%. The driver should comply to BIS standards and should be of reputed makes.

6.6 LED – 4FEET LUMINAIRE:

LED 4ft Batten made up of Aluminum housing for better heat dissipation and Opal diffuser for smooth distribution of light. It should have minimum system efficacy >110 lm/W. The luminaire has working voltage range of 150 – 300 AVC and 50/60HZ operating frequency. Color temperature of 6500K, CRI>80 with 120deg beam angle for good spread. The luminaire meets IP20 rating for indoor and IP 65 for outdoor applications with PF > 0.95 and THDi<10%. Surge protection of 4kV for indoor and 10kV for outdoor. Has lifetime of 50,000 hours at LM70. Luminaire must be suitable for surface/ suspended mounting.

The driver should comply to BIS standards and should be of reputed makes.

LED CLEAN ROOM RECESS MOUNTED TOP/BOTTOM OPENABLE TYPE LUMINAIRE

LED NON-CLEAN ROOM RECESS MOUNTED LUMINAIRE

LED RECESS MOUNTED CIRCULAR LUMINAIRE

LED LINEAR SUSPENDED/SURFACE MOUNTED LUMINAIRE

7.0 TECHNICAL SPECIFICATION OF LT CABLES

Cables shall be selected from one manufacturer who has been manufacturing such cables for at least ten (10) years using the Indian Standard Institution (ISI) certification produced for each cable.

This specification is intended to cover the technical requirements of design, manufacture, testing at works, inspection, supply and delivery at site of LT Cable.

The cable shall be rated for a voltage rating of 1.1 KV up to 11 KV.

- Frequency 50 Hz
- Variation in frequency ±3%

7.1 CONDUCTOR:

- The conductor shall be Aluminum or Copper as stated in BOQ.
- The conductor shall be stranded, compact, and circular of aluminum wires of H2 or H4 grade plain aluminum wires.
- The conductor shall be clean, uniform in size and shape smooth and free from harmful defects.
- Not more than two joints shall be allowed in anyone of the single wire forming every complete length of conductor and no joint shall be within 300 m of any other joint in the same layer. The joint shall be made by brazing, silver soldering or electric or gas welding.
- No joints shall be made in the conductor after it has been stranded.

7.2 INSULATION:

- The conductor shall be insulated with suitably compounded PVC/XLPE applied to the conductor by the extrusion. Insulation shall withstand to thermal and thermos mechanical stresses safely at continuous normal and short circuit temperature conditions.
- The PVC/XLPE compound used for insulation shall have reduced flame propagation property.
- This shall also have reduced emission of hydrogen-chloride gas fumes etc. when severely overheated during fires. It shall be capable to limiting displacement of cores in cables during short circuit.
- The cables shall be manufactured with latest manufacturing process to get improved reliability and compactness of cables.

7.3 INNER SHEATH:

- Inner sheath shall be provided thermoplastic material softer than insulation compatible with thermal rating of insulation. Inner sheath shall be applied either with extrusion or by wrapping closely on the laid of cores and stripped with ease without damaging insulation.

7.4 ARMOURING:

- The armouring shall be used for mechanical protection of the insulated conductors (cables). The armouring is applied over the inner sheath for multicore cables and over the core or inner sheath for single core cables. The direction of lay of armouring shall be opposite to that of the cores.

- The multicore cable shall be armoured with either GI round steel wires or GI flat strips and in case of single core cable armouring shall be of non-magnetic material such as hard drawn aluminium or aluminium alloy wires or strips to avoiding magnetic hysteresis losses on AC system.

7.5 OUTER SHEATH:

The Outer sheath shall be provided with an extruded PVC/Polymer on armouring. The PVC/polymer compound used for outer sheath shall be resistant to termites, fungus and rodent attacks and shall also have reduced flame propagation property.

Tests for cable flame retardancy shall be in accordance with the referenced standards.

The outer sheath of cables shall be embossed or engraved with

- The voltage designation
- Manufacturers identification
- Number of Cores and nominal cross-sectional area of conductors
- The drum progressive length of cable at every meter. (The starting point being the cable end at its inner coil on the cable drum.)
- In case of XLPE insulated PVC sheathed cables, cable filler, inner and outer sheath shall confirm to ST-2 compound as per standard. The inner sheath shall be applied over laid cores by extrusion.

7.6 CORE IDENTIFICATION

The cores of the cables shall be provided with the Indian colour scheme of XLPE/PVC insulation as per IS for any easy identification.

Different cores in a cable are identified by colours. Flowing colour scheme is followed.

1 Core	Red / Black/Yellow/ Blue
2 Core	Red and Black
3 Core	Red, Yellow and Blue
3.5 Core	Red, Yellow, Blue, and Black
4 Core	Red, Yellow, Blue, and Black

Wherever the number of cores exceeds 5, two adjacent cores (counting core and direction core) in each layer are coloured blue and yellow respectively and the remaining cores are Grey.

All multi core cables are laid up as per the colour scheme indicated above with thermoplastic fillers in the centre and the interstices whenever applicable to make the cable circular. Top layer of the laid up is always with right hand direction.

7.7 IDENTIFICATION:

The outer sheath shall have the following information embossed or indented on it; the manufacturer's name or trade mark, the voltage grade, the year of manufacture. The identification shall repeat every 300/350-mm along the length of the cable.

7.8 TYPE TESTS:

The following type tests will be conducted on the cable:

- Test on conductor
- Test on armor wires
- Test for thickness of XLPE insulation and inner and outer sheaths
- Physical test on XLPE insulation
- Physical test for outer sheath
- Partial discharge test
- Bending test
- Di-electric power factor test
  i. As a function of voltage
  ii. As a function of temperature 151
- Insulation resistance (Volume resistivity) test
- Heating cycle test
- Impulse withstand test
- High voltage test
- Flammability test

7.9 ACCEPTANCE TEST:

The sampling plan for acceptance test shall be as per 18:7098 Part (2)

The following shall constitute the acceptance test.

- Tensile test for aluminium

- Wrapping test for aluminium
- Conductor resistance test
- Test for thickness of insulation
- Test for thickness of inner and outer sheath
- Hot-set test for insulation
- Tensile strength and elongation at break test for insulation and outer sheath
- Partial discharge test (on full drum length)
- High voltage test
- Insulation resistance (volume resistivity) test.

7.10 ROUTINE TEST:

The following shall constitute routine tests:

- Conductor resistance test
- Partial discharge test on full drum length
- High voltage test.

7.11 DESCRIPTION OF FLEXIBLE CABLES:

The scope of this package, covers the design, manufacture, stage inspection at works, inspection and testing of finished cables at manufacture's works, testing at independent test house, packing, transport and delivery to consignee's address of 1100V 2C/3C/4C Copper conductor, PVC inner sheathed insulated FR-LSH outer sheathed Cables as per Class 5 of IS: 8130/1984, IS: 5831 Type A specified construction. And PVC insulated and PVC sheathed industrial copper flexible round cable conforming to IS: 694 voltage grade up to 1100volts.

- Insulation:
  The conductor is insulated with specifically formulated PVC compound with high oxygen index and temperature index which helps in restricting propagation of flame. The compound confirms to IS 5831 Type A.

  Online spark testers ensure fail proof high voltage test by employing nondestructive form of testing at six times the rated voltage.

- Sheath:
  In multi core flexible cables the insulated cores are assembled to form concentric shape. Inner cores are color coded for easy identification as per national/international color-coding practices. The sheathing is carried out on high-speed extruders with

specially formulated PVC compounds with additional FR properties and they with stand mechanical abrasion in use as well as provide ease of stripping. The FR PVC compounds used for insulation & sheath have high oxygen & temperature index index helping in restricting the spread of flame even at high temp.

8.0 STORING, LAYING, JOINTING AND TERMINATIONS

8.1 STORING:

- Cables shall be stored in accordance with the manufacturer's recommendations and labeled with its Manufacturing Date, Indian Standard for manufacture, cable grade, and description, number of cores and cross-sectional area, and length. On receipt of cables at site the cables shall be inspected and stored in a safe place.
- The ends of cable shall be in sealed condition. After inspection, cable shall be located in a proper place with battens of cable drums being replaced. The cable drums shall not be stored 'on flat' with flanges horizontal.
- Client/Consultant will inspect the cables before storing. Contractor shall take out samples from the drums as per their instructions and send them to the manufacturers to conduct the approval tests. After the receipt of the test analysis, the cable will be accepted by the Owner.

8.2 CABLES AND CABLE ENTRIES:

- Particular attention is drawn to the Contractor's responsibilities in safeguarding cables installed in outdoor locations and unfinished buildings. Such equipment is particularly vulnerable to damage from water and dust penetration. The Contractor shall ensure that cables are adequately protected in this respect while installation work is proceeding. Covers temporarily removed from trenches/entries for purpose of installation shall be reassembled on completion of the Work and replaced when such work is suspended or otherwise left incomplete. Similarly, all entries shall at times be effectively sealed against ingress of water and dust, eg. Duct entries shall be sealed by the insertion of proprietary stopper plugs or approved means.

8.3 CABLE LAYING

- Cables shall be laid in a manner to prevent strain and damage with no kinks or twists or stripping and be mechanically supported throughout their length. An adequate number of cable rollers, each of which shall be undamaged and completely free to rotate shall be used to support the cable during pulling in such a manner that not part of the cable can touch the ground, the trench bottom or side, or the wall of the buildings or the tray.
- Winches whether power driven, or hand operated and other mechanical aids shall only be used with the prior authorization of the main contractor. Whenever a winch or similar appliance is used, an approved tension gauge shall be fitted into the haulage line between the winch and the cable. The pulling tension must at all times be within the limit advised by the cable manufacturer, which shall be communicated in writing to the main contractor before the laying is commenced.
- All cables shall be pulled into position in such a manner as to avoid any damage whatsoever to the cable or its sheath. Cables shall wherever possible, be pulled directly from the top of the drum, which shall be supported throughout the operation in such a manner that it is completely free to rotate. In the event of damage to the sheath or armouring of any cable, the cable shall be replaced throughout its entire length at no cost to the contract.
- During the course of pulling operations, the cable shall not be allowed, under any circumstances, to twist or rotate about its longitudinal axis because of excessive pulling tension or for any other reason.
- Cables used on 415V system shall be of 1.1 KV / 11KV /22KV grade, aluminium/Copper stranded/single conductor, XLPE insulated PVC / FRLS outer sheath, PVC inner sheath, upto 10Sq.mm Copper with Round Strip, from 16Sq.mm and above Aluminium / Copper Multistrand Flat Strip as per the ST2 type 7098 Part-1 Cables Standards.
- Cable shall generally be installed in ladder type / perforated trays in trenches or buried in ground except for some short runs in conduit for protection or crossings the roads etc.
- Approximate lengths of cables run will be given in the cable schedule. Before commencement of work the Contractor shall take actual measurements and prepare his own cable cutting schedules to reduce wastage to a minimum.
- Each length of run shall be physically measured at site before cutting the cable. Contractor shall furnish cable cutting schedule to engineer in charge with respect to able drum length available at site and runs of cables & sizes of cables.

- Cable may also be laid through hume pipes/corrugated high density PVC pipes (as approved by the consultant/owner) in road crossings etc. The pipes shall be supplied and placed in position by the Contractor.
- Cable laid on trays and risers shall be neatly dressed and clamped at an interval of 2000 mm and 500 mm for horizontal and vertical cable run respectively and at each bend of cable.
- All power cables shall be clamped individually, and control cables shall be clamped in groups of three or four cables.
- Clamps for multi-core cables shall be fabricated of 25 x 3 mm G.I. flats. Single core power cables shall be laid in trefoil formation and clamped with trefoil clamps made of Fiber glass/PVC.
- Cable openings etc. in walls/floor made by the Contractor or by others shall be sealed by the Contractor suitably by Hessian tape and bitumen compound or by any other proven method to prevent ingress of water.
- Cables shall be neatly arranged on trays and neatly clamped / tied to prevent sagging.
- Wherever cables are laid in trenches (outdoor), depth of trenches shall not be less than 750mm and width 600mm, after cable has been laid and straightened, it shall be covered with 75mm thick layer of sand. Similarly, the excavated trenched should be filled upto 75mm sand prior to cable laying. Over this sand layer a course of cable protection tiles to overlap cables by 50mm on either side shall be laid. Trenches shall then be backfilled and consolidated. The suitable markers shall be provided at regular intervals to the 200mm above the ground level (MGL).
- After completion of installation and prior to connection, all High Voltage Power cables shall be given a high potential test. The contractor shall provide this Hi pot Test set having provision of leakage current measurement.
- Cable identification tags shall be of 2 mm thick, 20mm wide aluminium strip of suitable length to contain cable identification.
- Cable Trays from 600mm & above shall be supported with 50x50 Tubular Section / 50/50x6mm angle/channel fabrication.
- Cable Trays from 450mm shall be supported with 25x25 Tubular Section / 25/25x6mm angle/channel fabrication.
- 300mm & below shall be supported with down rod (12mm) & slotted angle for data & power distribution cable. At every 15mtrs length, 1no U clamp of 8mm dia hole to be provided. This is meant for internal 25X3mm GI earth strips to take tapping to vertical drop earth wires.

8.4 CABLE BENDING

- At all times almost care shall be exercised to prevent excessive bending or twisting of cable during installation.
- Changes in direction in cable trenches, racks or trays shall provide for a minimum cable bending radius of twelve times the overall cable diameter.

8.5 JOINTING AND TERMINATION:

- Cable jointing shall be done as per the recommendations of the cable manufacturer. Jointing shall be done by qualified & skilled cable jointers.

8.5.1 HT Cable Termination:

All HT cable termination/11Kv/22Kv Incoming and outgoing cables shall be terminated using heat shrinkable indoor type cable termination kits Terminal pothead shall be used at the Transformer / Switchgear terminals. The termination kits should be of approved make.

8.5.2 Cable Termination:

- Glands shall be selected for appropriately for the environment in which the cable is to be used. Each termination shall be carried out using brass double compression glands and in cable sockets Hydraulic crimping tool shall be used for making the end terminations. Cable gland shall be bonded to the earth by suing suitable size Cu/G.I. wire/tape.
- The general requirements for all joints and terminations of aluminium cables shall be:
    i. To remove oxide from the conductor and prevent the oxide re-forming.
    ii. To prevent corrosion resulting from contact between dissimilar metals.
    iii. To retain contact pressure under cyclic loading conditions.
- For all aluminium cables, the oxide shall be removed by thoroughly wire-brushing the bare end of the cable. After brushing, a liberal coating of approved oxide-inhibiting, moisture-excluding thermally stable grease shall be applied, and the cable shall be wire-brushed again through the grease. Cable strands shall not be separated before brushing.

- Bare aluminium / copper lugs, ferrules and other connectors, unless factory-tinned or factory pre-filled with inhibiting grease, shall be wire-brushed and grease coated in the same way as cables.
- Before making any joints or terminations in aluminium cables, the Contractor shall submit the proposed method for the Consultant / Main Contractor approval. Notice of at least three working days shall be given before making any joints or terminations, to enable the Consultant / Main Contractor to witness the work.
- Aluminium crimp lugs or tinned copper lugs and ferrules.
- Tinned copper ferrules shall be terminated using the compression method. For compression connections on stranded cables, a hexagonal die shall be used, on solid conductor cables, indent type dies shall be used, with at least two indentations per cable connection. Lugs of ferrules shall be selected to suit the size and shape of the conductor. Compression dies shall be selected to suit the lug or ferrule. Aluminum crimp lugs shall be filled with oxide inhibiting grease.
- Aluminum to copper connections shall be made by one of the following methods:
    a) Bi-metal connectors, or
    b) Tinned copper ferrules. or
    c) Electro-tinned cast aluminium lugs.
- Bi-metal connections shall consist of lugs or pin type connectors having a cast copper palm or pin, friction-welded to an aluminium barrel section which is subsequently factory filled with oxide-inhibiting grease. The aluminium cable shall be inserted in the barrel section and fixed using the compression method as detailed above. The copper pin or palm section shall be fixed to copper or brass connectors or bus-bars in the conventional manner. Tinned copper ferrules shall be terminated using the compression method.
- Where electro-tinned aluminum lugs are used, they shall be fixed to the cable using the compression method. The palm of the lug shall be bolted to the copper bus-bar or terminal using a stainless-steel bolt and nut, with one large diameter stainless steel flat washer and two "Belleville" spring cup washers.
- All nuts shall be adequately torque tightened to manufacturer's recommended levels. Identification tags for feeder designation shall be by using `Phoenix' plastic cable markers, tied to either end of each cable.
- The cable termination includes drilling of Gland plate as require size of the cable and no. of cables in each section/cable alley.
- The termination, Joints and connections of cables shall be done by qualified jointers strictly in accordance with manufacturer’s instruction drawings and/or as directed by

the Engineer. The cost of end termination of all the LT cables shall be excluded in the quoted price for laying of the cables and extra payment on this will be quote.

- The work shall include all clamping, fittings, fixing, plumbing, soldering, taping, compound filling, epoxy cable jointing, crimping, connecting, shorting and earthing as required for all such operations should be available with concerned contractor. For all size of LT termination, crimping tool (Hydraulic type) shall be used. Further, inhibiting compound shall be provided before termination.
- The equipment will be generally provided with blank plates for cable/conduit entry and cable end box for power cables.
- The Contractor shall perform all drilling, cutting on the blank plates and any minor modification work required to complete the job.
- If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires major modification, the same shall be carried out by the Contractor as extra work item.
- Control cable cores entering control panel / switch gear /PCC/ MCC etc. shall be neatly bunched and served with nylon cord or PVC perforated tape to keep in position at the terminal block.
- The contractor shall provide oil resistance ferrules for all control cable cores at all terminations including at all junction boxes and at all terminations. The ferrules shall carry terminal numbers as per drawing. The ferrules shall be of interlocked plastic type or approved equal.
- Spare cores shall be similarly tagged, crimped with lug and taped on the ends. Spare cores shall be tagged with individual cable number.
- Terminations and connections shall be carried out in such a manner as to avoid strain on the terminals.
- All cable entry points shall be sealed and made vermin and dust proof. Unused opening, if any shall be effectively closed.

8.5.3 Glands, Seals and Shrouds

- The entire body of a cable shall enter a gland, & the outer sheath of a cable shall not be removed before entering the weatherproof seal. Cable shall be on a straight axis from a point immediately before entering a gland.
- Cable glands shall securely retain the cable without damage to the outer sheath or armour.

- Glands shall be correctly sized and of a type suitable for installation in each respective type of enclosure.
- All glands shall be correctly sized and of a type which will maintain the integrity of the equipment within into which they are to be installed. Such factors as use of insulated plastic enclosure and explosion proof type protection shall be taken into account when selecting glands. Mechanical glands shall be of the hexagon double compression type, knurled type glands shall not be used.
- Earth continuity of brass glands & termination's shall be achieved by rigid clamping of armour within each gland and intimate contact between threaded components of glands and equipment.
- Brass glands terminating in unthreaded enclosures shall be provided with earth continuity by attachment of earth continuity bonds.
- Terminations of mineral insulated cable shall be provided with sleeves having a temperature rating equal to that of the seals.
- Cores of sheathed cables, from which the sheath has been removed, and non-sheathed cables at terminations of conduit, ducting or trunking, shall be enclosed according to the design specification.

8.5.4 Identification:

A permanent non-corroding securely retained identification label shall be provided at both ends of each cable identifying its cable schedule reference and at all termination points including joint boxes. An acceptable means of identification is an engraved trifoliate label fixed to the cable with plastic cable ties. Self-adhesive labels will not be accepted.

8.5.5 Route markers

- Route markers shall be provided along straight runs of the cables at locations approved and generally at intervals not exceeding 25 meters. Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.
- Route markers shall be made out of 100mm x 100mm x 5mm GI/aluminium plate welded or bolted onto 35 mm x 35 mm x 6 mm angle iron 600 mm long duly painted with anti-corrosive paint/ embossed. Such plate markers shall be mounted parallel to and 300.mm or so away from the edge of the trench/pipe/duct, or as directed at site.

- Plastic identification tags shall be provided at every 30m. Cables shall be identified at end terminations indicating the feeder number and the Panel/Distribution board from where it is being laid.

8.5.6 Road Crossings:

- All cables laid below roads shall be taken through suitable underground Hume pipes / GI Pipes / trenches. The size of Hume pipes / GI pipes/ trenches shall be as per drawings.

8.5.7 Construction across Roads:

- All works across roads shall be carried out as per the directions of the Project Manager. Necessary safety measures shall be taken to divert traffic. Care shall be taken not to disturb other service lines.

8.5.8 Protection of Existing Services:

- All pipes, water mains, cables, etc. met with during the course of excavation shall be carefully protected and supported. In any case damage is caused, the same shall be made good at no extra cost, failing which necessary rectification will be done by Project Manager at the risk and cost of the Contractor.
- Megger test and continuity test shall be conducted on the cable after carrying out the end termination.

8.6 PROTECTION FROM MOISTURE:

- Each cable system shall be installed either where it will not be exposed to rain, dripping water, steam, condensed water, etc., or be of a type designed to withstand such exposure.
- In damp situations and wherever they are exposed to weather, all metal sheaths and armour of cables, metal conduit, ducts, ducting trunking clips and their fixings, shall be of corrosion-resistant material or finish, and shall not be placed in contact with other metal with which they are liable to generate electrolytic action.

- For conductors insulated with impregnated paper, exposed conductor & insulation at terminations and cable joints shall be protected from ingress of moisture by being suitably sealed.

8.7 TESTING:

- Cables shall be tested at site as follows:
- Before shifting of cables drums from the yard to the site, insulation resistance shall be carried out on the cable and readings recorded in the presence of the Site Representative.
- On cable being laid prior to sand bedding an I.R. shall conducted and recorded in the presence of the Site Representative.
- On the cable trench route being completed and compassion done an I.R shall be conducted and recorded in the presence to the Site Representative.
- No backfilling of trenches shall be done till the trench/sand padding/ cables are inspected and tested.
- Before end terminations are made an I.R shall be conducted to ensure the cable is in order.
- On termination's being completed prior to connecting to the equipment. The following test shall be conducted.
  - ✓ An I.R. done on the cable/Termination.
  - ✓ Cable/term subject to a pressure test for 15 minutes. The voltage to be applied shall be as per manufacturer's recommendations and in co-ordination with Owners/Consultants.
  - ✓ An I.R. Done on completion of the above Hipot test. All tests shall be done and recorded in the presence of the Site Representative.

9.0 TECHNICAL SPECIFICATION FOR WIRING / CONDUITING

- This erection of low Voltage Distribution System shall be applicable for wiring 3 phase, 5 wire/core 415 Volts, 50 Hz AC and single phase, 3 wire/core 230 Volts, 50 Hz, AC supply.
- The thickness of the conduit shall be minimum 2 mm for 20/25/32 mm conduits and 2.5 mm for higher sizes.

9.1 INSTALLATION OF RECESSED CONDUIT SYSTEM:

- The conduits shall be installed in such a manner that running can be carried out from the fittings boxes and switch boxes only.
- Conduits which are to be taken in the ceiling slab shall be laid on the prepared shuttering work of the ceiling slab before concrete is poured, and tied to bars at every 750/900 mm. The conduits shall be made water-tight by using bituminous compound at the screwed ends. The conduits in ceiling slab shall be straight as far as possible.
- Conduits recessed in walls shall be secured rigidly by means of steel hooks/staples at 500 mm intervals. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper dimensions to accommodate the required number of conduits.
- The outlet boxes, point control boxes, inspection and draw boxes shall be securely fixed by means of counter sunk steel screws and rawl plugs. They shall be firmly grouted in position prior to plastering fixed as and when conduit is being laid. The recessing of conduits in walls shall be so arranged as to allow atleast 12 mm plaster cover on the same. All grooves, chases, etc. shall be refilled with cement mortar and finished upto the wall surface before plastering of walls is taken up by the general contractor. The top edge of the conduit shall be atleast 25 mm below the finished surface of wall. Wherever conduits terminate into point control boxes, distribution boards, etc. conduits shall be rigidly connected to the boxes, boards, etc. with checknuts on either side of the entry to ensure electrical continuity.
- After conduits, junction boxes, outlet boxes, etc. fixed in position their outlets shall be properly plugged with PVC stoppers or with any other suitable materials so that water, mortar, vermin's or any other foreign material do not enter into the conduit system.
- To facilitate easy drawing of wires in conduit necessary GI pull wires of 16 SWG shall be inserted into the conduit immediately after shuttering is removed.
- The Electrical Contractor shall be present during the pouring of concrete to ensure that the conduits and accessories are not displaced or blocked.
- The conduits shall be swabbed out by drawing dry swabs of rag through the conduit to remove all moisture prior to drawing of wires.
- Where vertical concealed conduits pass through floors or beams and horizontal concealed conduits required to pass through columns or beams, these shall be taken through rigid PVC/GI pipes to be inserted in the floors /columns/beams, etc. during casting for which no extra payment shall be entertained.

- Extension collars of suitable depth shall be used as necessary to leave all boxes absolutely flush with the finished wall or ceiling surface.
- Conduits shall not be buried or plastered etc. unless and until the work has been inspected by the Client/ Consultant.
- Lighting, Power, UPS wiring circuits shall be segregated and taken in separate conduits. Separate earth wire shall be run for each circuit of specific rating accordingly.
- In the false ceiling area, the conduits shall be run above the false ceiling frame work supported by means of M.S/GI strips secured and fixed to both conduits and structural ceiling, keeping the outlet box as near as possible to the fittings/fans for connections. The conduit boxes for fittings/fans are independently supported by means of separate fixing arrangements to the box and structural ceiling so that the box is held rigidly.

9.2 INSTALLATION OF SURFACE CONDUIT SYSTEM

- Conduits shall run in square and symmetrical lines. Before the conduits are installed, the exact routes shall be marked at site and approval of the Consultant shall be obtained. Conduits shall be fixed by heavy gauge GI base plates, saddles, secured to suitable raw plugs, at an interval of not more than 500 mm. Conduits shall be joined by means of screwed couplers and screwed accessories only. In long distance straight runs of conduit, inspection type couplers or running type couplers or pull boxes shall be provided.
- Bends in conduit runs shall be done by bending conduits by pipe bending machine. Bends which cannot be negotiated by pipe bends, shall be accompanied by introducing inspection boxes or inspection bends. Not more than three equivalent 90 C bends shall be used in a conduit run from outlet to outlet.
- All the conduit openings shall be properly plugged with PVC stoppers/bushes. The conduits shall be adequately protected against rust by applying two coats of approved synthetic enamel paint after the installation is completed.
- Wherever conduits terminate conduits shall be rigidly connected to the box/board with brass hexagonal checknuts with compression washers on either side of the entry to ensure proper electrical and mechanical continuity.
- The crossing of surface conduits shall not be generally permitted and to avoid such crossings, adopter boxes shall be used at junctions/crossings.
- All unused conduit entries shall be blanked off in an approved and where a conduit terminates in adopter boxes. All removable box covers shall be firmly secured to provide complete enclosure.

- Lighting, Power, UPS wiring circuits shall be segregated and taken in separate conduits. Separate earth wire shall be run for each circuit of specific rating accordingly.

9.3 INSTALLATION OF WIRING

- Wiring forms the most vital area as it is the closest point of access to all. Therefore, this shall be done with utmost skill keeping all safety aspects and aesthetics and future works in mind. The workmanship shall be of the best quality, following good engineering and safety practices and adhering to the relevant codes / Rules / Acts / IS specification such as IS 2774/ IS 732 etc.
- The wiring conductors shall not be drawn into the conduits until all the works of any nature that may cause damage to the wires are completed. The installation and termination of wires shall be carried out with due regard to the followings
- While drawing the wiring conductors, care shall be taken to avoid scratches and kinks which cause breakage of conductors. There shall be no sharp bends in the conduit system.
- All wires and cables shall bear the manufacturer's label and shall be brought to site in original packing.
- For all internal wiring, PVC insulated FR-LSH type of multistrand copper wires/cables of 650/1100 volts grade shall be used.
- The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors.
- Before the wires/cables are drawn into the conduits, the conduits shall be thoroughly cleaned of moisture, dirt of any other obstruction by forcing compressed air through the conduits.
- The minimum size of PVC insulated FR-LSH type of multistrand copper wires/cables for all circuit wiring for light points shall be 2.5 sq.mm & for socket outlet shall be 4.0 Sqmm.
- Separate conduit shall run for LAN wiring and the same shall not run in parallel to power wiring conduit.
- Strands of the wires shall not be cut for connecting to the terminals or lugs. The terminals shall have adequate cross section to take all the strands.
- Wiring for power and lighting circuits shall be carried out in separate and distinct wiring systems.
- Wires/cables originating from two different phases shall not run in the same conduit.

- The incoming cable size from MLDB to DB shall be as indicated in the respective SLDs/lighting layout drawings.
- The wiring system envisaged is generally shown on the layout drawings and line diagrams. However, a brief account of the general wiring system is given below:
  - Circuit Wiring (Main Point) – Circuit wiring shall mean the wiring from Distribution boards to the 1st Tapping point inside the Switch box from where point wiring starts and inside the first socket outlets and shall consist inclusive of supply & installation of wire/cable, conduits along with conduit accessories, pull wire wiring, pull boxes, junction boxes, as required and specified. Wires/cables shall be drawn in conduits as required without being damaged, with necessary draw boxes if required. The wire/cable lengths must be adequate for terminating at either end and identifying ferrules shall be provided at termination. The wiring shall be colour coded. The rate shall include all materials, connections, labour etc.
  - Point wiring – point wiring (other than socket outlets point) shall include all work necessary in complete wiring to the following outlets from the controlling switch or MCB.
    - Single Point wiring means the wiring from the Switch box to the first (one) light fitting controlled by one switch.
    - Two Point wiring means the wiring from the Switch box to the first and second (Two) light fittings controlled by one switch.
    - Three Point wiring means the wiring from the Switch box to the first, second, third (Three) light fittings controlled by one switch.

      OR

    - Primary Point wiring means the wiring from the Switch box/MCB to the 1st tapping point (first light fitting).
    - Secondary point wiring means the wiring from the 1st tapping point (first light point) to 2nd tapping point (Second light point)
  - Power wiring - The wiring from DB's to Power plug wiring for 16A single phase industrial plug & sockets and 32A three phase industrial plug & sockets shall also be carried out in recessed/surface MS conduit. The scope of work shall be same as in Circuit wiring.

- Looping wiring - Looping wiring means the wiring from the switch box to the 1st tapping point inside the switch box, from where point wiring starts.

- Point wiring shall commence from the first point control box/local control box for the points connected to the same circuit. Point wiring for lights, ceiling and exhaust fans etc. shall be carried out with 1100 V Grade PVC insulated FR-LSH type of multistrand copper wires/cables. The point wiring shall be inclusive of supply & installation of conduits along with conduit accessories, pull wire, wiring, pull boxes, junction boxes, covers etc. together with wiring accessories such as ceiling roses wires/cables upto 1000 mm long at outlet end connectors point control boxes (enclosure for electrical accessories) switches, etc. Point wiring shall be installed with earth continuity wire as specified for earthing 3rd pin of sockets, luminaries and fan fixtures. Light control shall be either single, twin or multiple points controlled by a switch, as specified.
- The point wiring for Light/Fans/regulator etc. shall include supply of all material & labour job.
- The fan point shall be complete with fan hook box flush mounted in slab complete with cover. The measurement will be numbers of each kind of point and as specified in Schedule of Quantities.
- Each circuit main/power wiring/point wiring/looping circuit shall also have its own earth continuity wire as specified.
- All the wiring shall be carried out in loop-in-loop system only and phase or line conductors and neutral conductor shall be looped at switch box.
- The maximum number of various size conductors that could be drawn into various sizes of conduits shall be as per table II of IS:732 (Latest Edition). The wiring shall be colour coded for easy identification of phases and neutral. The following colour codes shall be adopted.
  - Phases - Red, Yellow and Blue.
  - Neutral - Black.
  - Earth - Green or Bare wire as specified.
- All circuit wiring/point wiring shall be provided with printed PVC identification ferrules at either end bearing the circuit number and designation.
- The number of power socket circuits, not more than 2/3 points or maximum 2kw shall be fed from one circuit, irrespective whether they are 6 Amps or 16 Amps Sockets. Separate circuits shall be drawn directly from the DBs for high-wattage loads.

- All circuits shall have positive isolation of neutral by using Double pole / four pole isolators in single phase / 3 -phase circuits respectively. If three phase supply is feeding single phase loads, the loads shall be evenly distributed amongst all the three phases.
- Switch boxes shall be branded and made of 16 Gauge sheet steel of minimum depth of 50mm and shall be provided with 20/25/32 mm knockouts on all four sides, earthing studs of minimum 5 mm plated bolt/ screws, nuts and washers shall be provided in the boxes. The boxes shall be powder coated or plated. Prior to drawing of wires/ fixing of components, it shall be fully cleaned to remove all cement/plaster/dust etc.
- The switch boxes shall be provided with 4 mm thick acrylic covers of approved color with plated / colored / brass hardware or poly carbonate dual plates in case of Modular Switches are specified.
- All unused knockouts/ cutouts shall be neatly and properly plugged/ covered.
- The measurements given in the Specifications / Schedule of quantities are tentative. The actual measurements will be taken at the time of execution of work. Measurement of cables / wires shall be taken from entry point to entry point of panels / distribution boards/ boxes/ switch boxes etc.

10.0 GENERAL SPECIFICATIONS FOR CABLE TRAYS & RACEWAY

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/Instrumentation/Communication systems.

10.1 DESIGN AND FABRICATION OF CABLE TRAYS / LADDERS:

The cable trays / ladders shall be fabricated according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 5 meters							
Description	**Side Height (in mm)**	**Width (in mm)**	**Span length (in meters)**				
			1.5m	**2m**	**2.5m**	**3m**	**4m**	**5m**
			Permitted Load (in kg/meter)					

Perforated tray	50	100-500	150	100	50	-	-	-
	100	150-500	185	130	75	60	-	-
Cable Ladder	50	200 - 600	180	140	100	55		-
	75	200 - 1000		225	150	110	45	-
	100	200 - 1000		310	-	140	65	50

Fabrication of Tray / Ladder and accessories at site and welding is not permitted. In unavoidable circumstances, if any cut or holes are made in the trays/Ladder/accessories, zinc spray need to be applied over the surface. The metal edge has to be protected by edge protection sleeves to avoid cable damage. Edge of the supports has to be protected with plastic END caps. Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections.

Cables shall run in cable tray/ladder mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles, pipe racks, trenches or other building structures using mounting accessories

10.2.1 Perforated Cable Tray:

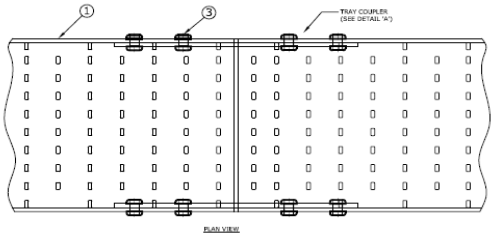
The cable tray and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346 / ISO1461-1999 for installations in indoor and outdoor applications respectively. Hot galvanisation using the dipping method according to DIN EN ISO1461 and coating thickness to DIN ISO 1461 approximate 40-60microns. The cable trays shall be supplied in standard lengths of 3000 mm and the width of the tray shall be as follows.

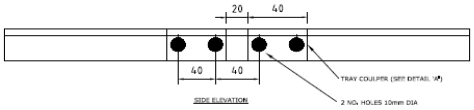
Width: 100, 150, 200, 300, 400, 500.

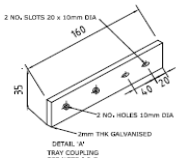
All the cable tray accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should be connected with the trays by using fasteners. Typical details of trays, fittings and accessories etc are shown in the enclosed drawings.

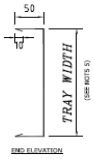
For Cable trays designed, tested and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non-tested tray, thickness should be 2 mm up to span length of 1.5-meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meter

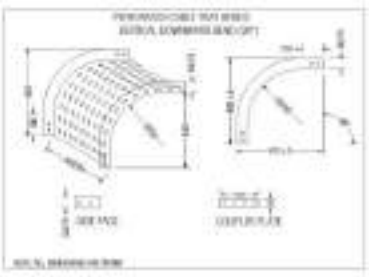
Vendor should follow and considered cable tray accessories of standard Tee; Reducer & Bends wherever applicable as per below.

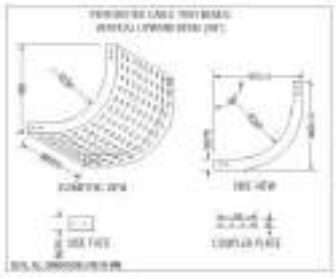


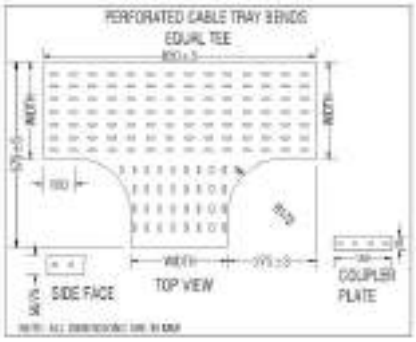


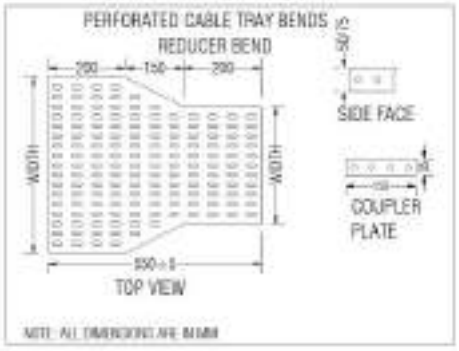












10.2.2 Cable ladder:

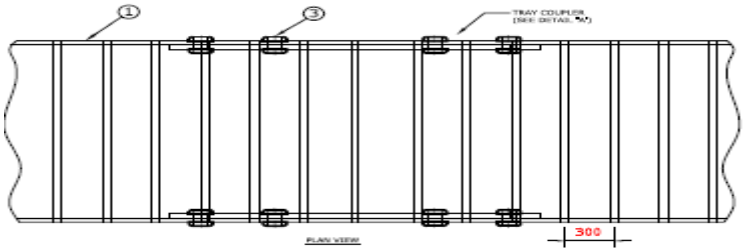
The cable Ladder and all accessories shall be fabricated from sheet steel and has to be galvanized against corrosion confirming to EN10346 / ISO 1461-1999 for installations in indoor and outdoor applications respectively. The cable ladders shall be supplied in standard lengths of 3000 mm and the width of the ladder shall be as follows.

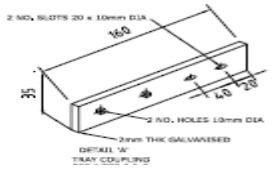
Width: 200 to 1000mm in multiples of 100 mm except 450mm & 750mm.

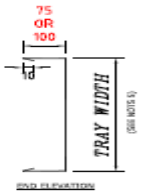
Maximum rung spacing in the ladder shall be 300mm. The rungs should be made of C profiles suitable to fix cables by special metal clamps according to the drawing. The ladder shall be of riveted and foldable type for easy transportation and to avoid damage during transportation and storage. All the ladder accessories like Bend's, TEES's, Cross over's etc should be designed in accordance with IEC 61537 and shall be factory fabricated. The accessories shall be made from the same material as of the ladder and modular type, it should be connected with the ladder by using fasteners. The details of ladders, fittings and accessories.etc. are shown in the enclosed drawing.

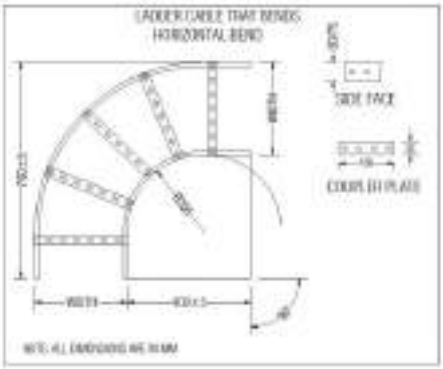
For Cable Ladders designed, tested and confirming to IEC 61537, thickness of cable Ladder should be according to the manufacturer's catalogue. For locally fabricated and nontested Ladder, thickness should be 2.5 mm up to span length of 1.5 to 2 meter, 3 mm for span length between 2.5 to 4 meter and 3 to 4 mm for span length between 5 and 10 meter.

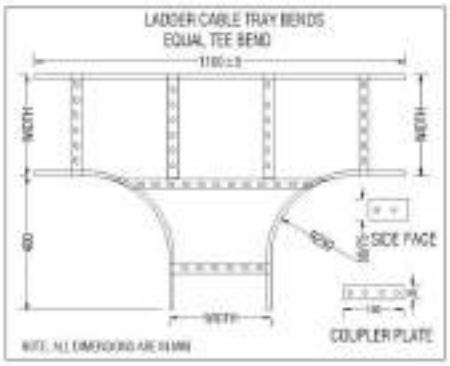
Vendor should follow and considered cable tray accessories of standard Tee; Reducer & Bends wherever applicable as per below.

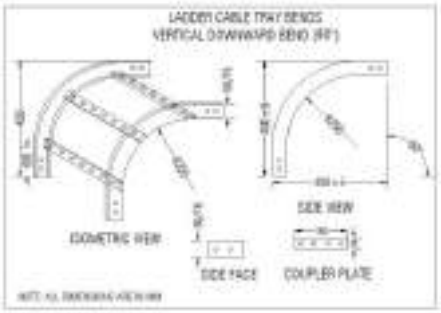

TRAY COUPLER
300
PLAN VIEW
20
40
40
40
TRAY COUPLER (SEE DETAIL 'A')
2 NO. HOLES 10mm DIA
SIDE ELEVATION

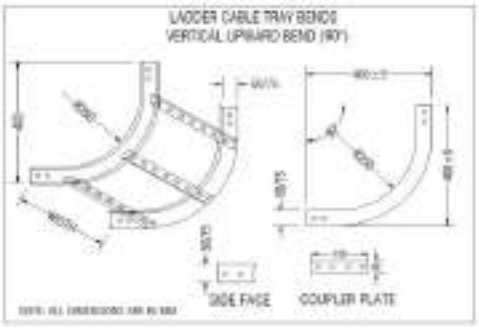

2 NO. SLOTS 20 x 10mm DIA
160
35
40
40
2 NO. HOLES 10mm DIA
2mm THK GALVANISED
DETAIL 'A'
TRAY COUPLING

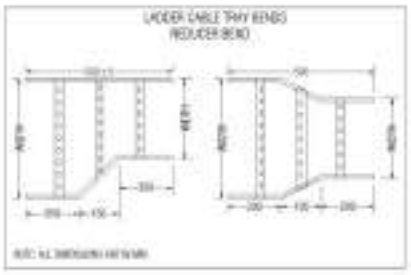

75
OR
100
TRAY WIDTH
END ELEVATION


LADDER/CABLE TRAY BENDS
HORIZONTAL BEND
SIDE FACE
COUPLER PLATE


LADDER CABLE TRAY BENDS
EQUAL TEE BEND
WIDTH
SIDE FACE
COUPLER PLATE


LADDER CABLE TRAY BENDS
VERTICAL DOWNWARD BEND (90°)
ISOMETRIC VIEW
SIDE VIEW
SIDE FACE
COUPLER PLATE


LADDER CABLE TRAY BENDS
VERTICAL UPWARD BEND (90°)
SIDE FACE
COUPLER PLATE



10.2.3 Cover for Cable Trays / Ladders:

Cover for trays/ladders to protect the cable insulation from falling objects, water droplets, and harmful effects of ultraviolet rays and accumulation of dust. The cover shall be Galvanized sheet steel. The cover for the cable trays shall be of snap fit type.

Mounting Accessories (supports and Brackets): -

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

10.2.4 Corrosion Protection:

The cable tray / ladder/accessories shall be galvanized according to EN10346 / ISO 1461-1999 for installations indoor and corrosive outdoor applications respectively. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 for > 150 hours & 500 hours. (*155 hours according to class 3 for pre-galvanized surface and 550 hours according to class 6 for Hot dip Galvanized surface as per ISO).

10.2 INSTALLATION OF CABLE TRAYS

- The contractor shall install the cable racks, trays, risers, shafts and supports. The cable trays shall be of Ladder/perforated/ wire mesh type.
- Vendor should consider standard accessories of Tee, Reducer & Bends wherever applicable.
- Cable trays and risers shall be aligned and levelled correctly. All runs shall be installed parallel to the trench/building walls and floors except otherwise noted on the drawings.
- The contractor shall provide install steel inserts/supports on wall, ceiling or floor by suitable anchoring & shall secure racks and supports by welding these to inserts.
- Minimum clearance between the top most tray tier and structural member shall be 300 mm.
- The trays in general shall be supported at a distance of 1.00 to 1.20 meters on horizontal and vertical run.
- Cable trays shall be installed as per drawings furnished to the Contractor. Any deviation in routes shall have the prior approval of the Engineer In-charge.
- Cable trays and accessories shall be assembled and erected at site as per instructions of Manufacturer. Alternately, the Contractor shall fabricate and install all cable trays, risers, shafts and supports as agreed upon during finalization of the award.
- All hardware such as bolts, nuts, washers, Anchor fasteners and other consumable required for the fabrication and erection shall be included in the rate quoted by contractor in supply stream and Hardware shall be SS 304 Matt finish.
- Sufficient spacing not less than 250 mm shall be provided between trays and maintained to permit adequate access for installing and maintaining the cables.
- Contractor shall co-ordinate with other contractors (such as for piping etc.) where there is a common support for cable trays and for other services.
- Each continuous length of cable tray shall be earthed at minimum two places.
- All necessary steel & all consumables as specified elsewhere shall be arranged by contractor.
- Plate inserts for cable tray mounting supports shall be provided by Civil Contractor.

10.3 SPECIFICATION FOR FLOOR RACEWAY

Raceway items are intended for the support and accommodation of Power, Data and communication cables and possibly other Electrical / Low Voltage equipment cabling required for Electrical/Instrumentation/Communication systems. The complete system and its components like service and junction outlets need to be supplied from a single manufacturer.

11.4.1 UPVC RACEWAYS:

The under floor duct for “in screed” system shall be of “UPVC” in combination of single, double or triple runs in compliance with the relevant sections of standard EN 50085 & DIN VDE 0634. UPVC ducts shall be of trapezoidal shape for better load withstand capacity and closed box type construction. Single, double or triple runs of ducts need to be used to accommodate different types of cables - Power, Data &Telecommunication. Coupler shall be used to connect the standard lengths of the ducts in screed covered system. Single or multiple runs of UPVC ducts need to be secured to the structural slab by means of fastening clamps. The vertical riser bends should be used as well for quick entry of cables in the under floor system.

The UPVC under floor ducts shall be made up of Lead free, non-flame propagating grade Poly vinyl chloride material as per EN 50085-2-1 and shall be ROHS compliant. The UPVC ducts shall have smooth surface finish without sharp edges and Burrs. The UPVC ducting shall have IP 40 Protection against access to hazardous parts.

11.4.2 GI UNDER FLOOR RACEWAYS:-

The under floor duct for “in screed” system shall be of GI – Metal with sheet metal grade GZ 275 grams per square meter corresponding to 18-24 micron meter galvanizing coating thickness. These under floor GI metal ducts shall be manufactured in line with the drawings and BOM details provided. The under-floor header trunking needs to be two compartments with one compartment utilized for networking second compartment utilized for the power cables. The under-floor ducts shall be manufactured with 1.5 mm thickness (+ or - 0.1 mm tolerance) base and Metal Inert Gas (MIG) cover welded to form a box section and shall have to comply with the relevant sections of standard EN 50085 & DIN VDE 0634.

The under-floor GI metal ducts shall be of rectangular shape with overlapping sides of cover and base for better load withstand capacity and closed box type construction. Under floor ducts manufactured with screws fixing the cover to the base shall not be acceptable. The under floor ducts shall have to be provided with required rigidity with a standard loading capacity as defined in relevant sections of EN 50085 norms and shall prevent the seepage of concrete and screed water.

These ducts shall have spot welded partitions (for multi compartment ducting) of the same thickness as base and cover and all the spot welded joints and Metal Inert Gas (MIG) welded

covers shall have to be cold galvanized for maintaining the required galvanizing coating thickness referred above.

These ducts are supplied in 2.5 meter standard length and complete overlapping box type jointing coupler shall be used to connect the standard lengths of the ducts in screed covered system. These ducts need to be secured to the structural slab by means of screws secured through the jointing couplers. The vertical riser bends should be used as well for quick entry of cables in the under floor system.

The under floor ducts shall be complying with all requirements as defined in EN 50085-2-1 and shall be ROHS compliant. These ducts shall have smooth surface finish without sharp edges and Burrs and cover. The ducting shall have IP 40 Protection against access to hazardous parts.

Under floor Junction boxes shall be robust in its construction with a base plate with SS cover and side walls manufactured from 1.5 mm thick (+ or - 0.1 mm tolerance) galvanized sheet steel. The base box bodies shall be made from galvanized sheet steel with a zinc coating in accordance with EN 10327 DX51D + Z275-N-A-C. Height of the under floor junction boxes shall be 60 mm as minimum and shall have to be provided with four corner pillars for height adjustment from 60 to 70 mm for first fix installation.

The Trap and frame of Junction outlets shall be manufactured from GI in line with the specifications detailed above and shall be of two- or three-piece construction – Trap, Frame and floor covering protection flange wherever required. The frame shall be fitted with the floor covering protection flange of 10 mm all around for protection of the cut edges of the floor finishing material – carpet or ceramic tiles wherever require. The entire three-piece GI trap and frame shall be powder coated colour matched to the floor finish material as per architect's choice. GI powder coated trap and frame shall have to be 2 mm thick with an additional 3mm thick GI powder coated load plate completely supported by the frame for ensuring maximum rigidity and providing adequate load bearing capacity. The junction outlet boxes shall be able to withstand a load of 1.5KN conforming to EN 50085. Junctions with open sides without knock outs shall not be acceptable.

Junction outlet boxes shall be substantially dimensioned to eliminate congestion and provide ample working space within. Junction boxes shall be supplied with cross over bridges for segregation of power, data and telecommunication cables if necessary.

Junction outlet trap and frames need to be fixed on the height adjusting corner pillars and load plate shall be easily removable for installation / easy access to the wiring contained within.

INSTALLATION: Under floor trunking system shall be installed strictly as per manufacturer's instructions and to a level of workmanship to ensure that all the floor race way completely concealed and junction boxes are consistently in level with final finish floor level. Contractor has to ensure that any part of the boxes is not detected below and or above the final finish floor level. Failure to comply in this respect, the affected boxes shall be re-installed by the contractor, as required by the engineer. Raceway should be separation of power, data and telecommunication cables are maintained.

11.0 TECHNICAL SPECIFICATION OF EARTHING

Indian TNS system of earthing as shown on IS: 3043 – 1987 shall be followed for the entire installation under the scope.

All non-current carrying metal parts of electrical installation shall be earthed as per IS 3043. All metal conduits, metal race way, bus trunking, process equipment, motor, switch gear, DB's, lights fixtures, fan and all other metal parts forming part of the works shall be bonded together and connected by two separate and distinct conductors to earth electrodes. All earthing shall be in conformity with Indian Electricity Rules and CEA safety regulation in vogue.

In case of star connected systems with earthed neutrals:

The neutral point of every generator and transformer shall be earthed by not less than two separate and distinct connections with the earth having its own electrodes of ratings according to the respective technical specification.

- Plate Earthing Station

The earthing station shall be as shown on the approved working drawing. The earth electrodes shall be 600 x 600 x 6.3 mm GI plate / 600 x 600 x 3.15 mm copper plate electrode as required. The earth resistance shall be maintained with a suitable soil treatment and watering arrangement as per approved working shown on drawings or as directed at site. Excavated soft soil shall be thoroughly mixed with 6% by weight of common salt with 10% by weight of water and alternate layers of charcoal and filled in the earth pit. Independent earth shall have same specification subject to meeting the earthing value criterion for communication system.

In the case of plate earth electrode, a watering pipe of 50mm diameter of B class GI Pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided at the top of this pipe for watering the earth. The watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300 mm. A cast iron/MS frame with cover having identity mode "EARTH" and having locking arrangement shall be suitably embedded in the masonry enclosure.

The resistance of each earth station should not exceed 1 Ω.

The earth lead shall be connected to the earth plate through copper/brass bolts as per approved working drawings.

- Pipe Earthing Station

Pipe electrode shall comprise of 100 mm dia. GI pipe class "C" as per IS 1239 and not less than 3.0 mtrs long buried vertically in a pit of 350x350 mm size and filled with alternate layers of charcoal, salt and river sand and pipe with a funnel at the other end, clamped to the pipe electrode with brass bolts, nuts and washers. GI pipe electrodes shall be cut tapered at the bottom and provided with holes of 12 mm dia. drilled not less than 75mm from each other upto 2 Mtrs. length from bottom. The top end of the pipe shall be threaded and provided with G.I cap. A hole shall be provided at 100 mm from the top end to receive a 13 mm bolt with double nuts and washers. The funnel and the earth lead connections shall be enclosed in a masonry precast chamber/inspection pit. The chamber shall be provided with C.I frame and C.I cover. A proper permanent identification tag/label/earth cable marker shall be provided for each electrode.

- Chemical Earthing Station
  - Primary Electrode shall be made of smaller diameter mild steel pipe and Secondary Electrode shall be made from larger than of mild steel pipe. Primary Electrode fitted into Secondary Electrodes
  - Both the Electrodes either hot dip galvanized with high coating of zinc on outer and inner pipes or copper coated. Both the electrodes are tightly packed with high conductive, anti-corrosive mixture call Crystalline Conductive Mixture (CCM) and top and bottom properly sealed.

- Pipe in Pie technology and the Super Conductive Crystalline Compound shall protects the primary electrode from corrosion and also shall increases the surface area for enhanced conductivity.
- 300 to 450 mm dia 3200 mm long bore to made and place the Electrode into bore and filled with back filling material. Back filling material shall be required Eco-friendly and moisture retaining capacity
- It shall be three level protection from corrosion comprising of

a) Pipe in pipe Electrodes with end to end sealing

b) Layers of super conductive crystalline compound inside the pipe.

c) Backfilling material supplied separately in Bags

- For Normal good soil resisitivity soil – make 300 mm dia bore in ground and place the Electrodes in centre of the hole ans filled Earthing back filling compound around the Electrodes .Hard rock , rocky area , literate soil make 450 mm Drill or auger a hole in the ground ,then fill the 150 mm dia. Bore with black cotton soil than balance 300 mm dia bore shall be filled with Chemical Earth Electrodes
- The Earthing Electrodes are comprising 50 mm dia pipe in pipe mild steel coated with hot dip GI or copper , 3048 mm long completely filled with the super conductive crystalline compound filled inside the pipe completely encloses the primary conductor.
- The backfill material should have high electrical conductivity, which should be constant and unaffected by changes in temperature and moisture. It should permanently remain embedded and should not dissolve in and swept away by water. It should have the ability to absorb large amount of water and retain the same over a long period of time. Finally, it should not cause or accelerate the corrosion of the earth electrode metal. SMI-280 C

- The earth lead connections shall be enclosed in a masonry precast chamber/inspection pit. The chamber shall be provided with C.I frame and C.I cover. A proper permanent identification tag/label/earth cable marker shall be provided for each electrode.
- Location of Earth Electrode
- An earth electrode shall not be situated less than 3 meters within the soil including base and raft it must be 4.2 M as per NBC 2016-part 2 section 8 from any building. This will be in accordance with IEC 62561 -5; 2011,
- The excavations for electrode shall not affect the column footings or foundations of the buildings. Entrances and pavements shall not be used for locating the earth electrode. In such cases electrode may be further away from the building.
- All earth strips shall be jointed as follows:
    a) Copper: Copper riveting with 80mm fish plate and brazing with at least 80mm brazing as a lap joint along the length.

    b) Galvanized: Lap welding with 50mm minimum lap Steel: Overlay - not less than 50 mm in all cases.

- General
- Earthing material:
- Materials of which the protective system is composed shall be resistant to corrosion or be adequately protected against corrosion. Adequate margin for corrosion should be taken for the selection of the size. The material shall be as specified in the schedule of quantities BOQ and shall comply to the following requirements:-
    a) Copper - When solid or stranded copper wire is used it shall be of the grade ordinarily required for commercial electrical work generally designated as being of 97% conductivity when annealed, conforming to Indian standard specifications as per IEEE 80 A.

b) Galvanized Steel - Galvanized steel used shall be thoroughly protected against corrosion by hot dipped Zinc coating. The material coating shall withstand the test specified in IS/IEC 62305.

- Each installation shall have one common earth grid connected to at least two groups of earth electrodes.
- The earth grid shall extend throughout the installation in the form of a ring circuit with branch connections to the equipment and structures to be earthed.
- The Contractor shall install the entire earthing system and complete all earth connections for the plant. Installation of earthing electrode, earthing conductor, excavation, back filling etc. wherever required is in the scope of Contractor.
- The earthing grid shall be formed at 500/1000 mm below grade or at column foundation level or as specified in the relevant dwgs, around the plant. The grid conductors are 75 x 10 / 50 x 6 mm Tinned Copper Flat / GI strip. The details of the earth pits shall be as per enclosed drawings.
- Above ground, 50x 6 mm Tinned copper flat / GI strip shall be run on cable trays or any support by clamping at interval not exceeding 1500mm. These earth conductors shall be connected to the earth mat through 50 x 6mm M.S. riser. Taps from the above earth conductor shall be used in earthing equipment and structure.
- When riser from underground mat have been provided for equipment earthing, the equipment conductor shall be welded to the riser at one end and its other end shall be connected to the equipment, in case the riser length is not adequate.
- All earth conductors shall be painted black for easy identification. Wherever earthing strips are welded bituminous paint shall be applied. All earth conductor connection shall be made by electric arc welding unless otherwise specified.
- Bolted earthing connection shall be used for equipment earthing. The contact surface shall be thoroughly cleaned before connection.

- Equipment will generally be furnished with two separate earth pads with tapped holes, bolts and spring washers. If however, the same are not furnished, Contractor shall drill and tap holes and provide bolts and spring washers for connection.
- Equipment earth connection, after checked and tested by the Engineer, shall be coated with anti-corrosive paint/cold compound.
- Whether specifically shown or not, all conduits, trays, cable armour and end box, electrical equipment such as switchboards, panels, cabinets, junction boxes, local push button stations etc. shall be effectively earthed.
- The local start-stop push button stations, junction boxes, control supply change over panels etc. shall be earthed through PVC earth wire.
- To make an effectively earthed 415V system, the earth bus of all 415V switchboards, MCCs shall be connected to earth grid at two different and distinct points unless otherwise specified.

Description	Earth Conductor sizes
Main grid & Raisers	2R 50X6 mm Aluminium OR As per calculations
Electrical Panels	2R 50X6 mm Aluminium OR As per calculations
Power DBs/Lighting DBs	2R 25x5 mm GI FLAT.
Process equipments /Tanks	2R 25X5 mm Aluminium OR As per calculations
Aircompressor	2R 25X5 mm Aluminium OR As per calculations
Lightning Protection system	70 Sqmm PVC Flexible Cable / 2R 25x3 mm Copper FLAT.
Motors	

Up to 7.5 KW	2R x 6 Sqmm² copper conductor PVC insulated wire (green colour with yellow strips)
9.3 KW to 18.5 KW	2R x 10 Sqmm² copper conductor PVC insulated wire (green colour with yellow strips)
22 KW to 37 KW	2R x 16 Sqmm² copper conductor PVC insulated wire (green colour with yellow strips)
Above 37 KW	2R 25x6mm GI Flat

- Resistance to Earth

  No earth electrode shall have a greater ohm resistance than 1 Ω as measured by an approved earth testing apparatus. In rocky soil the resistance may be up to 10 Ω.

12.0 TECHNICAL SPECIFICATION OF POWER SOCKETS AND SWITCHES

All sockets 6A/16A ratings shall be of flush & screw mounting type with control switches of plate type design of the same rating as that of the sockets. All socket outlets shall be of 3 pin/multipin modular type with metal boxes.

12.1 METAL OUTLET COVERS AND SWITCHES:

The switch box shall be made of modular metal boxes with suitable size modular cover plates. Modular metal box shall be made of mild steel on all sides except on the front. The metal box (other than modular type) shall be made of metal on all sides except on the front. Boxes shall be hot dip galvanized mild steel and painted with anti-corrosive paint before erection. All boxes shall be covered from top with Phenolic laminated / decorative sheet of approved shade. These shall be of 3 mm thick synthetic phenolic resin bonded laminated sheet as base material and conform to grade P-I of IS: 2036-1994.

All 6 or 16 Amp switches shall be modular type of 240 volts A.C grade. All switches shall be fixed on modular metal boxes. All 6 Amp socket shall be 5 pin type and 6/16 Amp socket shall

be 6 pin/multi pin type (unless otherwise specified). All modular switches, sockets, telephone, data outlets, etc. shall be in off white finish unless otherwise specified. The switches controlling the lights or fans shall be connected to the phase wire of the circuit. Switch boards shall be located at 1200 mm / above Furniture from finished floor level unless otherwise indicated on drawings or directed by engineer in charge.

In case of computer power points, power points, telephone points etc. to be fixed on laminated partition board (furniture), same shall be fixed on laminated board (portion of laminated board meant for fixing power points) with base plate/cover plate as applicable, duly fixed with screws.

All modular switches, sockets, telephone outlets etc. shall be fixed modular metal boxes with modular base plates and modular cover plates on top.

12.2 INDUSTRIAL TYPE SOCKETS:

Industrial type sockets shall be provided wherever specifically called for on the drawings. Industrial sockets shall be rated as specified. Plugs and sockets shall have 3 pins for single phase applications and 5 pins for 3 phase applications. The sockets shall be provided with suitable plug top and cable entry device and shall be controlled by a suitably rated rotary switch or MCB. The sockets shall be housed in suitable PVC housings of IP 54 protection class.

12.3 INSTALLATION

All switch connections shall be made only after ensuring the continuity of wires and terminations. Tapping of wires shall be done only at the terminals of switches, sockets and ceiling roofs with terminal blocks. Under joining and extension of wires in pipes and conduits shall not be carried out under any circumstances.

The arrangement of switches and sockets shall be neat, systematic, and aesthetic. The Contractor shall obtain approval from the CLIENT /CONSULTANTS with regard to the proper location of switches and all outlets.

The enclosures of sockets and pin of the sockets shall be connected to the ground through a proper size insulated earth continuity wire. Metal or FRP phase barriers shall be interposed between switches located in a common enclosure, when wired on different phases.

12.4 LABELING

The Contractor shall provide labeling for all, industrial-type sockets, socket outlets, permanently connected devices, etc, identifying the distribution board and circuit breaker number, in an approved manner, acceptable to the Client / Consultants, to provide ready identification. Hand painted labels are not acceptable.

12.5 TESTING OF ELECTRICAL INSTALLATION

a) Testing of Installation Shall Be As Per Is 732-1982

- The insulation resistance shall be measured by applying between earth and whole system of conductors of any section thereof with all fuses in place and all switches closed and except in earthed concentric wiring all lamps in position or both poles of the installation otherwise electrically connected together, where a direct current pressure of not less than twice the working pressure provided that it need not exceed 500 Volts for low voltage circuits. Where the supply is derived from the three wire (A.C or D.C) or a poly phase system, the neutral pole of which is connected to earth either direct or through added resistance, the working pressure shall be deemed to be that which is maintained between the outer or phase conductor and neutral.
- The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number or points on the circuits provided that the whole installation shall be required to have an insulation resistance greater than one mega ohm.
- Control rheostats, heating, power appliances and electric signs may, if required be disconnected from the circuit during the test. But in the event of the insulation resistance between the case or frame work and all live parts of each rheostat appliances and all live parts of each rheostat and sign shall be less than that specified in the relevant Indian Standard Specification or where there is no such specification shall not be less than half a mega ohm.
- The insulation resistance shall also be measured between all conductors connected to one pole or phase conductor of the supply and all the conductors connected to the middle wire or the neutral or to the other pole or phase conductors of the supply.

b) Testing of Earth Continuity Path

- The earth continuity conductor including metal conduits and metallic envelopes in all cases shall be tested for electrical 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 electrodes to any point in the earth continuity conductor in the completed installation shall not exceed one ohm. For checking the efficiency of earthing, the earth resistance of each earth electrode shall also be measured. This test shall preferably be done during summer months.

c) Testing of Polarity of Non-Linked Single Pole Switches

- In a two wire installation, a test shall be made to verify that all non-linked, single pole switches have been fitted in the same conductor throughout and that such conductor has been connected to an outer or phase conductor or to the non-earthed conductor of the supply.
- The contractor shall be responsible for providing the necessary instruments and subsidiary earth for carrying out the tests. The earth coordinating tests shall comply with the IS specifications as may be applicable. Should the above tests not complete with the limits laid down, the contractors shall do the necessary rectification of the fault till the required results are obtained.

d) Testing and Commissioning

- On completion of erection work, the Contractor shall request the Engineer, for inspection and tests with minimum of fourteen (14) days' advance notice.
- The Engineer shall arrange for joint inspection of the installation for completeness and correctness of the work. The Contractor shall promptly rectify any defect pointed out during such inspection.
- The installation shall be then tested and commissioned in presence of the Engineer.
- The Contractor shall provide all men, material and equipment required to carry out the tests.
- The Contractor, without any extra cost, shall carry out all rectification, repairs or adjustment work found necessary during inspection, testing and commissioning. The handing over of the installation shall be effected only after the receipt of written instruction from the Purchaser/his authorized representative.

e) Schedule of Pre-Commissioning Tests

- Circuit Breaker

- Insulation resistance test on each pole by Meggar.
- Insulation resistance test on control circuit.
- Checking of all joints for leakage in breaker.
- Measurement of contact resistance for all the Three Phases.
- Checking the auxiliary circuits associated with circuit breaker.
- Functional check of breaker operation electrically at 70% and 110% of rated D.C. supply voltage.
- Checking of interlock provided in Control Circuits and tripping through simulated protective relay contacts.
- Auto-reclosing duty cycle check wherever auto-reclosing is required.
- Measurement of resistance of closing and tripping coils.
- Current Transformer
- Insulation Resistance test on each winding by Megger to earth and between windings.
- Checking of all ratios on all cores by Primary injection set.
- Polarity check on each winding.
- Continuity test.
- Check for connection to correct taps.
- Oil level check.

- Grounding
  - Continuity of grounding connection.
  - Testing of Earth Resistance of Individual Electrode.
  - Testing of Earth Resistance of the combined earthing system.
- Switchboards /MCC /Distribution Board /Panels
  - Measurement of insulation Resistance of Bus-bar System.
  - Measurement of I.R. of Control Circuit.
  - Functional check of circuit components

- Continuity check of different circuits.
- Calibration test of Relays and Meters.
- Space heater operation.
- Annunciations.

- Motor
  - Insulation test of winding by Megger.
  - Proper direction of rotation.
  - RTD, BTD operation.
- Relays & Meters
  - Calibration test.
  - Operation / performance test.

NOTE: Tests required for some of the major items are indicated for Bidder's reference. Apart from the tests listed herein and also as mentioned elsewhere in this specification, any other test as necessary per relevant standards, Client recommendations, Code of Practice, Manufacturer's recommendations etc., shall have to be carried out by the Contractor without any implication within the quoted price and time schedules.

13.0 LIGHTNING ARRESTOR GROUNDING SYSTEM:

- The advanced lightning protection system shall include components as follows: ESE Air terminal, Mechanical supports, Down-conductors, Performance Recording Equipment and a low impedance Grounding system.
- The design of the components shall be traceable to field research, laboratory testing, fundamental analysis, and statistical levels of the lightning event.
- The design of the components shall be traceable to long term practical field studies laboratory testing, fundamental scientific principles and statistical levels of the lightning event as documented in international standard.
- The OPR Early Streamer Lightning Conductor shall be installed strictly to the manufacturer's instructions.

➢ **AIR TERMINAL:**

- The air termination shall be of the type that responds dynamically to the appearance of a lightning downleader by creating free electrons between outer surfaces and an earthed central finial rod.
- The Air terminal should work under Early Streamer Emission (ESE) Technology and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.
- The Lightning conductor should deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The Air terminal generates a leader that propagates rapidly to capture the Lighting stroke and conduct it towards the ground.
- Arcing is not to be continuous and shall only occur during the progress of the lightning leader.
- The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.
- The materials of the air termination shall be non-corroding in normal atmosphere.
- The air termination shall not be dependent upon batteries or external power supplies for any part of its operation.
- The Height of the air terminal support mast should be minimum 2mts and the height will be increased as per the coverage design.
- The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

➢ **DOWNCONDUCTOR:**

- The downconductor should be used 70sqmm copper single core cable or 25 x 3 mm copper strip. Two numbers of down conductors need to be used in case of the structure height is above 28mts and both should be connected with maintenance-free Grounding system.
- The main copper conductor shall be connected directly to the air termination.
- The down conductor shall be installed in accordance with the manufacturer's instructions and should not be subject to sharper bends.
- The downconductor must be kept in constant physical contact with the structure via conductive mounting clamps.

➢ **LIGHTNING STRIKE COUNTER:**

- Each protection system shall be supplied with Lightning strike counter. The counter shall have a register that activates one count for every discharge where the peak current exceeds 400A at the 8/20us standard.
- The lightning event counter shall be robust and easy to install. The counter shall operate from the energy of the lightning discharge and should not work on external or battery power to operate.
- The lightning event counter shall be installed to the manufacturer's instructions in a readily accessible manner (always 2mts above the Ground) so that reading can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20'C to + 60'C.

➢ **GROUNDING SYSTEM:**

- The Lightning arrestor grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.
- Grounding will be done by copper bonded steel core ground rods especially designed for electrical grounding.
- Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building to arriving services is recommended.
- Electrically conductive, non-soluble SUITABLE make TEREC Powder should be used to achieve low ground resistance. Provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

14.0 UPS TECHNICAL SPECIFICATION

The UPS system shall consist of the following main components:

- ✓ UPS module containing a Rectifier, Inverter, Battery Charger, Static Bypass and associated Control and Monitor Panel.
- ✓ Battery string(s) in Line-and-Match Battery Cabinets or racks.
- ✓ Optional Line-and-Match cabinet(s).
- ✓ External Isolation Transformer output side

14.1 UPS MODULE MODES OF OPERATION:

The UPS Module shall operate as frequency independent (class VFI-SS-111), fully automatic online system in the following modes:

1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating both voltage and frequency. The Rectifier shall derive power from the commercial AC source and shall supply DC power to the Inverter.
   Simultaneously, the Battery Charger shall charge the battery.
2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic.

14.2 SUBMITTALS

The UPS shall be supplied with sufficient documentation, including the following manuals:

1. Installation and Operation Manual:

One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment.
The manual shall include the following major items:

- ✓ UPS description
- ✓ UPS site planning and unpacking
- ✓ UPS installation
- ✓ Optional accessory installation
- ✓ UPS theory of operation
- ✓ Operating procedures

- ✓ System events
- ✓ UPS maintenance
- ✓ Performance and technical specifications
- ✓ Wiring requirements and recommendations
- ✓ Physical features and requirements
- ✓ Cabinet dimensions

14.3 QUALIFICATIONS

1. The UPS manufacturer shall have a minimum of twenty years experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.
2. The UPS manufacturer shall have ISO 14001 certification for engineering/R&D, manufacturing facilities and service organization.
3. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.
4. Field Engineering Support: The UPS manufacturer shall directly employ a field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist Uninterruptible Power of local offices managed from a central location. Field engineers shall be deployed in key population areas to provide on-site emergency response within 24 hours. A map of India showing the location of all field service offices must be submitted with the proposal. Third-party maintenance will not be accepted.

14.4 ENVIRONMENTAL REQUIREMENTS

The UPS shall withstand any combination of the following external environmental conditions without operational degradation.

1. Operating Temperature: 0 degrees C to + 40 degrees C (32 degrees F to 104 degrees F) without de-rating (excluding batteries).
2. Storage Temperature: - 25 degrees C to + 60 degrees C (-13 degrees F to 140 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will cause rapid battery self-discharge.
3. Relative Humidity (operating and storage): 95% maximum non-condensing.
4. Elevation:
   - Operational: 6600 ft (2000 m) maximum without de-rating.
   - Transportation: Capable of air transport.

14.5 SAFETY

The UPS shall be CE certified in accordance with EN62040-1-1 and EN500091-2.

14.6 UPS MODULE STANDARD FEATURES

The UPS module shall consist of the following standard components:

Rectifier/Charger:

The rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency PWM design, using Insulated Gate Bi-polar Transistors (IGBTs). The modular design of the UPS shall permit safe and fast removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.

The rectifier/charger module shall also provide the following:

1. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
2. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.

Inverter:

The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:

1. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
2. The modular design of the UPS shall permit safe and fast removal and replacement of the inverter module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return UPS to normal mode.
3. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.

Static Bypass:

The bypass shall serve as an alternative source of power for the critical load when performing maintenance on the UPS, or when a failure prevents operation in normal mode. The bypass shall consist of a fully rated, naturally commutated static switch for high-speed transfers. The bypass shall feature the following transfer and operational characteristics.

1. Transfers to bypass shall be automatically initiated for the following conditions:
   a) Output overload period expired.
   b) Critical bus voltage out of limits.
   c) Over temperature period expired.
   d) Total battery discharge.
   e) UPS failure.

   Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
2. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
   a. In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten minute period. The fourth transfer shall lock the critical load on the bypass source.
   b. UPS failure.
3. Static transfer time: No break, complete in less than 4ms.

Monitoring and control components:

The following components shall provide monitor and control capability:

1. Control panel with status indicators.
2. Alarm and metering display.
3. Building alarm monitoring.
4. Inverter and bypass contactor monitoring.
5. Communication ports.

14.7 UPS MODULE OPTIONS AND ACCESSORIES:

The UPS module shall consist of the following options and accessories:

a. UPS Power Monitoring Software:

This system shall continuously monitor critical power elements associated with the UPS, using the communication port on each module and a customer furnished PC. The system shall automatically alarm if any problems arise and notify local or remote personnel of the alarm condition via email, page, or text message. A communications interface between the UPS module and SNMP-compatible network management systems should be provided.

b. Battery Rack:

The battery rack shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery rack shall have the following features:

1. Each battery rack shall feature a DC rated circuit breaker.
2. The circuit breaker in each battery rack shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
3. The circuit breaker in each battery cabinet shall feature an under voltage release device. The UV device shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
4. The UPS battery system shall have the following characteristics:

a. Batteries shall provide enough capacity to operate the systems from battery power for 8 minutes of operation.
b. UPS module will automatically adjust battery shutdown based upon loading and battery capacity.

c. External Isolation Transformer:

An isolation transformer is a transformer used to transfer electrical power from a source of alternating current (AC) power to some equipment or device while isolating the powered device from the power source, usually for safety. Isolation transformers provide galvanic isolation and are used to protect against electric shock, to suppress electrical noise in sensitive devices, or to transfer power between two circuits which must not be connected. Isolation transformers block transmission of the DC component in signals from one circuit to the other, but allow AC components in signals to pass.

Considering the above Isolation properties of a Transformer, we can now describe the key beneficial and some necessary functions resulting from isolation:

- Creating new neutral connection when the mains neutral has serious power quality problems or the neutral is subject to disconnection when upstream 4-pole circuit breakers used.
- Combining two sources without the need to connect their neutral wires together.
- Preventing Circulating currents that could cause Residual Current Detectors (RCD) or other safety systems to activate unnecessarily.
- For 3Phase in 3Phase Out External Isolation Transformer, Neutral to Earth Voltage loss should not be more than 1Volt.

SL. No.	DESCRIPTION OF PARAMETER	SPECIFICATION
1	TYPE	Dry Type DYN11
2	MAKE	As per approved make list
3	TYPE OF COOLING	Forced Air Cooled
4	SERIES	
5	CAPACITY	As per the BOQ rating Delta to Star COPPER WINDINGS
6	PRODUCT	External Isolation Transformer with Auto-resistance starters
7	CONSTRUCTION	CRGO notch construction
8	INPUT VOLTAGE	415V, +/- 15%
9	OUTPUT VOLTAGE	415V +/- 5%
10	K RATING	k13
11	MAXIMUM OUTPUT CURRENT	At unity power factor Load
12	INPUT FREQUENCY	50 Hz +/- 3%
13	IR VALUE	>1000MΩ
14	DI ELECTRIC STRENGTH	2.5 kV for 60 Seconds
15	LEAKAGE CURRENT	< 5 milli Amps
16	IMPEDENCE VOLTAGE	3-4 %
17	REGULATION	3-4 %
18	LOSS PER KG	< 1.5 Watts at 1.7 Tesla
19	NO LOAD LOSSES	As per IS 2026

20	LOAD LOSSES	As per IS 2026
21	TEMPERATURE RISE	< 115° over and above ambient
22	EFFICIENCY	> 97%
23	DUTY	Continuous
24	CLASS OF INSULATION	Class 'H'
25	SERVICES	Indoor Application
26	METHOD OF WINDING	Multiple Parallel to Reduce Skin Effect
27	DEGREE OF IP	IP-20 (Other as Optional)
28	DIMENSION AND WEIGHT	As per the Vendor requirement
29	STANDARD	IS: 2026
30	ENCLOSURE COLOUR	RAL 7035
31	WINDING MATERIAL	COPPER
32	SWITCHES	INPUT MCCBs
33	LED METERING	YES – AT OUTPUT (KVA/KW/VOL/HZ/AMP)
34	INDICATION	INPUT /OUTPUT/FAULT/OVERTEMPERATURE
35	Cable Entry	Top/Bottom
36	INPUT DESGINED @voltage	352 V Lower side (415 V) – 477 V Higher side
36	OUTPUT DESGINED @voltage	415 V

14.8 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

UPS Continuous Ratings. The UPS shall be rated at maximum for a load power factor range of 0.9 lagging to 0.9 leading.

a. RECTIFIER / CHARGER INPUT:

1. Nominal three phase input voltage: 400 VAC:
   a) 4-wire plus ground for 4-wire plus ground output configuration
2. Operating input voltage range: + 10%, - 15% of average nominal input voltage without battery discharge.
3. For 50Hz systems, operating input frequency range shall be 45 to 65Hz.
4. Input power factor 0.99 lagging.
5. Normal input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode:

a) Rectifier/charger input current limit shall be adjustable from 100 to 125% of full-load input current.

b) Battery input current limit shall be adjustable from 10% to 15% of the UPS full load input current regardless of the actual load on the UPS.

6. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode on generator:

a) Rectifier/charger input current limit shall be adjustable from 50% to 125% of full-load input current.

b) Battery recharge input current limit shall be adjustable from 10% to 25% of the UPS full load input current regardless of the actual load on the UPS.

7. Input current total harmonic distortion (THD) shall be less than 5%
8. Power walk-in: Ramp-up to full utility load adjustable from 3 seconds to 60 seconds.

b. BYPASS INPUT:

1. Synchronizing bypass voltage range shall be +/- 10% of average nominal input voltage.
2. Synchronizing bypass frequency range is centered on the nominal frequency.
3. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).

c. RECTIFIER/CHARGER OUTPUT:

1. Nominal DC voltage shall be variable between 432VDC to 480VDC for 400V input.
2. Steady state voltage regulation shall be +/- 0.5%.

3. Voltage ripple shall be less than 0.5% (peak-to-peak).
4. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 95% of its full capacity within 10 times the discharge when input current limit is set at maximum.
5. Low line operation: The rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the ON battery indicator shall enunciate operation in this mode.
6. Battery equalize: Automatic and manual means must be provided for battery equalization.
7. DC sensing: Redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.

d. <u>UPS OUTPUT IN NORMAL MODE:</u>

1. Nominal output voltage 400V, 3-phase, 4 wire plus ground.
2. Steady-state voltage regulation (in inverter) shall be within +/- 1% average from nominal output voltage.
3. Transient voltage response shall be < +/- 5% from nominal voltage for 100% load step, full load re-transfers and full load drop on battery.
4. Transient voltage recovery shall be 10 ms to within +/- 1% of steady state.
5. Linear load harmonic distortion capability: Output voltage THD of less than 2% for 100% linear load.
6. Non-linear load harmonic distortion capability: Output voltage THD of less than 3% for 100% non-linear load when tested using the non-linear load described in IEC 62040-3 connected line to neutral.
7. Manual output voltage adjustment shall be +/- 3% from nominal.
8. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
9. Frequency regulation shall be +/- 0.01Hz free running.
10. Frequency slew rate shall be 1 Hz/second maximum (adjustable).
11. Phase angle control:
    a. Balanced linear load shall be +/- 1 degree from nominal 120 degrees
    b. Unbalanced linear loads shall be better than +/- 5degrees from average phase voltage for 100% load unbalance.
12. Phase voltage control:
    a. Balanced linear loads shall be +/- 1% from average phase voltage
    b. Unbalanced linear loads shall be better than +/- 5% for 100% load unbalanced

13. Fault clearing current capability: 150% phase-to-phase for 10 cycles; 300% phase-to-neutral for up to 10 cycles
14. Static transfer time: No break, completed in less than 4ms.
15. Common mode noise attenuation:
    a. -65dB up to 20 kHz, -40db up to 100 kHz

e. ACOUSTICAL NOISE:

Noise generated by the UPS under normal operation shall not exceed 70dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.

f. EMI SUPPRESSION:

The UPS shall meet FCC rules and regulation 47, part 15, for Class A devices.

g. ELECTROSTATIC DISCHARGE (ESD):

The UPS shall meet IEC 801-2 specifications.

The UPS shall withstand a 2.5 kV pulse without damage and with no disturbance or adverse effect to the critical load.

h. EFFICIENCY:

The typical UPS input to output efficiency shall be >93% at full load.

i. MECHANICAL DESIGN:

1. Enclosures:

The UPS shall be housed in free-standing double front enclosures (safety shields behind doors) equipped with leveling feet. The enclosures shall be designed for computer room applications

2. Ventilation:

The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top. 460 mm of clearance over the UPS outlets shall be required for proper air circulation. Air filters shall be commonly available sizes.

No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.

3. Cable entry:

Standard cable entry for the UPS rack shall be through either the enclosure bottom or top. A dedicated wire way shall be provided within the UPS rack for routing user input and output wiring.

4. **Front access:**

All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.

5. **Service area requirements:**

The system shall require no more than thirty-six inches of front service access room and shall not require side or rear access for service or installation.

j. CONTROLS AND INDICATORS:

1. **Microprocessor controlled circuitry:**

The UPS controls shall have the following design and operating characteristics:

a. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. DSP shall eliminate variances from component tolerance or drift, and provide consistent operational responses.
b. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.
c. Start-up and transfers shall be automatic functions.

2. **Digital Front Panel Display:**

The UPS control panel shall be a digital front panel display that features a 4x80 (4 lines, 80 characters) backlit LCD display. The LCD shall display UPS status, metering, battery status, alarm/event queue, active alarms and UPS configurations. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs.

3. **Control Panel Indicators:**

The UPS control panel shall provide the following monitoring functions with indicator LED's:

a. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.
b. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.
c. BATTERY: This shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.
d. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator's manual.

4. Control Panel Controls:

The UPS control panel shall provide the following functions from front panel push buttons:

a. EVENTS: Displays the list of Active System Events and a historical log of system events. Historical logs shall include a detailed time stamped list of the latest 500 events.
b. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters including; voltage, current and frequency. In addition, the battery display shall show runtime remaining.
c. CONTROLS: Displays a System Controls screen allows selection of operating mode, normal, bypass, charger on/off and Power Module on/off.
d. SETUP: Allows display contrast, date and time information serial communication port configuration and display of firmware revision numbers.
e. RETURN: Confirms selection or returns to previous screen.

5. Interface panel:

The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:

a. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be capable of supplying N/O or N/C states and shall be rated for operation at a minimum of 10 Amps at 240VAC or 14VDC.

b. RS232 (EIA / TIA-232) communications interface: Circuitry shall be provided for one RS232 (EIA / TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to gain remote access to all unit operation information.
c. Building alarms: Two inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the RS232 (EIA / TIA-232) port.
d. External EPO contacts: Shall be provided to connect an external remote emergency power off switch to shut down the UPS and de-energize the critical load.
e. Battery control contacts: Contacts shall be provided to connect the battery UVR and auxiliary signals from a battery breaker or battery disconnect switch.

6. Communications:

Communication Bay:

The UPS shall be equipped with field configurable communications bays that will accommodate two (2) communication devices.

A communication bay upgrade shall be available to increase the quantity of communication devices up to four (4).

a. Monitoring:

1. The UPS shall have standard or optional communication feature to provide basic or advance UPS monitoring, notification, management, and emergency computer shutdown capabilities.
2. The UPS shall be able to be monitored locally or across a network. Monitoring of UPS status may also be performed through isolated dry contact form C relays. Simultaneous monitoring of multiple UPSs shall be possible from one central location. Communication via modem for monitoring shall also be possible.
3. Monitoring of the UPS shall also be possible through status indicators on the UPS or elsewhere in the same facility through a device that replicates these indicators. The UPS should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored and managed via any standard internet browser (i.e. Internet Explorer and Netscape), PDA or cell phone. All optional hardware interfaces shall be "Hot-swappable" (UPS maintains power to critical applications while changing interfaces).

b. Shutdown:

1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime on battery for more critical systems.
2. Shutdown of AS/400 computers shall be possible through open-collector relay contacts or isolated, dry contact, Form-C relays.
3. The UPS shall also be capable of interfacing with an operating system's inbuilt shutdown routine, e.g. Windows NT. This shall be done through a cable connection to the optional serial port on the UPS.

c. Notification:

1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.
2. Dial-out to a computer for alarm notification may be performed. The user may respond by dialing-in to retrieve alarm history and a summary of current meter status.
3. Management: A remote battery test may be performed via an Ethernet network. The UPS shall be tested through invoking a single command.

14.9 UPS MODULE PROTECTION

- Rectifier/Charger and Bypass protection shall be provided through individual fusing of each phase.
- Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery rack (if standard battery pack is provided) or external protective device for an external battery.
- Output protection shall be provided by electronic current limiting circuitry and fuses in the Inverter circuit.
- To comply with agency safety requirements, the UPS module shall not rely upon any disconnect devices outside of the UPS module to isolate the battery rack from the UPS module.

14.10 WARRANTY

All components of the UPS system shall be covered by a standard Three-year limited factory warranty. Three -year limited factory warranty shall include replacement coverage for the UPS parts for a period of 36 months from shipment or 36 months from start-up, whichever occurs sooner. Manufacturer shall also include On-site user training, installation.

15.0 ABBREVIATIONS:

ACB	Air Circuit Breaker
AHU	Air Handling Unit
APFC	Automatic Power Factor Correction
BMS	Building Management System
DB	Distribution Board
DG	Diesel Generator
DP	Double pole
EC	Electronically Commutated
ED	Electrical Draw out
ELDB	Emergency Light Distribution Board
FFL	Finished Floor Level
FLP	Flame proof
FPS	Fire Protection System
FRLS	Fire Retardant Low Smoke
GF	Ground Floor
GI	Galvanized Iron
HP	Horse Power
IEC	International Electrotechnical Commission
IP	Ingress Protection
IS	Indian Standard
KPTCL	Karnataka Power Transmission Corporation Limited,
KV	Kilo Volt
KVA	Kilo Volt Ampere
KW	Kilo Watts
LDB	Light Distribution Board(s)
LED	Light Emitting Diode
LT	Low Voltage Transmission / Low Tension

LV	Low Voltage
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MDO	Mechanical Draw out
MELDB	Main Emergency Lighting Distribution Board
MFM	Multi-Function Meter
MLDB	Main Lighting Distribution Board
MLP	Main Lighting Panel
MPPL	MJA Pharmatech Private Limited
MS	Mild Steel
OLTC	On Load Tap Changer
PCC	Power Control Centre
PDB	Power Distribution Board
PLC	Programmable Logic Controller
PMCC	Power & Motor Control Centre
PVC	Poly Vinyl Chloride
RCBO	Residual Current & Over current Circuit Breaker
RCCB	Residual Current Circuit Breaker
RMU	Ring Main Unit
RPDB	Raw Power Distribution Board
SDP	Sub-Distribution Panel
SLD	Single Line Diagram
SPD	Surge Protection Device
SP	Single pole
SS	Stainless Steel
SWG	Standard Wire Gauge
TN-S	Terra Neutral - Separate
TTA	Type Tested Assembly
TP	Triple pole
UPS	Uninterrupted Power Supply
UPSDB	Uninterrupted Power Supply Distribution Board
VCB	Vacuum Circuit Breaker
VFD	Variable Frequency Drive
XLPE	Cross Linked Polyethylene

PART 3

HVAC WORKS

CONTENTS

1.0 SCOPE OF WORK

HVAC Tender Scope of work includes Detailed Design, Supply, Installation, Testing and Commissioning of HVAC system as proposed in this part of tender.

The scope of HVAC works includes the following.

- Design of Air Conditioning system & Exhaust system for proposed Facility.
- Preparation of Area Classification Zoning Layout.
- Preparation of AHU Zoning Layout.
- Preparation of Pressure Gradient Zoning Layout.
- Calculation of Heat Loads.
- Preparation of HVAC Room Data Sheet (RDS).
- Preparation of HVAC Equipment Schedule Sheet.
- Preparation of Air Flow Diagrams (Exhaust P&ID & 3-Pipe VRF Schematic for AHU).
- Preparation of AHU Design & positioning layout.
- Preparation of Supply air Terminals, Grille & Return air Raiser positioning layout.
- Preparation of Shop floor ducting drawings with sections.
- Submission of Technical Data Sheet for all BOQ line item.
- Coordination of drawings with other services / Vendors to uphold the design intend.
- Execution at site with all necessary PPE (Personal Protection Equipment)
- Testing & Commissioning.
- Preparation of all required regulatory documents like DQ, IQ, OQ & PQ.
- Preparation & handing over of As Built Drawings.
- Training of service personal & handing over documents.

2.0 DESIGN CRITERIA

The most significant environmental factors that must be controlled & are the basis of HVAC system design criteria are: Temperature, Relative Humidity, Pressure Gradient, air movement velocity & particulate matter.

Critical parameters for room environment and types of controls vary greatly with the Condition space intended purpose. It is particularly important to determine critical parameters with quality assurance to set limits for temperature, humidity, pressure and other control requirements. The system shall be designed to give optimum performance irrespective of the fluctuation in outdoor condition throughout the year.

3.0 OUTSIDE DESIGN CONDITIONS

- **Location: - Pune, Maharashtra.**
- Outdoor weather considered is for Pune & it is as per ISHRAE HVAC Engineering Handbook 2014 Second Edition.
- Outdoor weather consideration for design shall be as under.

SUMMER (April)

DRY BULB TEMPERATURE	:	104° F (40° C)
WET BULB TEMPERATURE	:	76° F (24.44° C)
RELATIVE HUMIDITY	:	29.3 %
DEW POINT	:	65.7° F
GRAINS / Lb	:	102.2
ENTHALPY IN BTU / Lb	:	41.1

MONSOON (September)

DRY BULB TEMPERATURE	:	83° F (28.33° C)
WET BULB TEMPERATURE	:	79° F (26.1° C)
RELATIVE HUMIDITY	:	84.4 %
DEW POINT	:	77.8° F
GRAINS / Lb	:	155.8
ENTHALPY IN BTU / Lb	:	44.4

WINTER (January)

DRY BULB TEMPERATURE	:	50° F (10° C)
WET BULB TEMPERATURE	:	42° F (5.5° C)
RELATIVE HUMIDITY	:	52.4 %
DEW POINT	:	33.4° F
GRAINS / Lb	:	29.9
ENTHALPY IN BTU / Lb	:	16.6

4.0 ROOM DESIGN CONDITIONS

Room conditions i.e., acceptable room Temperature, RH & cleanliness classification is as mentioned below table.

CLASSIFIED AREAS		
GRADE	**DRY BULB TEMPERATURE ° C**	**RELATIVE HUMIDITY %**
GRADE - B	NMT 25° C	NMT 60%
GRADE - C	NMT 25° C	NMT 60%
GRADE - D	NMT 25° C	NMT 60%
NON-CLASSIFIED AREAS		
GRADE	**DRY BULB TEMPERATURE ° C**	**RELATIVE HUMIDITY %**
CNC	NMT 25° C	NOT CONTROLLED
COMFORT AC	NMT 25° C	NOT CONTROLLED
VENTILATION & EXHAUST	AMBIENT	AMBIENT

Design of the HVAC system shall be based on the following parameters.

- Room Parameters & Area / Lab Classification
- Heat load Estimation for lab & office area with Indoor air quality Fresh air requirements
- Room Air Changes per hour
- Room Occupancy
- Connected Equipment load with diversity
- Room pressurization cascade

Following design parameters shall be maintained all round the year depending upon the type of activity given in the attached **HVAC Room data sheet**.

- **DB Temperature**: To be maintained as specified in HVAC Room Data Sheet.
- **Room RH:** To be maintained as specified in HVAC Room Data Sheet.
- **Room Pressure:** To be maintained as specified in Room Data Sheet, wherever specified.
- **Fresh Air (for Air-Conditioned Area):** The Fresh air for Heat load calculations shall be based on IAQ requirement & considered on the basis of exfiltration / infiltration through doors / wall service openings / direct exhaust from the air-conditioned area OR minimum 10% of total air

change per hour OR 10 CFM per working personal whichever is maximum OR 0.18 CFM/SQFT whichever is maximum.

Fresh air shall be as per ASHRAE 62.1-2016 table 6.2.2.1 Indoor air quality for occupied zone.

- **Occupancy:** Room Occupancy shall be considered based on the data provided as per User Requirement specification / Equipment Room Data sheet.
- **Lighting Load:** The Lux level considered is as per IS: 6665. LED light fittings are envisaged in this project & for HVAC heat load calculation we have considered 1 watt / Sqft as lighting load.
- **Equipment Load:** Shall be considered as given in **HVAC Room Data Sheet**. Heat generated by all equipment inside the conditioned area forms a part of room load. Diversity factor on equipment usage is considered as mentioned in the **HVAC Room Data Sheet**.
  - **Summer:** Full equipment load (with diversity) is considered in "ON condition" for heat load calculation for summer season.
  - **Monsoon:** Full equipment load is considered (with diversity) in "ON condition" for compensating reheating calculations for monsoon season.
  - **Winter:** Full equipment load is considered (with diversity) in "ON condition" for heating calculation for winter season.
- **Leakage around the doors:** For calculation of leakages due to pressure difference between two areas, the following gaps shall be considered:
  - Bottom - 5mm
  - Sides & Top - 3mm
  - Centre (Double leaf doors) - 3mm

For the detailed room conditions i.e. acceptable room conditions, room sizes, equipment machine load, lighting load, diversity considered, cleanliness classification etc., Please Refer Tender HVAC Room Data Sheet.

- **AIR CHANGES PER HOUR**

The Minimum room air change rates considered in the various areas are as under:

- 60 ACPH for Grade 'B' area OR Dehumidified CFM whichever is higher.
- 45 ACPH for Grade 'C' area OR Dehumidified CFM whichever is higher.
- 25 ACPH for Grade 'D' area OR Dehumidified CFM whichever is higher.
- 10 ACPH for CUC area OR Dehumidified CFM whichever is higher.
- 6 ACPH for Comfort Air Condition OR Dehumidified CFM whichever is higher.
- 20 ACPH for General Ventilation Areas.

❖ SPACE PRESSURIZATION

- A Clean room facility may consist of multiple rooms with different requirements for contamination control. All rooms in a clean facility should be maintained at static pressures sufficiently higher than atmospheric to prevent infiltration by wind and other effects. Differential pressures should be maintained between the rooms, sufficiently to assure airflow outward progressively from the cleanest spaces to the least clean during normal operation and periods of temporary upset in the air balance, as when a door connecting two rooms is suddenly opened.
- All systems shall be designed to attain the desired pressure levels within the rooms, relative to adjacent areas. In general, space pressure differential between adjacent areas will be maintained by fixed airflow differentials achieved by the air balance of the supply, return and exhaust air quantities. Space pressure differentials will be designed to cascade from the cleanest classified areas to the non – critical space
- All Classified room differential pressure will be monitored using Digital display with sensors. (Digital display is in EMS Scope)
- As per ISO 14644 Part 4 – The pressure differential creates the barrier between the cleaner zone and towards the less clean zone. The high-pressure differential between adjacent zones shall be controlled / balanced and care is taken to avoid turbulence.
- As per ISO 14644 Part 4 – The pressure differential considered shall be sufficient enough to prevent any reversal of airflow direction. The pressure differential concept considered is as under.
    - Same Class & Same AHU – 10 Pascal Difference.
    - Same Class & Different AHU – 10 to 15 Pascal Difference.
    - Different Class & Same AHU – 10 to 15 Pascal Difference.
    - Different Class & Different AHU – 15 Pascal Difference.
    - Unclassified to Classified – 15 Pascal Difference.
- **For validation** purpose the variation in room differential pressure shall be ± 2 Pascal from designed value.
- All Pressure values mentioned are with respect to Ambient / Atmosphere. The room pressure differentials value is with respect to adjacent room.
- All Entry and Exit rooms are maintained at pressures sufficiently higher than atmospheric to prevent infiltration by wind, any ingress of contamination and other effects on the condition of the room.

PRESSURE GRADIENT

- ♣ **MJ 437 – HVAC – DR - 2608 – R0 for Ground Floor HVAC Pressure Gradient Layout.**
- ♣ **MJ 437 – HVAC – DR - 2609 – R0 for First Floor HVAC Pressure Gradient Layout.**

❖ CONSULTANT'S ESTIMATE OF LOADS/CFMs:

HVAC design is being carried out on the basis of equipment's load / heat dissipations, occupancy, light loads and Machine Exhaust / Direct Room Exhaust air CFM (**Refer HVAC Room data sheet**). **The HVAC Room data sheet enclosed reflects the design estimate.**

Check the given data and parameters so as to ensure that the inside design conditions are maintained at all times. Responsibility for verifying, altering of parameters if called for, lies with the HVAC Vendor.

HVAC ROOM DATA SHEET

- **MJ 437 - HVAC RDS – 7110 – R0 for HVAC Room Data Sheet.**

❖ CLEANLINESS LEVEL - PARTICLE COUNT CHART

The HVAC system of all classified areas shall be designed as per EU & cGMP Guidelines. The following table gives the maximum number of non-viable particles permitted "at rest" and "in operation" conditions for each class of cleanliness, as per EU & cGMP.

GRADE	Maximum permitted No of Particles / m^3 equal to or above			
	At rest		In operation	
	0.5 micron	5 microns	0.5 micron	5 microns
GRADE – A	3520	20	3520	20
GRADE – B	3520	20	352000	2900
GRADE – C	352000	2900	3520000	29000
GRADE – D	3520000	29000	Not Defined	Not Defined

Maximum number of particles of >=5 micron is established as 1/m^3 but for reason related false counts associated with electronic noise, stray light etc. a limit of 20/ m^3 can be considered.

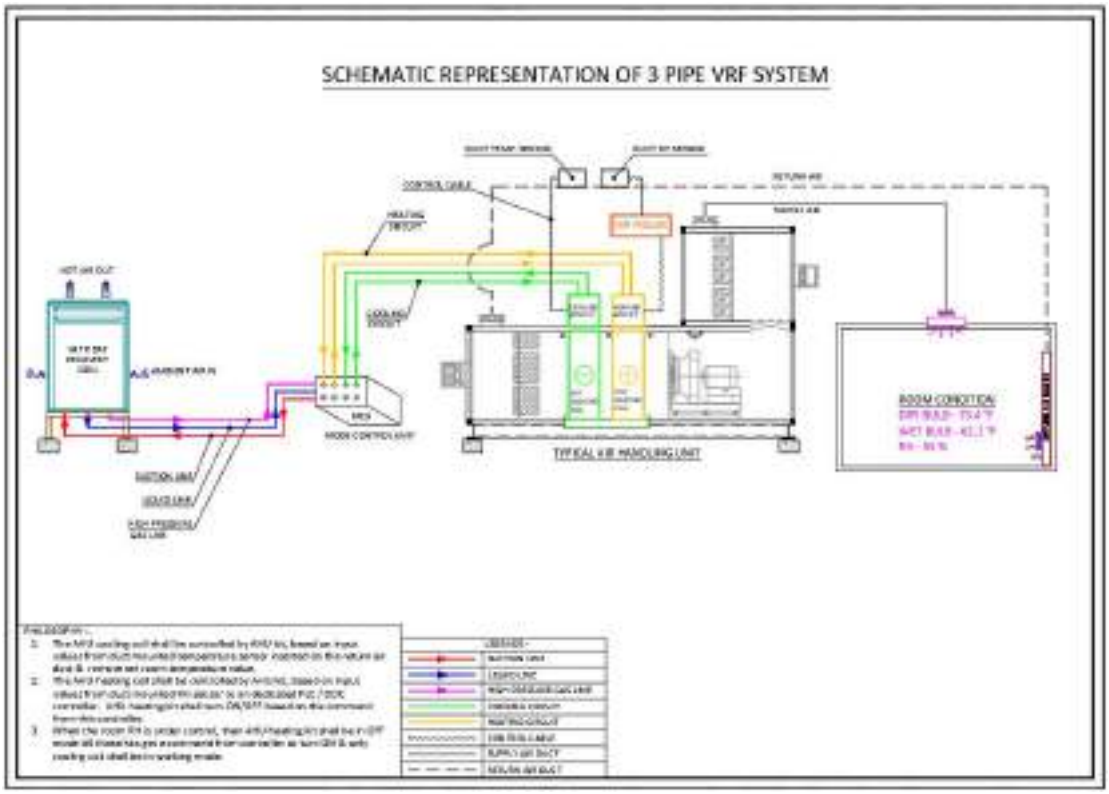
THE HVAC SYSTEM SHALL BE DESIGNED ON THE FOLLOWING BASIS

- All areas of the proposed plant shall run simultaneously. There shall not be any heat gain from interconnecting / adjacent areas.
- Lab Operation shall be considered for 24 hours per day, for 7 days a Week.
- The area classification, AHU classification & Pressure gradient are proposed based on the guidelines of ISO 14644 (Part 1 & Part 4).
- For economic, technical and operational reasons, clean zones are enclosed further by zones of lower cleanliness classification. This can allow the zones with the highest cleanliness demands to be reduced to the minimum size. Movement of material and personnel between adjacent clean zones gives rise to the risk of contamination transfer, therefore special attention has been paid to the detailed layout and management of material and personnel flow.
- A Clean room facility may consist of multiple rooms with different requirements for contamination control. All rooms in a clean facility should be maintained at static pressures sufficiently higher than atmospheric to prevent infiltration by wind and other effects. Differential pressures should be maintained between the rooms, sufficiently to assure airflow outward progressively from the cleanest spaces to the least clean during normal operation and periods of temporary upset in the air balance, as when a door connecting two rooms is suddenly opened.
- All systems shall be designed to attain the desired pressure levels within the rooms, relative to adjacent areas. In general, space pressure differential between adjacent areas will be maintained by fixed airflow differentials achieved by the air balance of the supply, return and exhaust air quantities. Space pressure differentials will be designed to cascade from the cleanest classified areas to the non – critical space.
- All Classified room differential pressure will be monitored using Digital display with sensors. (Digital display is in EMS scope)
- As per ISO 14644 Part 4 – The pressure differential creates the barrier between the cleaner zone and towards the less clean zone. The high-pressure differential between adjacent zones shall be controlled / balanced and care is taken to avoid turbulence.
- As per ISO 14644 Part 4 – The pressure differential considered shall be sufficient enough to prevent any reversal of airflow direction. The pressure differential concept considered is as under.
    - Same Class & Same AHU – 10 Pascal Difference.
    - Same Class & Different AHU – 10 to 15 Pascal Difference.
    - Different Class & Same AHU – 10 to 15 Pascal Difference.
    - Different Class & Different AHU – 15 Pascal Difference.
    - Unclassified to Classified – 15 Pascal Difference.

- **For validation purpose the variation in room differential pressure shall be ± 2 Pascal from designed value.**
- **All Pressure values mentioned are with respect to Ambient.**

- There shall not be any infiltration / exfiltration from hatches (static & dynamic).
- Movement of material and personnel between adjacent clean zones gives rise to the risk of contamination transfer, therefore special attention is taken during detailing of layout and management of material and personnel flow.
- No separate Fumigation Exhaust fans are envisaged.
- Room air flow rate is calculated based on the quantity of dehumidified air required to remove thermal loads or the minimum air changes, whichever is greater.
- Inside room conditions (Temp/RH) shall be maintained before start of process.
- Fresh air intake into the technical area shall be through the Louvres & G2 pre filters provided along with rain protection Air inlet Louvres on the outer peripheral wall / cladding sheet.
- The proposed air handling units shall be of Double/Single decker construction.
- It is proposed to provide Belt Driven DIDW Centrifugal Blower for all AHUs, Ventilation and Exhaust units.

- Standard IE 2 drive motors are proposed for all type of fans.
- It is proposed to provide variable frequency drives (VFD) for Drive motors in all AHUs.
- It is proposed to provide a factory fitted differential pressure transmitter across the DIDW Centrifugal type fan inside the AHU, which will control the static pressure of the blower through a Variable Frequency Drive.
- VRF type **(3 Pipe System) Heat Recovery system** is proposed to take care Cooling & Heating load requirement.



- Heat Recovery VRF Systems, also known as 3-pipe VRF, allow heating and cooling in Air handling unit simultaneously. Each outdoor air-cooled VRF is connected via 3 pipes to an indoor heat recovery unit; a high-pressure gas refrigerant line (for heating), a high-pressure liquid refrigerant line (for cooling), and a low-pressure gas suction line (for return to the outdoor unit).
- VRF (DX type) cooling coil is provided to take care of Dehumidified air requirement / Removal of total heat picked up from room.
- VRF (DX type) Heating coil is provided to take care of Compensation Heating & Winter Reheat requirement in AHU.
- Heat recovery VRF outdoor unit provides simultaneous cooling and heating by transferring exhaust heat from a unit being cooled to a unit that requires heating.
- VRF condenser are connected to AHU system through a direct Mode Control Units (MCU), which will divert the refrigerant based on the AHU operating mode.
- The Classified area AHUs are proposed with VRF (DX type) coil for cooling requirement, whereas VRF (DX type) Heating coil is provided for maintaining RH / winter reheat requirement. These areas are to be maintained within the acceptable ranges of temperature & RH. These factors such as Temperature & RH are monitored / recorded on day-to-day basis by an automated system.
- The Controlled Unclassified Area AHUs are proposed with VRF (DX type) coil for cooling requirement. These areas are to be maintained within acceptable ranges of temperature.

- For Comfort Air Conditioning Area VRF type Cassette unit / Hi wall unit is proposed.
- EN779 & EN1882 standards / ratings are followed for filter design.

Rev :1 30th April 2018	FILTER GRADE EQUIVALENCE TABLE								FILTER EFFICIENCY VALUES AT PRESENT IN PHARMA MARKET IN INDIA	ISO 14644 BASIC REQUIREMENTS				
	PRE & FINE FILTERS					HEPA & ULPA FILTERS			STANDARD FRACTIONAL EFFICIENCIES (ALTERNATE ONLY IF CUSTOMER DEMANDS)	ISO 14644 MINIMUM EFFICIENCY REQUIREMENT %	ISO 14644 MANDATORY TO BE REPORTED			
	EUROVENT 4/5	EN 779	EN 779	ASHRAE 52.2	ISO 16890	EUROVENT 4/5	EN 1822	ISO 29463			PARTICULATE MATTER EFFICIENCY %			DUST HOLDING CAPACITY
	1997	1994	2012	2007/ MERV	2017		2011							
COARSE	EU 1	G1	G1	1	ISO Coarse					< 50 % Initial Gravimetric Efficiency	YES	NO	NO	YES
	EU 2	G2	G2	2 to 4					65 % Down To 26 µ					
	EU 3	G3	G3	5 & 6					90 % Down To 26 µ					
	EU 4	G4	G4	7 to 8					90-95 % Down To 10 µ					
FINE	EU 5	F5	M5	9 to 10	ISO ePM10				60-65 % Down To 5 µ	≥ 50% @ 10 µ	YES	YES	YES	YES
	EU 6	F6	M6	11 to 12	ISO ePM2.5				85-90 % Down To 2.5 µ	≥ 50% @ 2.5 µ	YES	YES	YES	YES
	EU 7	F7	F7	13	ISO ePM1				95 % Down To 0.8 µ	≥ 60% @ 1 µ	YES	YES	YES	YES
	EU 8	F8	F8	14	ISO ePM1				80 % Down To 0.3µ (90% Down To 1µ)		YES	YES	YES	YES
	EU 9	F9	F9	15 to 16	ISO ePM1				85 % Down To 0.3µ (95% Down To 1µ)		YES	YES	YES	YES
EPA						EU 10	E10		85 % Down To 0.3 µ					
						EU 11	E11	ISO 15 E	95 % Down To 0.3 µ					
						-	-	ISO 20 E						
						EU 12	E12	ISO 25 E	99.97 % Down To 0.3µ					
						-	-	ISO 30 E						
HEPA						EU 13	H13	ISO 35 H	99.997 % Down To 0.3µ (99.99% @ MPPS)					
						-	-	ISO 40 H						
						EU 14	H14	ISO 45 H	99.999 % Down To 0.3µ (99.997% @ MPPS)					
						-	-	ISO 50 U						
ULPA							U15	ISO 55 U	99.9995 % @ MPPS					
							-	ISO 60 U						
							U16	ISO 65 U	99.99995 % @ MPPS					
							-	ISO 70 U						
							U17	ISO 75 U	99.999995 % @ MPPS					

- Filtered, cooled, and dehumidified air from the respective AHU's shall be fed into the air conditioning space of that particular zone by means of insulated GI ducting and Air Terminal.
- In the classified Areas low level Return is taken through return air raisers, G4 Pre filter collar damper, module & SS perforated grille. Return air raiser shall be an integral part of clean room panel tender.
- All other unclassified areas are with supply and return air terminals at false ceiling level.

- The ducting shall be designed as per SMACNA / ISI standards & the specifications mentioned in the tender.
- For Classified areas ducting shall be with TFD flanges fastened with 'G' clamps & these ducting shall be pressure tested for 750 Pascal.
- Comfort AC areas ducting shall be with TDF flanges & pressure tested for 250 Pascal.
- Pressure drop calculation for all AHU along with its connected ducting shall be calculated & submitted for approval.
- Thermal insulation for Ducts shall be with Self-adhesive type Nitrile Rubber insulation with factory applied reinforced aluminium foil on one side. All Insulation joints shall be covered by factory supplied 75mm wide aluminium tape.
- The dust particles from ambient is filtered at air inlet louvre with G2 Filter & the recirculation air is cleaned in AHU filter provided in so that maintenance will be reduced & the life of the filters shall increase.
- Terminal (H14) HEPA Filter where the velocities should not exceed more than 0.8 to 1.0 m/sec. And thus, a high ceiling coverage percentage and also lowering the air changes which ensures better circulation of air.
- Washable & reusable filters are proposed in the primary section of AHU & in return air raiser. Whereas disposable type filters are proposed in the secondary filter section & fine filter section of the AHU.
- AHUs of Controlled Unclassified air conditioning are proposed with G4 & F7 filters in AHU Supply Plenum & G4 filters in Exhaust Plenum.
- AHUs of Classified Areas (Grade 'D', Grade 'C' & Grade 'B') air conditioning are proposed with G4, F7 & F9 (Semi HEPA) filters in AHU Plenum. H14 HEPA filter is proposed at room air terminal.
- G4, F7 & F9 (Semi HEPA) Filters are placed in AHU plenum to reduce load on Terminal H14 HEPA Filters.
- H13 HEPA Filters are proposed for Bleed air damper from all Classified AHU's.
- General Ventilation Supply Unit & Exhaust Unit are proposed with G4 filter in Plenum.
- Once through exhaust air unit are proposed with G4 filter in Plenum.
- The AHU and air distribution system has been designed in such a way that the entire system is suitable for automatic operation through BAS (Building Automation System)
- AHU shall be delivered in assembled condition (max 2 to 3 modules) along with factory test certificates for AHU key parameters such as air flow, leakage, static pressure, vibration, noise

level, coil performance & power consumption etc. HVAC vendor to coordinate for lifting, shifting & commissioning at site.

- ❖ Pressure testing of AHUs at site after assembly shall be done by AHU vendor in coordination with HVAC vendor.

AHU CLASS	STAGES ON FILTRATION IN AHU PLENUM				ADP IN TERMINALS	
	PRIMARY FILTER	SECONDARY FILTER	SUPPLY AIR PLENUM FILTER	BLEED AIR FILTER	SUPPLY TERMINAL	RETURN AIR PLENUM
VENTILATION & EXHAUST	G4 (PRE FILTER)	---	---	---	GRILLE	GRILLE
CUC AHU	G4 (PRE FILTER)	F7 (FINE FILTER)	---	F7 (FINE FILTER)	4 WAY DIFFUSER	4 WAY DIFFUSER
CLASSIFIED AHU • GRADE 'D' • GRADE 'C' • GRADE 'B'	G4 (PRE FILTER)	F7 (FINE FILTER)	F9 (SEMI HEPA FILTER)	H13 (HEPA FILTER)	H14 (HEPA FILTER)	G4 FILTER IN RETURN AIR RAISER

- ❖ The system will be capable of maintaining temperature and RH conditions through automatic controls.
- ❖ Classified areas ducting shall be with G clamps & pressure testing shall be done for 750 Pascal.
- ❖ Controlled unclassified areas, Ventilation & Exhaust units areas ducting shall be with TDF flange & pressure testing shall be done for 250 Pascal.
- ❖ Self-adhesive type Thermal insulation for ducting using non-fibrous, CFC free, closed cell, elastomeric Nitrile Rubber foamed insulation in pre-formed sheets with thermal conductivity of not more than 0.036 W/(m.k) at 10°C. Factory applied reinforced aluminum foil facing on one side. The material should have high resistance to fire (Melting Class "0"). The material used shall be in rolls. The insulation sheet joints shall be sealed using self-adhesive Aluminum tapes of 75 mm width.
- ❖ Biosafety Cabinet shall be of Class II A2 type (30% once through type & 70% Recirculation type).

- The Exhaust air from BSC (only from virology lab) shall be filtered through a Dry scrubber before exhausting out. The Exhaust Blower & Dry scrubber are located in Terrace area.
- The exhaust air volume considered from Biosafety cabinet is as mentioned below: -

BIO SAFETY CABINET (CLASS II A2)	
BIO SAFETY CABINET SIZE	**EXHAUST AIR VOLUME (CFM)**
4 FEET BSC	360 CFM

- **HVAC Control Philosophy & related documents shall be submitted as a part of BMS/EMS tender.**
- **Civil Masonry Pedestals for HVAC units shall be part of Civil tender.**
- **HVAC Vendor shall submit Detailed Schedule providing details of Design / Engineering, Procurement, Production, Fabrication, Delivery, Erection & Commissioning activities while submitting the Tender.**
- **HVAC Vendor shall submit their safety protocols during Erection & Commissioning at site.**
- **HVAC Vendor shall submit details of FAT & SAT for BOQ line items wherever applicable.**
- **HVAC Vendor shall provide Method Statement for the site execution & erection activities.**

THE HVAC SYSTEM FOR THE PROPOSED AREA IS DESIGNED BASED ON THE USER REQUIREMENT AS MENTIONED BELOW.

AHU no.	Room name	Condition	Area classification	Type	Temperature (deg °c) & Relative humidity (%)	Minimum ACPH	Filtration in AHU	Supply air Terminal	Return air terminal
BASEMENT FLOOR									
B-CU-1	Reception	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-2	Passage	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-3	Material Out	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-4	Material In	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-5	Warehouse	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-6	Office	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-7	Sample Archival	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-HWU-1	IT Hub	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Hi Wall Unit	

GROUND FLOOR									
GF-AHU-1A GF-AHU-1B	Change Room-1, Cell Bank Repository & Cell Freezing Area 2 Isolation	AC	Controlled Not Classified	Recirculation / Once Through	Temp NMT 25°C & RH NC	10 - 15	G4 & F7 G4	4-way diffuser	4-way diffuser
GF-AHU-2	Change Room – 2 & Media Preparation	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Change Room – 3, Autoclave Room, Cool Zone, Media Storage, Corridor & Incubator Room		Grade - C		Temp NMT 25°C & RH NMT 60%	45			
GF-EAU-1	Washing Area, Decontamination & Waste Out		Grade - C	Once Through	Temp NMT 25°C & RH NC	45	G4		
GF-AHU-3	Change Room & Sterility Testing	AC	Grade - B	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
GF-AHU-4	Cell Culture - 1	AC	Grade - C	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille

GF-AHU-5	Cell Culture - 2	AC	Grade - C	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
FIRST FLOOR									
FF-AHU-1	Passage	AC	Controlled Not Classified	Recirculation	Temp NMT 25°C & RH NMT 60%	10 - 15	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Male Change, Female Change, Passage & Airlock		Grade - D			25			
	Unisex Change Room, Airlock & Passage		Grade - C			45			
FF-AHU-2	Inner Corridor, Microbiology Lab, QC Lab – 3, Dark Room, QC lab – 2 & QC lab – 1	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
FF-EAU-1	Wash + Cleaning Area + Decontamination & Waste out			Once Through	Temp NMT 25°C & RH NC		G4		
FF-AHU-3	Airlock	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Airlock & Cell Culture with Incubator		Grade - C			45			

FF-AHU-4	Airlock	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Airlock & Virology lab with Incubator		Grade - C			45			
SECOND FLOOR									
SF-DX-HWU-1	BMS Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-DX-HWU-2	UPS Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-DX-HWU-3	Battery Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-PF-EA-1	Electrical Room	NON-AC	Exhaust Ventilation	Once Through	Temp NC & RH NC	6	NA	DX type Hi Wall Unit	

GENERAL

1. The HVAC system is to be designed as per Good Lab Practice (GLP). The Vendor shall be responsible for preparation & supply of all documents to meet regulatory requirements and shall carry out all tests & necessary work at site to satisfy regulatory authorities.
2. The Tender has to be read in relation to the Drawings and Schedule which forms a part of the tender documents. AHU Capacities (Cooling and heating) shall be vetted by the HVAC vendor after detailed heat load calculations. Regarding any contradiction in specification/schedule/standard given in tender, client/consultant decision shall be final.
3. It is must for HVAC Vendor / Contractor- to provide good for construction drawings for co-ordination, shop drawings for production and final as built drawings after project completion.
4. Internal Pressure drop calculation for each AHU shall be provided along with AHU GA Drawing & External Pressure drop calculation for each AHU duct line shall be provided along with coordinated ducting drawing.
5. The ducting measurement shall be provided AHU wise at the time of ducting drawing approvals.
6. HVAC vendor shall make their own arrangements for covered storage of ducts and equipment's and other store material at site. Space shall be provided by client. Provision for cranes, hoist, scaffolding and other necessary arrangement for installation of HVAC system shall be included in the offer.
7. HVAC Vendor shall carryout all coordination activities with client/consultant/other sub vendors like AHU supplier, electrical contractor, piping contractor, civil contractor, false ceiling & clean room / wall partition contractor, validation team etc.
8. Last 10% payment shall be released only after submission of **final as built drawings**.
9. HVAC vendor shall provide shop drawings for all HVAC utilities for approval. Vendor shall check and vet coordination drawings for all services along with MJA. Vendor shall check the feasibility of installation of all equipment or part of system in the given space in coordination with client/consultant. Vendor shall check these before ordering their equipment's and components. Vendor should ensure site requirement before actual fabrication of any component. Any changes at the site shall be borne by the HVAC vendor. To expedite work, all these drawings shall be jointly checked by vendor in MJA office to enable clearance across table.
10. The tenderers shall quote according to the specifications as far as possible, but where deviations are unavoidable, they shall state the reason thereof clearly and shall also (in case alternative proposals are made) back them up by furnishing all relevant technical data. They shall also indicate the financial implications. No Price implications shall be entertained for variation in capacity of equipment within +10% of design parameter.
11. No terms and conditions stipulated by the tenderers (whether cyclostyled, printed or otherwise) will be accepted. In the event and in case, the tenderers find deviations unavoidable, such deviations shall be with reference to specific clauses in the tender documents. They shall, as far

as possible, be so worded that in the agreement, which the successful contractor shall enter into with the Owners, they can be introduced as amendments.

12. After the installation is completed, the contractor should conduct performance tests by keeping the plant running continuously for a period of 96 hours. After carrying out successfully acceptance tests Vendor shall also carry Summer/Monsoon/Winter Tests to establish the performance of plant during various seasons. Each test shall be continuously done for 48 Hours. All seasonal tests must be completed within 12 months of start-up of HVAC system.
13. Performance tests shall be carried out in the presence of the Owner's / Consultants representatives, if they so desire.
14. The plant shall be handed over after the contractor has furnished a certificate from the Consultants to the effect that the plant has been commissioned and tested. However, if the period during which such test is conducted does not coincide with either peak summer or monsoon, the tests shall be repeated during those seasons during the Guarantee Period.
15. All the instruments required for carrying out the tests shall be arranged for by the contractor at his own cost. Instruments so required shall also include Anemometers (Capture Hood, Pitot tube and hot wire method only), Manometers, Particle Counters, Temperature Indicators, Humidity Indicators, and any other instruments that may be required.
16. Cleaning Procedure will involve (but will not to be restricted to) the following:
    - Ductwork (or a part thereof) shall be put under negative pressure using a vacuum unit, which incorporates HEPA filters.
    - The accumulated dust in the ductwork shall be dislodged using compressed air / rotary brushes and such other special tools. The dust so loosened becomes air bound and will be extracted out of the duct system, by the prevailing negative pressure created by the vacuum unit. Compressed air employed shall help direct the air borne dust particles towards the suction point(s) of the vacuum unit.
    - Manufacturer's certificate shall be produced for all equipment's listed above including their components.

      The party, who will be carrying out the work, be identified by the Contractor and the details of the equipment, which the party so identified, will be applying for the methodology of cleaning procedure and all related information shall be furnished along with the tender
17. The successful Contractor shall be responsible for the validation as per GLP. Validation requirement should include applicable protocols:
    (a) DQ (Design Qualification):
    The design of the Clean Room with respect to parameters has to be verified & made sure that it full fills the purpose of the project. The parameters include air volume, temperature, RH, pressures, class level and any other specified parameters.
    (b) The following equipment shall be subject to IQ/OQ/PQ protocols.
    (c) IQ / OQ:
    Air Handling Units:
    - Filters
    - Motors
    - Fan

- Cooling coil
- Electrical Heater
- Condensate Draining System
- Constructional details.
- Ducting:

a. Material
b. Composition
c. Quality thickness
d. Galvanizing

PQ (Performance Qualification):

a. Temperature
b. Humidity
c. Particle count for all rooms with 1 cfm particle counter with printer
d. Air pressure difference & balancing
e. Flow visualization (video picture)
f. Installed filters
g. System leakage tests for both AHU's, duct, etc.
h. Velocity check at terminal filter / grille.
i. System recovery test.

Manufacturer's certificate shall be produced for all equipment's and their components listed above. The above procedures should be in addition to carrying out tests.

18. Standards:

Wherever reference is made to IS/BS Specifications, the latest version of the same at the time of tendering shall be adhered to.

19. Works to be done by the Tenderers:

Besides the supply, installation, testing and commissioning of the air conditioning and other allied works, the Contractor shall also include among other items, the following within the scope of his tender.

a. HVAC vendor shall submit a hard copy of tender document duly signed & sealed after reading & understanding the tender.

b. HVAC vendor shall provide the Bill of Materials (BOM) as mentioned below at the time of drawing approval.

- AHU wise ducting quantity in Sqmtr.
- HEPA Filter Schedule & Quantity in Nos
- Insulation Quantity in Sqmtr
- Grille Schedule & Quantity in Sqmtr
- Return air raiser Schedule & Quantity in Nos
- Volume control damper Schedule & Quantity in Sqmtr
- Fire damper Schedule & Quantity in Sqmtr
- Magnahelic gauge Schedule & Quantity in Nos

- Unit supports schedule & Quantity in Kgs

c. Grouting bolts, vibration isolation pads, etc., for all equipment.

d. Material movement in and out of site, storage of materials before erection has to be coordinated with Client's representative and the building service provider.

e. Giving details for making civil openings in masonry wall & slab / floor for all piping, ducts, cables, cable trays, etc. Details of openings in RCC slabs, if required, shall be furnished within 15 days from the acceptance of tender. As the building is ready / work in progress simultaneously, the Contractor shall maintain close liaison with the Building Contractor and intimate his requirement of openings in the walls for piping, ducting, cabling, etc., well in time, to avoid any breaking and making good thereafter. Owner / Consultant will not be made responsible to act as a coordinating agency between the two Contractors and no claim on his account on any matters will be entertained.

f. Providing supports / suspenders for ducts, pipes, cables, etc.

g. Providing drain piping inside the AHU room up to a point where it can be lead out (HVAC Vendor scope) HVAC / AHU vendor shall provide Float ball Type U trap.

h. Working on weekends including holidays without causing any disturbance to existing clients has to be factored in tendering.

i. HVAC Contractor has to co-ordinate with clean room panel vendor for Grille opening size, Raiser positioning, Drawing integration, Raiser installation etc.

j. HVAC Contractor has to co-ordinate with clean room panel vendor for installation.

k. All the internal wiring from the Fan section door limit switch & Internal wiring for AHU light & switch shall be carried by AHU vendor and terminated with a junction box on the AHU casing.

l. HVAC vendor (In coordination with AHU vendor) shall provide details of Masonry pedestals required for mounting AHU to civil vendor, placing of pedestals to suite to the requirement shall be in the scope of HVAC vendor.

m. Any other work connected with air conditioning work, which is deemed to have been included in the scope of this Contract for the satisfactory performance of the plant.

5.0 TECHNICAL SPECIFICATION

a) AIR HANDLING UNITS

❖ **Scope:**

The scope of this section comprises of the Design, Supply, erection, testing & commissioning of Air handling units confirming to the specifications & in accordance with requirement of Air Flow Diagram & AHU schedule sheet.

Space available for the units shall be confirmed with the civil and architectural proposals of the main contract and sizes of the units shall be selected to fit into the space available. The Unit configuration should suit the ducting arrangement.

Minimum acceptable parameters according to above standards shall comply with the following:

Mechanical Characteristics:

a) Casing Strength Classification: D1

The casings to withstand the maximum fan pressure at the selected design fan speed. The maximum relative deflection should not exceed 4 mm/m. No permanent deformation of the structural parts (structures and supports) or damage of the casing may occur.

b) Casing Air Leakage: L1

Air leakage of the air handling unit should be tested under positive & negative pressure & should not exceed the values given below

Max. Air leak rate at - 400 Pa test pressure : 0.15 l/sqm
Max. Air leak rate at +700 Pa test pressure : 0.22 l/sqm

c) Filter Bypass Leakage: F9

The maximum allowable filter bypass leakage rate shall be 0.5% of design flow rate at 400 Pa positive test pressure.

d) Thermal Transmittance: T3

The unit should be designed to have a heat transfer coefficient given below

Heat transfer coefficient U : 1.0 < U < 1.4 W/sqm.K

The test should be conducted in an environment chamber of Eurovent accredited laboratory & the readings should be taken after the steady state temperature difference of 20 K is established.

e) Thermal Bridging Factor : TB2

The unit should be designed to have a thermal bridging factor as given below.

Thermal bridging factor kb : 0.6< kb < 0.75

The lowest difference of temperature at any point on the external surface and the mean internal temperature shall be established. The ration between the lowest temperature difference and the mean air to air temperature difference defines the thermal bridging factor.

The test should be conducted in an environment chamber of Eurovent accredited laboratory and the readings should be taken after the steady state temperature difference of 20 K is established.

f) Air Handling Unit Performance as per EN 13053

The performance of air handling units should be tested in a Eurovent accredited laboratory in accordance with EN 13053.

The tests would be carried out for

- Air flow – static pressure data - power consumption
- Cooling duty
- Heating duty
- Air – side & water - side pressure drop

❖ **Type:**

Air handling units shall be with Double skin construction with Rock wool insulation in between outer & inner skin of the panel.

The Air handling units shall be double skin construction, draw-thru type comprising of various sections such as Fresh air Low Leakage Aluminium Volume Control Damper, mixing box with return air Low Leakage Aluminium Volume Control Damper, Pre & Fine Filter section, Cooling Coil, Heating Coil, Spark Resistance Plug Fan with High efficiency Flame Proof Motor, Bleed off damper with HEPA Filter / Fine Filter, Supply air section with Low leakage Aluminium Volume control damper.

For various configuration of units & other specific requirement, kindly refer Air Flow Diagram & Bill of Quantity for details of units.

All AHU shall be delivered in assembled condition (max 2 to 3 modules) along with factory test certificates for AHU key parameters such as air flow, leakage, static pressure, vibration, noise level, coil performance & power consumption etc.

During Factory Acceptance Test (FAT) AHU shall be completely inspected for all above said criteria's. The AHU shall be completely inspected for air flow conditions, min run test, leakage test, vibration test, sound level test, coil performance & power consumption etc.

Pressure testing & air leakage test shall be conducted for all AHU after assembly at site during **Site Acceptance Test (SAT).**

Unit construction and assembly shall be as per guidelines of EN 1886 and all internal joints to be provided with pencil coving.

Fan and motor base shall be properly earthed either from the factory OR after assembly at site by AHU vendor.

The Interior surfaces are completely smooth without sharp edges or welds and thus easy to clean.

All grooves are sealed with a disinfectant resistant gasket according to VDI 6022 and all gaskets are closed-pores and microbial inert. The door and panel gasket is a revolving, long life time, foamed PUR-gasket with a temperature resistance of –10 to +80°C. It should be of seamless type and designed for long life.

Manufacturer to confirm any impact on material of construction of AHU, filters, coils, during fumigation and de-fumigation (using formaldehyde / Vapour Hydrogen Peroxide)

All doors are equipped with D type gasket, hand levers, metal hinges. Generally, moisture-contact Components are constructed of corrosion- resistant material – exclusively stainless steel – and are equipped with a SS insulated drain pan & ping pong (Float type) drain trap, which ensures continuous and complete drainage of condensation. The AHU should have minimum 600 mm access doors for major components such as fan, filters etc.,

All internal electrical wiring for connecting marine light, limit switch & drive motor etc.. Shall be run in a conduit & neatly dressed, the same shall be terminated in switch on AHU casing either from the factory OR after assembly at site by AHU vendor.

FLOAT TYPE DRAIN TRAP

All AHU shall have float ball type drain trap as shown below.

- **Capacity**

Please refer Air flow diagram and Bill of Quantities for the air handling unit capacities and static pressure.

❖ **Housing/Casing**

The housing/casing of the air handling unit shall be of double skin construction. The Frame work shall be of Extruded Aluminium hollow sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting frame work for various sections. Units shall be complete with Thermal Break Profile as well as Double Skin Panels in Thermal Break Construction.

The casing shall comply with Mechanical Performance as per EN 1886 review: 2002 (E)

50 mm thick Double Skin Panels shall be made of 0.8 mm Pre-coated GI sheet on outside and 0.8 mm Plain GI sheet in the inside with **50 mm thick injected HFC - Filler Rock wool insulation material of 96 Kg/M3 density**, sandwiched between the external and internal sheets. The GSS sheet used for the Panel Manufacturing should have a minimum zinc coating of 120 gms/sqmts on both sides. These panels shall be screwed on to the frame work with soft rubber gasket fixed in built-in groove of aluminium frame in between to make the joints air tight to create a smooth surface inside and outside. All panels shall be sealed (anti fungicide sealant material) against the frame work.

The frame shall be assembled to make a strong, sturdy and self-supporting framework for different sections. The removal of the side panels should not affect the structural integrity of the unit. Frame work for each section shall be jointed together with soft rubber gasket (EDPM) in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges with the door hinge pin fabricated of stainless steel. Locks shall be provided for access to various sections for maintenance. Inspection Doors shall be provided with special Gasket (Food Grade Neoprene Rubber gasket-D type) for complete air tightness. The entire housing shall be mounted on Rolled Formed Continuous GSS channel frame work of 100mm height, having pressure die cast aluminium joints.

AHUs (1.8 Mtrs Height and above) shall be provided with 3 mm thick aluminium anti slip plate on fan section and the filter section with inspection door.

Volume control Dampers shall be of low leakage type with Graduation & interlocking arrangement, opposed blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free.

All the AHU after assembly at site has to be cleaned and mopped with disinfectant before fixing the filter, Pressure tested for leakage and leakage rate to be in compliance with Mechanical Performance as per EN 1886:1998.

Each Section has to have a Tag on the casing, mentioning the component (Mixing Box, Filter section, Coil section, Fan section etc.). Also the Airflow direction has to be marked on the casing.

All Air Handling Unit shall be Eurovent Certified EN-1886 & EN-130353 with following details

- ♣ Casing Strength of Units : Class D1
- ♣ Casing Air Leakage of Units : Class L1
- ♣ Thermal Bridging Factor : Class TB2

- ♣ Thermal Transmittance : Class T3
- ♣ Filter Bypass Leakage : Class F9

AHU needs to be equipped with a minimum 2 mm thick base frame. This base frame is galvanized and powder coated (60µm) and with aperture for crane transport via transport tubes or optional for shackle transport.

The doors should be provided with sturdy handles in steel with a rubberised covers for proper grip. In compliance with the highest applicable standards of hygiene, all components are factory-cleaned and packaged in foil for transport.

Fan

Fan Type: Centrifugal Backward Curved Fans

The fan shall be of double inlet, double width backward curved type. The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with Angle iron frame & heavy-duty ball bearings. The fan shall be selected for highest efficiencies and a noise level less than 85 db (A) at 1m distance from equipment. The impeller & fan shaft shall be statically and dynamically balanced.

The Fan outlet velocity shall not be more than 10.5 m/sec.

The fan outlet shall be connected to casing with the help of fire-retardant fabric acting as a flexible connection for anti-vibration.

Fan bearing shall be permanent lubricated type. Fan drive shall be rated 150% of rated shaft power of the units and shall be fitted with adjustable belt tension arrangement. System shall be constant speed. Fan drive package (Pulleys & belts) should not be left open. They must be protected with screen protection door or belt guard in Fan section. The fan shall be equipped with 'V' belt drive.

The contractor shall select the AHU fans subsequent to ascertaining system static pressure in

accordance with pressure drop calculations to the approval of the engineer.

The motor shall be mounted on a slide rail, common, torsionally rigid, galvanized steel base frame. The whole assembly shall be suitable for withdrawal from the fan section where personnel entry is not intended.

The fan shall be isolated from the casing by means of anti-vibration mountings selected to suit the speed of the fan and designed for 90% isolation. Fan should be selected at 10% higher than rated capacity.

Fan selection should be of the best possible efficiency. The technical submittal for AHU's shall have minimum 3 Fan selections with their family curve at same duty point, the client/consultant shall select the highest efficiency fan based on requirement.

AHU vendor shall submit AHU GA Drawing, Fan GA Drawing & Fan selection along with technical data sheet in the format mentioned below.

Format of Annexure A (Technical) enclosed

AHU No.	Air volume	Total Static	External Static	Hz at rated capacity	Fan speed at rated capacity	Power absorbed at rated capacity	Fan maximum speed at rated capacity	Max air volume and static efficiency of fan @ rated total static pr.	Motor KW @ maximum speed	Motor KW selected

Format of Annexure B (Technical) enclosed.

AHU No.	Design Criteria (rated)				Design Criteria (@75% total Pr.)				Design Criteria (@50% total Pr.)			
	Air volume	Internal Static	External Static	Hz at rated capacity	Air volume (Constant)	Internal Static @ 75%	External Static @ 75%	Hz at this capacity	Air volume (Constant)	Internal Static @ 50%	External Static @ 50%	Hz at this capacity

❖ **Motor:**

Fan motor shall be suitable for 415 ±10% V, 50Hz, totally enclosed surface-cooled 3phase current motor, IE 2.

Version B, protection type IP55, insulating material class F, motor protection by a thermal contact. Motor shall be especially designed for quite operations. Fan should be selected at 10% higher than rated capacity. The Motors are to be suitable to run with Industrial type VFDs.

❖ **Cooling / Heating coil**

Cooling coils / Heating coil should have the capacities as indicated in the Bill of quantity. The cooling coils should have VRF DX Refrigerant as the cooling medium. The cooling coil / Heating coil should be designed to suit R-407C/R410a refrigerant. The heat exchanger should be removable from the side and the frame material should be stainless steel SS304. The air velocity across the coil face shall not exceed more than 2.25 m/sec (450 FPM).

Cooling coil / Heating coil should be easily slide able type from sides without disturbing other sections for maintenance. Cooling / Heating Coil supports should be in complete stainless-steel material. No MS supports are acceptable.

The cooling coil / Heating coil should be made of copper tubes and Aluminium fins. Fin spacing should be 2.5mm only. Coil header shall also be made of MS pipe with anti-corrosive paint. The coil should have aluminium frame and base support in SS. The cooling coil shall be provided with drip separator having SS Frame and blades in Poly Propylene. The drip Pan should be designed for quick removal of moisture and constructed in SS with good insulation material.

The inlet and outlet connection shall be on the same side, the connection and maintenance side must be confirmed before starting the manufacturing. The coils should be designed for a maximum pressure of 16 bar and maximum temperature up to 120°C.

Cooling coil should be designed to cover the whole cross section of the unit. Coils inlets / outlet should have MS Flanges with Anti-corrosive painting and mating flanges.

Differential pressure or pressure drop measurement provision across coils to be provided by manufacturer for initial qualification and periodic measurement as and when required.

SS Temperature probes before and after the coil section to be provided.

❖ **FILTERS**

Filters should strictly meet MERV Standards and are to be supplied with manufacturers test certificates.

The G4 Pre filter shall be washable type, whereas the F7, H13 HEPA & H14 HEPA filter Disposable / Throw away type. The fresh air filter MERV 8 shall be designed for final pressure drop whereas the F7, H13 HEPA & H14 HEPA filter shall be designed for in-between pressure drop (between initial pressure drop and final pressure drop).

All Filter compartments of the AHU will be supplied with factory fitted differential pressure gauge / Transmitter, whereas the Bleed HEPA filter shall be with provision for an external differential pressure gauge / Transmitter is proposed to indicate the health / condition of the Filter.

PRIMARY FILTERS

G4 Filter should be washable type with a classification according to EN 779 Standards.

ISO Corse Filter should be washable type with a classification according to ISO 16890 Standards.

Filter depth should not be less than 50 mm. The clean filter pressure drop should not be exceeding 75 Pa @0.94m3/s (2000 CFM), but the system should be designed for washable filters.

G4 Pre Filter with Average Efficiency of Not Less than 90 - 95% as per ASHRAE standards 52.2 of Particle size 10 Micron.

Filter Manufacturer certificate to be provided.

SECONDARY FILTERS

F7 (ISO ePM1) Filter Inherently rigid filter element fastened into filter frame. The Filter media shall be washable type & pleated into mats in a zigzag format. The depth of filter should be 300 mm. The filter should be designed for non-washable / disposable type filters.

F7 (ISO ePM1) Fine Filter with Average Efficiency of Not Less than 95% as per ISO 16890 standards of Particle size 3 Micron.

Filter Manufacturer certificate to be provided.

F9 (ISO ePM1) Fine Filter Inherently rigid filter element fastened into a quick-change filter frame, material PCGI. Filter medium synthetic glass fibre temperature resistant up to 120°C. The endurance should be up to max final pressure difference of 800 Pa, the depth of filter should be 300mm. The filter should be designed for non-washable / disposable type filters.

F9 (ISO ePM1) Fine Filter with Average Efficiency of 85% as per ISO 16890 standards of Particle size 0.3 Micron & 99% as per ISO 16890 standards of Particle size 1 Micron.

Filter Manufacturer certificate to be provided.

Filter integrity test (with EMERY 3004 oil mist or as stated in ISO guideline 14644-2) should be carried out on all HEPA filter banks. A penetration of 0.01% on filter media and seals should not be exceeded. HEPA filter frames should be well sealed with a sealant to prevent any particles by-passing the HEPA filters. The filters should be mounted by SS wing nuts / Cam lock arrangements. The filter integrity tests should involve individually scanning filter media, filter frames and frames to plenum seals. Filters should be easily accessible.

Filter mounting frame should be sufficiently rigid to withstand a pressure differential equivalent to the filter bursting pressure, without distortion. Filter fixing frame should be in galvanised steel with powder coated finish and will be equipped with maintenance door. Magnahelic gauges to be provided all Filters. The tubing connections on all Magnahelic gauges should be silicone tubing.

Rev : 1 30th April 2018	FILTER GRADE EQUIVALENCE TABLE								FILTER EFFICIENCY VALUES AT PRESENT IN PHARMA MARKET IN INDIA	ISO 14644 BASIC REQUIREMENTS				
	PRE & FINE FILTERS					HEPA & ULPA FILTERS					ISO 14644 MANDATORY TO BE REPORTED			
	EUROVENT 4/9	EN 779	EN 779	ASHRAE 52.2	ISO 16890	EUROVENT 4/5	EN 1822	ISO 29463	STANDARD FRACTIONAL EFFICIENCIES (ALTERNATE ONLY IF CUSTOMER DEMANDS)	ISO 14644 MINIMUM EFFICIENCY REQUIREMENT %	PARTICULATE MATTER EFFICIENCY %			DUST HOLDING CAPACITY
	MERV	MERV	2012	(2007) MERV	2017		2011				ePM1 C	ePM2.5 C	ePM1	
COARSE	EU 1	G1	G1	1	ISO Coarse					< 50 % Initial Gravimetric Arrestance	YES	NO	NO	YES
	EU 2	G2	G2	2 to 4					65 % Down To 30 µ					
	EU 3	G3	G3	5 & 6					90 % Down To 20 µ					
	EU 4	G4	G4	7 to 8					90-95 % Down To 10 µ					
FINE	EU 5	F5	M5	9 to 10	ISO ePM10				95-85 % Down To 5 µ	≥ 50% @ 10 µ	YES	YES	YES	YES
	EU 6	F6	M6	11 to 12	ISO ePM2.5				85-90 % Down To 2 µ	≥ 50% @ 2.5 µ	YES	YES	YES	YES
	EU 7	F7	F7	13	ISO ePM1				95 % Down To 1 µ	≥ 50% @ 1 µ	YES	YES	YES	YES
	EU 8	F8	F8	14	ISO ePM1				80 % Down To 0.3µ (95% Down To 1µ)		YES	YES	YES	YES
	EU 9	F9	F9	15 to 16	ISO ePM1				85 % Down To 0.3µ (99% Down To 1µ)		YES	YES	YES	YES
EPA						EU 10	E10		85 % Down To 0.3 µ					
						EU 11	E11	ISO 15 E	95 % Down To 0.3 µ					
						-	-	ISO 20 E						
						EU 12	E 12	ISO 25 E	99.97 % Down To 0.3µ					
						-	-	ISO 30 E						
HEPA						EU 13	H13	ISO 35 H	99.997 % Down To 0.3µ (99.95% @ MPPS)					
						-	-	ISO 40 H						
						EU 14	H14	ISO 45 H	99.999 % Down To 0.3µ (99.995% @ MPPS)					
						-	-	ISO 50 U						
ULPA							U15	ISO 55 U	99.9995 % @ MPPS					
							-	ISO 60 U						
							U16	ISO 65 U	99.99995 % @ MPPS					
							-	ISO 70 U						
							U17	ISO 75 U	99.999995 % @ MPPS					

❖ Mixing Chamber

The two-way mixing box shall be designed for efficient mixing of fresh air and return air by means of interconnecting dampers.

❖ **Canvas connection**

The fan shall be isolated from casing by flexible connection; it should be made of polyester fabric, temperature resistant up to 160°C with high tearing strength. These should be connected on both sides with surrounding air tight duct connection flanges. The vendor to be provide sample of canvas connection after getting the order.

The flexible connection to be provided with counter flange to connect the duct on the discharge side

❖ **Dampers**

Dampers should be constructed in anodized aluminium, finished with powder coating. The dampers should have aerofoil design for minimum pressure drop. The dampers should be air tight. The damper is certified and approved to DIN 1946 Part 4, with opposed blades, distortion- free hollow profile aluminium fins, sealed with special rubber lips. Frame should be made of galvanized sheet steel with 60µm powder coating, depth 150mm. Bearing should be made of polyamide. The gear wheels for the drive should be located outside the air stream.

The manually operated dampers should be provided with Graduation & locking arrangement. The locking device to remain perfectly locked at all operational conditions of AHU.

The dampers should be provided with following accessories.

- Mechanical Lock with handle and graduation of opening marked on handle. Identification of open and close is must on damper handle side.
- Suitable Cover for Gear Train to avoid dust accumulation.
- The Damper surface shall be duly insulated after installation.

VOLUME CONTROL DAMPER WITH LOCKING & GRADUATION ARRANGEMENT

❖ Accessories

All air handling unit shall be supplied with following accessories:

- Marine Type Light, limit switch for blower section, safety grille for blower section and view glass for fan and filter sections shall be provided wherever required /specified.
- Fresh air damper, return air, by pass air, bleed air and supply air opposed blade Low leakage type volume control dampers suitable for manual and motorised operation.
- Each air handling unit shall be provided with manual air vent at high point in the cooling/heating coil and drain plug in the bottom of the coil.
- Magnehelic gauges Mounted in a box shall be provided for all type of filters.
- Pressure measuring ports (6mm SS) with dead nut shall be provided across each section to monitor the pressure drops.
- Stainless steel drain pans with insulation & Ping Pong type drain arrangement for proper draining of condensed water.
- Temperature measuring ports (20mm SS) at the inlet and outlet of cooling/heating batteries shall be provided to monitor the temperature.
- AHU name plate shall be provided with following information:
  - Fan details with all capacities.
  - Static pressure
  - Filtration level
  - Motor HP
  - Coil details.
  - AHU No. and the area it is feeding
  - Each compartment will be separately named including filtration level, filters, initial and final pressure drop, cooling coil data, heating coil data, etc.
  - Arrows for air directions
  - Schematic Airflow diagrams
  - Each AHU Shall be provided with laminated coloured AHU GA drawings showing all the components / Airflow Drawings duly pasted on AHU.

In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections, and quantities separately identified in Schedule of Quantities.

❖ **AHU GA drawings:**

Within 10 days after the award of contract, the contractor shall furnish 3 sets for approval (detailed GA drawing of AHU) and bar chart of complete activities required to complete the project as per specifications. These drawing shall contain details of construction, size and arrangement, BOQ, components data sheet with drawing, performance characteristic and capacity.

Shop drawing also includes performance curves of fan and motor.

Manufacturer will also be responsible for documentation like DQ/IQ protocol and same has to be submitted for approval by **Client.**

All supporting documents shall include

1. All air handling units MOC certificate
2. All air handling unit's insulation certificate
3. All air handling unit's components MOC certificate like damper, flexible connection, cooling coil, heating coil, drain pan, etc including size, qty, etc
4. Test and MOC certificate of all filters with filter numbering
5. Calibration certificates of all Magnehelic gauges, pressure transmitters or transducers, pressure switches, etc with serial no.
6. Hydro test certificates of cooling and heating coil mentioning the max test pressure conducted, etc
7. Motor and blower test certificate including performance curve drawing.
8. All components of AHU to be tagged physically in comparison with the approved drawing.
9. Instruction, Operation and Maintenance manual for AHU and EAU including Standard operating procedure, maintenance schedule, trouble shooting, spare / filters replacement practices, etc. The vendor shall also give the AHU foundation detail after receiving the LOI or purchase order from Client

Performance Data

Air handling units shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing commissioning of the installation.

Safety Features

Each Air Handling Unit must have safety features as under:

1. The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to enable switching of the fan motor automatically in the event of door opening.
2. The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
3. Fan and motor base shall be properly earthed from the factory
4. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.
5. All internal wiring for the light fixtures, micro switch inter-locking with fan motors to be carried out in the factory and terminated on the AHU casing in junction box.
6. In case of VFD driven motors, the necessary electrical & control cabling to be terminated on AHU casing in a terminal box. VFD is in the Electrical scope of supply.

❖ **Inspection:**

Inspection including witness of test will be carried out by purchaser or his authorised representative, if required. However, test certificate shall be submitted and obtained clearance before dispatch of the assembled unit.

Vendor shall notify purchaser in writing or his authorised representative in writing at least 15 days prior to the scheduled for inspection/tests.

Vendor shall submit calibration certificate for all instruments/pressure switches etc. supplied with the equipment indicating serial no of instrument and location of installation.

Testing

Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

❖ **Testing at Site**

All AHU, VSU, VEU and EAU to demonstrate Run Test for Air quantity v/s static pressure and Leak Testing, Vibration and Noise level, Coil performance, Power consumption. After the installation is finished, the bidder shall make all required adjustment until all guaranteed performance requirement are met. Vendor to adjust air flow quantity as per the approved airflow diagram during commissioning stage. After the entire system is adjusted, the supplier shall conduct acceptance test

in presence of Engineer-in-charge to meet the guaranteed performance requirement to the satisfaction of Engineer-in-charge. All instruments required to carry out these tests will be arranged by the bidder. The test report shall be submitted for Client's approval before handing over of the plant as per the test protocol supplied by consultant/client.

Manufacturer to provide site acceptance test procedure and testing criteria for customer/consultant approval. Completion of operational qualification along with SAL representative is vendor's scope of work.

The following readings shall be taken (and results computed) during the performance tests on the plant.

I AIR HANDLING UNITS:

1. Entering Air dry bulb temperature - ºC :
2. Entering Air wet bulb temperature - ºC :
3. Leaving air dry bulb temperature - ºC :
4. Leaving air wet bulb temperature - ºC :
5. Dry bulb temperature in S.A. Plenum of air leaving Fine Filter Section - ºC :
6. Air flow rate – CMH :
7. Total pressure developed by Fan - mm wg :
8. Static pressure of Fan - mm wg :
9. Fan speed – rpm :
10. Fan motor current – Amps :
11. Entering CH water temperature - ºC :
12. Leaving CH water temperature - ºC :
13. Pressure drops across CHW coil – mm wg :
14. Water-side pressure drop - Kg/sq.cm :
15. Entering Hot water temperature - ºC :
16. Leaving Hot water temperature - ºC :
17. Pressure drops across HW coil – mm wg :
18. Water-side pressure drop - Kg/sq.cm :
19. Vibration peak-to-peak displacement in microns :
20. AHU to be leak tested to 700Pa Positive Pressure Using Duct Leak Testing Machine :

II FILTER BANKS:

1. Efficiency - % (State method of test) :
2. Pressure drops across G4 – mm wg :
3. Pressure drops across F7 – mm wg :
4. Pressure drops across H14 – mm wg :

NOTE: 1. all readings shall be taken at 1 hour interval for 24 hours continuously.

❖ **Maintenance**

The AHU shall be maintained on a schedule as indicated by the supplier. Supplier is to provide (at minimum) the following maintenance instructions.

a) Maintenance activities for all Sub-Systems (maintenance and operational manual of vendor equipment)

b) A comprehensive recommended maintenance (regular recommended inspection intervals, wear points, recommended spare part list etc.)

c) Supplier should include 2 copies of operation, installation and maintenance manual.

❖ **Delivery**

The AHU should be delivered in an assembled condition and in a wooden packing or as per mfg std. The assembled AHU can be in 2 or 3 modules that are only required to be bolted at site to make a single assembled unit.

a) The AHU should be delivered along with maintenance and operational manual.

b) Control schematics (if Any)

c) Bill of Material

d) Spare part list.

e) Test and calibration certificates of all components used in the system.

❖ **Performance Guarantee**

Supplier shall guarantee that upon completion of the work all portions will be in full accordance with the requirements of the contract and will be perfect as to materials and workmanship and remain so far a minimum period of one year from the date of final acceptance by the client. The bidder shall also guarantee that the equipment will operate satisfactorily and the performance and efficiencies of the equipment when operating under normal condition shall not be less than the guaranteed values. The bidder shall further guarantee that during the one-year period he will repair all defective work and will replace all defective materials furnished or installed under the contract, free of cost to the Client within reasonable time from the detection thereof. The bidder shall be responsible for the performance irrespective of the specifications mentioned in the tender.

♣ Kindly note that any deviation from above specification must be notified in writing while quoting as an extra sheet – "List of technical deviations".

♣ Any deviation as considered by manufacturer other than those mentioned in this document should be explained with appropriate justification note (duly signed) wherever it is applicable during bid submission.

b) TECHNICAL SPECIFICATIONS FOR GI DUCTING

❖ GENERAL

The design, construction / fabrication, erection and performance of ducting shall comply, in general, with all currently applicable standards, codes, regulations and safety measures as applicable in the locality where it is to be installed. The items covered shall conform to the latest applicable American standards (SMACNA).

Ducting shall be prefabricated at factory and delivered to site for erection. Fabrication at Site with Lock forming machines / Electrical cutters / benders to be carried out only for the end connections and other ducting connections which are dependent on-site coordination.

Leak testing after installation is required. Leakage limits shall be as per Class "C" of DW 142 or Class A of SMACNA.

❖ SCOPE

The Scope of this section comprises of HVAC ducting & insulation work shall generally cover the following items.

Supply, fabrication, installation, testing, balancing, commissioning & qualification of

- Galvanized sheet steel (GSS) duct work, Insulated and flexible ductwork and Volume control damper.
- Fresh air intakes through Panel filters (G2) mounted in the existing filter mounting frames, exhaust duct with bird screen as specified.
- Duct support shall consist of the necessary Anchor fasteners, Slotted Angle, GI Threaded Rods, Bolts, Nuts, Washers, Dome nut & MS Supports wherever required.
- Thermal insulation for ducting within the building.
- Thermal insulation for exposed (to ambient) ducting.
- All kinds of fasteners as required.
- Gasket material and food grade sealants.
- Installation of ducts and insulation with necessary supports.

All work has to be done in accordance with these specifications and the general arrangement shown on the drawings.

The construction, installation and performance of the ducting system shall confirm to the SMACNA -2003 standards ("HVAC Duct Construction Standards-Metal and Flexible- Second Edition -2003"). The Tenderer shall prepare detailed working/shop drawing after award of work indicating air flow rate, system static pressure available for ducting and air distribution flow rate through each diffuser and grille of the system in consideration with actual site conditions.

HVAC Vendor shall provide method statement of Duct fabrication, Tools & Tackles used for Duct Fabrication.

❖ SPECIFICATION FOR GI DUCTING

MATERIAL

All Ducting shall be made out of cold rolled cold Annealed (CRCA) & LFQ (Lock forming quality) grade prime GI sheets, continuous galvanized with a zinc coating of 120 g/m2 on both sides. Sheets shall be flat and free from twists. Zinc coating shall be clean, even and free from un galvanized spots. Sheets shall not crack or peel during bending or fabrication. G.I Raw material should be used in coil form (instead of sheets) so as to limit the longitudinal joints at the edges only irrespective of cross section dimensions.

Following GSS ducting has been identified under different pressure rating

- For all classified area supply air ducts shall be fabricated for 750 Pa pressure rating.
- For all other area supply as well as return air duct will be for 250 Pa pressure rating.

Each lot of ducting to be provided with Mill test certificate for the GI sheets. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

All Duct work (thickness below 16 Gauges) including straight sections, tapers, elbows, branches, shoe pieces, collars, terminal boxes and other transformation pieces must be factory fabricated. Only End Connections to equipments and other ducting connections which are dependent on site coordination.

All transverse connectors / flanges shall be with GSS material TDF flanges with 100 MM pitch for bolts & nuts with washer on each side of flange, 6mm thk neoprene gaskets **(Food Grade)** and with G clamps. The G Clamps to be tightened using electric torque wrench to provide uniform tightening.

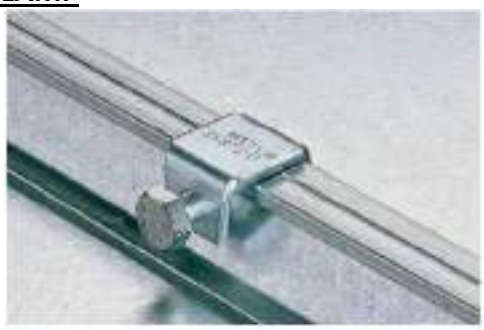
- Duct construction shall be in compliance with relevant norms as per SMACNA.
- Following GSS ducting has been identified under different pressure rating.
- All ductwork designated to serve Classified areas (Clean manufacturing areas) shall be stored inside of a building at the fabricator's facility at intermediate storage locations and at the project site. Have the closures of all duct openings maintained intact until they must be removed to makeup connections. Please refer the **SMACNA IAQ MANAGEMENT GUIDELINE** during construction in the last page of this specification.
- All ducts and supports shall be designed and fabricated as per applicable standards and unsupported length shall not exceed 2400 mm irrespective of duct material & size. Primary supports shall be provided by Client, whereas secondary supports shall be in vendor's scope.
- The fabricated duct dimensions should be as per approved drawings. All connecting sections shall be dimensionally matched to avoid any gaps. All fabricated dimensions shall be within +/- 1.0 mm

of specified dimensions. To obtain required perpendicularity, permissible diagonal tolerances shall be +/- 1.0 mm per meter.

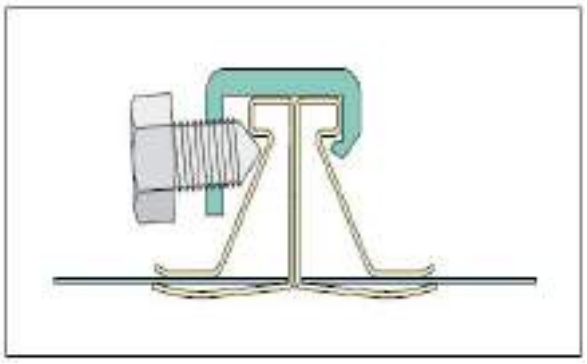
- Duct supports shall be anchored in slab (where ever applicable) by vendor by using expandable anchor bolts of length not more than 2/3rd of thickness of slab or MS bracket to suit the existing structure.
- Each and every duct pieces delivered to site should be identified by colour coded sticker which shows specific part numbers, job name, drawing number, duct sizes and gauge.
- Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners only, which shall be either Pittsburgh or Snap Button Punch as per SMACNA practice, to ensure air tightness. The duct shall be with Longitudinal sealed with silicon sealant from factory.
- Where light fittings / electrical fixtures are present below the ducting, supports for these shall be derived from duct supports. Adequate stiffening of ducts shall be ensured in such areas.
- Where ducts are above false ceiling and false ceiling structure needs to be cut to accommodate the ducting, some local supports for false ceiling may be derived from the duct supports. In such areas also adequate stiffening is to be ensured.
- Some area (Classified/ Non-Classified areas) supply air ducts shall be provided with Flow measuring station, Flow control dampers and Fire dampers in penetration thru interstitial floor slab (Fire damper, Flow measuring station Flow control dampers shall be provided by the purchaser and installed by HVAC Installation contractor).
- Vendor should make all the necessary arrangement for testing of ducts at site/factory. Duct testing procedure shall be submitted for client's approval.
- Duct sealant shall be non-hardening, non-migrating mastic or Liquid elastic asbestos-free sealant. The sealant type shall be applicable for the fabrication / installation detail. Duct materials, pressure and leakage requirements and service. Sealants shall be products compounded and recommended by their manufacturer specifically for sealing joints and seams in duct work except where the requirement preclude the use of such products. Adhesive tape, commonly known as duct-tape shall not be used for joining or sealing metal work.
- All ductwork shall be sealant filled in type and sealant as acceptable to the United States Food and Drug Administration (FDA) on all joints and seams, including flanged joints.
- Vendor to provide flexible ductwork where shown in the drawings.
- Changes in dimensions transformation of ducts shall be achieved gradually (between 1:4 and 1:7). Turning vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to turn without appreciable turbulence.
- Plenums shall be shop/factory fabricated - panel type and assembled at site.

- The deflection of transverse joints should be within specified limit for rectangular duct deflection as given in SMACNA.
- Reinforcement of ducts shall be achieved by either cross breaking or straight beading depending on length of ducts. As per SMACNA page no.1.74 .fig 1-8 Duct Sizes 19”(483mm) wide and larger which have more than 10 Sqft of Unbarred panel shall be beaded or cross broken unless ducts have insulation covering or acoustical liner. The requirement is applicable to 20 gauge (1.00mm) or less and 3”W.G (750 Pa) pressure or less. Ducts for 4”W.G (1000 Pa) or more do not require beads or Cross breaks.
- Elbows, bends, offsets, etc., should be fabricated with a width to radius ratio of not less than 1.0 to 1.5. Alternately, turning vanes should be provided at intervals so chosen that the aspect ratio of the various sections so formed by the vanes will be at least five.
- Turning vanes shall be provided at branch take-offs and collars. Similarly, straightening vanes shall be provided in all the collars unless and except in cases where conditions at site do not permit their installation.
- Duct sealant shall be non-hardening, non-migrating mastic or Liquid elastic asbestos-free sealant. The sealant type shall be applicable for the fabrication / installation detail. Duct materials, pressure and leakage requirements and service. Sealants shall be products compounded and recommended by their manufacturer specifically for sealing joints and seams in duct work except where the requirement preclude the use of such products. Adhesive tape, commonly known as duct-tape shall not be used for joining or sealing metal work.
- All ductwork shall be sealant filled in type and sealant as acceptable to the United States Food and Drug Administration (FDA) on all joints and seams, including flanged joints.
- Vendor to provide flexible ductwork where shown on the drawings.

G CLAMP



G-Clamp



- G Clamp is a universal flange clamp, formed out of zinc coated solid metal.
- The G Clamp shall be designed to cope with high loads. The G Clamp bolt shall always be the same size as the corresponding flange bolt.
- The installation shall be carried out by using electric torque wrench machine for uniform tightening of flanges.
- Installation of G Clamp shall start by fitting the G Clamps from the corner bolt and towards the center of the duct. The gap between the 'G' clamp shall be approximately 150 to 200.

- **PVC Duct pressure port**

- PVC pressure ports shall be provided on the supply & return air ducts for measuring & balancing the air flow.

Sealing of duct

Leakage norms shall be as per DW 142. Heavy mastic or silicon sealant is more suitable as fillers in grooves of longitudinal seams. Mastics having excellent adhesion and elasticity are preferred.

Duct Support System: Duct support shall consist of the necessary Anchor fasteners, Slotted Angle, GI Threaded Rods, Bolts, Nuts, Washers, Dome nut & MS Supports wherever required.

❖ **Threaded rod support**

A complete system consisting of fully threaded galvanized rods, galvanized angles or double-L bottom brackets (made out of 3.0 mm MS sheets with red oxide and black paint) nuts, washers and anchor bolts (Hilti Make) generally conforming to SMACNA standards should be used.

Table Support for Horizontal duct – Rectangular

Sl.No.	Maximum Duct Size (mm)	Hanger Rod Diameter	Support Interval (mm)	Flange /Bracing at every 1200 mm distance.
1	Upto - 700	6 mm	2400	25x25x3
2	701 - 1200	8 mm	2400	40x40x3
3	1201- 2000	10 mm	2100	40x40x6
4	Above 2000	12 mm	1800	50x50x6

The duct shall not sag or vibrate due to lack of supports. The NEOPRENE rubber gasket shall be used to provide the required thermal break effect between ducts & M.S. angle.

All support members and any kind of secondary structure required to install duct shall be included in the offer.

❖ **Hanger Supports**

Ducting Supports:

All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be. The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using MS shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method (refer to typical drawings) under ducts at no greater than 2000mm centre, for 2001-2250mm 50x50x5 mm angle should be used under the duct (refer to typical drawings), above 2250mm appropriate size angle should be used with prior approval. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wires shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services were recommended for by the manufacturer. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection. Support ducting in accordance with Schedule I at the end of this Section. Any other MS solution can be used based on manufacturer's recommendation on site conditions after prior approval. In cases of Spiral ducting the wire can be wrapped directly around the ducting without the need for a spiral ducting clamp for sizes above 1100 a cradle support should be provided refer to manufacturer's recommendations.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building. All supports of pipe shall be taken from structural slab/wall by means of fastener.

Comply with manufacturer's load ratings and recommended installation procedures.

Notes: All supports are considered at 2400 mm interval.

Fabrication, Equipment and process

- All cutting, folding, notching, beading, shearing operations must be done by machines. (CAD/CAM equipment preferred) for accuracy of parts and speed of fabrication. Fabricator to supply brochures and other documentation showing list of equipment used, manufacturing process involved and Quality Assurance Plan for approval.
- If specified Flexible Insulted or non- insulated ducts should be used. These ducts shall be preferably be rested in accordance to UL standards.
- Minimum number / length of flexible ducts should be issued. The insulation of flexible duct should be polythene or expanded polystyrene of fire-retardant quality.

(Recommended Configurations as per SMACNA *1 – 1995)

Flanges are available in different sizes and identified by its Rigidity/Reinforcement "Class" as per SMACNA. The proper selection of the right flange depends on the independent parameters:

- Duct static pressure.
- Duct size.
- Spacing between joints and / or reinforcements.

Testing

After duct installation, a part to duct section may be selected at random and tested for leakage. The procedure for leak testing should be followed as per SMACNA – "HVAC Air Duct Leakage Test Manual" (First Edition).

Access Panel

A hinged and gasket access panel shall be provided on duct work before each reheat coil and at each control device that may be located inside the duct work.

Miscellaneous

- All ducts above 450mm to be cross broken to provide rigidity to the ducts.
- All duct work joints to be square or approaching square with all sharp edges removed.
- Sponge rubber gaskets also to be provided behind the flange of all grilles.
- Each shoot from the duct, leading to a grille, shall be provided with an air defector to divert the air into the grille through the shoot.
- Inspection doors measuring at least 450mm x 450mm are to be provided in each system at an appropriate location.
- Diverting vanes must be provided at the bends exceeding 500mm and at branches connected into the main duct without a neck.

- Proper hangers and supports should be provided to hold the duct rigidly to keep them straight to avoid vibrations. Additional supports to be provided where required for rigidity.
- The duct should be routed directly with a minimum of directional change.
- The ductwork shall be provided with additional supports/ hangers, wherever required or as directed by the Consultants, at no extra cost.
- All duct supports, flanges, hangers and damper boxes etc. shall be given 2 coats of red oxide paint before installation and one coat of Epoxy / aluminum paint after the erection, at no extra cost.
- The duct should be supported by approved type supports at a distance not exceeding 2.4 Mtr.

Installation of ducts

- Duct work shall be rigid and straight without kinks and installed with good workmanship. All joints shall be air tight.
- All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings prepared by the contractor and approved by the client/consultant.
- The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.
- All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or the Obstructions in the building whether or not the same are shown on the drawings. Where there is interference/fouling with other beams, structural work, plumbing and conduits, the ducts shall be suitably modified as per actual site conditions.
- Ducting over false ceilings shall be supported from the slab above, or from beams. In no case shall any duct be supported from false ceilings hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractor's work in the building.
- Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick appropriate insulation around the duct and totally covered with fire barrier mortar for complete sealing and supported with the help of angle frame.
- All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge.
- Duct Sheets or duct shall be stored on wooden ply, not on floor or land.
- Before Installation of duct, it should be thoroughly cleaned.
- All Duct pieces to be covered with Polythene sheeting at both ends and securely taped to prevent ingress of debris/dust/moisture during installation/commissioning.

- For all supply and return air ducts, food grade silicone sealant must be applied on all duct joints including flanges to render the joints air tight.
- Non Toxic, food grade neoprene, P.E or PVC 6 mm thick gasketing with adhesive is required between all mating flanged Joints. Gasket sizes should confirm to flange manufacturers specification.
- Factory fabricated insulated access doors to be provided in ducts for cleaning/maintenance/access of dampers at suitable locations. Leak Tightness of access doors shall be ensured.
- Radium arrow stickers indicating direction of air flow in duct shall be provided.

- The contractor shall provide and neatly erect all sheet metal work as may be required and directed by the consultant. If a duct cannot be run as shown in the drawings, the contractor shall install the duct between the required points by path available, in accordance with other services and as per approval obtained from the owner/consultant.
- All ducts are required to be tested for leakages Pressure testing and as per SMACNA guideline.
- All duct work shall be independently supported from building construction, support shall be provided by the HVAC contractor. All horizontal ducts shall be rigidly and securely supported in an approved manner on MS hanger provided at sufficiently close intervals to avoid sag in the duct. The MS hanger shall be coated with silver paint or zinc chromate.
- Contractor shall indicate supporting arrangement table and method of supporting arrangement on all duct drawings in accordance with the mentioned standards.
- Use anchor fasteners when supported from slabs. Ducts should pass thru sleeves when passing through slabs and other civil works. Excess opening to be sealed properly to ensure water proofing as required.
- A good quality expanded polyethylene /rubber of uniform thickness and width shall be used as gasket between flange joints.
- Dampers shall be provided in branch duct connections for proper volume control and balancing the air quantities in the system. Suitable levers shall be provided for proper operation, control and setting of the dampers, every damper should have an indicating device with locking arrangement showing the position of the dampers.

Balancing and testing

The entire air distribution system shall be balanced to supply the air quantities as required in various zones and rooms to maintain the specified room conditions with anemometer. The final shall be recorded and submitted to the Consultant for approval before acceptance and taking over of the entire system by the Client. The measured air quantities at fan discharge and at the various outlets shall be within +/-5% of those specified / quoted. Damper adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct positions if disturbed at any time.

The duct branches, elbows, etc. shall be inspected and the joints, connections are to be checked before they are assembled in position. After assembly of the system, it shall be checked for tightness, vibration & noise due to turbulence.

After duct installation, all ducts have to be tested for duct leakage. The procedure for leak testing should be followed as per SMACNA- "HVAC Air Duct Leakage Test Manual" (First Edition)

Leak - Tightness of Ducting for Clean Rooms:

- Securing a leak tight air distribution system for the Clean Rooms is of the utmost importance in this project.
- Ensure that all duct joint flanges are provided with proper gasket joint at corner with dove tail joint and galvanized nut –bolts. Visually inspect the ducts externally and internally. No Damage of the ducts or dents should be visible. If any duct is found damaged, the same shall be replaced with a new duct before carrying out the test.
- Leak testing shall be carried out to comply with the requirements & provisions of SMACNA's "HVAC Air Duct Leakage Test Manual", First Edition – 1985 or current edition thereof.
- Ducting Construction for various operating pressures involved in the ductwork shall conform to the relevant class-wise construction standards specified in SMACNA's HVAC Duct Construction Standards. Such requirements are shown in the Table 1 of Clause 5 & reproduced below for ready reference.

TABLE- 1

STANDARD DUCT PRESSURE CLASSES AND CORRESPONDING SEAL CLASSES & LEAKAGE CLASSES

Duct Pressure Class		Operating Pressure	Seal Class	Sealing Requirements	Leakage Class
(in)	(Pa)				
½" w.g	125	Upto ½" w.g	C	Class C : Transverse joints only	C_L 24
1" w.g	250	Over ½" up to 1"w.g			
2" w.g	500	Over 1" up to 2"w.g			
3" w.g	750	Over 2" up to 3"w.g	B	Class B : All Transverse Joints and longitudinal seams only	C_L 12
4" w.g	1000	Over 3" up to 4"w.g	A	Class A : All Transverse joints, longitudinal seams, and duct wall penetrations	C_L 6
6" w.g	1500	Over 4" up to 6"w.g			

Reading guide: C_L 24 implies Leakage rate of 24cfm /100 Sq.Ft. at 1" w.g.

- Leak testing requirements will be as under:

Duct pressure class	Testing Requirement
(in)	
½" w.g	Sample assemblies of ducting not exceeding 10% of the total quantum of work in these pressure classes to be tested before carrying out the work.
1" w.g	
2" w.g	
3" w.g	All ducting to be tested.
4" w.g	
6" w.g	

- Contractor shall indicate the duct pressure class being adopted for various sections of ducting and obtain Consultants / Owners approval before taking up the work. The selection of the duct

pressure class for the various sections shall be made keeping in view that the total leakage in the duct work does not exceed 1.5% of the total flow rate of the system.

- The duct leakage-testing rig shall consist of a fan with damper / valve (for varying the flow rate), a flow measuring device like Orifice Plate Assembly with manometer and another manometer / Magnehelic gauge (for measurement of static pressure) together with necessary ducting. The orifice plate shall be duly calibrated (for pressure drop >< flow) with instruments whose calibration itself can be traced to accredited laboratories. The details of methodology adopted for calibration and a certificate (for calibration) shall be furnished by the contractor before taking up the work.

DUCTING MEASUREMENT

The entire ducting assembly including S.A. Plenums shall be measured for its running length & perimeter. Bare surface area of ducts will be used in calculating the duct measurements i.e. the total Sq.Ft. of finished surface area.

The rate per square meter of the external surface shall include flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connections, inspection doors, dampers, turning vanes, straightening vanes, and any other item which will be required to complete the duct installation except external insulation and finish thereon.

The external area shall be calculated by measuring the over-all width and depth (including the corner joints) in the Centre of the duct section and over-all length of each duct section from flange face to flange face in case of duct lengths with uniform cross section. Total area will be arrived at by adding up the areas of all duct sections.

In case of taper pieces average width and depth will be worked out as follows:

W1 = Width of small cross section
W2 = Width of large cross section
D1 = Depth of small cross section
D2 = Depth of large cross section

$$\text{Average Width} = \frac{W1 + W2}{2}$$

$$\text{Average Depth} = \frac{D1 + D2}{2}$$

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct / sections fitted with angle iron flanges; otherwise at the bottom of the flange where the flanges are of GSS. Face to face length for taper piece shall be the mean of the lengths measured face to face from the center of width and depth flanges.

For special pieces like bends, branches, and tees, etc., the same principal of area measurement as for linear lengths shall be adopted, except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along the curvature of angle of the piece.

The above said format will be applicable for all ducts & insulation measurement, **No extra / wastage area is applicable.**

Ducting erection / commission shall be calculated on the basis of actual measurements taken at site in presence of engineer / a representative of client. Duct measurements for calculation of area shall be taken before application of insulation.

Documentation and Measurement for Duct.

All ducts fabricated and installed should be accompanied and supported by following documentation:

- For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill of materials indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct area by gauge and duct size range as applicable.
- Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct gauge-wise.
- All duct pieces to have a part number, which should correspond to the serial number, assigned to it in the measurement sheet. The above system will ensure speedy and proper site measurement, verification and approvals.
- The same duct piece part number should appear in all construction as well as As-built drawing.
- Duct measurements shall be taken after commissioning of the system.
- Grilles and diffusers shall be measured by the cross-sectional areas, perpendicular to the air flow, and excluding the flanges.
- Volume control damper and fire damper shall be measured by cross sectional area, perpendicular to the air flow.
- Painting.

All grilles, diffusers shall be powder coated in the shade approved by the Client / Consultant.

TOOLS & TACKLES USED FOR DUCT FABRICATION & INSTALLATION

WOODEN MALLET

c) TECHNICAL SPECIFICATION FOR NITRILE RUBBER THERMAL INSULATION

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber with aluminium foil laminated on one side.
- Density of Material shall be 45 - 70 Kg/m3
- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667.
- The insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 2.9 x 10^{-14} g/m.s.Pa i.e. Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 12000.
- Insulation should have flame spread classification not more than 25 & smoke developed classification of not more than 50 as per ASTM E84-16
- Insulation should have anti-microbial property as per ASTM E 2180-07
- The insulation material shall have fire performance of V0, HB as per UL 94, 1996.
- Density of insulation material shall be between 40 to 55 Kg/m3.
- The insulation material shall be dust and fibre free.
- The insulation material shall withstand maximum surface temperature of +85 Deg.C and minimum surface temperature of 0 Deg.C as per EN 14706.
- The Aluminium foil shall be of 12 micron thickness with reinforced glass scrim and weight shall be 70 gsm as per EN 22286, tensile strength shall be 250N/50mm as per ISO 527-3 with elongation of 4% as per DIN 53354.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.
- The Proposed Insulation shall be of Self-Adhesive type Class O insulation.

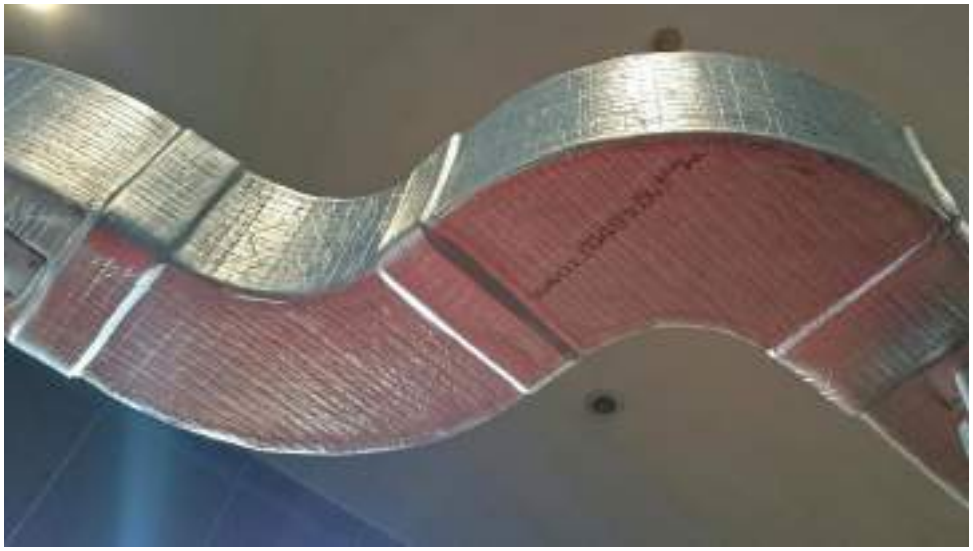
PURPOSE

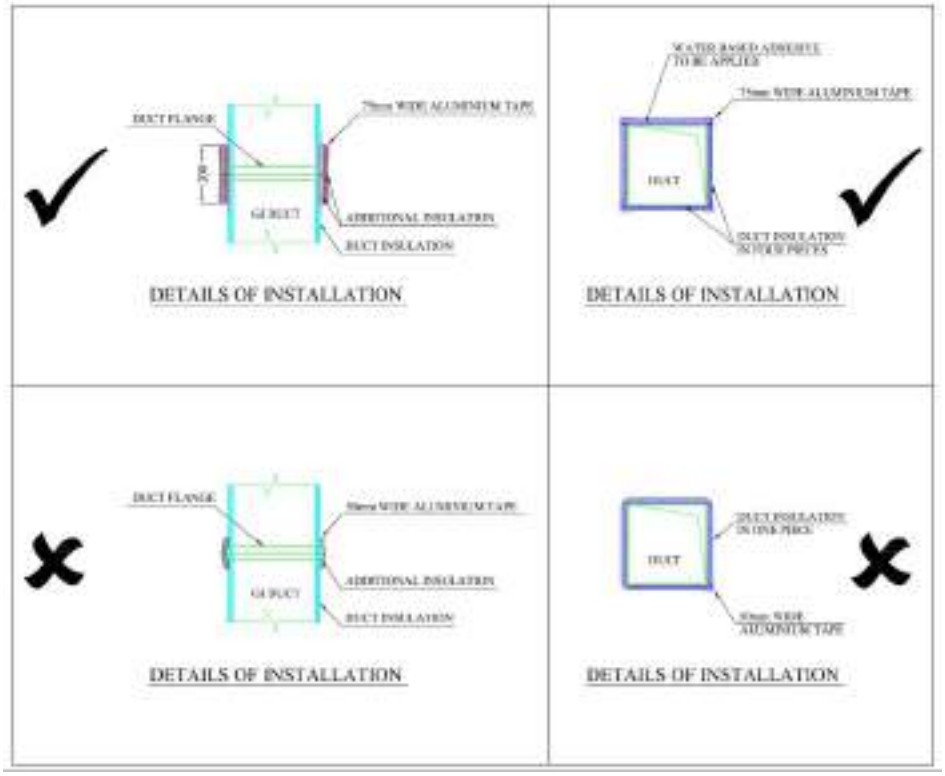
Insulation is applied to Duct to enhance thermal performance, prevent condensation and dripping. Duct thermal performance needs enhancement since Air transported through a duct is at a lower temperature than that of the surrounding area. Insulation reduces the rate of thermal loss to those surrounding areas. Without insulation, the air would need extra heating or cooling in order to arrive at the design supply air temperature.

Insulation prevents condensation and dripping from duct surface. Un-insulated ducts very often have surface temperatures below the local dew point. At this temperature, condensate will form and eventually drip off, causing an uncontrolled accumulation of moisture on the outside surface of the duct. Duct Insulation eliminates the formation of condensate and consequently prevents rusting and staining.

The Proposed Insulation shall be of Self-Adhesive type Class O insulation.

DUCT INSULATION SHALL BE DONE AS SHOWN IN PICTURE BELOW.





INSTALLATION PROCEDURE

ONLY FACTORY SUPPLIED 75 MM WIDE INSULATION TAPE SHALL BE USED

SCOPE OF WORK

1. The installation contract includes supply of all necessary insulating materials, with accessories including scaffolding / weather protection, etc.
2. The contractor shall supply and install the insulating materials on the respective surfaces as per shop drawings.
3. The contractor shall supply all necessary skilled and unskilled labour and supervision required for carrying out the insulation as per these specs and good engineering practice.

Insulation Type:

- Closed Cell Elastomeric Nitrile Rubber insulation with factory applied reinforced aluminum foil facing on one side. The material should have high resistance to fire (Melting Class "0"). The material used shall be in rolls. The insulation sheet joints shall be sealed using self-adhesive aluminium tapes of 75 mm width.
- Thickness of the insulation material should be in conjunction with manufacturer's recommendation.
- Insulation thickness selection shall be a part of submittal approval.

Installation:

- Insulation must be installed in accordance with manufacturer's instruction.
- All joints should be butted firmly against each other, seal all joints with overlapping self-adhesive 75mm wide reinforced aluminium tape, procured from the manufacturer of same material as the base insulation.
- Insulate each duct separately, flanges should be insulated with a 120mm wide strip of insulation material, ensuring joints are sealed with 75mm reinforced aluminium foil tape, procured from the manufacturer of same material as the base insulation.
- All supporting hangers should be lined with the same insulation material to avoid excess compression of insulation. (Refer manufacturer's instruction).

Ensure no air pockets during the installation of the insulation to the duct. Any minor surface cuts should be covered with aluminium foil tape.

DUCT INSULATION:

External thermal insulation shall be provided as follow:

The thickness of the nitrile rubber shall be as shown on drawing or identified in the schedule of quantity. Following installation procedure should be adopted:

- Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
- Material shall be fitted under compression and no stretching of material should be allowed.
- A thin film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface.
- When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond.
- All longitudinal and transverse joints shall be sealed as per manufacturer recommendations.

- The adhesive shall be strictly as recommended by the manufacturer.
- The detailed Application specifications are as per the manufacturer's recommendation.

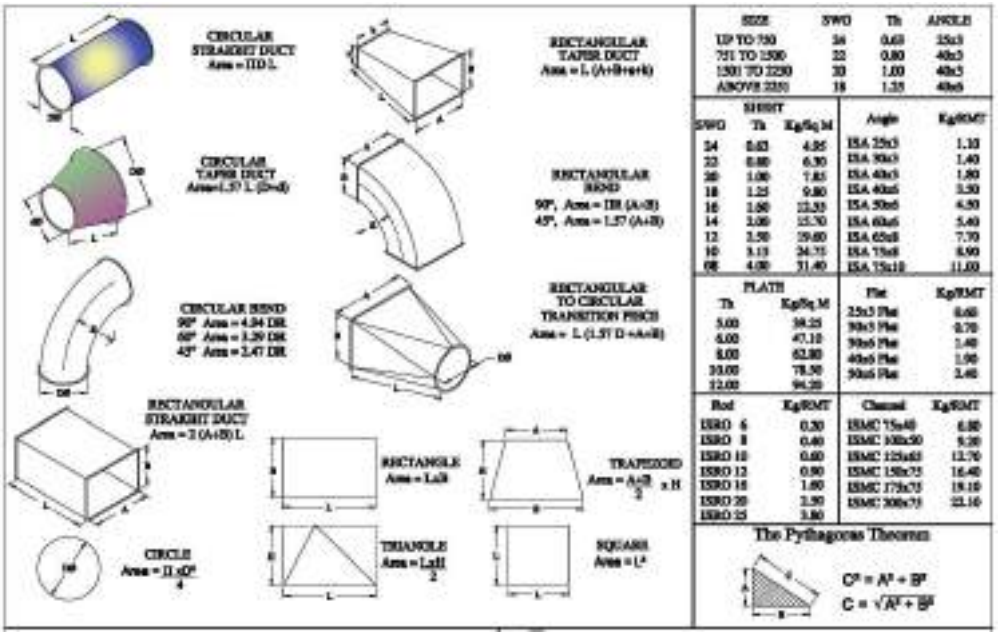
Measurement of insulation

Unless otherwise specified measurement for duct insulation for the project shall be on the basis of center line measurements described herewith: -

Duct insulation:

Shall be measured on the basis of surface area of bare duct only, no additional area shall be considered for insulation thickness measurement. Thus, the surface area of bare duct will be basis for calculating area of externally thermally insulated or acoustically lined duct - the perimeter of the Duct into Length of Duct. **No special measurement / extra allowed for tapers, transformations, dampers, elbows, branches, flanges (Box type insulation), etc.**

The Quoted rate shall be inclusive of all the above requirement.



EQUIPMENTS & SERVICES TO BE PROVIDED

To supply & deliver to site and apply thermal insulation for Ducting and satisfactorily hand over whole system as per attached schedule and as specified here. Arrange for all necessary inspection by owner / consultant / engineer-in-charge at various stages as needed.

OTHER REQUIREMENTS FOR INSULATION WORK

The Client shall not accept poor quality, badly finished work, or irregularities in the thickness of insulation or in the protective finish. To ensure that the correct thickness has been applied, one

piece from each run of insulation shall be cut out at the discretion of the Client. If the inspection reveals any defects, the contractor shall cut out a further two pieces for inspection.

If these also prove defective, then the insulation shall be removed and new insulation and finishes as specified be applied at the contractor's expense.

All insulating materials and associated products shall be applied strictly in accordance with the manufacturer's recommendations and instructions and work failing to comply with these shall not be accepted by the Client.

d) TECHNICAL SPECIFICATIONS FOR AIR TERMINAL DEVICES

GRILLES, DIFFUSERS & DAMPERS:

- **All supply air diffusers shall be fabricated out of 1.2 mm powder coated extruded aluminium material and removable core type. Volume control dampers shall be provided for all diffusers. Grills & diffusers shall be selected for an aerodynamic noise power value not in excess of NC 35. Return air diffusers shall be identical to supply air diffusers except that they do not incorporate volume control dampers.**
- Supply air diffusers shall be of powder coated extruded aluminium construction. They shall be complete with Volume control dampers of aluminium mounted directly on grilles. The vanes shall be 3 mm thick and 25 mm deep horizontal type. The width of the perimeter flanges shall be 25 mm.
- Return air diffusers shall also be Powder coated extruded aluminium construction. They shall incorporate (only) horizontal vanes, which shall be fixed. The perimeter flanges shall be 25 mm width. The vanes shall be 3 mm thick and 25 mm deep. The pitch of vanes shall be 20 mm.
- All dampers shall be louvered dampers (of GI) of robust construction and tightly fitted in epoxy painted MS angle iron frame. They shall be provided with suitable links, levers and quadrants as required for their proper operation, control or setting in any desired position. Dampers and their operating devices shall be made robust, easily operable and accessible through suitable access doors in the ducts / false ceiling. Where required, dampers shall have an indicating device, clearly showing the damper position at all times.
- Dampers shall be placed in ducts and at every branch (whether or not indicated on the drawings) for the proper volume control and for balancing the system.
- Supply and Return air diffusers shall be housed in modules / Insulated plenum box which have to be fixed to the false ceiling. The diffusers shall have ample margins, to minimize ceiling smudge.
- The shade of finished powder coated paint on Diffuser shall be as approved by the client. Sample shall be submitted before approval.

- A spigot connection has to be provided to connect flexible duct and damper unit assembly.

e) TECHNICAL SPECIFICATIONS FOR DAMPERS

Volume control dampers shall be placed at all suitable points in Supply and Return Air duct for proportional volume control of the system.

Volume control dampers shall be multiple opposed blade type with extended lever for operation and shall be lockable. The dampers shall be zero leakage aerofoil having minimum 1.2 thick aluminium extruded aerofoil with a locking arrangement.

Neoprene rubbers seals at tips of blades shall be provided. The motorized dampers shall be provided with motors/actuator and electrical wiring as required.

All dampers will be having open/close position indication on the damper.

f) TECHNICAL SPECIFICATIONS FOR FIRE DAMPERS:

Fire Dampers shall be provided as per the drawings and the bill of quantities and shall be at least of 90minutes fire rating of fusible link type.

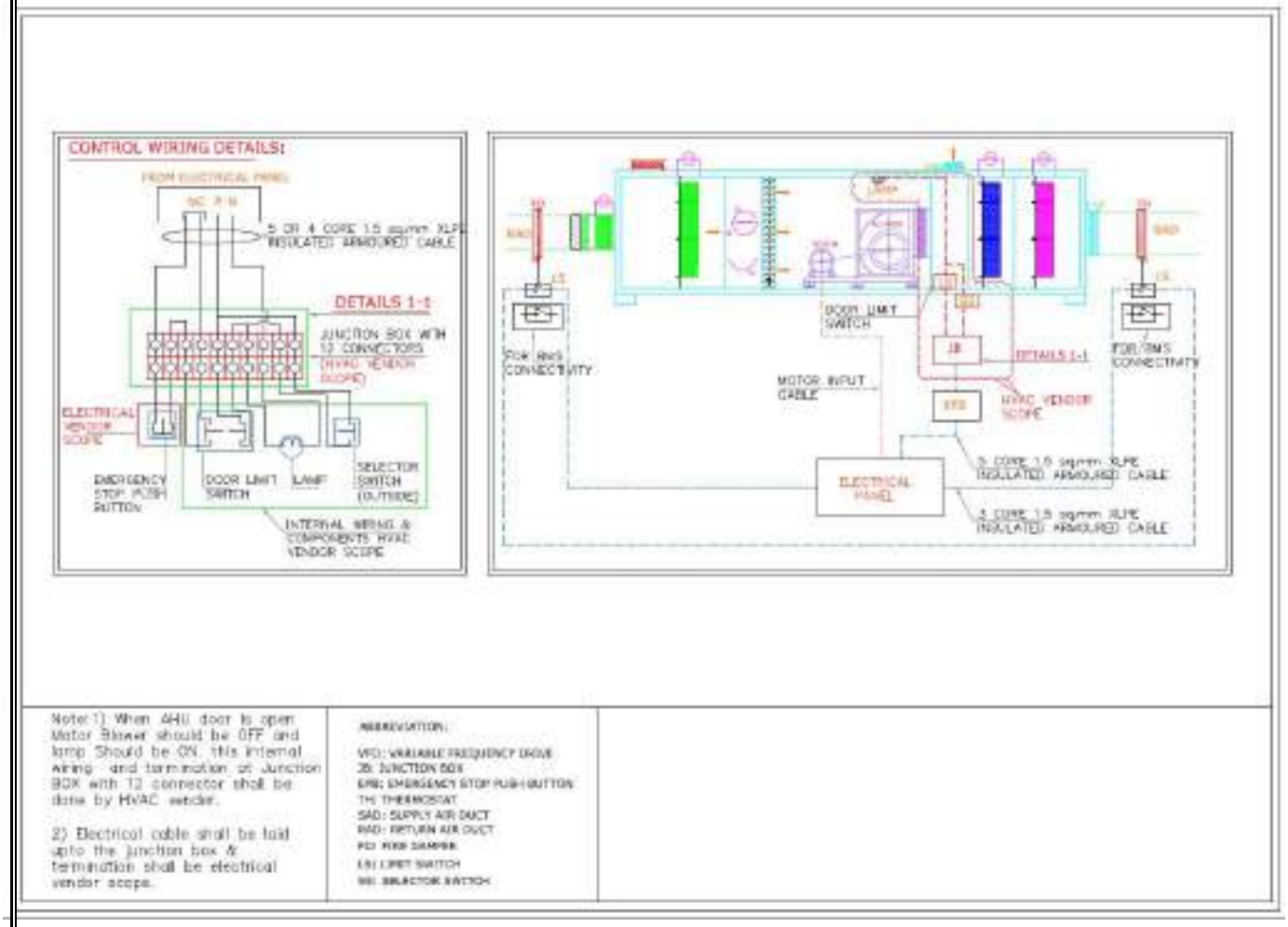
The damper shall consist of outer frame, damper blades, SS Spring, plated steel linkage, Twin Micro Switch, UL stamped fusible linkage, handle & sleeves. The blades & outer frame shall be formed out of 1.6 mm thick GSS as required.

Fire damper blades shall be one piece folded high strength galvanized steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air current from noise chatter. The blades shall be held in position through fusible links (UL certified). In case of fire, the intrinsic energy of the folded blades shall be utilized to close the openings. The thrust form closing of the damper shall operate a one of the two-limit switch mounted in the bottom frame of the fire damper within the damper, closing of this limit switch shall shut off the power supply to the air handling unit stopping all air flow instantaneously & The second Limit switch shall give a signal to DDC panel for shut off the power supply to the air handling unit.

All Fire dampers shall be complete with factory fabricated & fitted duct sleeves as per manufacturers recommendation. Access doors shall be provided in accordance with the manufacturer's recommendation.

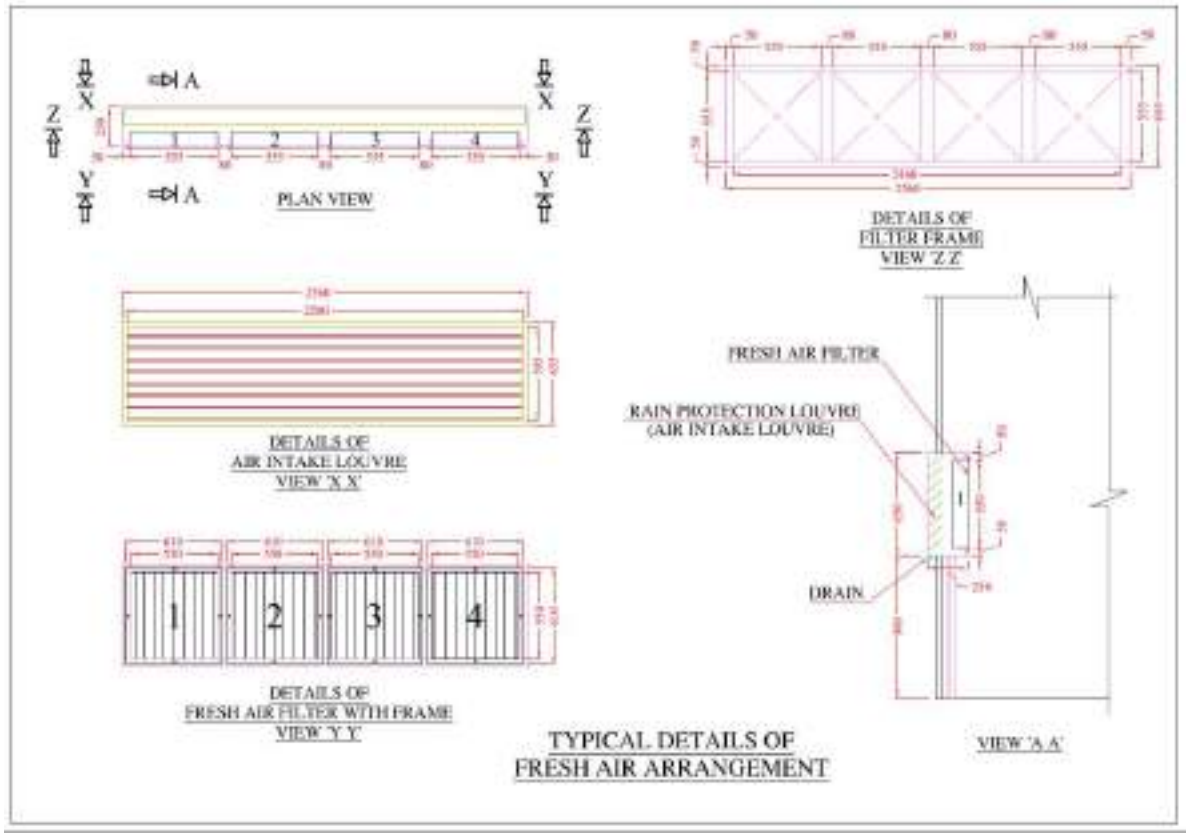
Certificate for Fire performance from CBRI is required. Minimum 2Nos Fusible Link shall be tested at site.

All the internal wiring from the Fan section door limit switch & Internal wiring for AHU light & switch shall be carried by HVAC vendor and left near the push button station which is placed at 1 Mtr distance from AHU. HVAC Vendor to coordinate with AHU vendor for Installation.



g) TECHNICAL SPECIFICATIONS FOR FRESH AIR INTAKE LOUVER & BIRD MESH

- Filter area shall be suitable for twice the quantity of fresh air.
- All the louvers shall be rain protection type & made from MS powder coated section shall be in modular panel. The outer frame shall be made structurally rigid & Corners of frame shall be welded. The louver shall be free from waves and buckles. Horizontal blades shall be truly horizontal.
- Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging / vibrating of the louvers, at not more than 750 mm centers where the louvers length is longer than 750 mm.
- A bird wire screen made of 12mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver & complete with G2 type panel filter with fixing frame.



h) TECHNICAL SPECIFICATIONS FOR INSULATED FLEXIBLE DUCT

The insulated flexible duct of class 1 air duct, light weight, strong, fully flexible & made of double lamination of films permanently bonded to a coated spring tough steel wire helix. The thermal efficiency is ensured with a blanket of fiberglass wool insulation in between. (With Spigot Connection & Rigid GI Round Duct). Insulation Density shall be of 16 Kg / M3. The Fixing Clamp shall be of a suitable size ~1" (25 mm) more than the Flexible hose.

INSULATED FLEXIBLE DUCT

FIXING CLAMP

i) TECHNICAL SPECIFICATIONS FOR HEPA FILTERS

Terminal HEPA filter boxes with CG Screen suitable for clean room application inclusive of ports for damper operation, PAO testing port & Magnahelic gauges shall be provided. These shall be room side replaceable, cleanable flush type and mounted on the ceiling.

The construction of H14 (ISO 45 H) HEPA Filter boxes shall be with Housing & Damper (Bottom Discharge Module Type). Housing made of extruded aluminium anodized material and low leakage aluminium collar damper with operating gear arrangement, Housing shall be suitable for fixing the Gel Seal (Polyurethane gel) type of terminal HEPA filter (H-14 as per EN1882 Class). The Filter Housing shall have provision for smoke aerosol test point, Diffuser Plate & differential pressure measuring point. The filter mounting box shall have a provision to control the airflow from Inside. A spigot connection has to be provided to connect flexible duct and damper unit assembly.

1. Each filter shall be subjected to PAO test and a certificate / certificate to the effect that such tests have been conducted shall be furnished by the contractor. The details of the PAO test procedure adopted by the contractors / manufacturers at their works, including the specifications applicable to the aerosol generator, particle counter and other accessories shall be submitted by the vendor.

   In addition to the tests carried out on each & every filter at the works, as noted above, the contractor shall also carry out performance test of the HEPA filters installation using – again, PAO as challenge. Provisions for carrying out the tests including installing necessary connectors/providing tapping for measurements shall be incorporated while carrying out the work. Tests shall be carried out to methods & practices developed & published by IEST (Institute of Environment Sciences & Technology).

2. The tenderers shall confirm that they will afford every facility for the owners / consultants or their representatives to observe the manufacturing of filters and witness the tests if they so desire.

3. The owners / consultants reserve the right to stipulate that a leak test be performed on any or all filters on their receipt at site before taking delivery. The tenderers shall specifically confirm that they are agreeable to comply with this requirement.

4. The following measurements / tests / checks shall be carried out on all HEPA Filters installed -

   - Integrity Test (Using PAO Test)
   - Velocity check
   - Flow rate measurements
   - Particle count

j) TECHNICAL SPECIFICATIONS FOR VRF UNITS

♣ **INVERTER TYPE VARIABLE REFRIGERANT VOLUME (VRV) / VARIABLE REFRIGERANT FLOW (VRF), OUTDOOR UNITS – AIR COOLED**

- Outdoor units, or condensing units, should comprise of cabinet, 100% Multi Inverter compressors, condenser coil, condenser fans, receiver / accumulator tanks, electrical and microprocessor panel, oil separation mechanism and supporting structure.
- Entire unit must be factory assembled & factory tested and dispatched as a unit from factory. The Unit shall be suitable for all weather Outdoor mounting.
- COP of every outdoor unit quoted must be more than or equal to 2.6 at **Pune** conditions – Out door temp 36 to 38 deg C, and motors above 1 KW capacity must have efficiency more than 85% when operating on full load capacity of condensing unit.
- The cabinets should be fabricated out of M.S. / C.R.C.A. sheets and sections, duly painted with anti-corrosive primer & paint. The painting procedure, material thickness and colour shades may be as per manufacturer's standards. The cabinet should have pre-drilled holes for installation on foundation / frame and should be installed using anti-vibration rubber pads. The cabinets should have adequate openable doors for accessing internal components for regular inspection and maintenance. The doors & locking arrangement should be suitable for outdoor installation in tropical weather.
- Compressors should be hermetically sealed type, of make & models as per manufacturer's standards.
- The Total Capacity should be as per Bill of Quantities.
- Minimum one compressor out of one circuit of system should be capable of providing variable capacity by operating on VRF electrical supply or by suitable means like discharge Bypass.
- Air cooled condenser coils should be made out of Copper tubes with Aluminium fins. Fins should be coated with protective layer. Heat transfer area of condenser coils should be adequate to reject extracted as well as compression & motor winding heat to the atmosphere.
- Condenser fans should be axial flow type, with static enough to pump out required quantity of air through a duct of length 8 m, having cross section 150% of fan opening area, and having two short radius elbows. Fans should be top or horizontal discharge.
- Electrical panel for condensing units should be microprocessor based. It should have necessary switchgear & terminations for receiving & processing signal from indoor units & central processor / IBMS, as well as for receiving 415 Volts + / - 10%, 50 Hz + / - 5%, 3 phase A.C. electrical supply. All cable entries should have glands / grommets suitable for exposed installation.

- All components & controls should be accessible for maintenance.
- Entire mechanism and control circuit should be BMS compatible.
- All Indoor Units must be provided with electronic expansion device and microprocessor circuit to modulate the valve, based on signals received from remote sensor and outdoor machine. It should also forward capacity / percentage opening, ON / OFF status and such data to outdoor machine.
- The indoor units (Duct able FCU / Cassette Unit / Hi wall Unit / Ceiling Mounted Hi static duct type indoor unit) should have evaporator coil adequately designed to absorb heat from air pumped over it. It should be fabricated out of copper tubes and Aluminum fins.
- The Indoor Units Cooling coil shall be designed as per the VRF manufacturer's recommendation to meet the cooling load requirement. The coil specification and selection should be signed off by the Contractor / VRF Vendor before coil manufacturing, a copy of which shall be submitted to the Consultant for sign off. Each coil shall be pressure tested for 560Psig at the Manufacturers place and Test certificate to be submitted.
- The Cooling coil specification shall be as under:

Pressure resistance up to 4.1M Pa, No. of rows: Standard 4, Maximum 6 with Intertwined design. Facial velocity: Around 2.0 m/sec, Minimum coil rows shall be 4 with Fin Pitch of 1.95MM.

The VRF outdoor Unit and the Indoor unit coils are connected by refrigerant Piping with ref net joints. Electronic Expansion valve (EEV) which will precisely control the system based on the Indoor demand. The EEV should control the flow of refrigerant system & to be controlled through wired remote control / centralized system.

EEV Kits are to be installed in a vertical/horizontal direction within the range of (9+/-1.5) feet distance from the DX coil header.

Room temperature sensor needs to be devised in the passage of return air, possibly in the Mixing Box, representing room temperature

- All sensors need to be properly insulated.
- The Feed Back between AHU kit & ODU shall be through communication cable.

Submittal Requirement

- Chart for capacity / power consumption ratings for all outdoor unit models, at varying ambient temperatures and part loads must be submitted with offer.

- Capacity charts for the compressor / s used must also be submitted with the offer.
- Datasheet attached must be filled in and submitted along with offers.

♣ **REFRIGERANT PIPING**

PARENT MATERIAL:

The parent material used for air – conditioning system refrigerant piping should be Copper tubes, pipes and fittings conforming to following specifications:

- Material composition should be conforming to C-1220 (JIS-H-3300) or C-12200 (ASTM). It should have a minimum Copper content of 99.9% and Phosphorus content between 0.015% and 0.040%. It should have low residue (below 0.038 g / sqm). The material should also be as per the RoHS norms specified by EU; that is, Mercury, Chromium and Lead contents below 1000 ppm, and Cadmium content below 100 ppm.
- Physical properties of the material should conform to JIS-H-3300 or ASTM-B-68 & B-75, should be tested for Tensile / elongation / hardness / grain size tests as per ASTM B – 280.
- Dimensional tolerance should be as per JIS-H-3300 or ASTM-B-251. The tubes should be tested using non-destructive eddy current test before the final anneal, as per JIS-H-3300 or ASTM-E-243.
- Heat treatment should be carried out in non-oxidizing atmosphere to ensure oxygen-free and cuprous oxide-free surface.
- Proper certificates describing composition and results of all tests carried out must be supplied with each consignment. These certificates, along with check results for dimensional and thickness accuracy are recommended to be carried out for every delivered lot, should be maintained till handing over of the project.
- Wall thickness for soft pipes should be 0.8 mm for ¼", 3 / 8" & ½" tubes, 1.0 mm for 5 / 8" tubes, 1.2 mm for ¾" tubes. Wall thickness for hard pipes should be 1 mm for 7 / 8", 1" and 1.1 / 8" pipes, 1.1 mm for 1.1 / 4", 1.2 mm for 1.3 / 8" and 1.3 mm for 1.5 / 8" pipes.
- Wall thickness for elbows and fittings should be minimum 0.2 mm more than corresponding pipe / tube size.
- For sizes up to ¾", pulley type benders should be used and brazed joints should be avoided as far as possible. Similarly, for pipes of size 7 / 8" or more, one side expanded pipes must be used and use of couplings should be minimized as it leads to increase in number of joints.

PIPING DESIGN:

- Contractor should study the Tender / GFC drawings carefully, and should carry out detailed survey of site / civil drawings, relating the drawings with site, and understand the system design and site limitations.
- Contractor should also collect final architectural and reflected ceiling plans and study the drawings for any mismatches with the HVAC drawings received.
- Contractor should discuss any such mismatches and any doubts regarding system design with the consultant and get all doubts clarified.
- Before commencement of piping work, proper shop drawings must be generated by the contractor USING THE VRF CONTRACTORS COMPUTER GENERATED SOFTWARE, and same should be got approved from the consultant. The drawings must clearly indicate schematic flow diagrams for various circuits, pipe sizes, description and quantities for refrigerant joints, indoor and outdoor unit models and room / block / floor names, pipe routes, levels for horizontal pipes, details regarding insulation type and thickness and surface treatment for insulation, typical and critical sections and any other details to explain the entire piping layout for easy installation.
- Pipe sizing and routing must be carried out taking into consideration various site constraints and VRF system manufacturer's recommendations.
- Care should be taken to design piping as per the manufacturer's recommendation for maximum piping total length, maximum piping length after first tapping, vertical height difference between outdoor and indoor units etc. and necessary corrections should be carried out in outdoor unit capacity if required. The computer-generated Refrigerant pipe sizing and routing layout shall be submitted for consultant approval before site execution.

REFRIGERANT PIPING INSTALLATION WORK:

- The installer must first study the shop drawings in detail with respect to the site condition and point out any fouling / alternatives to the agency prepare shop drawings and necessary revisions must be carried out in the drawings, to be approved by consultant.
- The layout must be marked on the true ceiling and any civil openings required should be marked and got done from concerned agency.
- Supports as described in BOQ / specifications should be installed, leaving adjustable free length for supports.
- Before installation, the pipes and tubes must not be removed from their original packing. Proper storage of piping is a must to maintain the temper of the pipes / tubes. Any abrasion on ends / surface, or any in grace of dirt / dust must be avoided. Proper Polyethylene sheets should be

used for covering the pipes and tubes, while wooden pellets and soft expanded Polyethylene / rubber sheets should be used as floor supports.

- Necessary loops / slopes must be followed as recommended by VRF system manufacturer.
- Pipes must be cut to required sizes using cutting tools recommended by VRF system manufacturer.
- Using proper quality of brazing set, Oxygen / Acetylene and Copper brazing rods having minimum 2% Silver content.
- During brazing, Nitrogen must be filled in the Copper piping at a mild positive pressure and must be kept bleeding out continuously, to prevent any oxidation of parent material.
- After piping work, each circuit should be pressure tested as per the VRF system manufacturer's recommendation and as per the procedure described in the following paragraphs. A certificate mentioning the test pressure, time of first and final pressure readings, make, model, serial number, range and least count of the gauge used, along with a copy of valid calibration certificate must be maintained, duly signed by the inspecting technician, and Engineer-in-charge.
- After pressure testing, insulation must be completed out as per the material, make and thickness mentioned in the approved shop drawing. The joints of insulation must be sealed by minimum 50 mm wide Aluminium adhesive tape. Care should be taken to avoid any air gaps between pipe / tube and insulation sleeves, and between two insulation sleeve joints.
- Proper tagging must be carried out to trace the piping to respective indoor and outdoor circuits.
- The pipes running inside the building will be run on perforated powder coated M.S. cable tray as per the specification in Tender BOQ.
- The pipes exposed to sunlight will run in perforated powder coated MS cable tray with Powder coated bolted covers without perforation, cladded / treated to prevent damage from UV radiation and bird pecks / tampering, (To protect refrigerant pipe insulation on terrace, wherever exposed)
- The entire work shall be done in co-ordination with other agencies. General Arrangement Drawing, Layout Drawing and sample of Cable Tray shall be got approved before taking up the manufacturing.
- While cladding, care should be taken to avoid penetrating the insulation by screws. Short screws of metallic straps should be used for securing cladding sheets. Instead of cladding, glass cloth, with two coats of protective resin should be used.

- While charging refrigerant, manufacturer's recommendations must be strictly followed, and charging must be carried out using proper charging hose, gauge manifold with calibrated gauges and electronic weigh scale. Further leak check using a gas leak detector should be carried out. Charging must be carried out after proper evacuation of the piping. The quantity of refrigerant to be charged should be calculated by totalizing the liquid pipe volume as per the manufacturer's recommendation.

RECOMMENDATIONS FOR PRESSURE TESTING:

Refrigerant pipes carry refrigerant at pressures different from atmospheric pressure. When pressure inside pipes is more than atmospheric pressure, refrigerant may escape to the atmosphere, causing commercial loss due to loss of refrigerant, inefficient system performance or even system breakdown and contamination of surroundings. When pressure inside the pipes is less than atmospheric pressure, such as in case of suction pipes of some low temperature refrigeration machines, or during pump-down cycle of normal air-conditioning systems, leakages in pipes leads to ingress of air and moisture, causing severe system damage. Therefore, it is a must that the refrigerant piping is thoroughly tested for leakages.

Pressure testing for any piping must be carried out at a pressure higher than the maximum operating pressure within the system. It is recommended that the pressure recommended by manufacturer be followed very strictly. Testing at lower pressures may lead to no detection of some small leakages, while testing at higher pressures may lead to damage to some factory manufactured components within the system.

For system operating on R-410 refrigerant a pressure of around 600 psig is used for pressure testing.

Nitrogen is the most common gas used for carrying out pressure testing. It has numerous advantages, some of which are listed below:

- Nitrogen is easily available as a commercial gas packed in easy-to-handle cylinders.
- Nitrogen, being the most abundant component of the atmosphere, is safe for leaking out without contaminating the atmosphere.
- Nitrogen is less costly as compared with other gases.
- Nitrogen is safe for handling and testing.
- Nitrogen does not readily react with system components Pressure gauges used for testing must be calibrated and a calibration certificate with traceability to a Government (National) Physical Laboratory must be documented. The gauge should be capable of measuring pressure at least 10% above the reading to be recorded.

PROCEDURE FOR CARRYING OUT PRESSURE TEST

- Ensure that the piping to be tested is properly secured / supported and the openings have been sealed off as per manufacturer's recommendation.
- Install pressure gauges at strategic locations where it shall not be tampered with, at the same time, should be easily visible.
- Install a valve and connecting tubing so that the open end of the tube reaches the cylinder outlet without moving the cylinder.
- Connect the tube to the cylinder and after ensuring proper connection, crack open the cylinder valve, keeping an eye on the pressure gauge. Let the pressure rise to around 10 psig.
- Check for proper sealing of all flanged / flare nut joints or valves / valve glands looking for noise of escaping Nitrogen and seal same.
- Open the cylinder valve again and raise the pressure to 200 psig.
- Check the pipeline for major leakages at brazed joints, elbows, valve glands, equipment end connections and pipe seams with the help of soap water. Make up the leaks by tightening nuts. If the leaks are in brazed joints, flush out Nitrogen and carry out necessary re-brazing.
- Open the cylinder valve again and increase the pressure to 150 psig less than the final test pressure. Repeat leak check as above.
- Open the cylinder valve again and slowly raise the pressure to the manufacturer recommended pressure. Carry out a thorough leak check.
- Record the pressure and time. Let the pressure stand for 24 hours without tampering. Check the pressure again after 24 hours. If pressure has dropped, the piping should be checked very thoroughly for minor leakages. It is important to follow this 24 hours period as it gives enough time to detect minute leakages, and it removes the doubt created by thermal expansion of Nitrogen (as after exact 24 hours, ambient conditions are generally same).
- In case of piping extending to lengths more than 30 m and / or having more than 20 site fabricated joints, the pressure should be recorded after 24 hours as well as after 48 hours, so that all leakages are detected and made up.
- After detecting and making up any leak, the pressure testing must be carried out once again from beginning.

DOCUMENTATION RECOMMENDED FOR ENSURING PROPER QUALITY ASSURANCE:

- Manufacturer's certificate with every Delivery Challan declaring composition of parent material.
- Signed and approved Shop drawings approved by Client/PMC prior to start of work.

- Indoor Unit cooling coil Pressure test and the system Pressure test report signed by Client / PMC.
- False Ceiling closure check list duly signed by Client / PMC.

DRAIN PIPING

All condensate drains should be routed with proper slope to nearest drain point through PVC pipes of minimum thickness 3 mm. Pipes above false ceiling must be insulated with 9 mm thick cross-linked expanded Poly Ethylene Tubular insulation. Pipes buried inside walls or below flooring must be insulated as above and further wrapped with 3 mm thick tar felt / bituminous cloth.

Pipes above false ceiling must be supported at every 1 m distance using circular PVC / metal clamps and full-threaded GI rods 6 mm dia. and must not be allowed to have sags. PVC pipe sleeves must be provided at each support in order to distribute the clamping pressure on a larger area of insulation. In the event of more than one drains being connected to same pipe, "U" traps should be used between indoor machine and common drain header.

Drain piping must be hydro - tested with the help of colored water held in pipes for 24 hours at a pressure of 1 Kg / sq cm. After testing, the open ends should be properly plugged with removable plugs and a certificate of drainpipe testing and plugging should be submitted prior to closing false ceiling / closing shaft / making up wall or partition chasing.

CONTROL SYSTEM

Air-conditioning system should have hardware & software to achieve following levels of control.

AT INDOOR UNIT LEVEL:

ON / OFF status / scheduler, thermostat, air speed, all controls available on respective corded remote controllers.

AT OUTDOOR UNIT LEVEL:

Viewing / monitoring / setting of all controls available at indoor unit level, along with features incorporating monitoring, alarm and safety features for outdoor unit

AT CENTRAL REMOTE CONTROLLER LEVEL:

Viewing / monitoring / setting of all controls available at indoor unit level, along with facility to receive & translate / transit commands received from IBMS & Fire alarm systems, suitable for indoor units.

The control systems at outdoor and central remote controller must have protected passwords.

The control systems should be user-friendly and should be provided with ports and interface for connectivity with standard IBMS packages like BACNET, MODBUS, and LONWORKS. In absence of IBMS, the system must have capability to display status and facilitate remote monitoring through PC.

BAC NET GATEWAY:

A multifunctional compact centralized controller shall be provided with the system which makes it easy to Control and Monitor the air conditioning network in various ways. It shall be able to control up to 256 of indoor units with the following functions & all the data's shall be viewed in the laptop / computer (to be provided by client in the designated room in the building).

SALIENT FEATURES

- Starting/Stopping of Air conditioners as a zone or group or individual unit.
- Temperature setting for each indoor unit or zone.
- Switching between temperature controls modes (Cooling /Heating /Fan /Dry), Enabling/disabling of individual remote controller operation.
- Monitoring of operation status such as operation mode & temperature setting of Individual indoor units, maintenance information, troubleshooting information.
- Display of air conditioner operation history.
- Daily management automation through yearly schedule function with possibility of various Schedules.
- The BAC net Gateway is to be wired by a non-polar 2 wire transmission cable from the VRF ODU to the Controller.

TECHNICAL REQUIREMENTS

Drawings Parameters to be tested on Testing & Commissioning of VRF System:

Before commissioning of the equipment the entire installation shall be tested in accordance with Indian Electricity Rules and IS: 732 and the Test Report of a licensed electrical contractor shall be furnished.

On Commissioning of the HVAC System, the following parameters shall be tested by the Contractor under full load conditions, to confirm compliance with the data furnished earlier and achievement of specified room conditions. All readings to be taken every 2 hours during 12 hours continuous operation, for 4 days:

Balancing:

- Area-wise air balancing to establish air quantity as per design.
- Balancing of refrigerant circuit.

Room Conditions:

- Room conditions in each A/C Area to be recorded under full load conditions.
- Corresponding ambient conditions should also be recorded.
- Uniformity of temperature

VRF Unit Parameters:

- Air CFM
- Air Inlet / Outlet Temperature
- Power Consumption
- Corresponding Ambient Conditions
- Suction Pressure
- Discharge Pressure
- Oil pressure
- Check Functioning of Unloading/Capacity Control
- Noise Level & Vibrations (should not be objectionable)

NOTES:

- After completing air & refrigerant-side balancing, the HVAC Contractor shall carry out testing of the entire HVAC System; and submit specified test results to Client / PMC in a Test Results Format pre- approved by the Client. After carrying out modifications / balancing / corrections (as required), the Contractor shall carry out final testing in the presence of Client / PMC.
- The VRF system's Indoor and outdoor units shall be tested in accordance the provision of ARI Standards, AHRI -1230 2009 for VRF System.
- Noise level & vibrations of all equipment shall be within acceptable limits appropriate for the application & use of the Area.
- All the instruments, special test materials (e.g. Nitrogen gas, helium gas for VAC) required for Testing shall be arranged by the HVAC Contractor only.

- If additional parameters are required to be tested/measured for the purpose of troubleshooting, or for establishing performance of the system / equipment or if required by the Consultant; the same shall be carried out by the Contractor, without additional cost to the client.
- In addition to the above, tests & measurements specified in Technical Specifications of the respective equipment shall also be performed, and test-results there in shall be submitted for the client/consultant review and approval.

TESTS AT SITE

General

The Contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the PMC / Site Engineer, in accordance with the provisions of the applicable 'ASHRAE/IS' standards or approved equal and as per site requirements. All tests shall be recorded in the format approved by the Client / PMC

Piping System

In general pressure tests shall be applied to refrigerant piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

Balancing and Adjustment

All indoor units shall be balanced to deliver the specified air quantities indicated, at each inlet and outlet, as required. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power

Performance Tests

The installation as a whole shall be balanced and tested upon completion and all relevant information as per 'Test Proforma' including the following shall be submitted to the Department.

- Air volume passing through each unit, etc.
- Electrical current readings, in amperes of full and average load running, and starting together with name plate current of each electrical motor.

Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil, also suction temperatures and pressures for each refrigerating unit, the current and voltage drawn by each machine.

Any other reading shall be taken which may subsequently be specified by the Client.

The fabrication and shop drawings shall be prepared by the Contractor and got approved from the Consultant & Client before erection.

Test Data

The plant shall be tested as per the specifications given elsewhere and complete `Test Performa' shall be furnished on prescribed sheet.

Technical Data

The HVAC Contractor shall furnish complete technical data on the equipment offered by him as required under the heading `Technical Data'.

Performance Data

The HVAC Contractor shall guarantee that the air-conditioning system performance and shall maintain the designed inside temperature and the relative humidity as specified. The Contractor shall also guarantee that the capacity of various components as well as the whole system shall not be less than specified.

Miscellaneous

The above tests are mentioned herein amplification but not by way of limitation to the provisions specification. Duration of the test shall be continuous 120 working hours. HVAC contractor shall carry out three seasonal tests each of 48 hours duration during defect liability period of the approved dates.

The date of commencement of all tests listed above shall be subject to the approval of the Consultant and in accordance with the requirements of this specification.

The HVAC Contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the Client requests such a test for determining specified or guaranteed data, as given in the specifications or on the drawings.

Any damage resulting from the tests shall be repaired and /or damaged material replaced, all to the satisfaction of the Client / PMC.

In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

The HVAC Contractor must inform to the Client / PMC when such tests are to be carried out giving sufficient notice, in order that the nominated representative of the Client could be nominated to witness the test.

Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Client / PMC.

The HVAC Contractor may be required to repeat the test as required, should the ambient conditions at the time, in the opinion of the Engineer-in-charge is not sufficient and suitable for the performance of the installation as a whole or of any part, as required.

TECHNICAL DATA (To be filled in by HVAC Contractor)

Sl. No.	Description	Unit
1.0	VARIABLE REFRIGERANT FLOW UNITS	
1.1	Actual Capacity at design conditions	HP (TR)
1.2	Weight of Unit	Kg
1.3	Physical Dimensions	mm x mm x mm
1.2	**COMPRESSORS**	
1.2.1	Manufacturer	Name
1.2.2	Model	No.
1.2.3	Compressor type	-
1.2.4	Number of Circuits	No.
1.2.5	Number of compressors	No.
1.2.6	Speed (Maximum)	RPM
1.2.7	Input power at 100% capacity	KW
1.2.8	Refrigerant used	R
1.3	**CONDENSERS**	
1.3.1	Type	
1.3.2	Fans	Nos.
1.3.3	Speed	RPM
1.4	**REFRIGERANT PIPING**	
1.4.1	Name of Manufacturer	Name
1.4.2	Material for pipes	Name
1.4.3	Thickness of pipe	mm
1.4.4	Material of fittings	Name
1.4.5	Material of valves	Name

1.4.6	Make of expansion valve if provided	Name
1.5	**STARTER FOR COMPRESSOR MOTOR**	
1.5.1	Manufacturer	Name
1.5.2	Type of starter	-
2.0	**INDOOR UNIT**	
2.1	Manufacturer	
2.2	Type	-
2.3	Operating weight	Kg
2.4	Overall dimensions	mm
2.5	Noise level	db
2.6	Material and thickness of casing	Name/ mm
2.7	drain pan	
2.8	Dimension of coil	mm
2.9	No. of rows	No.
2.10	Fins per CM	No.
2.11	Type of fins	Plain/crimped
2.12	Tube material	Name
2.13	Thickness of tube	mm
2.14	Tube dia	Mm
2.15	Fin material	Name
2.16	Method of bonding of tubes	- and fins
2.17	Fan section manufacturer	Name
2.18	Type of fan	-
2.19	No. of fans	No.
2.20	Fan speed	RPM
2.21	Fan wheel diameter	Mm
2.22	Drive arrangement	
2.23	Fan outlet area	Sqm
2.24	Fan outlet velocity	m/s
2.25	Air quantity	CFM
2.26	Total static pressure	mm WG
2.27	Motor rating	Kw
2.28	Type of air filters	-
2.29	Size of air filter and quantity	mm/No.

2.30	Thickness of air filters	mm
2.31	Air velocity at filter face	m/s
2.32	Pressure drop across filter	mm WG
3.0	**INSULATION**	
3.1	Manufacturer	Name
3.2	Materials	Name
3.3	Density	Kg/m3
3.4	Mean `K' value	

k) TECHNICAL SPECIFICATION FOR DX TYPE SPLIT UNITS

General Construction: The fan coil units shall be wall/ceiling mounted draw through type complete with finned coil, fan with motor, Extended insulated drain pan, Inbuilt drain pump, cleanable air filters and fan speed regulator and other controls as described.

Casing: The casing shall be factory fabricated / moulded with sturdy construction.

Cooling coil: The coil shall be of seamless copper tubes with aluminium fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity across the coil shall not exceed 2.5 m/sec.

Fan: This shall consist of lightweight aluminium impellers of forward curved type, statically and dynamically balanced, along with properly designed GI sheet casings. The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds.

Drain Pan: Drain pan shall be fabricated out of minimum 1.00 mm thick stainless steel covering the whole of coil section and extended on one side for accommodating coil connection valve etc. and complete with a 25 mm drain connection. The drain pan shall be insulated with 10 mm thick closed cell polyethylene foam insulation and jacketed from outside with single piece molded FRP tray. Insulated drain pan with built in auto drain pump shall be considered.

Air Filter: The filter shall be cleanable type 15 mm thick with 90% efficiency down to 10 microns of dry cleanable synthetic type to be mounted behind the return air grille in the unit casing

Speed control: A sturdy switch shall be provided with the unit complete with wiring for ON/OFF operation and with minimum three speed control of the fan.

Automatic Controls: Each unit shall have a room type thermostat and control valve. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions.

l) TECHNICAL SPECIFICATION FOR PROPELLER EXHAUST FAN

Wall mounting propeller exhaust fan made of Mild Steel with polymer coating, Suitable for wall mounted outdoor application. The Fan shall be fixed on to the wall with mounting plate. The fan shall be equipped with single phase motor with outer rotor & impeller with backward curved blades. Motor are supplied with thermal protection, Motor Terminal Block is to be provided on fan for power termination. The unit support cost shall be considered. The unit shall be with connecting GI short piece & **Aluminium gravity louvre**. The entire unit shall be suitable for wall mounting type with necessary brackets.

The propeller fans should be suitable for continuous operation and heavy duty type. Impeller must be dynamically balanced. Motor casing should be aluminium die caste for heat dissipation. Bearings should be pre lubricated for maintenance free operation.

ABBREVIATIONS

DB	:	Dry Bulb Temperature
WB	:	Wet Bulb Temperature
RH	:	Relative Humidity
NC	:	Not Controlled
NMT	:	Not More Than
CFM	:	Cubic Feet Per Minute
CMH	:	Cubic Meter Per Hour
AHU	:	Air Handling Unit
EAU	:	Exhaust Air Unit
VRF	:	Variable refrigerant flow
SP	:	Static Pressure
GSS	:	Galvanized Sheet steel
DIDW	:	Double Inlet Double Width
VFD	:	Variable Frequency Drive
GLP	:	Good Lab Practice
ID	:	Identification
IQ	:	Installation and Operational Qualification
MOC	:	Materials of Construction
PA	:	Pascal
QAD	:	Quality Assurance Department
SA	:	Supply Air
RA	:	Return Air
RH	:	Relative Humidity
RPM	:	Rotation per minute
SOP	:	Standard Operating Procedure
TEFC	:	Totally Enclosed Fan Cooled
TR	:	Tonnes of Refrigeration
VRF	:	Variable Refrigerant Flow
PP	:	Polypropylene
FRP	:	Fiber Reinforced Polymer
ID	:	Identification
IQ	:	Installation and Operational Qualification

6.0 PART 3 – HVAC WORKS - ANNEXURE 1 – TENDER DRAWINGS

- MJ 437 - HVAC - DR – 2600 - BASEMENT FLOOR HVAC AREA CLASSIFICATION ZONING LAYOUT
- MJ 437 - HVAC - DR – 2601 - GROUND FLOOR HVAC AREA CLASSIFICATION ZONING LAYOUT
- MJ 437 - HVAC - DR – 2602 - FIRST FLOOR HVAC AREA CLASSIFICATION ZONING LAYOUT
- MJ 437 - HVAC - DR – 2603 - SECOND FLOOR HVAC AREA CLASSIFICATION ZONING LAYOUT
- MJ 437 - HVAC - DR – 2604 - BASEMENT FLOOR HVAC AHU ZONING LAYOUT
- MJ 437 - HVAC - DR – 2605 - GROUND FLOOR HVAC AHU ZONING LAYOUT
- MJ 437 - HVAC - DR – 2606 - FIRST FLOOR HVAC AHU ZONING LAYOUT
- MJ 437 - HVAC - DR – 2607 - SECOND FLOOR HVAC AHU ZONING LAYOUT
- MJ 437 - HVAC - DR – 2608 - GROUND FLOOR HVAC PRESSURE GRADIENT LAYOUT
- MJ 437 - HVAC - DR – 2609 - FIRST FLOOR HVAC PRESSURE GRADIENT LAYOUT
- MJ 437 - HVAC - DR – 2615 - BASEMENT FLOOR HVAC VRF CASSETTE UNIT LOCATION LAYOUT
- MJ 437 - HVAC - DR – 2616 - GROUND FLOOR HVAC GRILLE LAYOUT
- MJ 437 - HVAC - DR – 2617 - FIRST FLOOR HVAC GRILLE LAYOUT
- MJ 437 - HVAC - DR – 2618 - SECOND FLOOR HVAC DX HWU & PF LOCATION LAYOUT
- MJ 437 - HVAC - DR – 2620 - BASEMENT FLOOR VRF REFRIGERANT PIPING LAYOUT
- MJ 437 - HVAC - DR – 2621 - GROUND FLOOR HVAC SLD LAYOUT
- MJ 437 - HVAC - DR – 2622 – FIRST FLOOR HVAC SLD LAYOUT
- MJ 437 - HVAC - DR – 2623 – SECOND FLOOR HVAC SLD WITH UNIT LOCATION LAYOUT
- MJ 437 - HVAC - DR – 2624 – TERRACE FLOOR HVAC SLD WITH UNIT LOCATION LAYOUT
- MJ 437 - HVAC - DR – 2630 – AIRFLOW DIAGRAM FOR GF-AHU-1A& GF-AHU-1B
- MJ 437 - HVAC - DR – 2631 – AIRFLOW DIAGRAM FOR GF-AHU-2 & GF-EAU-1
- MJ 437 - HVAC - DR – 2632 – AIRFLOW DIAGRAM FOR GF-AHU-3
- MJ 437 - HVAC - DR – 2633 – AIRFLOW DIAGRAM FOR GF-AHU-4
- MJ 437 - HVAC - DR – 2634 – AIRFLOW DIAGRAM FOR GF-AHU-5
- MJ 437 - HVAC - DR – 2635 – AIRFLOW DIAGRAM FOR FF-AHU-1
- MJ 437 - HVAC - DR – 2636 – AIRFLOW DIAGRAM FOR FF-AHU-2 & FF-EAU-1
- MJ 437 - HVAC - DR – 2637 – AIRFLOW DIAGRAM FOR FF-AHU-3
- MJ 437 - HVAC - DR – 2638 – AIRFLOW DIAGRAM FOR FF-AHU-4 & SCB-1, EAB-1
- MJ 437 - HVAC RDS - 7110 - HVAC ROOM DATA SHEET
- MJ 437 - HVAC RDS – 7111 - HVAC EQUIPMENT SCHEDULE SHEET

PART 4

VRF WORKS

CONTENTS

1.0 SCOPE OF WORK

VRF Tender Scope of work includes Detailed Design, Supply, Installation, Testing and Commissioning of VRF system as proposed in this part of tender.

The scope of VRF works includes the following.

- Design of Air Conditioning system & VRF system for proposed Facility.
- Preparation of 3-Pipe VRF Schematic for AHU.
- Preparation of VRF ODU Design & positioning layout.
- Preparation of Shop floor VRF copper piping drawings with sections.
- Submission of Technical Data Sheet for all BOQ line item.
- Coordination of drawings with other services / Vendors to uphold the design intend.
- Execution at site with all necessary PPE (Personal Protection Equipment)
- Testing & Commissioning.
- Preparation of all required regulatory documents like DQ, IQ, OQ & PQ.
- Preparation & handing over of As Built Drawings.
- Training of service personal & handing over documents.

2.0 DESIGN CRITERIA

The most significant environmental factors that must be controlled & are the basis of HVAC system design criteria are: Temperature, Relative Humidity, Pressure Gradient, air movement velocity & particulate matter.

Critical parameters for room environment and types of controls vary greatly with the Condition space intended purpose. It is particularly important to determine critical parameters with quality assurance to set limits for temperature, humidity, pressure and other control requirements. The system shall be designed to give optimum performance irrespective of the fluctuation in outdoor condition throughout the year.

3.0 OUTSIDE DESIGN CONDITIONS

- **Location: - Pune, Maharashtra.**
- Outdoor weather considered is for Pune & it is as per ISHRAE HVAC Engineering Handbook 2014 Second Edition.
- Outdoor weather consideration for design shall be as under.

SUMMER (April)

DRY BULB TEMPERATURE	: 104° F (40° C)
WET BULB TEMPERATURE	: 76° F (24.44° C)
RELATIVE HUMIDITY	: 29.3 %
DEW POINT	: 65.7° F
GRAINS / Lb	: 102.2
ENTHALPY IN BTU / Lb	: 41.1

MONSOON (September)

DRY BULB TEMPERATURE	: 83° F (28.33° C)
WET BULB TEMPERATURE	: 79° F (26.1° C)
RELATIVE HUMIDITY	: 84.4 %
DEW POINT	: 77.8° F
GRAINS / Lb	: 155.8
ENTHALPY IN BTU / Lb	: 44.4

WINTER (January)

DRY BULB TEMPERATURE	: 50° F (10° C)
WET BULB TEMPERATURE	: 42° F (5.5° C)
RELATIVE HUMIDITY	: 52.4 %
DEW POINT	: 33.4° F
GRAINS / Lb	: 29.9
ENTHALPY IN BTU / Lb	: 16.6

4.0 ROOM DESIGN CONDITIONS

Room conditions i.e., acceptable room Temperature, RH & cleanliness classification is as mentioned below table.

CLASSIFIED AREAS		
GRADE	**DRY BULB TEMPERATURE ° C**	**RELATIVE HUMIDITY %**
GRADE - B	NMT 25° C	NMT 60%
GRADE - C	NMT 25° C	NMT 60%
GRADE - D	NMT 25° C	NMT 60%
NON-CLASSIFIED AREAS		
GRADE	**DRY BULB TEMPERATURE ° C**	**RELATIVE HUMIDITY %**
CNC	NMT 25° C	NOT CONTROLLED
COMFORT AC	NMT 25° C	NOT CONTROLLED
VENTILATION & EXHAUST	AMBIENT	AMBIENT

Design of the HVAC system shall be based on the following parameters.

- Room Parameters & Area / Lab Classification
- Heat load Estimation for lab & office area with Indoor air quality Fresh air requirements
- Room Air Changes per hour
- Room Occupancy
- Connected Equipment load with diversity
- Room pressurization cascade

Following design parameters shall be maintained all round the year depending upon the type of activity given in the attached **HVAC Room data sheet**.

- **DB Temperature**: To be maintained as specified in HVAC Room Data Sheet.
- **Room RH:** To be maintained as specified in HVAC Room Data Sheet.
- **Room Pressure:** To be maintained as specified in Room Data Sheet, wherever specified.
- **Fresh Air (for Air-Conditioned Area):** The Fresh air for Heat load calculations shall be based on IAQ requirement & considered on the basis of exfiltration / infiltration through doors / wall service openings / direct exhaust from the air-conditioned area OR minimum 10% of total air

change per hour OR 10 CFM per working personal whichever is maximum OR 0.18 CFM/SQFT whichever is maximum.

Fresh air shall be as per ASHRAE 62.1-2016 table 6.2.2.1 Indoor air quality for occupied zone.

- **Occupancy:** Room Occupancy shall be considered based on the data provided as per User Requirement specification / Equipment Room Data sheet.
- **Lighting Load:** The Lux level considered is as per IS: 6665. LED light fittings are envisaged in this project & for HVAC heat load calculation we have considered 1 watt / Sqft as lighting load.
- **Equipment Load:** Shall be considered as given in **HVAC Room Data Sheet**. Heat generated by all equipment inside the conditioned area forms a part of room load. Diversity factor on equipment usage is considered as mentioned in the **HVAC Room Data Sheet**.
  - **Summer:** Full equipment load (with diversity) is considered in "ON condition" for heat load calculation for summer season.
  - **Monsoon:** Full equipment load is considered (with diversity) in "ON condition" for compensating reheating calculations for monsoon season.
  - **Winter:** Full equipment load is considered (with diversity) in "ON condition" for heating calculation for winter season.
- **Leakage around the doors:** For calculation of leakages due to pressure difference between two areas, the following gaps shall be considered:
  - Bottom - 5mm
  - Sides & Top - 3mm
  - Centre (Double leaf doors) - 3mm

For the detailed room conditions i.e. acceptable room conditions, room sizes, equipment machine load, lighting load, diversity considered, cleanliness classification etc., Please Refer Tender HVAC Room Data Sheet.

- **AIR CHANGES PER HOUR**

The Minimum room air change rates considered in the various areas are as under:

- 60 ACPH for Grade 'B' area OR Dehumidified CFM whichever is higher.
- 45 ACPH for Grade 'C' area OR Dehumidified CFM whichever is higher.
- 25 ACPH for Grade 'D' area OR Dehumidified CFM whichever is higher.
- 10 ACPH for CUC area OR Dehumidified CFM whichever is higher.
- 6 ACPH for Comfort Air Condition OR Dehumidified CFM whichever is higher.
- 20 ACPH for General Ventilation Areas.

❖ **CONSULTANT'S ESTIMATE OF LOADS/CFMs:**

HVAC design is being carried out on the basis of equipment's load / heat dissipations, occupancy, light loads and Machine Exhaust / Direct Room Exhaust air CFM (**Refer HVAC Room data sheet**). **The HVAC Room data sheet enclosed reflects the design estimate.**

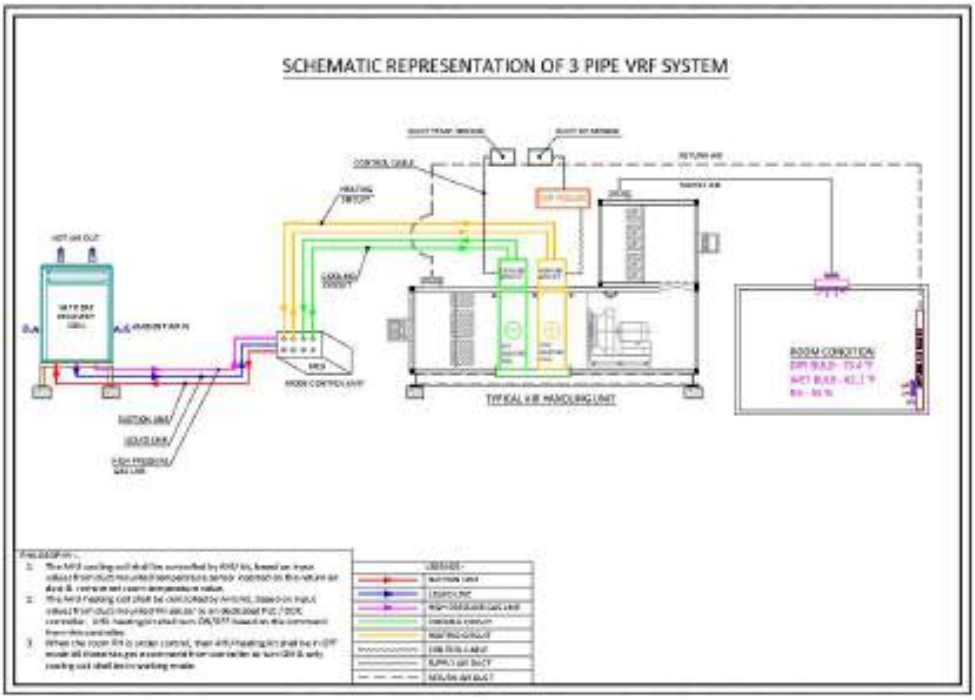
Check the given data and parameters so as to ensure that the inside design conditions are maintained at all times. Responsibility for verifying, altering of parameters if called for, lies with the HVAC Vendor.

HVAC ROOM DATA SHEET

- **MJ 437 - HVAC RDS – 7110 – R0 for HVAC Room Data Sheet.**

THE HVAC SYSTEM SHALL BE DESIGNED ON THE FOLLOWING BASIS

- All areas of the proposed plant shall run simultaneously. There shall not be any heat gain from interconnecting / adjacent areas.
- Lab Operation shall be considered for 24 hours per day, for 7 days a Week.
- VRF type **(3 Pipe System) Heat Recovery system** is proposed to take care Cooling & Heating load requirement.



- Heat Recovery VRF Systems, also known as 3-pipe VRF, allow heating and cooling in Air handling unit simultaneously. Each outdoor air-cooled VRF is connected via 3 pipes to an indoor heat recovery unit; a high-pressure gas refrigerant line (for heating), a high-pressure liquid refrigerant line (for cooling), and a low-pressure gas suction line (for return to the outdoor unit).
- VRF (DX type) cooling coil is provided to take care of Dehumidified air requirement / Removal of total heat picked up from room.
- VRF (DX type) Heating coil is provided to take care of Compensation Heating & Winter Reheat requirement in AHU.
- Heat recovery VRF outdoor unit provides simultaneous cooling and heating by transferring exhaust heat from a unit being cooled to a unit that requires heating.
- VRF condenser are connected to AHU system through a direct Mode Control Units (MCU), which will divert the refrigerant based on the AHU operating mode.
- The Classified area AHUs are proposed with VRF (DX type) coil for cooling requirement, whereas VRF (DX type) Heating coil is provided for maintaining RH / winter reheat requirement. These

areas are to be maintained within the acceptable ranges of temperature & RH. These factors such as Temperature & RH are monitored / recorded on day-to-day basis by an automated system.

- The Controlled Unclassified Area AHUs are proposed with VRF (DX type) coil for cooling requirement. These areas are to be maintained within acceptable ranges of temperature.
- For Comfort Air Conditioning Area VRF type Cassette unit / Hi wall unit is proposed.
- Filtered, cooled, and dehumidified air from the respective AHU's shall be fed into the air conditioning space of that particular zone by means of insulated GI ducting and Air Terminal.
- The system will be capable of maintaining temperature and RH conditions through automatic controls.
- The blower outlet duct shall have a silencer to reduce the air noise, the silencer shall be made out of outer & inner layer PP FRP ducting the space between them shall be filled with Mineral wool insulation. Internal duct of the silencer shall be perforated with suitable size holes (minimum 16 mm dia & pitch of 30 mm) the silencer shall be with both ends flanged (For more details refer silencer specification & drawing). The inner & Outer duct area shall be considered as a part of PP FRP ducting, Whereas the Mineral wool insulation shall be supplied as per tender specification & part of insulation line item.
- Smooth internal PP Ducting with FRP outer lining is considered for conveying the fumes from source of generation to Scrubber inlet.
- Fire resistant Isophthalic resin shall be used for binding FRP over & above PP ducting.
- **VRF Control Philosophy & related documents shall be submitted as a part of BMS/EMS tender.**
- **Civil Masonry Pedestals for VRF ODU units shall be part of Civil tender.**
- **VRF Vendor shall submit Detailed Schedule providing details of Design / Engineering, Procurement, Production, Fabrication, Delivery, Erection & Commissioning activities while submitting the Tender.**
- **VRF Vendor shall submit their safety protocols during Erection & Commissioning at site.**
- **VRF Vendor shall submit details of FAT & SAT for BOQ line items wherever applicable.**
- **VRF Vendor shall provide Method Statement for the site execution & erection activities.**

THE HVAC SYSTEM FOR THE PROPOSED AREA IS DESIGNED BASED ON THE USER REQUIREMENT AS MENTIONED BELOW.

AHU no.	Room name	Condition	Area classification	Type	Temperature (deg °c) & Relative humidity (%)	Minimum ACPH	Filtration in AHU	Supply air Terminal	Return air terminal
BASEMENT FLOOR									
B-CU-1	Reception	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-2	Passage	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-3	Material Out	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-4	Material In	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-5	Warehouse	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-6	Office	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-CU-7	Sample Archival	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Cassette Unit	
B-HWU-1	IT Hub	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	VRF type Hi Wall Unit	

GROUND FLOOR									
GF-AHU-1A GF-AHU-1B	Change Room-1, Cell Bank Repository & Cell Freezing Area 2 Isolation	AC	Controlled Not Classified	Recirculation / Once Through	Temp NMT 25°C & RH NC	10 - 15	G4 & F7 G4	4-way diffuser	4-way diffuser
GF-AHU-2	Change Room – 2 & Media Preparation	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Change Room – 3, Autoclave Room, Cool Zone, Media Storage, Corridor & Incubator Room		Grade - C		Temp NMT 25°C & RH NMT 60%	45			
GF-EAU-1	Washing Area, Decontamination & Waste Out		Grade - C	Once Through	Temp NMT 25°C & RH NC	45	G4		
GF-AHU-3	Change Room & Sterility Testing	AC	Grade - B	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
GF-AHU-4	Cell Culture - 1	AC	Grade - C	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille

GF-AHU-5	Cell Culture - 2	AC	Grade - C	Recirculation	Temp NMT 25°C & RH NMT 60%	60	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
FIRST FLOOR									
FF-AHU-1	Passage	AC	Controlled Not Classified	Recirculation	Temp NMT 25°C & RH NMT 60%	10 - 15	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Male Change, Female Change, Passage & Airlock		Grade - D			25			
	Unisex Change Room, Airlock & Passage		Grade - C			45			
FF-AHU-2	Inner Corridor, Microbiology Lab, QC Lab – 3, Dark Room, QC lab – 2 & QC lab – 1	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
FF-EAU-1	Wash + Cleaning Area + Decontamination & Waste out			Once Through	Temp NMT 25°C & RH NC		G4		
FF-AHU-3	Airlock	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Airlock & Cell Culture with Incubator		Grade - C			45			

FF-AHU-4	Airlock	AC	Grade - D	Recirculation	Temp NMT 25°C & RH NMT 60%	25	G4, F7 & F9	Terminal HEPA (H14) Filter with SS Perforated Grille	Return Air Raiser with G4 filter & SS perforated Grille
	Airlock & Virology lab with Incubator		Grade - C			45			
SECOND FLOOR									
SF-DX-HWU-1	BMS Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-DX-HWU-2	UPS Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-DX-HWU-3	Battery Room	AC	Comfort	Recirculation	Temp NMT 25°C & RH NC	6	NA	DX type Hi Wall Unit	
SF-PF-EA-1	Electrical Room	NON-AC	Exhaust Ventilation	Once Through	Temp NC & RH NC	6	NA	DX type Hi Wall Unit	

GENERAL

1. The HVAC system is to be designed as per Good Lab Practice (GLP). The Vendor shall be responsible for preparation & supply of all documents to meet regulatory requirements and shall carry out all tests & necessary work at site to satisfy regulatory authorities.
2. The Tender has to be read in relation to the Drawings and Schedule which forms a part of the tender documents. AHU Capacities (Cooling and heating) shall be vetted by the HVAC vendor after detailed heat load calculations. Regarding any contradiction in specification/schedule/standard given in tender, client/consultant decision shall be final.
3. It is must for HVAC Vendor / Contractor- to provide good for construction drawings for co-ordination, shop drawings for production and final as built drawings after project completion.
4. Internal Pressure drop calculation for each AHU shall be provided along with AHU GA Drawing & External Pressure drop calculation for each AHU duct line shall be provided along with coordinated ducting drawing.
5. The ducting measurement shall be provided AHU wise at the time of ducting drawing approvals.
6. HVAC vendor shall make their own arrangements for covered storage of ducts and equipment's and other store material at site. Space shall be provided by client. Provision for cranes, hoist, scaffolding and other necessary arrangement for installation of HVAC system shall be included in the offer.
7. HVAC Vendor shall carryout all coordination activities with client/consultant/other sub vendors like AHU supplier, electrical contractor, piping contractor, civil contractor, false ceiling & clean room / wall partition contractor, validation team etc.
8. Last 10% payment shall be released only after submission of **final as built drawings**.
9. HVAC vendor shall provide shop drawings for all HVAC utilities for approval. Vendor shall check and vet coordination drawings for all services along with MJA. Vendor shall check the feasibility of installation of all equipment or part of system in the given space in coordination with client/consultant. Vendor shall check these before ordering their equipment's and components. Vendor should ensure site requirement before actual fabrication of any component. Any changes at the site shall be borne by the HVAC vendor. To expedite work, all these drawings shall be jointly checked by vendor in MJA office to enable clearance across table.
10. The tenderers shall quote according to the specifications as far as possible, but where deviations are unavoidable, they shall state the reason thereof clearly and shall also (in case alternative proposals are made) back them up by furnishing all relevant technical data. They shall also indicate the financial implications. No Price implications shall be entertained for variation in capacity of equipment within +10% of design parameter.
11. No terms and conditions stipulated by the tenderers (whether cyclostyled, printed or otherwise) will be accepted. In the event and in case, the tenderers find deviations unavoidable, such deviations shall be with reference to specific clauses in the tender documents. They shall, as far

as possible, be so worded that in the agreement, which the successful contractor shall enter into with the Owners, they can be introduced as amendments.

12. After the installation is completed, the contractor should conduct performance tests by keeping the plant running continuously for a period of 96 hours. After carrying out successfully acceptance tests Vendor shall also carry Summer/Monsoon/Winter Tests to establish the performance of plant during various seasons. Each test shall be continuously done for 48 Hours. All seasonal tests must be completed within 12 months of start-up of HVAC system.
13. Performance tests shall be carried out in the presence of the Owner's / Consultants representatives, if they so desire.
14. The plant shall be handed over after the contractor has furnished a certificate from the Consultants to the effect that the plant has been commissioned and tested. However, if the period during which such test is conducted does not coincide with either peak summer or monsoon, the tests shall be repeated during those seasons during the Guarantee Period.
15. All the instruments required for carrying out the tests shall be arranged for by the contractor at his own cost. Instruments so required shall also include Anemometers (Capture Hood, Pitot tube and hot wire method only), Manometers, Particle Counters, Temperature Indicators, Humidity Indicators, and any other instruments that may be required.
16. Cleaning Procedure will involve (but will not to be restricted to) the following:
    - Ductwork (or a part thereof) shall be put under negative pressure using a vacuum unit, which incorporates HEPA filters.
    - The accumulated dust in the ductwork shall be dislodged using compressed air / rotary brushes and such other special tools. The dust so loosened becomes air bound and will be extracted out of the duct system, by the prevailing negative pressure created by the vacuum unit. Compressed air employed shall help direct the air borne dust particles towards the suction point(s) of the vacuum unit.
    - Manufacturer's certificate shall be produced for all equipment's listed above including their components.

      The party, who will be carrying out the work, be identified by the Contractor and the details of the equipment, which the party so identified, will be applying for the methodology of cleaning procedure and all related information shall be furnished along with the tender
17. The successful Contractor shall be responsible for the validation as per GLP. Validation requirement should include applicable protocols:

    (a) DQ (Design Qualification):

    The design of the Clean Room with respect to parameters has to be verified & made sure that it full fills the purpose of the project. The parameters include air volume, temperature, RH, pressures, class level and any other specified parameters.

    (b) The following equipment shall be subject to IQ/OQ/PQ protocols.

    (c) IQ / OQ:

    Air Handling Units:
    - Filters
    - Motors
    - Fan

- Cooling coil
- Electrical Heater
- Condensate Draining System
- Constructional details.
- Ducting:

a. Material
b. Composition
c. Quality thickness
d. Galvanizing

PQ (Performance Qualification):

a. Temperature
b. Humidity
c. Particle count for all rooms with 1 cfm particle counter with printer
d. Air pressure difference & balancing
e. Flow visualization (video picture)
f. Installed filters
g. System leakage tests for both AHU's, duct, etc.
h. Velocity check at terminal filter / grille.
i. System recovery test.

Manufacturer's certificate shall be produced for all equipment's and their components listed above. The above procedures should be in addition to carrying out tests.

18. Standards:

Wherever reference is made to IS/BS Specifications, the latest version of the same at the time of tendering shall be adhered to.

19. Works to be done by the Tenderers:

Besides the supply, installation, testing and commissioning of the air conditioning and other allied works, the Contractor shall also include among other items, the following within the scope of his tender.

a. HVAC vendor shall submit a hard copy of tender document duly signed & sealed after reading & understanding the tender.

b. HVAC vendor shall provide the Bill of Materials (BOM) as mentioned below at the time of drawing approval.

- AHU wise ducting quantity in Sqmtr.
- HEPA Filter Schedule & Quantity in Nos
- Insulation Quantity in Sqmtr
- Grille Schedule & Quantity in Sqmtr
- Return air raiser Schedule & Quantity in Nos
- Volume control damper Schedule & Quantity in Sqmtr
- Fire damper Schedule & Quantity in Sqmtr
- Magnahelic gauge Schedule & Quantity in Nos

- Unit supports schedule & Quantity in Kgs

c. Grouting bolts, vibration isolation pads, etc., for all equipment.

d. Material movement in and out of site, storage of materials before erection has to be coordinated with Client's representative and the building service provider.

e. Giving details for making civil openings in masonry wall & slab / floor for all piping, ducts, cables, cable trays, etc. Details of openings in RCC slabs, if required, shall be furnished within 15 days from the acceptance of tender. As the building is ready / work in progress simultaneously, the Contractor shall maintain close liaison with the Building Contractor and intimate his requirement of openings in the walls for piping, ducting, cabling, etc., well in time, to avoid any breaking and making good thereafter. Owner / Consultant will not be made responsible to act as a coordinating agency between the two Contractors and no claim on his account on any matters will be entertained.

f. Providing supports / suspenders for ducts, pipes, cables, etc.

g. Providing drain piping inside the AHU room up to a point where it can be lead out (HVAC Vendor scope) HVAC / AHU vendor shall provide Float ball Type U trap.

h. Working on weekends including holidays without causing any disturbance to existing clients has to be factored in tendering.

i. HVAC Contractor has to co-ordinate with clean room panel vendor for Grille opening size, Raiser positioning, Drawing integration, Raiser installation etc.

j. HVAC Contractor has to co-ordinate with clean room panel vendor for installation.

k. All the internal wiring from the Fan section door limit switch & Internal wiring for AHU light & switch shall be carried by AHU vendor and terminated with a junction box on the AHU casing.

l. HVAC vendor (In coordination with AHU vendor) shall provide details of Masonry pedestals required for mounting AHU to civil vendor, placing of pedestals to suite to the requirement shall be in the scope of HVAC vendor.

m. Any other work connected with air conditioning work, which is deemed to have been included in the scope of this Contract for the satisfactory performance of the plant.

5.0 TECHNICAL SPECIFICATION

a) AIR HANDLING UNITS

❖ **Scope:**

The scope of this section comprises of the Design, Supply, erection, testing & commissioning of Air handling units confirming to the specifications & in accordance with requirement of Air Flow Diagram & AHU schedule sheet.

Space available for the units shall be confirmed with the civil and architectural proposals of the main contract and sizes of the units shall be selected to fit into the space available. The Unit configuration should suit the ducting arrangement.

Minimum acceptable parameters according to above standards shall comply with the following:

Mechanical Characteristics:

a) Casing Strength Classification: D1

The casings to withstand the maximum fan pressure at the selected design fan speed. The maximum relative deflection should not exceed 4 mm/m. No permanent deformation of the structural parts (structures and supports) or damage of the casing may occur.

b) Casing Air Leakage: L1

Air leakage of the air handling unit should be tested under positive & negative pressure & should not exceed the values given below

Max. Air leak rate at - 400 Pa test pressure : 0.15 l/sqm
Max. Air leak rate at +700 Pa test pressure : 0.22 l/sqm

c) Filter Bypass Leakage: F9

The maximum allowable filter bypass leakage rate shall be 0.5% of design flow rate at 400 Pa positive test pressure.

d) Thermal Transmittance: T3

The unit should be designed to have a heat transfer coefficient given below

Heat transfer coefficient U : 1.0 < U < 1.4 W/sqm.K

The test should be conducted in an environment chamber of Eurovent accredited laboratory & the readings should be taken after the steady state temperature difference of 20 K is established.

e) Thermal Bridging Factor : TB2

The unit should be designed to have a thermal bridging factor as given below.

Thermal bridging factor kb : 0.6< kb < 0.75

The lowest difference of temperature at any point on the external surface and the mean internal temperature shall be established. The ration between the lowest temperature difference and the mean air to air temperature difference defines the thermal bridging factor.

The test should be conducted in an environment chamber of Eurovent accredited laboratory and the readings should be taken after the steady state temperature difference of 20 K is established.

f) Air Handling Unit Performance as per EN 13053

The performance of air handling units should be tested in a Eurovent accredited laboratory in accordance with EN 13053.

The tests would be carried out for

- Air flow – static pressure data - power consumption
- Cooling duty
- Heating duty
- Air – side & water - side pressure drop

❖ **Type:**

Air handling units shall be with Double skin construction with Rock wool insulation in between outer & inner skin of the panel.

The Air handling units shall be double skin construction, draw-thru type comprising of various sections such as Fresh air Low Leakage Aluminium Volume Control Damper, mixing box with return air Low Leakage Aluminium Volume Control Damper, Pre & Fine Filter section, Cooling Coil, Heating Coil, Spark Resistance Plug Fan with High efficiency Flame Proof Motor, Bleed off damper with HEPA Filter / Fine Filter, Supply air section with Low leakage Aluminium Volume control damper.

For various configuration of units & other specific requirement, kindly refer Air Flow Diagram & Bill of Quantity for details of units.

All AHU shall be delivered in assembled condition (max 2 to 3 modules) along with factory test certificates for AHU key parameters such as air flow, leakage, static pressure, vibration, noise level, coil performance & power consumption etc.

During Factory Acceptance Test (FAT) AHU shall be completely inspected for all above said criteria's. The AHU shall be completely inspected for air flow conditions, min run test, leakage test, vibration test, sound level test, coil performance & power consumption etc.

Pressure testing & air leakage test shall be conducted for all AHU after assembly at site during **Site Acceptance Test (SAT).**

Unit construction and assembly shall be as per guidelines of EN 1886 and all internal joints to be provided with pencil coving.

Fan and motor base shall be properly earthed either from the factory OR after assembly at site by AHU vendor.

The Interior surfaces are completely smooth without sharp edges or welds and thus easy to clean.

All grooves are sealed with a disinfectant resistant gasket according to VDI 6022 and all gaskets are closed-pores and microbial inert. The door and panel gasket is a revolving, long life time, foamed PUR-gasket with a temperature resistance of –10 to +80°C. It should be of seamless type and designed for long life.

Manufacturer to confirm any impact on material of construction of AHU, filters, coils, during fumigation and de-fumigation (using formaldehyde / Vapour Hydrogen Peroxide)

All doors are equipped with D type gasket, hand levers, metal hinges. Generally, moisture-contact Components are constructed of corrosion- resistant material – exclusively stainless steel – and are equipped with a SS insulated drain pan & ping pong (Float type) drain trap, which ensures continuous and complete drainage of condensation. The AHU should have minimum 600 mm access doors for major components such as fan, filters etc.,

All internal electrical wiring for connecting marine light, limit switch & drive motor etc.. Shall be run in a conduit & neatly dressed, the same shall be terminated in switch on AHU casing either from the factory OR after assembly at site by AHU vendor.

FLOAT TYPE DRAIN TRAP

All AHU shall have float ball type drain trap as shown below.

- **Capacity**

Please refer Air flow diagram and Bill of Quantities for the air handling unit capacities and static pressure.

❖ **Housing/Casing**

The housing/casing of the air handling unit shall be of double skin construction. The Frame work shall be of Extruded Aluminium hollow sections. The entire frame shall be assembled using pressure die cast aluminium joints to make a sturdy, strong & self-supporting frame work for various sections. Units shall be complete with Thermal Break Profile as well as Double Skin Panels in Thermal Break Construction.

The casing shall comply with Mechanical Performance as per EN 1886 review: 2002 (E)

50 mm thick Double Skin Panels shall be made of 0.8 mm Pre-coated GI sheet on outside and 0.8 mm Plain GI sheet in the inside with **50 mm thick injected HFC - Filler Rock wool insulation material of 96 Kg/M3 density**, sandwiched between the external and internal sheets. The GSS sheet used for the Panel Manufacturing should have a minimum zinc coating of 120 gms/sqmts on both sides. These panels shall be screwed on to the frame work with soft rubber gasket fixed in built-in groove of aluminium frame in between to make the joints air tight to create a smooth surface inside and outside. All panels shall be sealed (anti fungicide sealant material) against the frame work.

The frame shall be assembled to make a strong, sturdy and self-supporting framework for different sections. The removal of the side panels should not affect the structural integrity of the unit. Frame work for each section shall be jointed together with soft rubber gasket (EDPM) in between to make the joints air tight. Suitable air tight access doors/panels with Nylon hinges with the door hinge pin fabricated of stainless steel. Locks shall be provided for access to various sections for maintenance. Inspection Doors shall be provided with special Gasket (Food Grade Neoprene Rubber gasket-D type) for complete air tightness. The entire housing shall be mounted on Rolled Formed Continuous GSS channel frame work of 100mm height, having pressure die cast aluminium joints.

AHUs (1.8 Mtrs Height and above) shall be provided with 3 mm thick aluminium anti slip plate on fan section and the filter section with inspection door.

Volume control Dampers shall be of low leakage type with Graduation & interlocking arrangement, opposed blade louver type. Blades shall be made of extruded aluminium construction and shall be rattle-free.

All the AHU after assembly at site has to be cleaned and mopped with disinfectant before fixing the filter, Pressure tested for leakage and leakage rate to be in compliance with Mechanical Performance as per EN 1886:1998.

Each Section has to have a Tag on the casing, mentioning the component (Mixing Box, Filter section, Coil section, Fan section etc.). Also the Airflow direction has to be marked on the casing.

All Air Handling Unit shall be Eurovent Certified EN-1886 & EN-130353 with following details

- ♣ Casing Strength of Units : Class D1
- ♣ Casing Air Leakage of Units : Class L1
- ♣ Thermal Bridging Factor : Class TB2

- ♣ Thermal Transmittance : Class T3
- ♣ Filter Bypass Leakage : Class F9

AHU needs to be equipped with a minimum 2 mm thick base frame. This base frame is galvanized and powder coated (60µm) and with aperture for crane transport via transport tubes or optional for shackle transport.

The doors should be provided with sturdy handles in steel with a rubberised covers for proper grip. In compliance with the highest applicable standards of hygiene, all components are factory-cleaned and packaged in foil for transport.

Fan

Fan Type: Centrifugal Backward Curved Fans

The fan shall be of double inlet, double width backward curved type. The wheel & housing shall be fabricated from heavy gauge galvanized steel. The fan impeller shall be mounted on a solid shaft supported to housing with Angle iron frame & heavy-duty ball bearings. The fan shall be selected for highest efficiencies and a noise level less than 85 db (A) at 1m distance from equipment. The impeller & fan shaft shall be statically and dynamically balanced.

The Fan outlet velocity shall not be more than 10.5 m/sec.

The fan outlet shall be connected to casing with the help of fire-retardant fabric acting as a flexible connection for anti-vibration.

Fan bearing shall be permanent lubricated type. Fan drive shall be rated 150% of rated shaft power of the units and shall be fitted with adjustable belt tension arrangement. System shall be constant speed. Fan drive package (Pulleys & belts) should not be left open. They must be protected with screen protection door or belt guard in Fan section. The fan shall be equipped with 'V' belt drive.

The contractor shall select the AHU fans subsequent to ascertaining system static pressure in

accordance with pressure drop calculations to the approval of the engineer.

The motor shall be mounted on a slide rail, common, torsionally rigid, galvanized steel base frame. The whole assembly shall be suitable for withdrawal from the fan section where personnel entry is not intended.

The fan shall be isolated from the casing by means of anti-vibration mountings selected to suit the speed of the fan and designed for 90% isolation. Fan should be selected at 10% higher than rated capacity.

Fan selection should be of the best possible efficiency. The technical submittal for AHU's shall have minimum 3 Fan selections with their family curve at same duty point, the client/consultant shall select the highest efficiency fan based on requirement.

AHU vendor shall submit AHU GA Drawing, Fan GA Drawing & Fan selection along with technical data sheet in the format mentioned below.

Format of Annexure A (Technical) enclosed

AHU No.	Air volume	Total Static	External Static	Hz at rated capacity	Fan speed at rated capacity	Power absorbed at rated capacity	Fan maximum speed at rated capacity	Max air volume and static efficiency of fan @ rated total static pr.	Motor KW @ maximum speed	Motor KW selected

Format of Annexure B (Technical) enclosed.

AHU No.	Design Criteria (rated)				Design Criteria (@75% total Pr.)				Design Criteria (@50% total Pr.)			
	Air volume	Internal Static	External Static	Hz at rated capacity	Air volume (Constant)	Internal Static @ 75%	External Static @ 75%	Hz at this capacity	Air volume (Constant)	Internal Static @ 50%	External Static @ 50%	Hz at this capacity

❖ **Motor:**

Fan motor shall be suitable for 415 ±10% V, 50Hz, totally enclosed surface-cooled 3phase current motor, IE 2.

Version B, protection type IP55, insulating material class F, motor protection by a thermal contact. Motor shall be especially designed for quite operations. Fan should be selected at 10% higher than rated capacity. The Motors are to be suitable to run with Industrial type VFDs.

❖ **Cooling / Heating coil**

Cooling coils / Heating coil should have the capacities as indicated in the Bill of quantity. The cooling coils should have VRF DX Refrigerant as the cooling medium. The cooling coil / Heating coil should be designed to suit R-407C/R410a refrigerant. The heat exchanger should be removable from the side and the frame material should be stainless steel SS304. The air velocity across the coil face shall not exceed more than 2.25 m/sec (450 FPM).

Cooling coil / Heating coil should be easily slide able type from sides without disturbing other sections for maintenance. Cooling / Heating Coil supports should be in complete stainless-steel material. No MS supports are acceptable.

The cooling coil / Heating coil should be made of copper tubes and Aluminium fins. Fin spacing should be 2.5mm only. Coil header shall also be made of MS pipe with anti-corrosive paint. The coil should have aluminium frame and base support in SS. The cooling coil shall be provided with drip separator having SS Frame and blades in Poly Propylene. The drip Pan should be designed for quick removal of moisture and constructed in SS with good insulation material.

The inlet and outlet connection shall be on the same side, the connection and maintenance side must be confirmed before starting the manufacturing. The coils should be designed for a maximum pressure of 16 bar and maximum temperature up to 120°C.

Cooling coil should be designed to cover the whole cross section of the unit. Coils inlets / outlet should have MS Flanges with Anti-corrosive painting and mating flanges.

Differential pressure or pressure drop measurement provision across coils to be provided by manufacturer for initial qualification and periodic measurement as and when required.

SS Temperature probes before and after the coil section to be provided.

❖ **FILTERS**

Filters should strictly meet MERV Standards and are to be supplied with manufacturers test certificates.

The G4 Pre filter shall be washable type, whereas the F7, H13 HEPA & H14 HEPA filter Disposable / Throw away type. The fresh air filter MERV 8 shall be designed for final pressure drop whereas the F7, H13 HEPA & H14 HEPA filter shall be designed for in-between pressure drop (between initial pressure drop and final pressure drop).

All Filter compartments of the AHU will be supplied with factory fitted differential pressure gauge / Transmitter, whereas the Bleed HEPA filter shall be with provision for an external differential pressure gauge / Transmitter is proposed to indicate the health / condition of the Filter.

PRIMARY FILTERS

G4 Filter should be washable type with a classification according to EN 779 Standards.

ISO Corse Filter should be washable type with a classification according to ISO 16890 Standards.

Filter depth should not be less than 50 mm. The clean filter pressure drop should not be exceeding 75 Pa @0.94m3/s (2000 CFM), but the system should be designed for washable filters.

G4 Pre Filter with Average Efficiency of Not Less than 90 - 95% as per ASHRAE standards 52.2 of Particle size 10 Micron.

Filter Manufacturer certificate to be provided.

SECONDARY FILTERS

F7 (ISO ePM1) Filter Inherently rigid filter element fastened into filter frame. The Filter media shall be washable type & pleated into mats in a zigzag format. The depth of filter should be 300 mm. The filter should be designed for non-washable / disposable type filters.

F7 (ISO ePM1) Fine Filter with Average Efficiency of Not Less than 95% as per ISO 16890 standards of Particle size 3 Micron.

Filter Manufacturer certificate to be provided.

F9 (ISO ePM1) Fine Filter Inherently rigid filter element fastened into a quick-change filter frame, material PCGI. Filter medium synthetic glass fibre temperature resistant up to 120°C. The endurance should be up to max final pressure difference of 800 Pa, the depth of filter should be 300mm. The filter should be designed for non-washable / disposable type filters.

F9 (ISO ePM1) Fine Filter with Average Efficiency of 85% as per ISO 16890 standards of Particle size 0.3 Micron & 99% as per ISO 16890 standards of Particle size 1 Micron.

Filter Manufacturer certificate to be provided.

Filter integrity test (with EMERY 3004 oil mist or as stated in ISO guideline 14644-2) should be carried out on all HEPA filter banks. A penetration of 0.01% on filter media and seals should not be exceeded. HEPA filter frames should be well sealed with a sealant to prevent any particles by-passing the HEPA filters. The filters should be mounted by SS wing nuts / Cam lock arrangements. The filter integrity tests should involve individually scanning filter media, filter frames and frames to plenum seals. Filters should be easily accessible.

Filter mounting frame should be sufficiently rigid to withstand a pressure differential equivalent to the filter bursting pressure, without distortion. Filter fixing frame should be in galvanised steel with powder coated finish and will be equipped with maintenance door. Magnahelic gauges to be provided all Filters. The tubing connections on all Magnahelic gauges should be silicone tubing.

Rev : 1 30th April 2018	FILTER GRADE EQUIVALENCE TABLE								FILTER EFFICIENCY VALUES AT PRESENT IN PHARMA MARKET IN INDIA	ISO 14644 BASIC REQUIREMENTS				
	PRE & FINE FILTERS					HEPA & ULPA FILTERS					ISO 14644 MANDATORY TO BE REPORTED			
	EUROVENT 4/9	EN 779	EN 779	ASHRAE 52.2	ISO 16890	EUROVENT 4/9	EN 1822	ISO 29463	STANDARD FRACTIONAL EFFICIENCIES (ALTERNATE ONLY IF CUSTOMER DEMANDS)	ISO 14644 MINIMUM EFFICIENCY REQUIREMENT %	PARTICULATE MATTER EFFICIENCY %			DUST HOLDING CAPACITY
	MERV	MERV	2012	(2007) MERV	2017		2011				ePM1 C	ePM2.5 C	ePM1	
COARSE	EU 1	G1	G1	1	ISO Coarse					< 50 % Initial Gravi. Arrestance	YES	NO	NO	YES
	EU 2	G2	G2	2 to 4					65 % Down To 30 µ					
	EU 3	G3	G3	5 & 6					90 % Down To 20 µ					
	EU 4	G4	G4	7 to 8					90-95 % Down To 10 µ					
FINE	EU 5	F5	M5	9 to 10	ISO ePM10				95-98 % Down To 5 µ	≥ 50% @ 10 µ	YES	YES	YES	YES
	EU 6	F6	M6	11 to 12	ISO ePM2.5				98-99 % Down To 2 µ	≥ 50% @ 2.5 µ	YES	YES	YES	YES
	EU 7	F7	F7	13	ISO ePM1				99 % Down To 1 µ	≥ 50% @ 1 µ	YES	YES	YES	YES
	EU 8	F8	F8	14	ISO ePM1				80 % Down To 0.3µ (90% Down To 1µ)		YES	YES	YES	YES
	EU 9	F9	F9	15 to 16	ISO ePM1				85 % Down To 0.3µ (99% Down To 1µ)		YES	YES	YES	YES
EPA						EU 10	E10		85 % Down To 0.3 µ					
						EU 11	E11	ISO 15 E	95 % Down To 0.3 µ					
						-	-	ISO 20 E						
						EU 12	E 12	ISO 25 E	99.97 % Down To 0.3µ					
						-	-	ISO 30 E						
HEPA						EU 13	H13	ISO 35 H	99.997 % Down To 0.3µ (99.99% @ MPPS)					
						-	-	ISO 40 H						
						EU 14	H14	ISO 45 H	99.999 % Down To 0.3µ (99.997% @ MPPS)					
						-	-	ISO 50 U						
ULPA							U15	ISO 55 U	99.9995 % @ MPPS					
							-	ISO 60 U						
							U16	ISO 65 U	99.99995 % @ MPPS					
							-	ISO 70 U						
							U17	ISO 75 U	99.999995 % @ MPPS					

❖ Mixing Chamber

The two-way mixing box shall be designed for efficient mixing of fresh air and return air by means of interconnecting dampers.

❖ **Canvas connection**

The fan shall be isolated from casing by flexible connection; it should be made of polyester fabric, temperature resistant up to 160°C with high tearing strength. These should be connected on both sides with surrounding air tight duct connection flanges. The vendor to be provide sample of canvas connection after getting the order.

The flexible connection to be provided with counter flange to connect the duct on the discharge side

❖ **Dampers**

Dampers should be constructed in anodized aluminium, finished with powder coating. The dampers should have aerofoil design for minimum pressure drop. The dampers should be air tight. The damper is certified and approved to DIN 1946 Part 4, with opposed blades, distortion- free hollow profile aluminium fins, sealed with special rubber lips. Frame should be made of galvanized sheet steel with 60µm powder coating, depth 150mm. Bearing should be made of polyamide. The gear wheels for the drive should be located outside the air stream.

The manually operated dampers should be provided with Graduation & locking arrangement. The locking device to remain perfectly locked at all operational conditions of AHU.

The dampers should be provided with following accessories.

- Mechanical Lock with handle and graduation of opening marked on handle. Identification of open and close is must on damper handle side.
- Suitable Cover for Gear Train to avoid dust accumulation.
- The Damper surface shall be duly insulated after installation.

VOLUME CONTROL DAMPER WITH LOCKING & GRADUATION ARRANGEMENT

❖ Accessories

All air handling unit shall be supplied with following accessories:

- Marine Type Light, limit switch for blower section, safety grille for blower section and view glass for fan and filter sections shall be provided wherever required /specified.
- Fresh air damper, return air, by pass air, bleed air and supply air opposed blade Low leakage type volume control dampers suitable for manual and motorised operation.
- Each air handling unit shall be provided with manual air vent at high point in the cooling/heating coil and drain plug in the bottom of the coil.
- Magnehelic gauges Mounted in a box shall be provided for all type of filters.
- Pressure measuring ports (6mm SS) with dead nut shall be provided across each section to monitor the pressure drops.
- Stainless steel drain pans with insulation & Ping Pong type drain arrangement for proper draining of condensed water.
- Temperature measuring ports (20mm SS) at the inlet and outlet of cooling/heating batteries shall be provided to monitor the temperature.
- AHU name plate shall be provided with following information:
  - Fan details with all capacities.
  - Static pressure
  - Filtration level
  - Motor HP
  - Coil details.
  - AHU No. and the area it is feeding
  - Each compartment will be separately named including filtration level, filters, initial and final pressure drop, cooling coil data, heating coil data, etc.
  - Arrows for air directions
  - Schematic Airflow diagrams
  - Each AHU Shall be provided with laminated coloured AHU GA drawings showing all the components / Airflow Drawings duly pasted on AHU.

In addition, the following accessories may be required at air handling units, their detailed specifications are given in individual sections, and quantities separately identified in Schedule of Quantities.

❖ **AHU GA drawings:**

Within 10 days after the award of contract, the contractor shall furnish 3 sets for approval (detailed GA drawing of AHU) and bar chart of complete activities required to complete the project as per specifications. These drawing shall contain details of construction, size and arrangement, BOQ, components data sheet with drawing, performance characteristic and capacity.

Shop drawing also includes performance curves of fan and motor.

Manufacturer will also be responsible for documentation like DQ/IQ protocol and same has to be submitted for approval by **Client.**

All supporting documents shall include

1. All air handling units MOC certificate
2. All air handling unit's insulation certificate
3. All air handling unit's components MOC certificate like damper, flexible connection, cooling coil, heating coil, drain pan, etc including size, qty, etc
4. Test and MOC certificate of all filters with filter numbering
5. Calibration certificates of all Magnehelic gauges, pressure transmitters or transducers, pressure switches, etc with serial no.
6. Hydro test certificates of cooling and heating coil mentioning the max test pressure conducted, etc
7. Motor and blower test certificate including performance curve drawing.
8. All components of AHU to be tagged physically in comparison with the approved drawing.
9. Instruction, Operation and Maintenance manual for AHU and EAU including Standard operating procedure, maintenance schedule, trouble shooting, spare / filters replacement practices, etc. The vendor shall also give the AHU foundation detail after receiving the LOI or purchase order from Client

Performance Data

Air handling units shall be selected for the lowest operating noise level of the equipment. Fan performance rating and power consumption data, with operating points clearly indicated shall be submitted and verified at the time of testing commissioning of the installation.

Safety Features

Each Air Handling Unit must have safety features as under:

1. The Fan Access Door shall be equipped with micro-switch inter locked with fan motor to enable switching of the fan motor automatically in the event of door opening.
2. The Access Door shall further have wire mesh screen as an added safety feature bolted on to the unit frame.
3. Fan and motor base shall be properly earthed from the factory
4. All screws used for panel fixing and projecting inside the unit shall be covered with PVC caps to avoid human injury.
5. All internal wiring for the light fixtures, micro switch inter-locking with fan motors to be carried out in the factory and terminated on the AHU casing in junction box.
6. In case of VFD driven motors, the necessary electrical & control cabling to be terminated on AHU casing in a terminal box. VFD is in the Electrical scope of supply.

❖ **Inspection:**

Inspection including witness of test will be carried out by purchaser or his authorised representative, if required. However, test certificate shall be submitted and obtained clearance before dispatch of the assembled unit.

Vendor shall notify purchaser in writing or his authorised representative in writing at least 15 days prior to the scheduled for inspection/tests.

Vendor shall submit calibration certificate for all instruments/pressure switches etc. supplied with the equipment indicating serial no of instrument and location of installation.

Testing

Cooling/heating capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by an anemometer and temperature measurements by accurately calibrated mercury in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

❖ **Testing at Site**

All AHU, VSU, VEU and EAU to demonstrate Run Test for Air quantity v/s static pressure and Leak Testing, Vibration and Noise level, Coil performance, Power consumption. After the installation is finished, the bidder shall make all required adjustment until all guaranteed performance requirement are met. Vendor to adjust air flow quantity as per the approved airflow diagram during commissioning stage. After the entire system is adjusted, the supplier shall conduct acceptance test

in presence of Engineer-in-charge to meet the guaranteed performance requirement to the satisfaction of Engineer-in-charge. All instruments required to carry out these tests will be arranged by the bidder. The test report shall be submitted for Client's approval before handing over of the plant as per the test protocol supplied by consultant/client.

Manufacturer to provide site acceptance test procedure and testing criteria for customer/consultant approval. Completion of operational qualification along with SAL representative is vendor's scope of work.

The following readings shall be taken (and results computed) during the performance tests on the plant.

I AIR HANDLING UNITS:

1. Entering Air dry bulb temperature - ºC :
2. Entering Air wet bulb temperature - ºC :
3. Leaving air dry bulb temperature - ºC :
4. Leaving air wet bulb temperature - ºC :
5. Dry bulb temperature in S.A. Plenum of air leaving Fine Filter Section - ºC :
6. Air flow rate – CMH :
7. Total pressure developed by Fan - mm wg :
8. Static pressure of Fan - mm wg :
9. Fan speed – rpm :
10. Fan motor current – Amps :
11. Entering CH water temperature - ºC :
12. Leaving CH water temperature - ºC :
13. Pressure drops across CHW coil – mm wg :
14. Water-side pressure drop - Kg/sq.cm :
15. Entering Hot water temperature - ºC :
16. Leaving Hot water temperature - ºC :
17. Pressure drops across HW coil – mm wg :
18. Water-side pressure drop - Kg/sq.cm :
19. Vibration peak-to-peak displacement in microns :
20. AHU to be leak tested to 700Pa Positive Pressure Using Duct Leak Testing Machine :

II FILTER BANKS:

1. Efficiency - % (State method of test) :
2. Pressure drops across G4 – mm wg :
3. Pressure drops across F7 – mm wg :
4. Pressure drops across H14 – mm wg :

NOTE: 1. all readings shall be taken at 1 hour interval for 24 hours continuously.

❖ **Maintenance**

The AHU shall be maintained on a schedule as indicated by the supplier. Supplier is to provide (at minimum) the following maintenance instructions.

a) Maintenance activities for all Sub-Systems (maintenance and operational manual of vendor equipment)

b) A comprehensive recommended maintenance (regular recommended inspection intervals, wear points, recommended spare part list etc.)

c) Supplier should include 2 copies of operation, installation and maintenance manual.

❖ **Delivery**

The AHU should be delivered in an assembled condition and in a wooden packing or as per mfg std. The assembled AHU can be in 2 or 3 modules that are only required to be bolted at site to make a single assembled unit.

a) The AHU should be delivered along with maintenance and operational manual.

b) Control schematics (if Any)

c) Bill of Material

d) Spare part list.

e) Test and calibration certificates of all components used in the system.

❖ **Performance Guarantee**

Supplier shall guarantee that upon completion of the work all portions will be in full accordance with the requirements of the contract and will be perfect as to materials and workmanship and remain so far a minimum period of one year from the date of final acceptance by the client. The bidder shall also guarantee that the equipment will operate satisfactorily and the performance and efficiencies of the equipment when operating under normal condition shall not be less than the guaranteed values. The bidder shall further guarantee that during the one-year period he will repair all defective work and will replace all defective materials furnished or installed under the contract, free of cost to the Client within reasonable time from the detection thereof. The bidder shall be responsible for the performance irrespective of the specifications mentioned in the tender.

♣ Kindly note that any deviation from above specification must be notified in writing while quoting as an extra sheet – "List of technical deviations".

♣ Any deviation as considered by manufacturer other than those mentioned in this document should be explained with appropriate justification note (duly signed) wherever it is applicable during bid submission.

b) TECHNICAL SPECIFICATION FOR NITRILE RUBBER THERMAL INSULATION

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber with aluminium foil laminated on one side.
- Density of Material shall be 45 - 70 Kg/m3
- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667.
- The insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed 2.9 x 10^{-14} g/m.s.Pa i.e. Moisture Diffusion Resistance Factor or 'μ' value shall be minimum 12000.
- Insulation should have flame spread classification not more than 25 & smoke developed classification of not more than 50 as per ASTM E84-16
- Insulation should have anti-microbial property as per ASTM E 2180-07
- The insulation material shall have fire performance of V0, HB as per UL 94, 1996.
- Density of insulation material shall be between 40 to 55 Kg/m3.
- The insulation material shall be dust and fibre free.
- The insulation material shall withstand maximum surface temperature of +85 Deg.C and minimum surface temperature of 0 Deg.C as per EN 14706.
- The Aluminium foil shall be of 12 micron thickness with reinforced glass scrim and weight shall be 70 gsm as per EN 22286, tensile strength shall be 250N/50mm as per ISO 527-3 with elongation of 4% as per DIN 53354.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.
- The Proposed Insulation shall be of Self-Adhesive type Class O insulation.

c) TECHNICAL SPECIFICATIONS FOR VRF UNITS

♣ **INVERTER TYPE VARIABLE REFRIGERANT VOLUME (VRV) / VARIABLE REFRIGERANT FLOW (VRF), OUTDOOR UNITS – AIR COOLED**

- Outdoor units, or condensing units, should comprise of cabinet, 100% Multi Inverter compressors, condenser coil, condenser fans, receiver / accumulator tanks, electrical and microprocessor panel, oil separation mechanism and supporting structure.
- Entire unit must be factory assembled & factory tested and dispatched as a unit from factory. The Unit shall be suitable for all weather Outdoor mounting.
- COP of every outdoor unit quoted must be more than or equal to 2.6 at **Pune** conditions – Out door temp 36 to 38 deg C, and motors above 1 KW capacity must have efficiency more than 85% when operating on full load capacity of condensing unit.
- The cabinets should be fabricated out of M.S. / C.R.C.A. sheets and sections, duly painted with anti-corrosive primer & paint. The painting procedure, material thickness and colour shades may be as per manufacturer's standards. The cabinet should have pre-drilled holes for installation on foundation / frame and should be installed using anti-vibration rubber pads. The cabinets should have adequate openable doors for accessing internal components for regular inspection and maintenance. The doors & locking arrangement should be suitable for outdoor installation in tropical weather.
- Compressors should be hermetically sealed type, of make & models as per manufacturer's standards.
- The Total Capacity should be as per Bill of Quantities.
- Minimum one compressor out of one circuit of system should be capable of providing variable capacity by operating on VRF electrical supply or by suitable means like discharge Bypass.
- Air cooled condenser coils should be made out of Copper tubes with Aluminium fins. Fins should be coated with protective layer. Heat transfer area of condenser coils should be adequate to reject extracted as well as compression & motor winding heat to the atmosphere.
- Condenser fans should be axial flow type, with static enough to pump out required quantity of air through a duct of length 8 m, having cross section 150% of fan opening area, and having two short radius elbows. Fans should be top or horizontal discharge.
- Electrical panel for condensing units should be microprocessor based. It should have necessary switchgear & terminations for receiving & processing signal from indoor units & central processor / IBMS, as well as for receiving 415 Volts + / - 10%, 50 Hz + / - 5%, 3 phase A.C. electrical supply. All cable entries should have glands / grommets suitable for exposed installation.

- All components & controls should be accessible for maintenance.
- Entire mechanism and control circuit should be BMS compatible.
- All Indoor Units must be provided with electronic expansion device and microprocessor circuit to modulate the valve, based on signals received from remote sensor and outdoor machine. It should also forward capacity / percentage opening, ON / OFF status and such data to outdoor machine.
- The indoor units (Duct able FCU / Cassette Unit / Hi wall Unit / Ceiling Mounted Hi static duct type indoor unit) should have evaporator coil adequately designed to absorb heat from air pumped over it. It should be fabricated out of copper tubes and Aluminum fins.
- The Indoor Units Cooling coil shall be designed as per the VRF manufacturer's recommendation to meet the cooling load requirement. The coil specification and selection should be signed off by the Contractor / VRF Vendor before coil manufacturing, a copy of which shall be submitted to the Consultant for sign off. Each coil shall be pressure tested for 560Psig at the Manufacturers place and Test certificate to be submitted.
- The Cooling coil specification shall be as under:

Pressure resistance up to 4.1M Pa, No. of rows: Standard 4, Maximum 6 with Intertwined design. Facial velocity: Around 2.0 m/sec, Minimum coil rows shall be 4 with Fin Pitch of 1.95MM.

The VRF outdoor Unit and the Indoor unit coils are connected by refrigerant Piping with ref net joints. Electronic Expansion valve (EEV) which will precisely control the system based on the Indoor demand. The EEV should control the flow of refrigerant system & to be controlled through wired remote control / centralized system.

EEV Kits are to be installed in a vertical/horizontal direction within the range of (9+/-1.5) feet distance from the DX coil header.

Room temperature sensor needs to be devised in the passage of return air, possibly in the Mixing Box, representing room temperature

- All sensors need to be properly insulated.
- The Feed Back between AHU kit & ODU shall be through communication cable.

Submittal Requirement

- Chart for capacity / power consumption ratings for all outdoor unit models, at varying ambient temperatures and part loads must be submitted with offer.
- Capacity charts for the compressor / s used must also be submitted with the offer.
- Datasheet attached must be filled in and submitted along with offers.

♣ **REFRIGERANT PIPING**

PARENT MATERIAL:

The parent material used for air – conditioning system refrigerant piping should be Copper tubes, pipes and fittings conforming to following specifications:

- Material composition should be conforming to C-1220 (JIS-H-3300) or C-12200 (ASTM). It should have a minimum Copper content of 99.9% and Phosphorus content between 0.015% and 0.040%. It should have low residue (below 0.038 g / sqm). The material should also be as per the RoHS norms specified by EU; that is, Mercury, Chromium and Lead contents below 1000 ppm, and Cadmium content below 100 ppm.
- Physical properties of the material should conform to JIS-H-3300 or ASTM-B-68 & B-75, should be tested for Tensile / elongation / hardness / grain size tests as per ASTM B – 280.
- Dimensional tolerance should be as per JIS-H-3300 or ASTM-B-251. The tubes should be tested using non-destructive eddy current test before the final anneal, as per JIS-H-3300 or ASTM-E-243.
- Heat treatment should be carried out in non-oxidizing atmosphere to ensure oxygen-free and cuprous oxide-free surface.
- Proper certificates describing composition and results of all tests carried out must be supplied with each consignment. These certificates, along with check results for dimensional and thickness accuracy are recommended to be carried out for every delivered lot, should be maintained till handing over of the project.
- Wall thickness for soft pipes should be 0.8 mm for ¼", 3 / 8" & ½" tubes, 1.0 mm for 5 / 8" tubes, 1.2 mm for ¾" tubes. Wall thickness for hard pipes should be 1 mm for 7 / 8", 1" and 1.1 / 8" pipes, 1.1 mm for 1.1 / 4", 1.2 mm for 1.3 / 8" and 1.3 mm for 1.5 / 8" pipes.
- Wall thickness for elbows and fittings should be minimum 0.2 mm more than corresponding pipe / tube size.

- For sizes up to ¾", pulley type benders should be used and brazed joints should be avoided as far as possible. Similarly, for pipes of size 7 / 8" or more, one side expanded pipes must be used and use of couplings should be minimized as it leads to increase in number of joints.

PIPING DESIGN:

- Contractor should study the Tender / GFC drawings carefully, and should carry out detailed survey of site / civil drawings, relating the drawings with site, and understand the system design and site limitations.
- Contractor should also collect final architectural and reflected ceiling plans and study the drawings for any mismatches with the HVAC drawings received.
- Contractor should discuss any such mismatches and any doubts regarding system design with the consultant and get all doubts clarified.
- Before commencement of piping work, proper shop drawings must be generated by the contractor USING THE VRF CONTRACTORS COMPUTER GENERATED SOFTWARE, and same should be got approved from the consultant. The drawings must clearly indicate schematic flow diagrams for various circuits, pipe sizes, description and quantities for refrigerant joints, indoor and outdoor unit models and room / block / floor names, pipe routes, levels for horizontal pipes, details regarding insulation type and thickness and surface treatment for insulation, typical and critical sections and any other details to explain the entire piping layout for easy installation.
- Pipe sizing and routing must be carried out taking into consideration various site constraints and VRF system manufacturer's recommendations.
- Care should be taken to design piping as per the manufacturer's recommendation for maximum piping total length, maximum piping length after first tapping, vertical height difference between outdoor and indoor units etc. and necessary corrections should be carried out in outdoor unit capacity if required. The computer-generated Refrigerant pipe sizing and routing layout shall be submitted for consultant approval before site execution.

REFRIGERANT PIPING INSTALLATION WORK:

- The installer must first study the shop drawings in detail with respect to the site condition and point out any fouling / alternatives to the agency prepare shop drawings and necessary revisions must be carried out in the drawings, to be approved by consultant.
- The layout must be marked on the true ceiling and any civil openings required should be marked and got done from concerned agency.

- Supports as described in BOQ / specifications should be installed, leaving adjustable free length for supports.
- Before installation, the pipes and tubes must not be removed from their original packing. Proper storage of piping is a must to maintain the temper of the pipes / tubes. Any abrasion on ends / surface, or any in grace of dirt / dust must be avoided. Proper Polyethylene sheets should be used for covering the pipes and tubes, while wooden pellets and soft expanded Polyethylene / rubber sheets should be used as floor supports.
- Necessary loops / slopes must be followed as recommended by VRF system manufacturer.
- Pipes must be cut to required sizes using cutting tools recommended by VRF system manufacturer.
- Using proper quality of brazing set, Oxygen / Acetylene and Copper brazing rods having minimum 2% Silver content.
- During brazing, Nitrogen must be filled in the Copper piping at a mild positive pressure and must be kept bleeding out continuously, to prevent any oxidation of parent material.
- After piping work, each circuit should be pressure tested as per the VRF system manufacturer's recommendation and as per the procedure described in the following paragraphs. A certificate mentioning the test pressure, time of first and final pressure readings, make, model, serial number, range and least count of the gauge used, along with a copy of valid calibration certificate must be maintained, duly signed by the inspecting technician, and Engineer-in-charge.
- After pressure testing, insulation must be completed out as per the material, make and thickness mentioned in the approved shop drawing. The joints of insulation must be sealed by minimum 50 mm wide Aluminium adhesive tape. Care should be taken to avoid any air gaps between pipe / tube and insulation sleeves, and between two insulation sleeve joints.
- Proper tagging must be carried out to trace the piping to respective indoor and outdoor circuits.
- The pipes running inside the building will be run on perforated powder coated M.S. cable tray as per the specification in Tender BOQ.
- The pipes exposed to sunlight will run in perforated powder coated MS cable tray with Powder coated bolted covers without perforation, cladded / treated to prevent damage from UV radiation and bird pecks / tampering, (To protect refrigerant pipe insulation on terrace, wherever exposed)

- The entire work shall be done in co-ordination with other agencies. General Arrangement Drawing, Layout Drawing and sample of Cable Tray shall be got approved before taking up the manufacturing.
- While cladding, care should be taken to avoid penetrating the insulation by screws. Short screws of metallic straps should be used for securing cladding sheets. Instead of cladding, glass cloth, with two coats of protective resin should be used.
- While charging refrigerant, manufacturer's recommendations must be strictly followed, and charging must be carried out using proper charging hose, gauge manifold with calibrated gauges and electronic weigh scale. Further leak check using a gas leak detector should be carried out. Charging must be carried out after proper evacuation of the piping. The quantity of refrigerant to be charged should be calculated by totalizing the liquid pipe volume as per the manufacturer's recommendation.

RECOMMENDATIONS FOR PRESSURE TESTING:

Refrigerant pipes carry refrigerant at pressures different from atmospheric pressure. When pressure inside pipes is more than atmospheric pressure, refrigerant may escape to the atmosphere, causing commercial loss due to loss of refrigerant, inefficient system performance or even system breakdown and contamination of surroundings. When pressure inside the pipes is less than atmospheric pressure, such as in case of suction pipes of some low temperature refrigeration machines, or during pump-down cycle of normal air-conditioning systems, leakages in pipes leads to ingress of air and moisture, causing severe system damage. Therefore, it is a must that the refrigerant piping is thoroughly tested for leakages.

Pressure testing for any piping must be carried out at a pressure higher than the maximum operating pressure within the system. It is recommended that the pressure recommended by manufacturer be followed very strictly. Testing at lower pressures may lead to no detection of some small leakages, while testing at higher pressures may lead to damage to some factory manufactured components within the system.

For system operating on R-410 refrigerant a pressure of around 600 psig is used for pressure testing.

Nitrogen is the most common gas used for carrying out pressure testing. It has numerous advantages, some of which are listed below:

- Nitrogen is easily available as a commercial gas packed in easy-to-handle cylinders.
- Nitrogen, being the most abundant component of the atmosphere, is safe for leaking out without contaminating the atmosphere.
- Nitrogen is less costly as compared with other gases.

- Nitrogen is safe for handling and testing.
- Nitrogen does not readily react with system components Pressure gauges used for testing must be calibrated and a calibration certificate with traceability to a Government (National) Physical Laboratory must be documented. The gauge should be capable of measuring pressure at least 10% above the reading to be recorded.

PROCEDURE FOR CARRYING OUT PRESSURE TEST

- Ensure that the piping to be tested is properly secured / supported and the openings have been sealed off as per manufacturer's recommendation.
- Install pressure gauges at strategic locations where it shall not be tampered with, at the same time, should be easily visible.
- Install a valve and connecting tubing so that the open end of the tube reaches the cylinder outlet without moving the cylinder.
- Connect the tube to the cylinder and after ensuring proper connection, crack open the cylinder valve, keeping an eye on the pressure gauge. Let the pressure rise to around 10 psig.
- Check for proper sealing of all flanged / flare nut joints or valves / valve glands looking for noise of escaping Nitrogen and seal same.
- Open the cylinder valve again and raise the pressure to 200 psig.
- Check the pipeline for major leakages at brazed joints, elbows, valve glands, equipment end connections and pipe seams with the help of soap water. Make up the leaks by tightening nuts. If the leaks are in brazed joints, flush out Nitrogen and carry out necessary re-brazing.
- Open the cylinder valve again and increase the pressure to 150 psig less than the final test pressure. Repeat leak check as above.
- Open the cylinder valve again and slowly raise the pressure to the manufacturer recommended pressure. Carry out a thorough leak check.
- Record the pressure and time. Let the pressure stand for 24 hours without tampering. Check the pressure again after 24 hours. If pressure has dropped, the piping should be checked very thoroughly for minor leakages. It is important to follow this 24 hours period as it gives enough time to detect minute leakages, and it removes the doubt created by thermal expansion of Nitrogen (as after exact 24 hours, ambient conditions are generally same).
- In case of piping extending to lengths more than 30 m and / or having more than 20 site fabricated joints, the pressure should be recorded after 24 hours as well as after 48 hours, so that all leakages are detected and made up.

- After detecting and making up any leak, the pressure testing must be carried out once again from beginning.

DOCUMENTATION RECOMMENDED FOR ENSURING PROPER QUALITY ASSURANCE:

- Manufacturer's certificate with every Delivery Challan declaring composition of parent material.
- Signed and approved Shop drawings approved by Client/PMC prior to start of work.
- Indoor Unit cooling coil Pressure test and the system Pressure test report signed by Client / PMC.
- False Ceiling closure check list duly signed by Client / PMC.

DRAIN PIPING

All condensate drains should be routed with proper slope to nearest drain point through PVC pipes of minimum thickness 3 mm. Pipes above false ceiling must be insulated with 9 mm thick cross-linked expanded Poly Ethylene Tubular insulation. Pipes buried inside walls or below flooring must be insulated as above and further wrapped with 3 mm thick tar felt / bituminous cloth.

Pipes above false ceiling must be supported at every 1 m distance using circular PVC / metal clamps and full-threaded GI rods 6 mm dia. and must not be allowed to have sags. PVC pipe sleeves must be provided at each support in order to distribute the clamping pressure on a larger area of insulation. In the event of more than one drains being connected to same pipe, "U" traps should be used between indoor machine and common drain header.

Drain piping must be hydro - tested with the help of colored water held in pipes for 24 hours at a pressure of 1 Kg / sq cm. After testing, the open ends should be properly plugged with removable plugs and a certificate of drainpipe testing and plugging should be submitted prior to closing false ceiling / closing shaft / making up wall or partition chasing.

CONTROL SYSTEM

Air-conditioning system should have hardware & software to achieve following levels of control.

AT INDOOR UNIT LEVEL:

ON / OFF status / scheduler, thermostat, air speed, all controls available on respective corded remote controllers.

AT OUTDOOR UNIT LEVEL:

Viewing / monitoring / setting of all controls available at indoor unit level, along with features incorporating monitoring, alarm and safety features for outdoor unit

AT CENTRAL REMOTE CONTROLLER LEVEL:

Viewing / monitoring / setting of all controls available at indoor unit level, along with facility to receive & translate / transit commands received from IBMS & Fire alarm systems, suitable for indoor units.

The control systems at outdoor and central remote controller must have protected passwords.

The control systems should be user-friendly and should be provided with ports and interface for connectivity with standard IBMS packages like BACNET, MODBUS, and LONWORKS. In absence of IBMS, the system must have capability to display status and facilitate remote monitoring through PC.

BAC NET GATEWAY:

A multifunctional compact centralized controller shall be provided with the system which makes it easy to Control and Monitor the air conditioning network in various ways. It shall be able to control up to 256 of indoor units with the following functions & all the data's shall be viewed in the laptop / computer (to be provided by client in the designated room in the building).

SALIENT FEATURES

- Starting/Stopping of Air conditioners as a zone or group or individual unit.
- Temperature setting for each indoor unit or zone.
- Switching between temperature controls modes (Cooling /Heating /Fan /Dry), Enabling/disabling of individual remote controller operation.
- Monitoring of operation status such as operation mode & temperature setting of Individual indoor units, maintenance information, troubleshooting information.
- Display of air conditioner operation history.
- Daily management automation through yearly schedule function with possibility of various Schedules.
- The BAC net Gateway is to be wired by a non-polar 2 wire transmission cable from the VRF ODU to the Controller.

<u>TECHNICAL REQUIREMENTS</u>

Drawings Parameters to be tested on Testing & Commissioning of VRF System:

Before commissioning of the equipment the entire installation shall be tested in accordance with Indian Electricity Rules and IS: 732 and the Test Report of a licensed electrical contractor shall be furnished.

On Commissioning of the HVAC System, the following parameters shall be tested by the Contractor under full load conditions, to confirm compliance with the data furnished earlier and achievement of specified room conditions. All readings to be taken every 2 hours during 12 hours continuous operation, for 4 days:

Balancing:

- Area-wise air balancing to establish air quantity as per design.
- Balancing of refrigerant circuit.

Room Conditions:

- Room conditions in each A/C Area to be recorded under full load conditions.
- Corresponding ambient conditions should also be recorded.
- Uniformity of temperature

VRF Unit Parameters:

- Air CFM
- Air Inlet / Outlet Temperature
- Power Consumption
- Corresponding Ambient Conditions
- Suction Pressure
- Discharge Pressure
- Oil pressure
- Check Functioning of Unloading/Capacity Control
- Noise Level & Vibrations (should not be objectionable)

NOTES:

- After completing air & refrigerant-side balancing, the HVAC Contractor shall carry out testing of the entire HVAC System; and submit specified test results to Client / PMC in a Test Results Format pre- approved by the Client. After carrying out modifications / balancing / corrections (as required), the Contractor shall carry out final testing in the presence of Client / PMC.
- The VRF system's Indoor and outdoor units shall be tested in accordance the provision of ARI Standards, AHRI -1230 2009 for VRF System.

- Noise level & vibrations of all equipment shall be within acceptable limits appropriate for the application & use of the Area.
- All the instruments, special test materials (e.g. Nitrogen gas, helium gas for VAC) required for Testing shall be arranged by the HVAC Contractor only.
- If additional parameters are required to be tested/measured for the purpose of troubleshooting, or for establishing performance of the system / equipment or if required by the Consultant; the same shall be carried out by the Contractor, without additional cost to the client.
- In addition to the above, tests & measurements specified in Technical Specifications of the respective equipment shall also be performed, and test-results there in shall be submitted for the client/consultant review and approval.

TESTS AT SITE

General

The Contractor must perform all inspection and tests of the system as a whole and of components individually as required, under the supervision of the PMC / Site Engineer, in accordance with the provisions of the applicable 'ASHRAE/IS' standards or approved equal and as per site requirements. All tests shall be recorded in the format approved by the Client / PMC

Piping System

In general pressure tests shall be applied to refrigerant piping only before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressures exceeding their test ratings.

Tests shall be completed and approved before any insulation is applied.

Balancing and Adjustment

All indoor units shall be balanced to deliver the specified air quantities indicated, at each inlet and outlet, as required. If these air quantities cannot be delivered without exceeding the speed range of the sheaves or the available horse power

Performance Tests

The installation as a whole shall be balanced and tested upon completion and all relevant information as per 'Test Proforma' including the following shall be submitted to the Department.

- Air volume passing through each unit, etc.
- Electrical current readings, in amperes of full and average load running, and starting together with name plate current of each electrical motor.

Daily records should be maintained of hourly readings, taken under varying degrees of internal heat load and use and occupation, of wet and dry bulb temperatures, upstream 'ON-COIL' of each cooling coil, also suction temperatures and pressures for each refrigerating unit, the current and voltage drawn by each machine.

Any other reading shall be taken which may subsequently be specified by the Client.

The fabrication and shop drawings shall be prepared by the Contractor and got approved from the Consultant & Client before erection.

Test Data

The plant shall be tested as per the specifications given elsewhere and complete `Test Performa' shall be furnished on prescribed sheet.

Technical Data

The HVAC Contractor shall furnish complete technical data on the equipment offered by him as required under the heading `Technical Data'.

Performance Data

The HVAC Contractor shall guarantee that the air-conditioning system performance and shall maintain the designed inside temperature and the relative humidity as specified. The Contractor shall also guarantee that the capacity of various components as well as the whole system shall not be less than specified.

Miscellaneous

The above tests are mentioned herein amplification but not by way of limitation to the provisions specification. Duration of the test shall be continuous 120 working hours. HVAC contractor shall carry out three seasonal tests each of 48 hours duration during defect liability period of the approved dates.

The date of commencement of all tests listed above shall be subject to the approval of the Consultant and in accordance with the requirements of this specification.

The HVAC Contractor shall supply the skilled staff and all necessary instruments and carry out any test of any kind on a piece of equipment, apparatus, part of system or on a complete system if the Client requests such a test for determining specified or guaranteed data, as given in the specifications or on the drawings.

Any damage resulting from the tests shall be repaired and /or damaged material replaced, all to the satisfaction of the Client / PMC.

In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be recommended after the adjustment or repairs have been completed.

The HVAC Contractor must inform to the Client / PMC when such tests are to be carried out giving sufficient notice, in order that the nominated representative of the Client could be nominated to witness the test.

Complete records of all tests must be kept and 3 copies of these and location drawings must be furnished to the Client / PMC.

The HVAC Contractor may be required to repeat the test as required, should the ambient conditions at the time, in the opinion of the Engineer-in-charge is not sufficient and suitable for the performance of the installation as a whole or of any part, as required.

TECHNICAL DATA (To be filled in by HVAC Contractor)

Sl. No.	Description	Unit
1.0	VARIABLE REFRIGERANT FLOW UNITS	
1.1	Actual Capacity at design conditions	HP (TR)
1.2	Weight of Unit	Kg
1.3	Physical Dimensions	mm x mm x mm
1.2	**COMPRESSORS**	
1.2.1	Manufacturer	Name
1.2.2	Model	No.
1.2.3	Compressor type	-
1.2.4	Number of Circuits	No.
1.2.5	Number of compressors	No.
1.2.6	Speed (Maximum)	RPM
1.2.7	Input power at 100% capacity	KW
1.2.8	Refrigerant used	R
1.3	**CONDENSERS**	
1.3.1	Type	
1.3.2	Fans	Nos.
1.3.3	Speed	RPM
1.4	**REFRIGERANT PIPING**	
1.4.1	Name of Manufacturer	Name
1.4.2	Material for pipes	Name

1.4.3	Thickness of pipe	mm
1.4.4	Material of fittings	Name
1.4.5	Material of valves	Name
1.4.6	Make of expansion valve if provided	Name
1.5	**STARTER FOR COMPRESSOR MOTOR**	
1.5.1	Manufacturer	Name
1.5.2	Type of starter	-
2.0	**INDOOR UNIT**	
2.1	Manufacturer	
2.2	Type	-
2.3	Operating weight	Kg
2.4	Overall dimensions	mm
2.5	Noise level	db
2.6	Material and thickness of casing	Name/ mm
2.7	drain pan	
2.8	Dimension of coil	mm
2.9	No. of rows	No.
2.10	Fins per CM	No.
2.11	Type of fins	Plain/crimped
2.12	Tube material	Name
2.13	Thickness of tube	mm
2.14	Tube dia	Mm
2.15	Fin material	Name
2.16	Method of bonding of tubes	- and fins
2.17	Fan section manufacturer	Name
2.18	Type of fan	-
2.19	No. of fans	No.
2.20	Fan speed	RPM
2.21	Fan wheel diameter	Mm
2.22	Drive arrangement	
2.23	Fan outlet area	Sqm
2.24	Fan outlet velocity	m/s
2.25	Air quantity	CFM
2.26	Total static pressure	mm WG

2.27	Motor rating	Kw
2.28	Type of air filters	-
2.29	Size of air filter and quantity	mm/No.
2.30	Thickness of air filters	mm
2.31	Air velocity at filter face	m/s
2.32	Pressure drop across filter	mm WG
3.0	**INSULATION**	
3.1	Manufacturer	Name
3.2	Materials	Name
3.3	Density	Kg/m3
3.4	Mean `K' value	

PERFORMANCE GUARANTEE

Supplier shall guarantee that upon completion of the work all portions will be in full accordance with the requirements of the contract and will be perfect as to materials and workmanship and remain so far a minimum period of one year from the date of final acceptance by the client. The bidder shall also guarantee that the equipment will operate satisfactorily and the performance and efficiencies of the equipment when operating under normal condition shall not be less than the guaranteed values. The bidder shall further guarantee that during the one-year period he will repair all defective work and will replace all defective materials furnished or installed under the contract, free of cost to the Client within reasonable time from the detection thereof. The bidder shall be responsible for the performance irrespective of the specifications mentioned in the tender.

- ♣ Kindly note that any deviation from above specification must be notified in writing while quoting as an extra sheet – “List of technical deviations”.
- ♣ Any deviation as considered by manufacturer other than those mentioned in this document should be explained with appropriate justification note (duly signed) wherever it is applicable during bid submission.

PART 5

SCRUBBER WORKS

CONTENTS

1.0 SCOPE OF WORK

SCRUBBER EXHAUST Tender Scope of work includes Detailed Design, Supply, Installation, Testing and Commissioning of SCRUBBER EXHAUST system as proposed in this part of tender.
The scope of SCRUBBER works includes the following.

- Design of Exhaust system for proposed Facility.
- Preparation of Exhaust P&ID for AHU.
- Preparation of Scrubber, Exhaust Blower Design & positioning layout.
- Preparation of Shop floor ducting drawings with sections.
- Submission of Technical Data Sheet for all BOQ line item.
- Coordination of drawings with other services / Vendors to uphold the design intend.
- Execution at site with all necessary PPE (Personal Protection Equipment)
- Testing & Commissioning.
- Preparation of all required regulatory documents like DQ, IQ, OQ & PQ.
- Preparation & handing over of As Built Drawings.
- Training of service personal & handing over documents.

THE HVAC SYSTEM SHALL BE DESIGNED ON THE FOLLOWING BASIS

- Biosafety Cabinet shall be of Class II A2 type (30% once through type & 70% Recirculation type).
- The Exhaust air from BSC (only from virology lab) shall be filtered through a Dry scrubber before exhausting out. The Exhaust Blower & Dry scrubber are located in Terrace area.
- Corrosion resistant, centrifugal backward type, aerodynamically designed, statically & dynamically balanced, low noise level, Exhaust PP Imported blowers are proposed for this project.
- The blower outlet duct shall have a silencer to reduce the air noise, the silencer shall be made out of outer & inner layer PP FRP ducting the space between them shall be filled with Mineral wool insulation. Internal duct of the silencer shall be perforated with suitable size holes (minimum 16 mm dia & pitch of 30 mm) the silencer shall be with both ends flanged (For more details refer silencer specification & drawing). The inner & Outer duct area shall be considered as a part of PP FRP ducting, Whereas the Mineral wool insulation shall be supplied as per tender specification & part of insulation line item.
- Smooth internal PP Ducting with FRP outer lining is considered for conveying the fumes from source of generation to Scrubber inlet.
- Fire resistant Isophthalic resin shall be used for binding FRP over & above PP ducting.

- The exhaust air volume considered from Biosafety cabinet is as mentioned below: -

BIO SAFETY CABINET (CLASS II A2)	
BIO SAFETY CABINET SIZE	**EXHAUST AIR VOLUME (CFM)**
4 FEET BSC	360 CFM

- **EXHAUST Control Philosophy & related documents shall be submitted as a part of BMS/EMS tender.**
- **Civil Masonry Pedestals for SCRUBBER & EXHAUST Blower shall be part of Civil tender.**
- **Scrubber Exhaust Vendor shall submit Detailed Schedule providing details of Design / Engineering, Procurement, Production, Fabrication, Delivery, Erection & Commissioning activities while submitting the Tender.**
- **Scrubber Exhaust Vendor shall submit their safety protocols during Erection & Commissioning at site.**
- **Scrubber Exhaust Vendor shall submit details of FAT & SAT for BOQ line items wherever applicable.**
- **Scrubber Exhaust Vendor shall provide Method Statement for the site execution & erection activities.**

a) TECHNICAL SPECIFICATIONS FOR SCURUBBER EXHAUST WORKS

DRY SCURUBBER FILTER SPECIFICATION

❖ Design intent:

In order to achieve the desired level of contaminant removal of exhaust air the following equipment and components shall be installed.

❖ Scope:

It has been determined that the air being exhausted must be treated to remove the following:

- A wide range of gas phase volatile organic compounds including solvents, corrosive gases, and other odorous gases.
- One system design must handle all these challenges in a cost effective, environmentally safe and energy efficient manner.

❖ General:

The Dry scrubbing system shall be a complete package, designed for the removal of gas phase contaminants specified by the customer from the air stream. The manufacturer shall have a minimum of two (2) years' experience in the design, fabrication and testing of systems that are capable of removing these gases. The manufacturer shall be a single-source provider of equipment, media and testing services.

The Dry scrubbing system shall be capable of maintaining a high removal rate of all contaminants using media beds of Iodine filters that are required to remove specific gases.

❖ Housing Construction:

The Dry scrubbing System Vendor shall follow the minimum standards for housing construction as mentioned below.

Housing materials shall be suitable for outdoor operation/application.

Housing shall be 5 mm thick Acid Proof PP / PVC with single wall and no insulation seams sealed for absolute prevention of any leakage, and reinforced with support posts where structural integrity is required. Latches shall have a positive over center locking action. All hinges and draw latches shall be constructed of corrosion resistant steel or ABS. Skid base shall be galvanized or aluminized.

Door seals shall be attached by mechanical means along with glue over full door face area. They shall be provided with fully gasketed doors for edge seal and across the face area and opposing walls to seal between internal components of filters and modules.

There shall be no bypass or leakage of air past any filter stage through the pre-filter section and all subsequent stages of the Iodine filter.

Stainless steel or aluminum nameplates shall be provided, permanently attached to the unit. Nameplate shall be engraved with the filter type, order number and serial number, electrical data if included.

Pressure differential gages for pre-filters and Activated Carbon filters shall be provided as part of the housing either integral to housing or mounted on a bracket that is attached to the housing. Tubing for air supply from filter stage to gage shall be supplied and integral to housing.

❖ Analytical Service.

The manufacturer shall provide appropriate lab analysis to determine the remaining service life of the sampled gas-phase media. Such service shall be provided at the manufacturer's expense during the warranty period, including shipping of the media samples to manufacturer's lab.

Site support and Commissioning.

Vendor shall be capable of technical support, trained on all aspects of dry scrubbing system.

After installation of exhaust system ducting, dry scrubbing module and has all necessary electrical / mechanical components to complete for run test.

Vendor shall make available installation and commissioning support on site to ensure all components are tested properly and functional at startup.

❖ ACTIVATED CARBON FILTERS WITH PVC HOUSING / FILTERBOX

Dry Scrubbers are frequently used in applications where the air stream is being treated to remove acid fumes, solvent fumes, Corrosive gasses & other odorous gas.

The activated carbon filter shall be of great adsorption capacity, the activated carbon plates shall be specially designed to filter fumes from proposed lab areas. The Filter casing shall be fabricated out of acid-proof anticorrosive, PVC (MOC). All the components shall be resistant to chemical agents. High-performance pre-filter shall be provided to protect the activated carbon filter from dust & other foreign particles. This pre filter shall increase the performance and durability of Activated carbon filters. Both Pre filter & ACF shall be housed in an anticorrosive injection-moulded casing suitable for outdoor installation. The housing shall be provided with access doors for easy replacement of filters, Door / PVC cover shall protect the filters against rainfall.

The Activated carbon filters / Plates shall be made with highly efficient activated carbons media.

❖ ACTIVATED CARBON MEDIA:

Activated carbon is a micro porous granular carbon that can be produced with different raw material such as peat, wood or fossil coal. The activation process, carried out with vapour or chemical agents, produces millions of pores of molecular dimension that make up a great surface area with a ratio probably larger than 2,000 m2 per gram of activated carbon. Due to the repulsive force these carbon atoms present on the internal surface of the activated carbon attract the neighboring gas molecules.

Due to this mechanism / distribution of pores that guarantees perfect adsorption of the compounds. Activated carbon is used to eliminate all components of a mixture.

DATA TO CONSIDER WHILE DESIGNING / CHOOSING AN ACTIVATED CARBON FILTER:

- Airflow to be treated.
- Composition and concentration of the air to be treated.
- Required performance.
- Maximum temperature NMT 60°C.
- Relative humidity NMT 70 %.
- The contact time between the air and the activated carbon shall be between 0.15 sec to 0.2 sec.

NOTE:

- The activated carbon compactness is a fundamental aspect that must be observed in order to achieve effective results.
- Plates and panels that are not compacted or that have great granulometric values cannot render good results.
- The installation of the activated carbon filter must enable it to work in depression. The use of very small activated carbon filters should be discouraged.
- The list of Chemical used in the lab shall be provided by end user to the tender awarded vendor.
- Filter Manufacturer shall provide a certificate for filter selection to the Chemical list provided.

❖ TERMINOLOGY:

- Adsorption: it is the process by which a very thin layer of gas molecules adheres onto the solid surface of the activated carbon.
- Adsorbent: it is a material, such as activated carbon, through which adsorption is produced.
- Adsorbed: it refers to all the particles that the activated carbon (adsorbent) holds back in its pores.

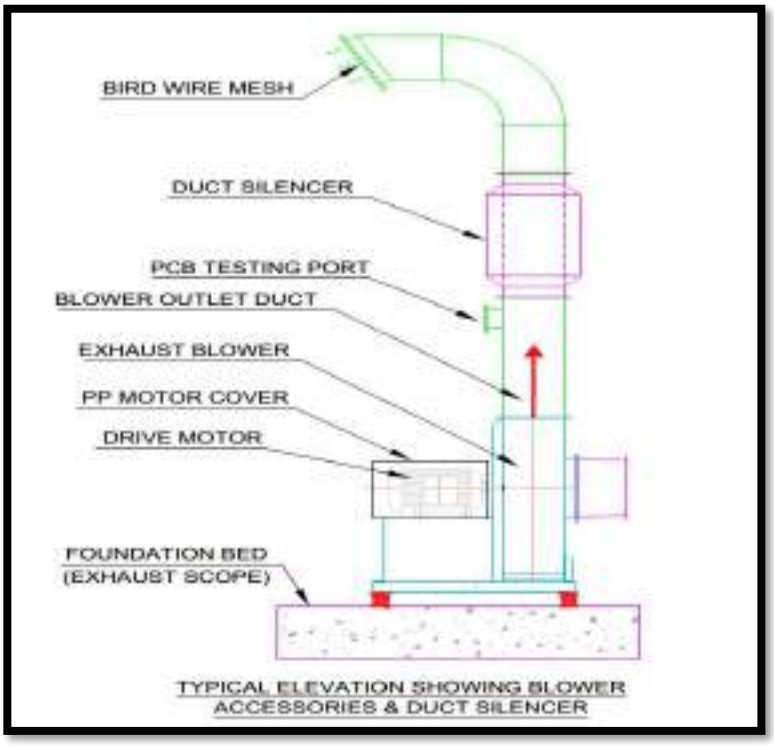
The system shall include but is not limited to the following:

- All scrubber internals necessary to provide adequate process capture and to achieve the designed performance.
- Flange connections with matching flange shall be provided on both the side of the Dry scrubber to connect PP FRP exhaust ducting.
- The Dry scrubber / Activated carbon filter housing shall be supported by an MS supporting structure. The supports shall be shop coated with 2 coats of red oxide paint & 1 coat of epoxy / resistant paint.
- The center line of Dry scrubber / Activated carbon filter housing shall be in line with the exhaust blower center line.

- The fan and motor are designed for system static pressure as per application & depending upon the type & static pressure of Dry scrubber.

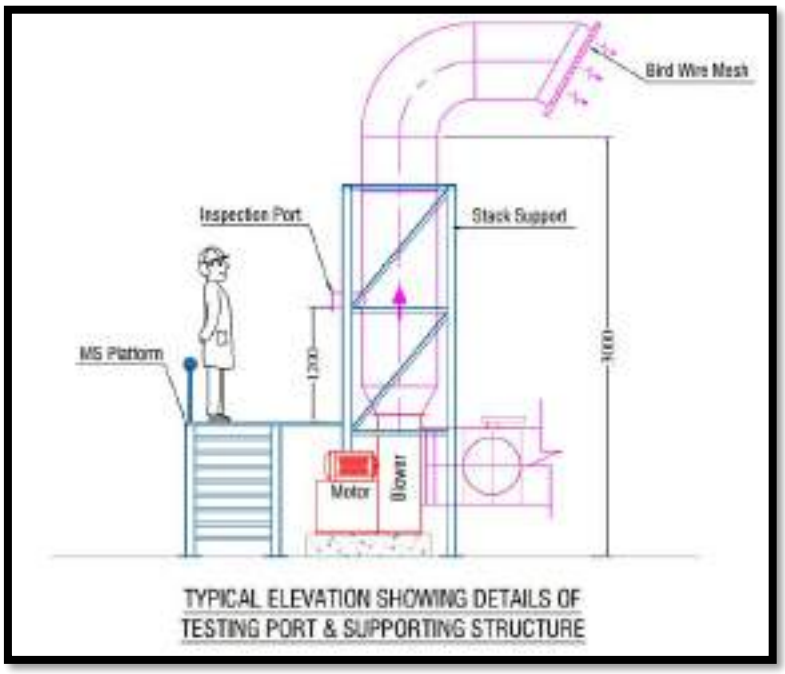
MAIN FEATURES / CONSIDERATION OF THE PROPOSED EXHAUST SYSTEM

- All blowers to be selected as per tender BOQ capacities.
- Corrosion resistant, Centrifugal Backward Type, Aero-dynamically designed, statically & dynamically balanced, low noise level, imported make Exhaust PP blowers are proposed for this project.
- The vertical blower outlet duct shall be let out at minimum three mtrs height from the terrace level.
- 100 mm thick Mineral wool / Rock wool insulation material of 96 Kg/M3 density, sandwiched between the external Plain PP sheet & internal Perforated PP sheets. Insulation shall be spread equal across the silencer to avoid any air pocket. Chicken mesh along with RP Tissue Paper over & above Mineral Wool Insulation shall be considered.
- The blower outlet duct shall have a silencer to reduce the air noise, the silencer shall be made out of outer & inner layer PP FRP ducting the space between them shall be filled with Mineral wool insulation. Internal duct of the silencer shall be perforated with suitable size holes (minimum 16 mm dia & pitch of 30 mm) the silencer shall be with both ends flanged (For more details refer silencer specification & drawing). The inner & Outer duct area shall be considered as a part of PP FRP ducting, Whereas the Mineral wool insulation shall be supplied as per tender specification & part of insulation line item.



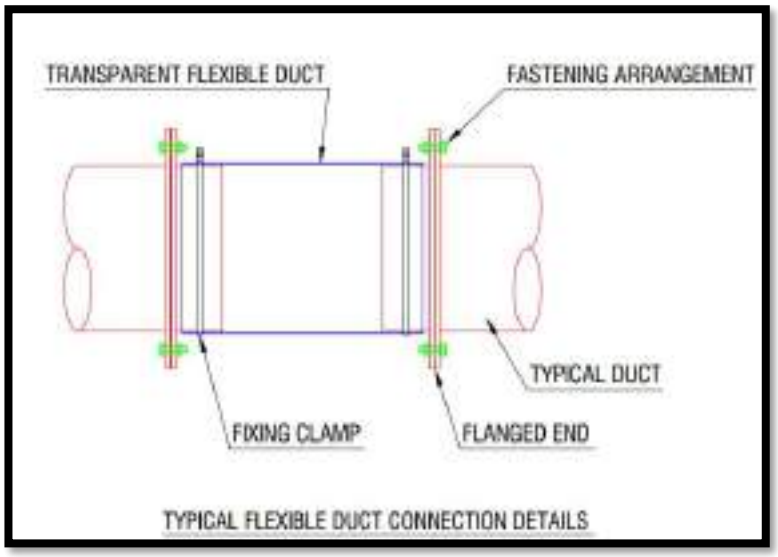
TYPICAL ELEVATION SHOWING BLOWER ACCESSORIES & DUCT SILENCER

- Each blower outlet duct shall have a testing port / sampling port at suitable accessible height.

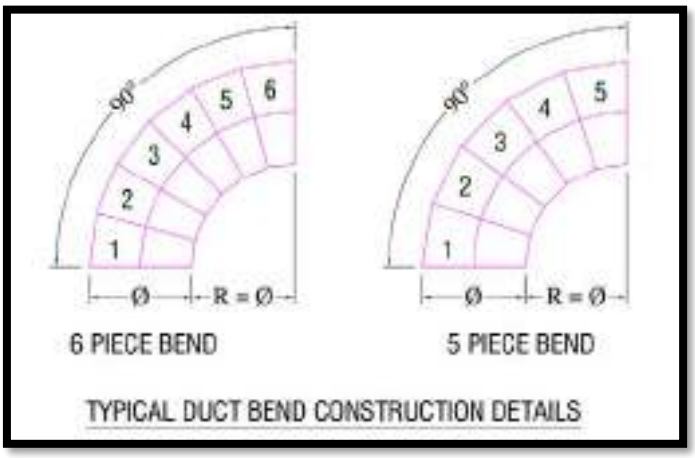


TYPICAL ELEVATION SHOWING DETAILS OF TESTING PORT & SUPPORTING STRUCTURE

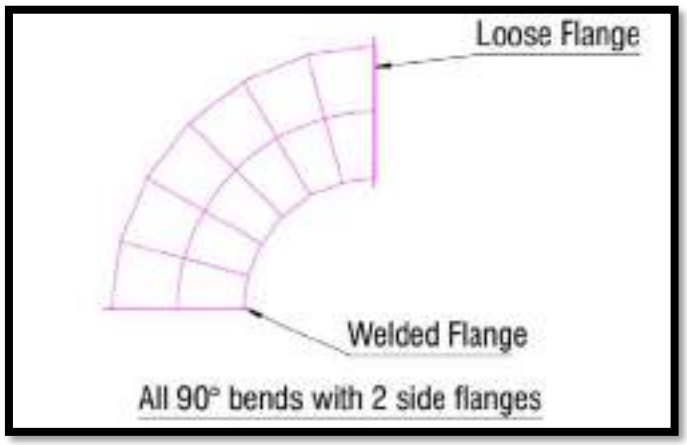
- Blower Inlet & Outlet shall have Flexible connection made out of transparent PP sheet along with flanged spigot & fixing GI clamps on the both ends. The proposed arrangement shall be as shown in the figure below.



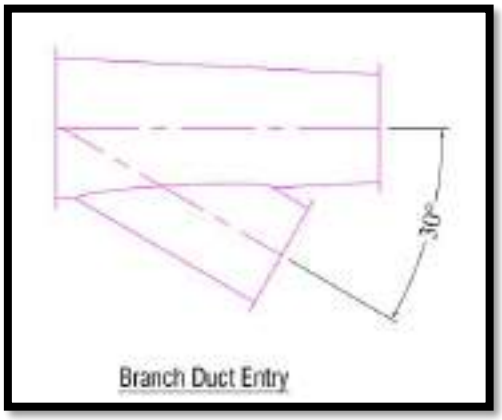
- Dry scrubbers are proposed for scrubbing the gases before letting it to atmosphere
- Smooth internal PP Ducting with FRP outer lining is considered for conveying the fumes from source of generation to Scrubber inlet.
- Fire resistant Isophthalic resin shall be used for binding FRP over & above PP ducting. Resins with combined oxidation and alkali resistance are necessary for Scrubber.
- 5mm thk Neoprene gasket shall be used in between each flange joints.
- All the duct bends shall be of smooth with 5 / 6 - piece construction.

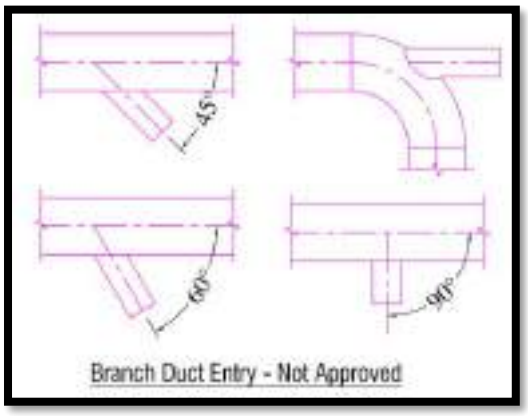


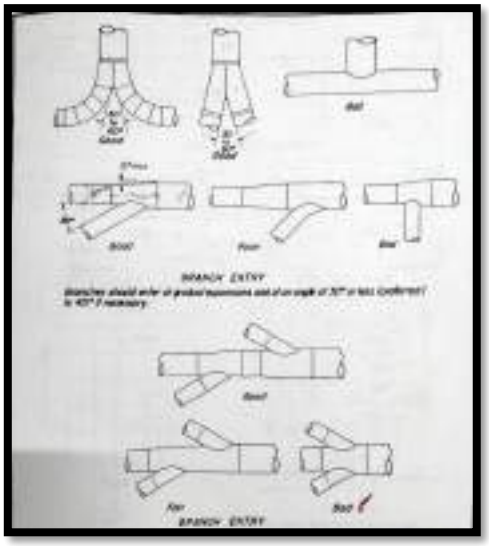
- The 90 Deg bends / ducts shall have flanges on both sides. (Minimum one side loose flange).

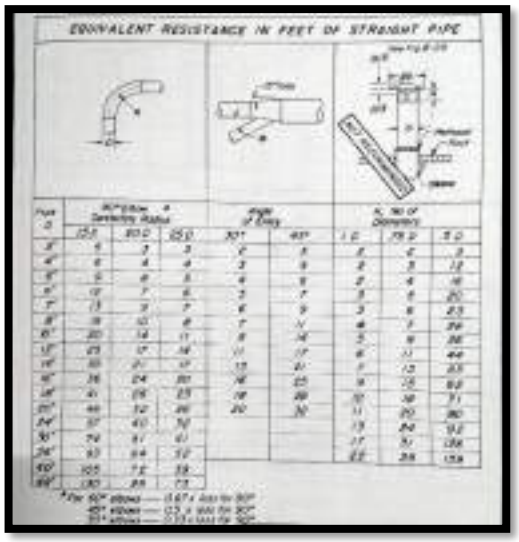


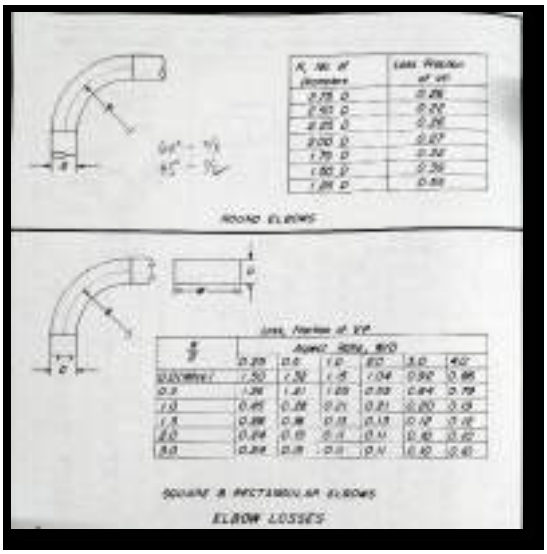
- All branch duct entry shall be 30 Deg to the 'Y' piece / main duct.











- The maximum distance between the two duct supports shall be not more than 2500 mm.
- The Construction / Fabrication of PP exhaust duct shall be round in cross section & Elliptical duct construction is not accepted.
- All flanges shall be made at factory only, no drilling of holes at site is acceptable.
- Radium Sticker showing blower number, scrubber number, airflow directions & future provision on the duct surface shall be provided as per direction of consultant / engineer incharge.

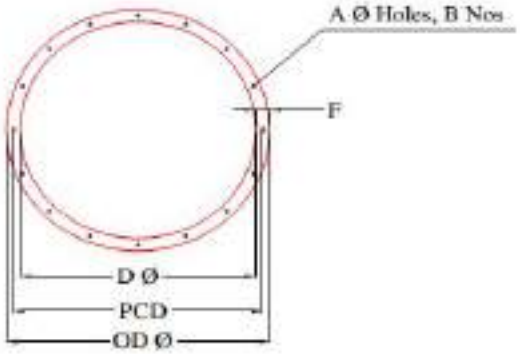
SPECIFICATIONS FOR PP-FRP DUCTING AND ACCESSORIES

❖ Technical Specification for PP-FRP Ducting:

- PP means PPGL: One side smooth & glossy finish and other end is mat finish.
  The smooth surface should be the inner surface of the duct.
  On mat side, FRP lining to be done.
- FRP Lining to be done on the outer surface of PPGL i.e. on mat side.
  One-layer FRP is one mm.
  The final layer should be with fine mat to have smooth and good finish.
- Fire resistant Isophthalic resin to be used
- All the flanges should be properly ground and dressed.
- Duct support distance should not be more than 2500 mm.
- Any duct length should not be more than 2500 mm.
- The finish paint should be admiral grey unless specified by client.
- 5 mm Thick Neoprene gasket to be used between the flange joints.

STANDARD FOR CIRCULAR DUCT FLANGE DETAILS

STANDARD FOR CIRCULAR DUCT FLANGE DETAILS						
SL NO	DUCT DIAMETER	FLANGE THICKNESS	OUTER DIA	PCD	NO OF HOLES	HOLE DIA
	D	F	OD	PCD	B	A
1.	150	30 x 8	210	186	4	8
2.	175	30 x 8	235	211	4	8
3.	200	30 x 8	260	236	4	8
4.	225	40 x 8	285	261	8	8
5.	250	40 x 8	310	286	8	8
6.	275	40 x 8	335	311	8	8
7.	300	40 x 8	360	336	8	8
8.	325	40 x 8	385	361	8	8
9.	350	50 x 8	410	380	12	10
10.	375	50 x 8	435	405	12	10
11.	400	50 x 8	460	430	12	10
12.	425	50 x 8	485	455	16	10
13.	450	50 x 8	510	480	16	10
14.	475	50 x 8	535	505	16	10
15.	500	50 x 8	560	530	16	10
16.	550	50 x 8	610	580	16	10
17.	600	50 x 8	660	630	16	10
18.	700	50 x 8	760	730	16	10



Thickness of PP Flange for Duct shall be 2 times of the specified Duct Thickness over & above FRP coating

NOTE:- FLANGE THICKNESS

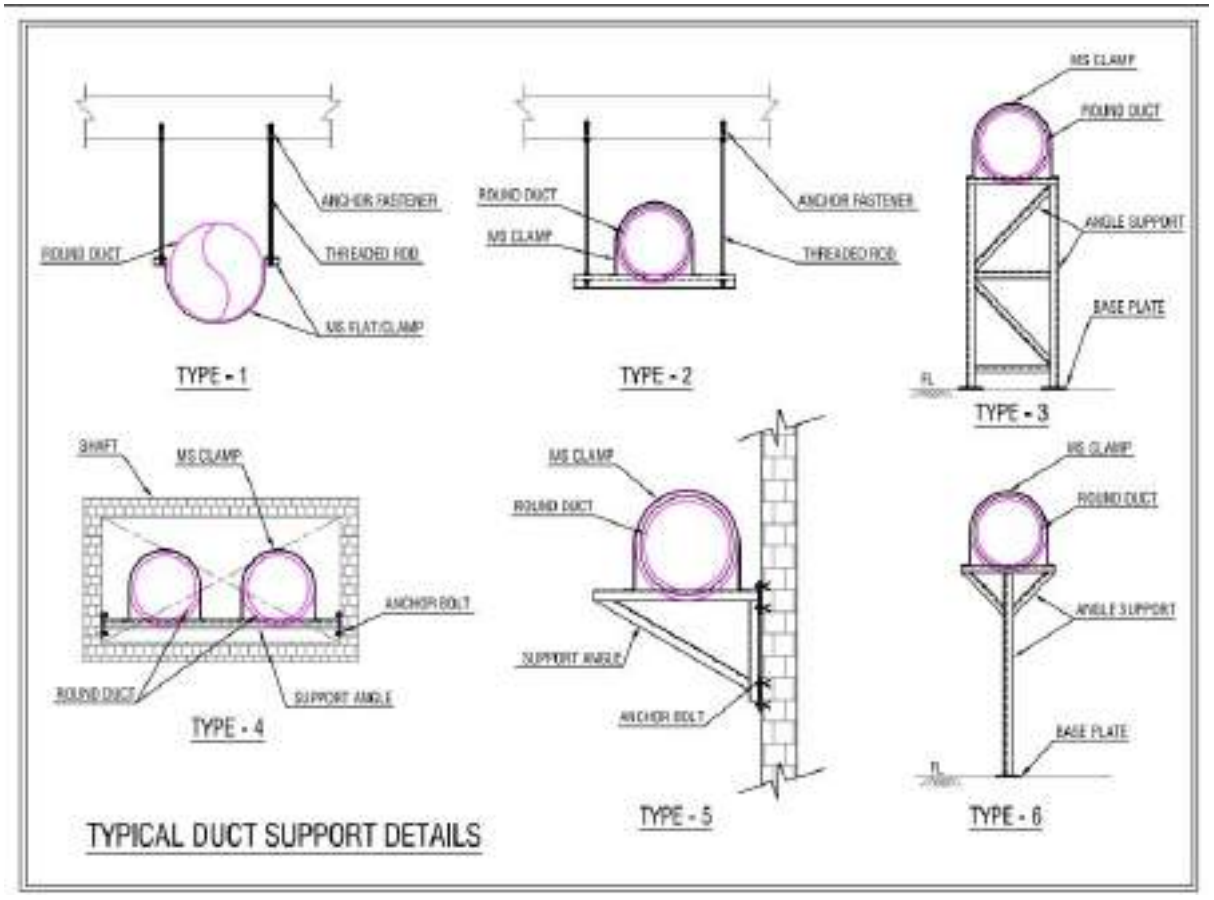
- **Ducting upto 500 mm Dia - Flange thickness shall be 6 mm PP + 3 mm FRP**
- **Ducting above 501 mm Dia - Flange thickness shall be 8 mm PP + 3 mm FRP**

SUPPORT SYSTEM

All duct supports which are coming within the building shall be a part of PP FRP ducting line item, whereas the duct supports in the terrace floor area shall be considered a part of MS support BOQ line item.

A completely supporting system consisting of fully threaded rods, double L bottom brackets nuts, washers, clamps for circular ducts and anchor bolts as supplied.

To provide the required thermal brake effect, Neoprene or equivalent material of suitable thickness shall be used between duct joints.



Duct supports Type 1, 2, 4 & 5 are considered as a part of ducting, whereas type 3 & 6 OR similar type of duct support proposed on terrace area shall be considered as a part of MS structural support & can be claimed separately under respective BOQ line item.

INSTALLATION
TOOLS AND TACKLES FOR SITE WORK:

For duct assembly and Installation, the use of suitable tools and tackles should be used to give the required duct quality and speed of installation including.

a) Drilling machine with drill bits – for drilling holes on the PP/FRP flanges.

b) Hammer drill machine with drill bits – for drilling holes in building structure for anchors.

c) Hoisting system – for lifting the duct assembly up to mounting heights.

d) The duct pricing shall inclusive of all above facility.

INSTALLATION PRACTICE:

a) All necessary allowances and provision shall be made for beams, pipes, or other obstructions in the building whether or not the same are shown on the tender drawings. Where there is interference/ fouling with other beams, structural work, plumbing and conduits, the ducts shall be modified suitably as per actual site conditions.

b) Ducting over false ceiling shall be supported from the slab or from beams. In no case shall any duct be supported from false ceilings hangers or be permitted to rest on false ceiling. All Sheet work in dead or furred down spaces shall be erected in time to occasion no delay to other Vendor's work in the building.

c) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge.

DAMPERS AND FLEXIBLE HOSE

Volume control damper sets shall be provided where specified according to the specifications in the offer BOQ. Dampers shall be double thickness heavier than the thickness of the large duct & shall be rigid in construction.

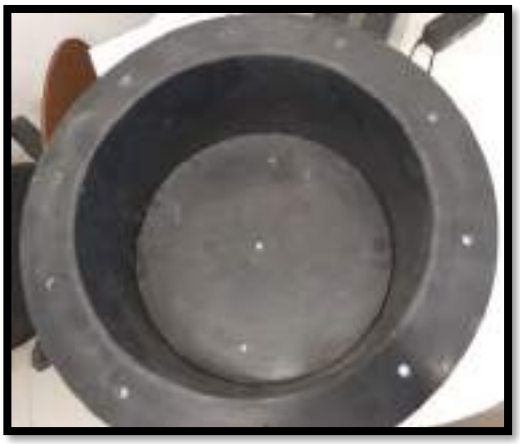
The volume control dampers shall be of an approved type, lever operated & complete with locking devices which will permit the dampers to be adjusted & locked in any positions.

Construct blades of 3 mm thick PP MOC, provide heavy-duty molded self-lubricating nylon bearings, 13mm (1/2") diameter Plastic axles spaced on 225mm (9") centers. Construct frame of 300 mm diameter outer with Flange for fitting minimum 6 bolts and nuts. The outer shell body shall be a transparent material of Poly propylene.

Automatic manual volume opposed blade shall be not over 225mm wide. The dampers for fresh air inlet shall additionally provide with fly mesh screen, on the outside of 0.8mm thickness with fine mesh.

MANUALLY ADJUSTABLE DAMPER SETS

Damper sets shall be arranged in substantial supporting frames and each blade shall be mounted on a shaft, which turns in sintered bronze bearings. All damper blades shall be inter-connected by means of a suitable bar linkage for ganged operation. All dampers shall be arranged with spindle horizontal and shall be sized to handle the air quantities shown on the drawings. Where manually adjustable damper sets are installed in ductwork or other accessible locations the operating shafts shall be extended through the duct and a lockable quadrant fitted.

PVC DUCT HOSE

BIRD SCREENS

Galvanized woven mesh or weld mesh bird screens in rigid galvanized iron frames shall be installed (with 2 coat of paint) behind all exhaust air openings to the outside of the building.

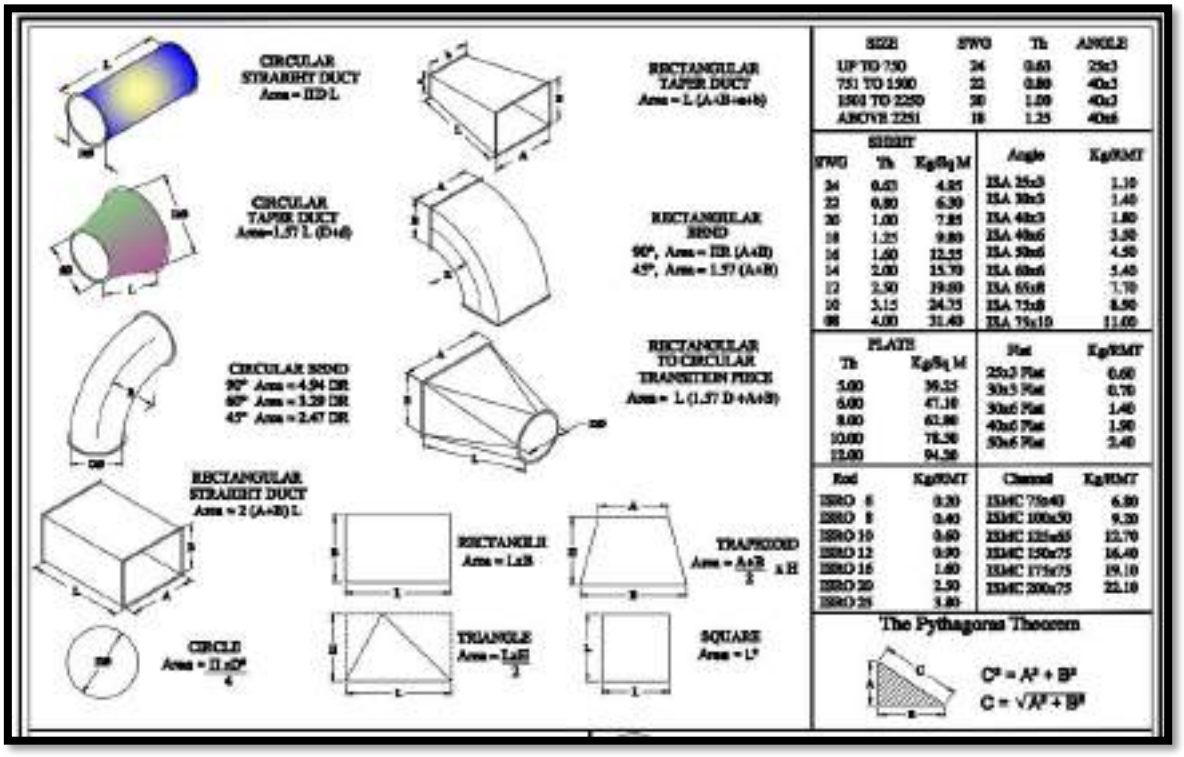
FLEXIBLE CONNECTIONS

Provide flexible duct connections wherever ductwork connects to vibration isolated equipment and on all exhaust final connections to spot extractor and as indicated in the tender schematic drawings.

Flexible connections shall be fitted to isolate fans from equipment's and/or ductwork. The connections shall be arranged to permit the renewal of the connection without disturbing the duct work or the plant. The metal parts of connected equipment shall be separated by not less than six inches and installed with sufficient slack to compensate for free movement of fans or spring vibration isolators.

JOINT MEASUREMENTS

The following procedure for measurement shall be followed for the purpose of billing in case of items subject to variation in quantities.



Payment for ducting shall be on the basis of the external surface area of the ducting.

The rate per square meter of the external surface shall include flanges, gaskets for joints, bolts and nuts, duct supports and hangers, vibration isolation pads or suspenders, flexible connections, inspection doors, dampers, turning vanes, straightening vanes, and any other item which will be required to complete the duct installation except external insulation and finish thereon.

The external area shall be calculated by measuring the over-all width and depth (including the corner joints) in the centre of the duct section and over-all length of each duct section from flange face to flange face in case of duct lengths with uniform cross section.

Total area will be arrived at by adding up the areas of all duct sections.

In case of taper piece average width and depth will be worked out as follows:

W1 = Width of small cross section

W2 = Width of large cross section

D1 = Depth of small cross section

D2 = Depth of large cross section

Average Width = (W1 + W2)/2

Average Depth = (D1 + D2)/2

Width and depth in the case of taper pieces shall be measured at the edge of the collar of the flange for duct/sections. Face to face length for taper piece shall be the mean of the lengths measured face to face from the center of width and depth flanges.

For special pieces like bends, branches, and tees, etc., the same principle of area measurement as for linear lengths shall be adopted, except for bends and elbows, the length of which shall be the average of the lengths of inner and outer periphery along with curvature of angle of the piece.

Duct measurements for calculation of area shall be taken before application of insulation (if any).

Closeout Submittals such as Operation and maintenance manuals, including as-built ducting layout, final P& ID diagrams, unit location drawing and component lists, shall be provided as closeout submittals.

SPECIFICATION FOR CORROSION RESISTANT THERMOPLASTIC CENTRIFUGAL EXHAUST BLOWER

The exhaust fans supplied and installed shall be of 'Centrifugal Corrosion Resistant' type and shall be capable of delivering the design airflow against all duct static losses.

The fans shall be robust in construction and suitable for continuous duty operation. It shall be mounted with ease of maintenance and shall be installed with proper "vibration isolators" and "flexible connectors" on both the inlet and outlet to minimize vibration transmission to ductwork and supporting structure.

The Blower selected shall be silent and vibration free during operation, Blower outlet velocity Not to Exceed 15 m/s and the Blower speed shall not exceed 3000 rpm. The sound pressure level shall not exceed 75 dBA @ 3m (free field conditions) at the design operating conditions.

The proposed Blower and motors shall be suitable for outdoor installation and operation. It shall come fitted with a protective polypropylene (PP) motor cover to prevent direct rain impact and splashes onto the motor.

Aerodynamic performance of the fan shall be design, tested and comply in accordance to 'AMCA' & **'ISO 5801'** standard.

The fan's sound level shall be design, tested and comply in accordance to 'ISO 5136.2' standard.

Fan size from 125 mm Dia to 400 mm Dia

The casing shall be of self-supporting design and manufacture using "twin-sheet" thermoforming technology. The material of construction shall be **fire retardant polypropylene (PPs)** for fire safety

and shall be suitable against the "corrosive" media commonly present in the exhaust system. No metal parts shall be expose and be in contact with the airstream. The casing shall come with factory fitted drain pipe at the lowest point.

The casing design shall come with removable inlet cone that allow for easy inspection and cleaning without major removal of the adjoining ductworks.

The fan impeller design shall consist of twenty (20) injection moulded forward curved blades (inclined impeller design @ Ø180mm and below) and the material of construction shall be **fire retardant polypropylene (PPs).** It shall be suitable for use against the "corrosive" media commonly present in the exhaust system.

The torque transmission between the impeller bore and fan shaft shall be by a propriety design aluminum clamp adapter system or "keyway" for Ø38mm shaft diameter.

A standard **polyethylene (PE)** hub cap shall be fitted onto the impeller hub to prevent the corrosive 'media' from contacting the shaft.

The impeller shall be shall be design and "statically" balanced in accordance to **ISO 1940-1 G6.3** standard.

The casing and motor shall be suitably supported by an **electro-galvanized** fan stand.

If the environment is highly corrosive, a **AISI 304SS** fan stand and fasteners shall be proposed instead; where applicable.

The proposed fan shall be driven by an international premium make TEFC motor and shall come but not limited to the followings: -

- Premium efficiency (IE2)
- Class 'F' insulation and class 'B' temperature rise
- IP55
- 3 x PTC thermistors
- VSD duty
- 415V/3Ph/50Hz
- IEC design and standards

<u>Fan size from 450 mm Dia to 1250 mm Dia</u>

The fan casing shall be of self-supporting plastic construction, design and welded by machine. The material of construction shall be **fire retardant polypropylene (PP)** and shall be suitable against the "corrosive" media commonly present in the exhaust system. No metal parts shall be expose and be

in contact with the airstream. The casing shall come with factory fitted drain cap (NG25) at the lowest point.

The fan impeller design shall consist of twenty (20) forward curved blades and the material of construction shall be **fire retardant polypropylene (PP)**. It shall be suitable for use against the "corrosive" media commonly present in the exhaust system.

The torque transmission between the impeller bore and fan shaft shall be by a standard taper lock system.

One **fire retardant polypropylene (PP)** impeller of each production batch shall be tested in an over-speed test stand at 10% above its maximum impeller speed.

The impeller shall be dynamically balanced over two stages and shall be design and tested in accordance to **ISO 1940-1 G6.3** standard.

Initial balancing to prepare the impeller for testing in a centrifuge for a period of twenty-four (24) hours.
Final balancing before delivery.

A standard **polypropylene (PP)** hub cap shall be fitted onto the impeller hub to prevent the corrosive 'media' from contacting the shaft.

The casing and motor shall be suitably supported by a **"electro-galvanized modular design"** fan stand that allow or facilitate "partial stand part" replacement; when required.

If the environment is highly corrosive, a **AISI 304SS (or AISI 316L)** fan stand and fasteners shall be proposed instead; where applicable.

The proposed fan shall be driven by an international premium make TEFC motor and shall come but not limited to the followings: -

- Premium efficiency (IE2)
- Class 'F' insulation and class 'B' temperature rise
- IP55
- 3 x PTC thermistors
- VSD duty
- 415V/3Ph/50Hz
- IEC design and standards

During the tender submission stage, the vendor shall submit the following documents: -

- Certified fan performance curve
- Dimensional drawing
- Technical data sheet

- Material datasheet (prove of suitability against exhaust gases)
- FAT procedures
- The Vendor shall submit a calculation of all losses to consultant & get it approved prior to ordering of equipment.

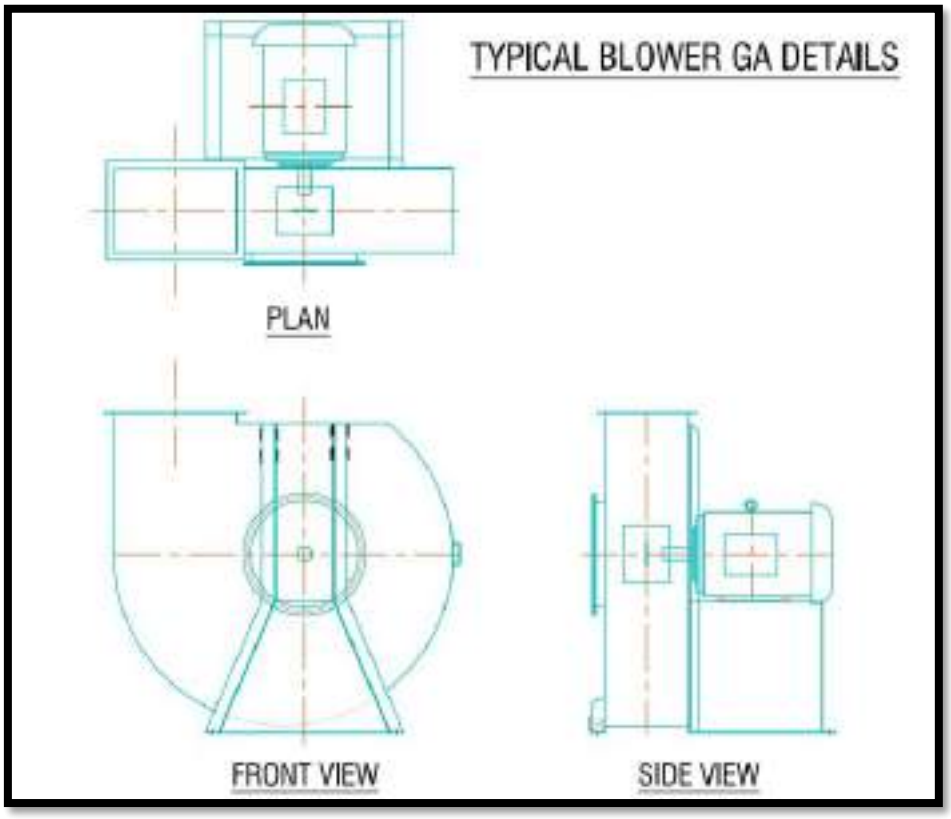
♣ The casing shall be of self-supporting design, thermoformed (size 400 and below), welded by machine (automatically welded for size 400 and below). The material of construction shall be fire retardant polypropylene (PPs) for fire safety and suitable for use against corrosive 'medium' and a maximum allowable operating temperature of 70°C.

♣ Impeller material shall be fire retardant polypropylene (PPs) for fan size up to 400 (polypropylene {PP} for fan size 450 and above) suitable for use against corrosive 'medium' and a maximum allowable operating temperature of 70°C. It shall consist of 20 forward curved blades injection moulded up to size 710 (thermoformed blades, automatically welded from 800). The impeller balancing shall be tested in accordance to VDI2060, Q6.3 standards.

♣ Each impeller above size 450 shall be tested in an over speed test stand above its nominal rate and dynamically balanced on two levels in accordance to VDI2060, Q6.3 standards.

♣ Stainless steel stand shall be used to support the fan and the motor for sizes up to 400 in view of the corrosive environment. Sturdy metal galvanized steel stand shall be used from fan size 450 onwards.

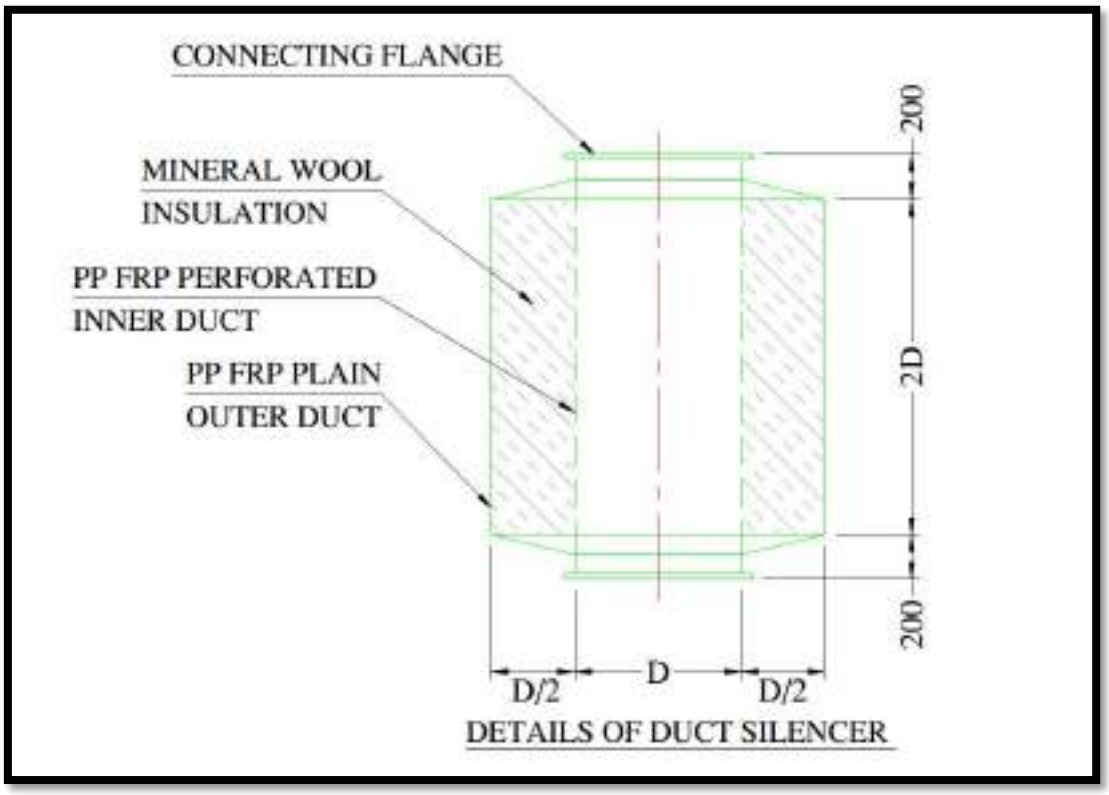
♣ **The fans shall be from one of the approved makes only.**



DUCT SILENCER

The blower outlet duct shall have a silencer to reduce the air noise, the silencer shall be made out of outer & inner layer PP FRP ducting the space between them shall be filled with Mineral wool insulation. Internal duct of the silencer shall be perforated with suitable size holes (minimum 10mm dia & pitch of 25mm) the silencer shall be with both ends flanged (For more details refer silencer specification & drawing). Mineral wool insulation shall be supplied as per tender specification.

DETAILS OF DUCT SILENCER

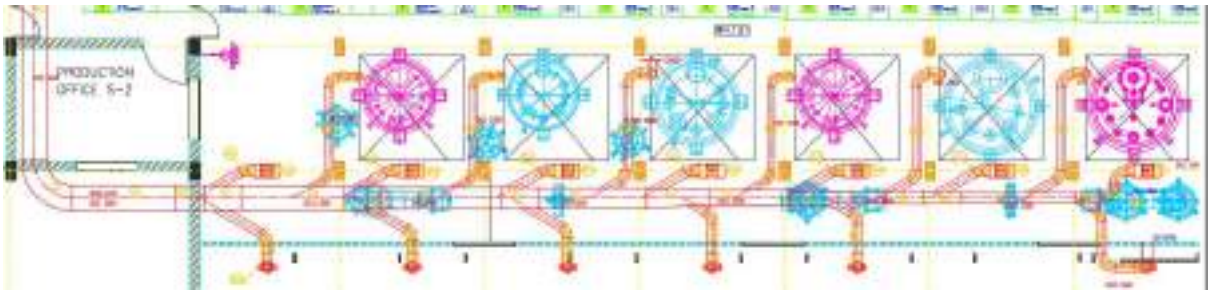


The above-mentioned details in the drawing is the minimum requirement for silencer, the vendor shall design the duct silencer to reduce the noise level & achieve 75 dB @ 1 mtr from the blower assembly.

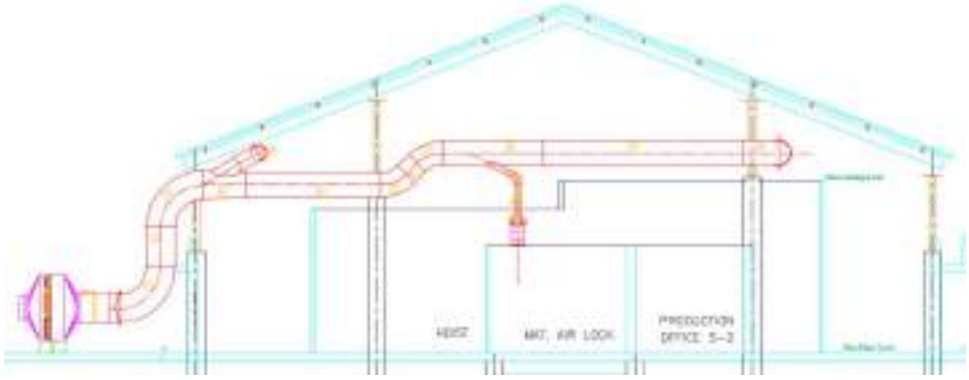
1.0 TEST RUN AND COMMISSIONING:

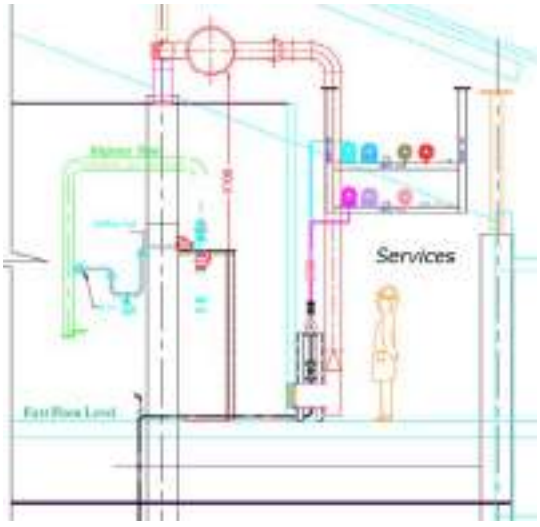
- Check, whether inlet and outlet are connected to ducts or protected by a protection grid.
- Check mechanical and electrical safety devices; make sure, they are properly installed.
- Remove foreign bodies, which still might be in the housing or ducts.
- Check the rotation of the impeller by means of a quick switch on/off of the motor; it
- must run in the direction as shown on the arrow. In case of wrong direction, change the connection of the wires.
- To protect the motors against overload, the fans shall never be operated with open
- Inlet or outlet. For test runs, the inlet has to be covered with a suitable plate.
- The current (Amps) as indicated on the motor data plate shall never exceed. The fan has to be checked for its' smooth running.

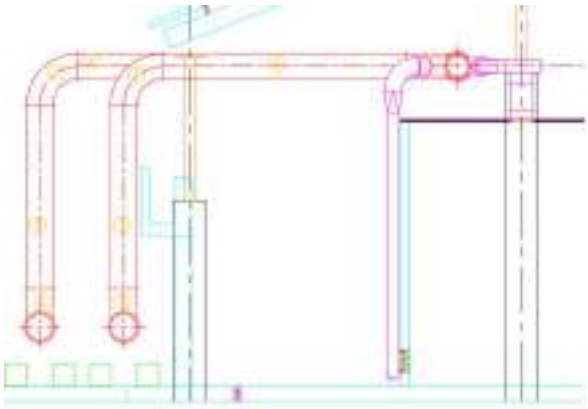
TYPICAL DRAWING SHOWING THE MAIN DUCT & BRANCH DUCT CONNECTION DETAILS



TYPICAL DRAWING SHOWING THE SECTION DETAILS







EXHAUST SYSTEM TESTING & COMMISSIONING FORMAT – SHEET 1

BLOWER TAG NO:-						
BSC						
Sl NO.	**NO. OF BSC**	**---**	**---**	**AIR VELOCITY (FPM)**	**AIR VOLUME (CFM)**	**TOTAL EXHAUST (CFM)**
1						

EXHAUST SYSTEM TESTING & COMMISSIONING FORMAT – SHEET 2

Sl NO.	BLOWER TAG NO.	CLUSTER NO.	FREQUENCY (Hz)	RPM	EXHAUST AIR VOLUME (CFM)
1.					

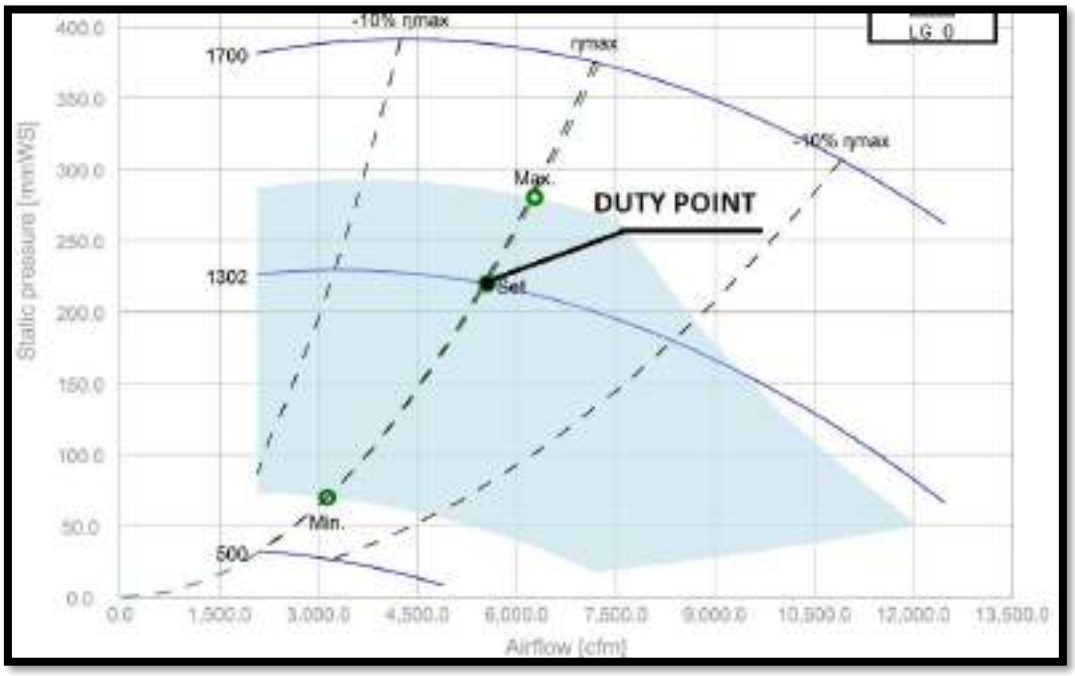
EXHAUST SYSTEM TESTING & COMMISSIONING FORMAT – SHEET 3

BLOWER COMMISSIONING FORMAT	
BLOWER TAG NO	
CLUSTER NO	
BLOWER SIZE	
STATIC PRESSURE (MM)	
FLOW VELOCITY (m/s)	
SHAFT POWER (kW)	
MOTOR CAPACITY (kW)	
MECHANICAL EFFICIENCY (%)	
OPERATING IMPELLER SPEED (RPM)	
MAXIMUM IMPELLER SPEED (RPM)	
STARTING CURRENT (AMPS)	
RUNNING CURRENT (AMPS)	
SOUND PRESSURE @ 3 MTR LEVEL (dB)	
BLOWER INLET SIZE (MM)	
BLOWER OUTLET SIZE (MM)	
STATIC WEIGHT (KG)	
DYNAMIC WEIGHT (KG)	

SUBMITTALS FOR CONSULTANT APPROVAL

- Vendor to submit exhaust summary sheet as per their respective Reactors, condenser, anfd air volumes.
- Vendor to submit P & ID based on the final requirement. (P & ID should be submitted in the same format as mentioned in the tender).
- Exhaust ducting shop drawing.
- The Vendor shall submit a calculation of all Pressure losses in the duct system, prior to ordering of Exhaust Blowers. A sample selection sheet is shown in exhibit below.
- Provide dimensional drawings and product data on each laboratory exhaust fan assembly.
- Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- Scrubber GA drawing.
- Damper selection, pressure loss chart & GA drawing.
- Supporting structure GA drawings with respective weights & quantities.
- Civil coordination drawing showing wall / floor cut-out details, construction details of skirting around floor opening & foundation pedestal details for exhaust blower / scrubber unit.
- Vendor to coordinate with other services like Civil, Electrical, Gas & lab controls.
- Commissioning report for individual blower / exhaust system.

SAMPLE BLOWER SELECTION



SAMPLE PRESSURE DROP SELECTION SHEET

PROJECT : IISC, BANGALORE							CONSULTANT : MJ ASSOCIATES, BANGALORE			
SCB-14 (FUME HOOD EXHAUST)										
DUCTING PRESSURE DROP CALCULATION										
Sl No.	Description	Air Vol	Duct	Duct C/s	Duct Length	Duct Lengt	Velocity	Press Drop per	Actucal P D	
		CFM	dia	area	in mm.	in Ft.	FPM	100 ft in inch	Drop in inch	
	Discharge Side								Ind PD	Total PD
1	Transition Piece	900	250	0.0491	1000	3.28	1704	0.56	0.018	0.018
2	St Duct	900	250	0.0491	3000	9.84	1704	0.56	0.055	0.073
3	Duct Silencer								0.100	0.173
4	Flexible Connection								0.150	0.323
5	Weather Cowl								0.250	0.573
	Suction Side									0.573
1	Flexible Connection								0.150	0.723
2	Manual Damper								0.250	0.973
3	Transition Piece	900	250	0.0491	1000	3.28	1704	0.56	0.018	0.992
4	St Duct	900	250	0.0491	1000	3.28	1704	0.56	0.018	1.010
5	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	1.089
6	St Duct	900	250	0.0491	3000	9.84	1704	0.56	0.055	1.144
7	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	1.222
8	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	1.300
9	Wet Scrubber								3.000	4.300
10	St Duct	900	250	0.0491	1100	3.61	1704	0.56	0.020	4.320
11	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	4.399
12	St Duct	900	250	0.0491	5800	19.02	1704	0.56	0.106	4.505
13	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	4.584
14	St Duct	900	250	0.0491	14000	45.90	1704	0.56	0.257	4.841
15	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	4.919
16	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	4.997
17	St Duct	900	250	0.0491	4000	13.11	1704	0.56	0.073	5.071
18	90° Bend	900	250	0.0491	4267	13.99	1704	0.56	0.078	5.149
19	St Duct	900	250	0.0491	500	1.64	1704	0.56	0.009	5.158
20	Flexible Connection								0.200	5.358
21	Manual Damper								0.250	5.608
22	Suction Hopper								0.250	5.858
23	Fume Hood (Suc Presssure)								1.000	6.858
									Total	6.858
	CFM	900		STATIC INCH	8			Static Pressure =	6.86	
	EFFICIENCY	50	60					Dynamic Pressure =	0.18	
	BKW	2.03	1.69					Total Pressure =	7.04	
	MOTOR CAPACITY	9.30	7.50					Safety 5% =	7.39	
The exhaust blower shall be designed for 900 cfm at 8" Static Pressure										

SPECIFICATIONS FOR MOTOR AND ACCESSORIES

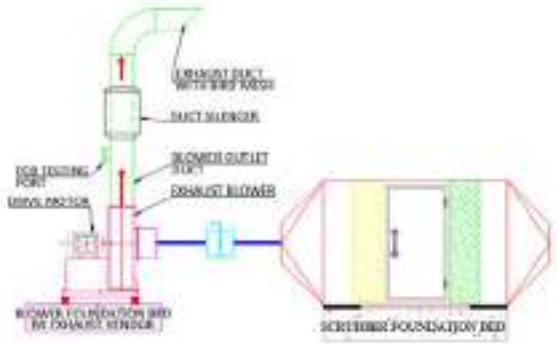
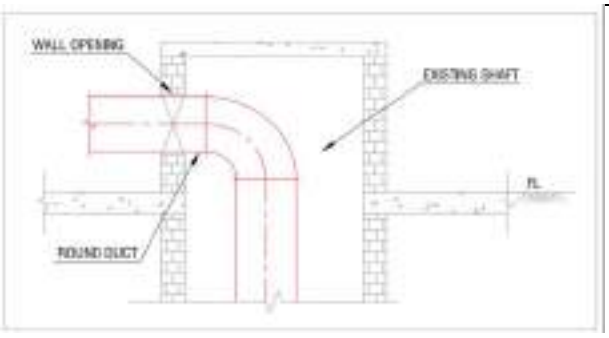
Use an electric motor built to IEC standards flange mounted (B5) and Foot mounted (B3), also in ex-protected or multistage versions, for the drive. The impeller hub is coated with aluminium. Power transmission from motor to impeller by means of a directly mounting the impeller on motor shaft. The impeller is fixed on to a flange bearing and the tightening adopter system guarantees secure mechanical connection.

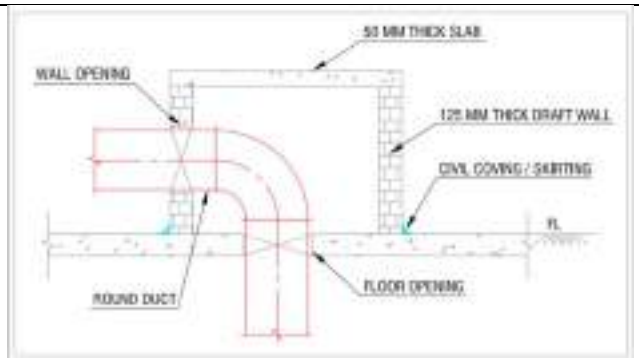
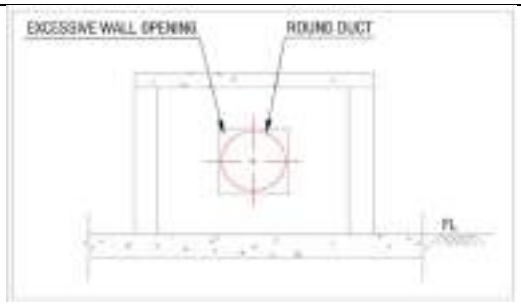
Motor Standard IEC three-phase motors in accordance with IEC. Mounting B5 and B3

Available in motor-mounted (IP55) or cabinet-mounted versions.

The fan shall be driven by a standard TEFC electric motor with class ‘F’ insulation and class ‘B’ temperature rise. Motor shall be suitable for outdoor installation with IP55 protection and suitable for operation with 415V/3Ph/50Hz electrical supply. Motor supplied shall be in accordance to IEC standards.

PP motor guard / cover shall be supplied along with blower & motor assembly.

Foundation Bed for Scrubbers & Exhaust blowers. **Minimum 200 mm thickness OR Based on the equipment loading.**	
Making necessary holes for duct entry in walls.	

Making necessary holes for duct entry in floors, construction of draft wall around the opening & ceiling with 50 mm thick slab & making it rain / leak proof.	
Closing of excessive opening after erection of ducts & making it rain / leak proof.	

CLOSEOUT SUBMITTALS

Closeout Submittals such as Operation and maintenance manuals, including as-built ducting layout, final P& ID diagrams, unit location drawing and component lists, shall be provided as closeout submittals.

INSTRUCTIONS

The Following points to be read in conjunction with BOQ & understand before Quoting.

- **Refer the above tender specification for all the line items mentioned in the Exhaust BOQ & quote accordingly.**
- Installation, integration, testing, balancing, commissioning & documentation work of all the BOQ line items & including making / preparing shop drawings, technical data sheet, coordination with drawings of other services of this tender and submission for approval, checking the design and its functionality of the whole system including the cost of all accessories, termination, connections, conduiting, nuts & bolts as per tender requirement manufacturer's requirements, all necessary supports from ceiling, walls, floors as required for all items mentioned in the BOQ & its accessories necessary to make the whole system operational. The rate shall be inclusive of the cost of all items labour removal of debris, dirt and rubbish accumulated as a result of installation / commissioning of the exhaust system and accessories and leaving the premises broom clean and orderly etc.,

- The final documentation includes commissioning reports, warranty / guarantee certificates, 6 sets of as built drawing hard copies & soft copy in DVD. Operational & Maintenance manuals and Handling over documents to be submitted.
- The vendor shall design the duct silencer to reduce the noise level & achieve 75 dB @ 1 mtr from the blower assembly.
- Support clamps for flexible hose to be provided at all user points.
- All Drawings, Technical submittals & installation procedure should be as per Good engineering practices. Drawings & material approval must be obtained before fabrication.

General Conditions

- It is must for Contractor- to provide good for construction drawings and final as built drawings after project completion.
- Pressure drop calculation for Scrubber exhaust system shall be provided.
- Ducting drawing to be complete with Tag No which is to be followed in all documents till completion of validation.
- Tag No. for all components to be fixed physically during installation.
- Samples of Duct, Duct Silencer, Rock wool insulation, Damper, etc…, to be arranged and approval to be taken from Client / Consultant before ordering / fabrication / final delivery to site.
- The contractor shall be responsible for co-ordination with other services like HVAC, Piping, Electrical, Clean Room panel Vendor and will share responsibility for installation, commissioning and validation of complete system.
- This BOQ is to be read in conjunction with Duct Specification and Tender Drawings for Further Details. Compliance to specification is a must and any deviation is to be brought out specifically during tendering and sought approval from Client.
- The Technical Submittal and GA Drawing have to be submitted for review and approval before placing of order.
- The Exhaust contractor has to coordinate with HVAC, Electrical, Clean Room panel vendor & other vendors for the Timely execution of the Project Upholding the design intent and finish of this tender.

PERFORMANCE GUARANTEE

Supplier shall guarantee that upon completion of the work all portions will be in full accordance with the requirements of the contract and will be perfect as to materials and workmanship and remain so far a minimum period of one year from the date of final acceptance by the client. The bidder shall also guarantee that the equipment will operate satisfactorily and the performance and efficiencies of the equipment when operating under normal condition shall not be less than the guaranteed values. The bidder shall further guarantee that during the one-year period he will repair all defective work and will replace all defective materials furnished or installed under the contract, free of cost to the Client within reasonable time from the detection thereof. The bidder shall be responsible for the performance irrespective of the specifications mentioned in the tender.

- ♣ Kindly note that any deviation from above specification must be notified in writing while quoting as an extra sheet – "List of technical deviations".
- ♣ Any deviation as considered by manufacturer other than those mentioned in this document should be explained with appropriate justification note (duly signed) wherever it is applicable during bid submission.

TECHNICAL SUBMITTALS REQUIRED BEFORE COMMENCING OF JOB AT SITE FOR REVIEW AND APPROVAL:

- BASIS OF DESIGN / SCRUBBER EXHAUST SUMMARY
- CENTRIFUGAL BLOWER GA DRAWINGS WITH FAN SELECTION.
- 2-DIMENSIONAL DUCT ROUTING DWG WITH SCRUBBER LOCATION

- **TYPICAL GA DWGS FOR:**

A. DRY SCRUBBER & BLOWER

DRAWINGS:

- SCRUBBER P & ID
- DUCT DISTRIBUTION LAYOUT WITH SECTIONS.
- EQUIPMENT LOCATION AND SCHEDULE
- CIVIL COORDINATION DWGS

ABBREVIATIONS

DB	:	Dry Bulb Temperature
WB	:	Wet Bulb Temperature
RH	:	Relative Humidity
NC	:	Not Controlled
NMT	:	Not More Than
CFM	:	Cubic Feet Per Minute
CMH	:	Cubic Meter Per Hour
AHU	:	Air Handling Unit
EAU	:	Exhaust Air Unit
VRF	:	Variable refrigerant flow
SP	:	Static Pressure
GSS	:	Galvanized Sheet steel
DIDW	:	Double Inlet Double Width
VFD	:	Variable Frequency Drive
GLP	:	Good Lab Practice
ID	:	Identification
IQ	:	Installation and Operational Qualification
MOC	:	Materials of Construction
PA	:	Pascal
QAD	:	Quality Assurance Department
SA	:	Supply Air
RA	:	Return Air
RH	:	Relative Humidity
RPM	:	Rotation per minute
SOP	:	Standard Operating Procedure
TEFC	:	Totally Enclosed Fan Cooled
TR	:	Tonnes of Refrigeration
VRF	:	Variable Refrigerant Flow
PP	:	Polypropylene
FRP	:	Fiber Reinforced Polymer
ID	:	Identification
IQ	:	Installation and Operational Qualification

PART-6

EMS & BMS

CONTENTS

1.0 SCOPE OF WORKS:

The scope of work to be carried out under this contract is illustrated in the IO summary, Technical Specifications, and the Bill of the quantities. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the client/consultants. The contractor shall furnish all labor, materials and equipment as listed under the Bill of quantities and specified otherwise, transportation and incidentals necessary for supply, installation, testing and commissioning of the complete HVAC CONTROL (BMS & EMS) system as described in the specifications. This also includes any material, equipment, appliances, and incidental work not specifically mentioned herein or noted in the documents as being furnished or installed. But which are necessary and customary to be performed under this contract and which are required under the Bill of Quantities and the specifications for the central Integrated Building Management System.

1.1 PROJECT EXECUTION AND MANAGEMENT:

- The contractor shall ensure that senior planning and execution personnel from his organization are assigned exclusively for this project. They shall have a minimum of 10 years' experience in this type of installation.
- For quality control & monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control, adherence to the specifications and ensuring top class workmanship for the air-conditioning installation.
- The contractor shall arrange to have mechanized and modern facilities for transportation of materials to the place of installation for speedy execution of work.

1.2 PERFORMANCE GUARANTEE:

- The Contractor shall carry out the works in accordance with the specifications, Bill of the quantities and other documents forming part of the Tender / contract. The contractor shall be fully responsible for the performance of selected items/equipment (installed by him) at the specified parameters and for the efficiency of the installations to deliver the required end results. The contractor shall guarantee that the HVAC CONTROL (BMS & EMS) system as installed shall maintain the parameters required

under the BOQ and specifications. The guarantee shall be submitted on the Performa sheet. The contractor shall also guarantee that the performance of various equipment's individually shall not be less than the quoted capacity.

1.3 SHOP DRAWINGS:

- All the shop drawings shall be prepared through AutoCAD system based on the architectural drawings and site measurements. These shop drawings shall contain all information required to complete terminations. These shop drawings shall contain all the information required to complete the project as per specifications and as required by the Client/Consultant. These drawings shall contain details of constructions, size arrangement, operating clearances, performance characteristics and capacity of all items of equipment. Minimum 5 sets of drawings shall be submitted for final sign off.

- Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in under the approved list of makes and quoted by tenderer in technical data part of tender.

- When the Client/Consultant makes any amendment to the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints for approval. The contractor shall submit a further 5 sets of the shop drawings.

- Samples of all materials like sensors, field devices, controls, control wires etc. shall be submitted to the client/consultant prior to procurement. These will be submitted in 2 sets of approval and retention by client site representative and shall be kept in their site office for reference and verification till the completion of the project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installations.

- Within four weeks of the approval of the relevant shop drawings the contractor shall submit four copies of a comprehensive variation in quantity statement.

1.4 TESTING AND COMMISIONING:

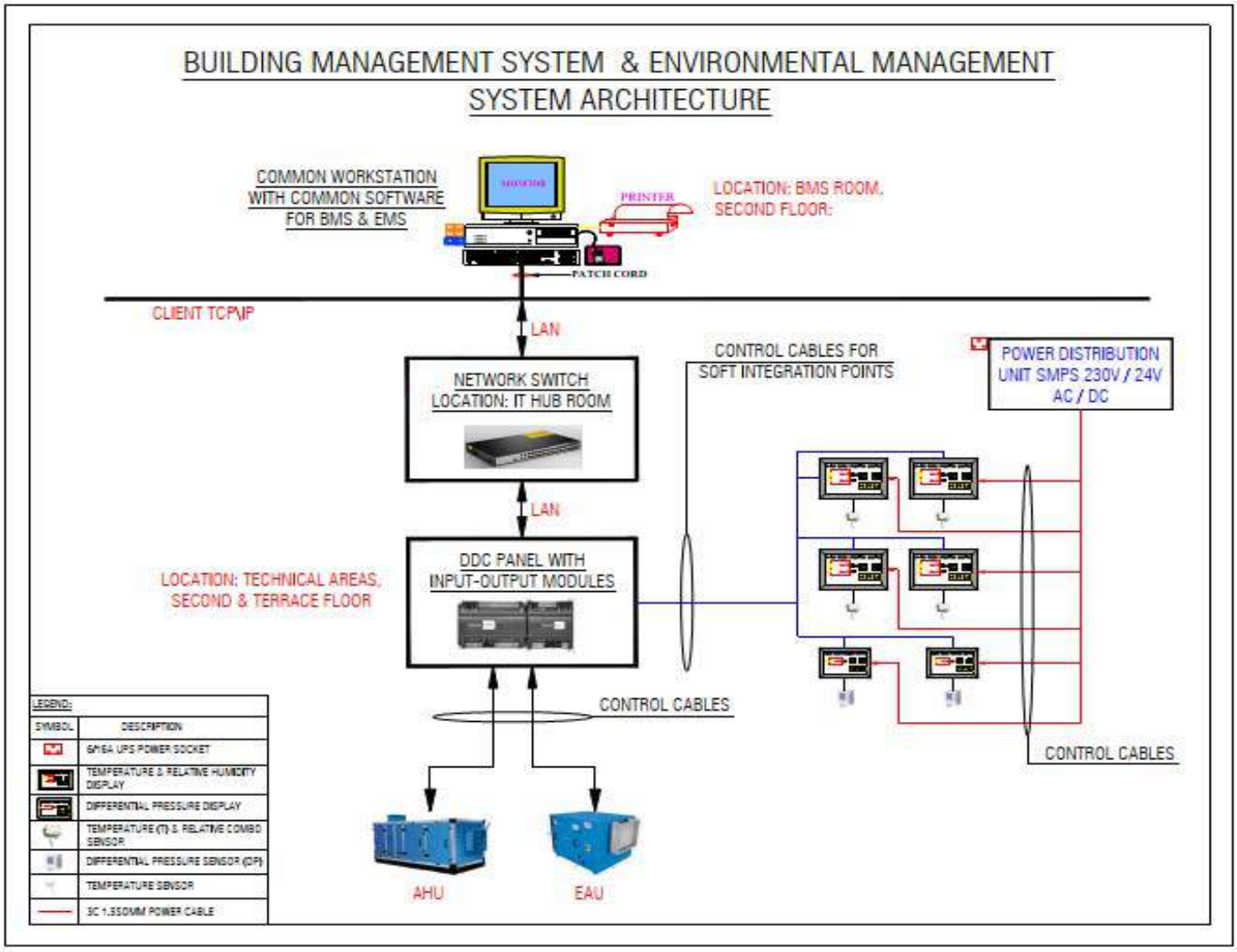
- Four copies of the certified manufacturer's performance certificates for each piece of equipment, highlighting operational parameters for the project, shall be submitted along with the test certificates. Contractors shall also provide four copies of the record of all safety and automatic control settings for the entire installation.

- The installation shall be tested again after removal of defects and shall be commissioned only after approval by the client site representative. All tests shall be carried out in presence of the representatives of the Client/consultant.

2.0 BASIS OF DESIGN:

HVAC Controls scope of works covers the following: -

- Building Management system (BMS).
- Environmental Management system (EMS).



Building Management System & Environmental Management System Architecture

❖ BUILDING MANAGEMENT SYSTEM:

- We have proposed IP based DDC panels to control & monitor 3 to 4 AHU's.

- The proposed DDC panel continues to work standalone & saves data in its memory for specific duration.
- IP based DDC controller is envisaged.
- Single DDC panel is considered to control & monitor 2 to 3 number of AHUs based on the unit locations.
- Field devices like Duct type Temperature sensor, Duct type Temperature & Rh combo transmitter, Duct type Static pressure Transmitter and Differential pressure Switch are considered.
- The Digital signal from fire damper is taken to the BMS which is integrated with fire alarm panel.
- BMS related data from the individual DDC panel shall be transferred into the workstation located at the Second floor BMS room through the port switch, which is in the HUB room, where the data shall be monitored through the Dashboard located at the BMS room.

❖ **Schedule For the Building Management System Mentioned Below: -**

- **<u>MONITORING: -</u>**

✓ AHU ON/OFF status
✓ AHU Trip status
✓ AHU Auto/Manual status
✓ AHU Speed feedback
✓ AHU Supply Duct static pressure
✓ AHU Return air Temperature & RH
✓ AHU SA & RA fire damper status
✓ Fire alarm status
✓ VRF system status

- **<u>CONTROLING:</u>**

✓ AHU ON/OFF Command
✓ AHU Speed control

- ✓ We are controlling temperature & RH through VRF system.

➢ **SAFTEY INTERLOCKING:**

- ✓ AHU status should be ON for VRF system.
- ✓ SA & RA fire damper interlocked with AHU ON/OFF command.
- ✓ The fire alarm status is interlocked with AHU ON/OFF command.

❖ **Control Logic for Building Management System:**

➢ **Typical Sequence of Operation for Air Handling Unit:**

- ✓ Switching ON/OFF AHU supply air fan based on program time schedule & monitoring AHU On/Off status.
- ✓ Based on comparison between Supply air CFM through the duct static pressure transmitter & set point CFM, the Supply air plug fan VFD shall be Monitored and set the range for control.
- ✓ Monitor the Supply air plug fan Auto/Manual status, Trip status, Run status VFD Speed RPM.
- ✓ Monitor the fan status through Differential Pressure Switch which is to be installed across the FAN.
- ✓ Monitor the temperature & RH in return air.
- ✓ Monitoring of fire status via duct smoke detector, in case of fire in the catering rooms both supply air Fan shall be switched off & Exhaust air fans shall run continuously.

❖ **AHU IO Summary List for DDC Panel:**

IO SUMMARY FOR AHU							
Sr. No.	**Description**	**AI**	**DI**	**AO**	**DO**	**From**	**To**
	DDC PANEL-1 (GF-AHU-01, GF-EAU-1 & GF-AHU-02)						
1	Return Air fusible link Fire Damper Open/Close Status		2			DDC	Return Air fusible link Fire Damper
2	Return Air Temperature Sensor	1				DDC	Near AHU
3	Return Air Temperature & Rh Transmitter	2				DDC	Near AHU
4	VRF ON / OFF Command				2	DDC	Near AHU

IO SUMMARY FOR AHU							
Sr. No.	**Description**	**AI**	**DI**	**AO**	**DO**	**From**	**To**
5	VRF Condition Status	2				DDC	Near AHU
6	Heating Coil AHU kit ON Command				4	DDC	Near AHU
7	Cooling Coil AHU kit ON Command				4	DDC	Near AHU
8	AHU VFD Speed control			3		DDC	Electrical Panel
9	AHU trip (Crash) Status		3			DDC	Electrical Panel
10	AHU Auto/Manual Status		3			DDC	Electrical Panel
11	AHU VFD Speed feed back	3				DDC	Electrical Panel
12	AHU VFD ON/OFF command				3	DDC	Electrical Panel
13	EAU VFD Speed control			1		DDC	Electrical Panel
14	EAU trip (Crash) Status		1			DDC	Electrical Panel
15	EAU Auto/Manual Status		1			DDC	Electrical Panel
16	EAU VFD Speed feed back	1				DDC	Electrical Panel
17	EAU VFD ON/OFF command				1	DDC	Electrical Panel
18	Supply Air fusible link Fire Damper Open/Close Status		2			DDC	Supply Air fusible link Fire Damper
19	Feedback to Motorized Damper	3				DDC	Motorised Damper
20	Control to Motorized Damper			3		DDC	Motorised Damper
21	Differential Pressure Switch Across the Fan		4			DDC	Near AHU
22	Duct Static Pressure Transmitter	2				DDC	Duct type Pressure sensor
23	ON/OFF pushbutton command for Cell bank Repository room				1	DDC	ON/OFF Push Button
24	ON/OFF pushbutton command for Cell Freezing area-2 isolation room				1	DDC	ON/OFF Push Button
25	Supply Air Temperature Sensor	2				DDC	Duct type Temperature sensor
26	Fire input from control module		2			DDC	FAS control module
	TOTAL	16	18	7	16		
	Spare	3	4	1	3		
	GRAND TOTAL FOR DDC PANEL-1	**19.2**	**22**	**8**	**19**		
	DDC PANEL-2 (GF-AHU-03, GF-AHU-04 & GF-AHU-05)						
1	Return Air fusible link Fire Damper Open/Close Status		3			DDC	Return Air fusible link Fire Damper
2	Return Air Rh & Temperature Transmitter	6				DDC	Near AHU

IO SUMMARY FOR AHU							
Sr. No.	**Description**	**AI**	**DI**	**AO**	**DO**	**From**	**To**
3	VRF ON / OFF Command				3	DDC	Near AHU
4	VRF Condition Status	3				DDC	Near AHU
5	Heating Coil AHU kit ON Command				12	DDC	Near AHU
6	Cooling Coil AHU kit ON Command				12	DDC	Near AHU
7	AHU VFD Speed control			3		DDC	Electrical Panel
8	AHU trip (Crash) Status		3			DDC	Electrical Panel
9	AHU Auto/Manual Status		3			DDC	Electrical Panel
10	AHU VFD Speed feed back	3				DDC	Electrical Panel
11	AHU VFD ON/OFF command				3	DDC	Electrical Panel
12	Supply Air fusible link Fire Damper Open/Close Status		3			DDC	Supply Air fusible link Fire Damper
13	Differential Pressure Switch Across the Fan		3			DDC	Near AHU
14	Fresh Air Motorized Damper Feedback	1				DDC	Motorised Damper
15	Fresh Air Motorized Damper Control			1		DDC	Motorised Damper
16	For Ambient Temperature sensor	1				DDC	Ambient Temperature Sensor
17	Duct Static Pressure Transmitter	3				DDC	Duct type Pressure sensor
18	Supply Air Temperature Sensor	3				DDC	Duct type Temperature sensor
19	Fire input from control module		3			DDC	FAS control module
	TOTAL	20	18	4	30		
	Spare	4	4	1	6		
	GRAND TOTAL FOR DDC PANEL-2	**24**	**22**	**5**	**36**		
	DDC PANEL-3 (FF-AHU-01, FF-EAU-1, FF-AHU-02, FF-AHU-03, FF-AHU-04 with SCB-01)						
1	Return Air fusible link Fire Damper Open/Close Status		4			DDC	Return Air fusible link Fire Damper
2	Return Air Temperature & Rh Transmitter	8				DDC	Near AHU
3	VRF ON / OFF Command				4	DDC	Near AHU
4	VRF Condition Status	4				DDC	Near AHU
5	Heating Coil AHU kit ON Command				16	DDC	Near AHU
6	Cooling Coil AHU kit ON Command				16	DDC	Near AHU
7	AHU VFD Speed control			4		DDC	Electrical Panel
8	AHU trip (Crash) Status		4			DDC	Electrical Panel

IO SUMMARY FOR AHU							
Sr. No.	**Description**	**AI**	**DI**	**AO**	**DO**	**From**	**To**
9	AHU Auto/Manual Status		4			DDC	Electrical Panel
10	AHU VFD Speed feed back	4				DDC	Electrical Panel
11	AHU VFD ON/OFF command				4	DDC	Electrical Panel
12	EAU VFD Speed control			1		DDC	Electrical Panel
13	EAU trip (Crash) Status		1			DDC	Electrical Panel
14	EAU Auto/Manual Status		1			DDC	Electrical Panel
15	EAU VFD Speed feed back	1				DDC	Electrical Panel
16	EAU VFD ON/OFF command				1	DDC	Electrical Panel
17	Fresh Air Motorized Damper Feedback	2				DDC	Motorised Damper
18	Fresh Air Motorized Damper Control			2		DDC	Motorised Damper
19	For Ambient Temperature sensor	1				DDC	Ambient Temperature Sensor
20	Scrubber VFD Speed control			1		DDC	Electrical Panel
21	Scrubber trip (Crash) Status		1			DDC	Electrical Panel
22	Scrubber Auto/Manual Status		1			DDC	Electrical Panel
23	Scrubber Run Status		1			DDC	Electrical Panel
24	Scrubber VFD Speed feed back	1				DDC	Electrical Panel
25	Scrubber VFD ON/OFF command				1	DDC	Electrical Panel
26	Supply Air fusible link Fire Damper Open/Close Status		4			DDC	Supply Air fusible link Fire Damper
27	Feedback to ON/OFF Damper	2				DDC	Motorised Damper
28	Control to ON/OFF Damper			2		DDC	Motorised Damper
29	Differential Pressure Switch Across the Fan		5			DDC	Near AHU
30	Supply Air Temperature Sensor	4				DDC	Duct type Temperature sensor
31	Duct Static Pressure Transmitter	4				DDC	Duct type Pressure sensor
32	Fire input from control module		4			DDC	FAS control module
	TOTAL	31	30	10	42		
	Spare	6	6	2	8		
	GRAND TOTAL FOR DDC PANEL-3	**37.2**	**36**	**12**	**50**		
	AI - Analogue Input						
	DI - Digital Input						
	AO - Analogue Output						
	DO - Digital Output						

Refer to the Control Flow Diagram for Ground Floor AHU-1 Attached as a Separate Annexure: ANNEXURE-A

Refer to the Control Flow Diagram for Ground Floor AHU-2 Attached as a Separate Annexure: ANNEXURE-B

Refer to the Control Flow Diagram for Ground Floor AHU-3 Attached as a Separate Annexure: ANNEXURE-C

Refer to the Control Flow Diagram for Ground Floor AHU-4 Attached as a Separate Annexure: ANNEXURE-D

Refer to the Control Flow Diagram for Ground Floor AHU-5 Attached as a Separate Annexure: ANNEXURE-E

Refer to the Control Flow Diagram for First Floor AHU-1 Attached as a Separate Annexure: ANNEXURE-F

Refer to the Control Flow Diagram for First Floor AHU-2 Attached as a Separate Annexure: ANNEXURE-G

Refer to the Control Flow Diagram for First Floor AHU-3 Attached as a Separate Annexure: ANNEXURE-H

Refer to the Control Flow Diagram for First Floor AHU-4 Attached as a Separate Annexure: ANNEXURE-I

Refer to the BMS Cable tray Layout for Second Floor Attached as a Separate Annexure: ANNEXURE-J

Refer to the BMS Cable tray Layout for Terrace Floor Attached as a Separate Annexure: ANNEXURE-K

Refer to the EMS Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-L

Refer to the EMS Layout for First Floor Attached as a Separate Annexure: ANNEXURE-M

❖ ENVIRONMENTAL MANAGEMENT SYSTEM:

- Two line & Single line Local display units with Room type Temperature & Rh combo room sensor & Differential Pressure sensors are proposed.
- A power distribution unit (supply voltage) shall be provided to power up the local display unit.

- The displays shall be connected in series and shall be soft integrated to the DDC, in which the controller has a provision for modbus integration.
- A common workstation (for monitoring purpose) for both BMS & EMS shall be considered.
- 2-row local display unit (parameters like Temperature, & Humidity (Rh)), and 1-row local display unit (parameter like Differential pressure (DP)) are considered for following area: -

EMS SCHEDULE				
SL. NO.	**ROOM NUMBER**	**DESCRIPTION**	**FROM**	**TO**
	GROUND FLOOR			
1	GF-005	MEDIA PREPARATION	Signal from Room Temperature, Rh Sensor	Local Display
	GF-004	CHANGE ROOM-2	Signal from DP sensor	Local Display
2	GF-009	AUTOCLAVE ROOM	Signal from Room Temperature, Rh Sensor	Local Display
	GF-006	CHANGE ROOM-3	Signal from DP sensor	Local Display
3	GF-008	COOL ZONE & MEDIA STORAGE	Signal from Room Temperature, Rh Sensor	Local Display
	GF-006	CHANGE ROOM-3	Signal from DP sensor	Local Display
4	GF-011	STERILITY TESTING	Signal from Room Temperature, Rh Sensor	Local Display
	GF-010	CHANGE ROOM / ENTRY	Signal from DP sensor	Local Display
5	GF-013	WASHING AREA	Signal from Room Temperature, Rh Sensor	Local Display
	GF-007	CORRIDOR ENTRY	Signal from DP sensor	Local Display
6	GF-015	CELL CULTURE-2	Signal from Room Temperature, Rh Sensor	Local Display
	GF-007	CORRIDOR ENTRY	Signal from DP sensor	Local Display
7	GF-014	CELL CULTURE-1	Signal from Room Temperature, Rh Sensor	Local Display
	GF-007	CORRIDOR ENTRY	Signal from DP sensor	Local Display
8	GF-012	INCUBATOR ROOM	Signal from Room Temperature, Rh Sensor	Local Display
	GF-007	CORRIDOR ENTRY	Signal from DP sensor	Local Display
9	GF-007	CORRIDOR	Signal from Room Temperature, Rh Sensor	Local Display
	GF-006	CHANGE ROOM-3	Signal from DP sensor	Local Display

EMS SCHEDULE				
SL. NO.	**ROOM NUMBER**	**DESCRIPTION**	**FROM**	**TO**
	FIRST FLOOR			
1	FF-018	QC LAB-3	Signal from Room Temperature, Rh Sensor	Local Display
	FF-011	INNER CORRIDOR	Signal from DP sensor	Local Display
2	FF-017	QC LAB-2	Signal from Room Temperature, Rh Sensor	Local Display
	FF-011	INNER CORRIDOR	Signal from DP sensor	Local Display
3	FF-016	QC LAB-2	Signal from Room Temperature, Rh Sensor	Local Display
	FF-011	INNER CORRIDOR	Signal from DP sensor	Local Display
4	FF-015	WASH + CLEANING AREA + DECONTAMINATION	Signal from Room Temperature, Rh Sensor	Local Display
	FF-011	INNER CORRIDOR	Signal from DP sensor	Local Display
5	FF-012	MICROBIOLOGY LAB	Signal from Room Temperature, Rh Sensor	Local Display
	FF-012A	AIRLOCK ENTRY	Signal from DP sensor	Local Display
6	FF-008	VIROLOGY LAB WITH INCUBATOR	Signal from Room Temperature, Rh Sensor	Local Display
	FF-006	PASSAGE	Signal from DP sensor	Local Display
7	FF-007	CELL CULTURE WITH INCUBATOR	Signal from Room Temperature, Rh Sensor	Local Display
	FF-006	PASSAGE	Signal from DP sensor	Local Display
8	FF-011	CORRIDOR	Signal from Room Temperature, Rh Sensor	Local Display
	FF-010	AIRLOCK ENTRY	Signal from DP sensor	Local Display

❖ **CABLES:**

- 690V grade armored PVC insulated FRLS ATC Screened twisted pair cables shall be used for field devices, sensors, transmitter & local displays.
- CAT-6 UTP cable shall be considered in two cases as follows:
  - ✓ For BMS: CAT-6 UTP cable with port switch shall be considered connectivity from the DDC panel to port switch located in the HUB rack.
  - ✓ For EMS: From Power supply unit to EMS display power cable is considered.

- Optical fiber cable / Copper cable shall be considered for fiber backbone connectivity from HUB rack to BMS Server to store the data.
- We shall consider 25mm/32mm diameter, 2mm thick heavy duty PVC FRLS conduits for field devices, sensors, Transmitter etc,.

❖ **CABLE TRAY:**

- The following types of cable trays are proposed.
  - ✓ GI powder coated Ladder type cable trays are proposed for 450mm and above.
  - ✓ GI powder coated perforated type cable trays are proposed for 300mm and below.
  - ✓ GI cable trays with 90 GSM is considered.
  - ✓ The cable tray below 300mm wide shall be supported with anchor bolt & threaded rod support, 450mm & above cable tray shall be supported with corrosion protected and painted MS supports.
  - ✓ Cable tray laying shall be with considering reducers, bends, up & down frames etc., for smooth laying of the cables.

3.0 SOFTWARE PROGRAMMING & INTEGRATION:

4.1 SYSTEM DESCRIPTION

The system offered shall be completely modular in structure and freely expandable at any stage. Each level of the system shall operate independently of the next level up.

The system shall be fully consistent with the latest industry standards of Niagara 4.x, operating on Windows latest version on a network environment, allowing the user to make full use of the features provided with these operating systems.

4.2 CENTRAL STATIONS HARDWARE

The Control stations shall comprise of server grade Machine providing high-level operator interface with the system. The terminals shall be capable of providing the operator with the facility for remote system interrogation, control, and retrieval / storage of logged data, annunciation of alarms and reports, analysis of recorded data and the formatting of management reports.

The control station shall consist of the following hardware with all of them suitable for the power supply voltage of 230 V AC ± 10%, 50 HZ + 3%.

FEATURES	DESCRIPTION
Processor	I7, Min 2.8GHz
Operating system	Windows®8 Pro or latest version
Graphic	NVIDIA Quadra optional
Hard Disk	SATA – 500GB/1TB
Power Supply	350 W switchable/50 Hz or as per requirement
Keyboard	104 keys window 98 keyboard, PS/2 Compatible
Power	EPA compliant
Desktop Manager	Based on SNMP protocol
Network	100ps Network Interface Card with two LAN ports

4.3 NETWORK

The system configuration shall facilitate the current network to be expanded in future at locations designated by the user.

Central management of user-specific information such as passwords and protected access to data and programs shall thus be made easily possible. The management system shall also support software updates and changes to the project data.

4.4 PRINTING

It shall be possible to connect printers directly to the central server/client machine. The Inkjet A3 color or B/W printer shall have a Hi-speed USB port for direct connection from central station.

4.5 REMOTE MANAGEMENT

The BAS software shall support Remote Access management i.e., Remote management station shall be connected via hard integration for monitoring only.

4.6 DDC PROGRAMMING SOFTWARE

The software shall be a graphic programming tool. It enables the user to make the function diagrams, to parameter, commission all the automation stations and to change the parameters while the system is in operation.

The programming tool shall be Windows based for convenience. It shall preferably fulfil the requirements laid down in the IEC1131-3 standard concerning the configuration (programming) of DDC/PLC devices.

All programming tools with license key shall be handed over to client post final commissioning and handing over.

4.7 SOFTWARE FEATURES

The software shall be modular, structured and shall be based on Windows 8 or higher, 32-bit technology.

Software shall have the following,

- Open system
- Web technology
- Shall support min 10 concurrent users.
- Scalable system
- Smart user/maintenance management
- Smart alarm management

The Software shall be a flexible, user friendly, user programmable package that will allow the operator to construct customized display screens and programs for achieving optimum monitoring, controls and information management and analysis. The software shall be latest international standards complaint.

The Software shall include as a minimum the Operating system, Communications Control, Graphic Operator Interface (OI) which includes editors and viewers with original licenses for editing and viewing.

The Software shall be a real time operating system and provide true multitasking providing concurrent execution of multiple real time programs and custom program development. “Switching” from foreground applications to background applications where the background applications are suspended is not acceptable.

The software shall be totally user-programmable to allow an operator without any software programming skills to construct programs for control, monitoring and information analysis. All program configurations will be done in clear English language.

The Software shall allow the user to modify and tailor the Operator Interface software to the specific and unique requirements of the equipment installed, the programs implemented and to staffing and operational practices.

Online modification of system configuration, program parameters, and data base shall be provided via menu selection and keyboard entry of data into preformatted self-prompting templates.

The Software shall be capable of allowing the operator to view information related to Building Automation along with the information related to Integration.

The Software shall provide a hierarchical linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. The graphics shall form the main interface for all the operator actions.

Descriptors for graphics, points, alarms, etc. shall be modified through the operator's station under password control.

Points shall be uniquely defined as to coloration, animation, audible rate and duration, point descriptors, operator messages, printer options, alarm archival option, alarm and warning limits, and engineering units.

Point related change capability shall include system/point enable/disable; run time enable/disable; analogue value offset, lockout, run time limits, and setting a fixed input value or output status.

Operator access to the system shall be allowed only under personal ID and password entry for use to 20 unique operators. Up to 15 alphanumeric characters for personal ID and up to 50 alphanumeric characters for password shall be assignable to each operator via the operator station. Operator assignment capability shall include designation of operator passwords, privilege(s), starting graphic and auto sign off duration.

Each operator shall be assignable an access level for system use as follows:

Level 1: View data
Level 2: Modify time programs.
Level 3: Modify intermediate level data such as set points and alarm limits.
Level 4: Modify high level data such as control parameters.

The operator shall be able to access the system from any operator station in the system by entry of the proper ID and password. The operators shall be permitted to change their own password without permitting access to any other password.

Sign-off from a station shall be a manual operation via pull-down menu or, if no mouse or keyboard activity takes place within an assignable time-period shall be automatic. Automatic sign-off period shall be selectable from ten minutes to 120 minutes for each operator or may be disabled on a per operator basis. All sign on/Sign-off activity shall be automatically achieved on the operator station disk for subsequent display or printout as desired.

Operator access to system points shall be controlled by individual operator-assigned graphic hierarchy and by privileges, i.e., an operator shall have access to only those graphics and points as assigned to him. The hierarchy shall permit access to an operator-assigned initial graphic and to all graphics linked to and below the initial graphic.

Each operator shall have any combination of user assigned operating privileges of alarm acknowledgement, point commanding, data modification, Operating system access, schedule changes, and system configuration changes.

The graphics shall provide the operator dynamic screen displays of real-time data with full colour animated displays of equipment status, site layouts/building plans and other system configurations.

An on-line graphic development facility shall be provided to allow the user to develop or modify graphic displays and assign and position any array of points within each graphic. Systems in which graphic creation & programming is not an on-line activity and/or which requires operator to close the Operator interface software shall not be accepted. Creation of the graphics and assigning of points to the graphics shall not require taking the operator station off-line or interfere with point archiving and alarms.

Graphics shall be created via mouse and keyboard selection of graphic library stored symbols and system profiles. The Software shall provide the capability to create custom symbols, system profiles, floor plans, buildings, etc., and to store them in the graphic library.

It shall be possible to import third party developed drawings developed using popular CAD software (ex ACAD). These imported drawings shall be displayed just as regular graphics with dynamic displays programmed on them.

It shall be possible for the operator to penetrate from one graphic to another by a simple mouse click on the graphic. Unlimited penetration feature is preferred.

It shall be possible for the operator to select further penetration via a mouse click on an area, building, floor, fan etc. The defined linked graphic below that selection shall then be displayed. Dynamic data shall be assignable to all graphics.

It shall be possible to display all data on a graphic regardless of physical hardware address, communication channel or point type (temperature, humidity, fire alarm, etc.) Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation and where specified.

Graphics shall also contain calculated or pseudo points. Each physical point and each point assigned to a graphic shall be assigned an English descriptor for use in reports. Points (Physical and pseudo) shall be displayed on the Graphic with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit.

To enable operators to view graphics in greater detail, a zoom/pan display feature shall be provided. Zooming shall be by dragging the cursor diagonally across the area to be zoomed. Panning shall allow horizontal and vertical scrolling around graphics.

Coloration shall be used to denote status and alarm states. Coloration schemes shall be variable for each class of points, as chosen by the user. It shall also be possible for the user to create and apply custom colours to depict different equipment status and conditions.

Dynamic animation shall be used to represent data (e.g., fan rotation, damper position, fluid flow, tank levels, etc.) It shall be possible to create customize animation to enable effective depiction of real-time data on the screen. The animation shall be applicable to both analogue as well as digital points.

It shall be possible for an operator with authorized privileges to stimulate a point condition from the Operator station. This would enable operators to test logic functions and other control functionality without having to physically have the input devices connected.

It should be possible to simulate all types of points (analogue as well as digital irrespective of the nature of the point hardware.

An on-line context-sensitive "help" utility shall be provided to facilitate operator training and understanding, the help being project specific.

The document shall contain text and graphics to clarify system operation. At a minimum, help shall be available for every menu item and dialog box.

The system shall also have a context-sensitive help feature whereby an operator may, on as single mouse click call up the help document pertaining to the dialog box that he is currently on.

Messaging and Alarm routing facility shall be provided on the operator station for e-mail, mobile, pager, fax etc., (such as field alarms like "FILTER CLOGGED" and operator messages like "CLEAN FILTER ON AHU-4")

Operator shall be able to command a point without having to place the system in manual mode first. This shall be only against password control.

For a digital command point such as a 2-position damper actuator, the actuator would show its current state (e.g., CLOSED) and the operator could select OPEN via mouse click. A keyboard equivalent shall be available for those operators with that preference. (Optional As per tender BOQ).

Upon selection of analogue commendable points (such as cooling coil valve) the dialog box shall provide facility to change the value as under.

- Click the cursor on the decimal set point value and enter a new value via the keyboard decimal keypad.
- Drive the value up or down via the up-down arrows or slider feature.

The main software applications shall, as a minimum, include.

- Plant Viewer : Graphics based operation of the plant.
- Trend Viewer : Logging and display of measured values
- Alarm Viewer : Display of alarm messages
- Alarm Router : Automatic routing of alarms

- Event Summary : Logging of alarms, system events and user activities

4.8 PLANT VIEWER

The plant viewer shall support the following features.

- Hierarchically linked animated high-resolution bit-map color graphics.
- Graphics shall be 3D, Layered, vector and supporting HTML5.
- Choice of 2D and 3D symbols with animation based on status.
- Direct access to set points, parameters, operating modes, alarms, time programs, on-line and off-line trend features.
- Dynamic multi-tasking with all active pages
- Monitoring and operation of plant at several levels
- Navigation to all other management station software applications
- User definable page size.
- Jump tags for jumps on the same level or between levels.
- Capable of graphics to be printed in color or monochrome.
- All graphic file formats supported by Windows can be imported (e.g., jpg, bmp etc.,)

4.9 ALARMS HANDLING & ALARM VIEWER

As a minimum, the system shall support the following features.

- Operation and manipulation of alarms (based on user privileges).
- Alarm message printing.
- Alarms printed independently of the central station (direct connection at automation level).
- Automatic pop-up windows for immediate display and operation of alarms.
- Audible or multimedia alarm indication.
- Continuous overview of all active alarms from site (updated automatically, displayed in order of priority, option of personalized view).
- Option of displaying detailed information.
- Direct access to associated plant graphics.
- Comprehensive filter and search criteria (time, date, priority, discipline, alarm status, Space, Equipment, alarm type.)
- Color-coding based on alarm priority/alarm status.

- Alarms for out of limit values (high, low), change of status, run time limits exceeded etc.,
- Option of repeating unacknowledged alarms at regular intervals.
- Facility to save user-defined criteria.
- Clear view of Equipment relationship with other equipment's in hierarchy during alarm rectification of any equipment.

4.10 ALARM ROUTING

To monitor alarms round the clock, alarm routing is an important feature of HVAC Control. The HVAC Control shall have the following features.

- Routing of alarms through email.
- Time schedule for each message recipient.
- Alarm routing based on priority.
- Alarm routing based on discipline (ACMV, Security etc.,).
- Alarms routing to person responsible at site.
- Alarm routing to person(s) responsible for specific equipment's or systems.
- Alarm escalation to higher authority in case any critical alarm is not addressed by BMS operator in a certain time limit defined by client.

4.11 TIME SCHEDULING

The time scheduler shall have the following features.

- 7-day time programs.
- Exception programs (local, building wise or system wise).
- Direct display of time programs within Plant viewer graphics.
- Direct entry of various operating modes.
- Easy creation, modification, and deletion of all-time programs.
- Scroll features for fast access to specific weeks or days.
- Printed reports in various display forms.
- Bulk Modification of Schedule. This can be either equipment wise or Space wise.
- Schedule of any equipment and Space can be copied and selected for any equipment and space respectively.

4.12 TREND VIEWER

The trend viewer shall have the following features.

- On-line or off –line real time data.
- Simultaneous display of up to ten signals per window.
- Absolute or relative time intervals.
- Zoom, scroll and cursor features for faster data analysis.
- Flexible, easy to use scaling feature with charts displayed in 2D or 3D.
- Management station display and archiving of on-line and offline trend data.
- Printouts of trend data.
- Capable of showing 3 trend charts in a single view / Dashboard.

4.13 EVENT SUMMARY

The Event Summary enables the operator to see the active alarms and events and to acknowledge the alarms. The features are as follows.

- It displays the active alarms and events according to the events summary profile definitions that have been set by the system integrator.
- The system integration enables the operator to change some of the settings of the Event summary and can also prevent such changes from being made by the operator.
- The Event summary profiles file should contain the filter (zones, severity, stations), security/feature options, default display options, default color and default sort order.
- Event summary displays filtered alarms and events by using filter.
- Event summary enables assigning color to the alarms and events displayed in the browser.

4.14 WEB SCHEDULER AND WEB ENABLING

The Software shall have a feature to function over a standard web browser to be accessible through a standard Internet/Intranet connection this shall enable remote development of all scheduling programs, provide remote visualizing capabilities, and obtain alarm and other status logs and other status logs at any remote location using only a web browser.

Using the browser, the user can do the following against password authorization.

- Define/modify tasks.
- Visualize authorized schematics.

- View authorizes alarm status.
- View historical alarm list.
- Schedule a time schedule.
- View trend and HDB data, where control authorization is provided.
- Create weekly timetable templates.
- Activity blocking both partially and fully for special days (some holidays, religious days).

4.15 EXCHANGE OF DATA THROUGH STANDARD INTERFACES.

The system shall be an open system using an OPC, which is a standard communication protocol to exchange data. The system shall support the use of standard interfaces and drivers that make it easy to integrate to third party software directly at the management station level, or to make common use of data from the system, e.g., via ODBC (Open Database Connectivity). DDE (Dynamic Data Exchange) shall enable current data to be loaded continuously into a spreadsheet program such as MS Excel. Further the system shall also be capable of integrating with third party system using Modbus RTU, BACNET or Lon Works protocols.

4.16 REPORTS

Reports shall provide the user with the latest information from the system at specific times or when specific events occur. The following features shall be supported.

- Reports routed based on time and /or priority.
- Manual or automatic triggering.
- User-definable or standard reports.

4.17 ACCESS PROTECTION

The management station shall grant access to the system only to authorized users. The system administrator shall adapt to an environment to match the individual requirements of each user. The access protection facility shall define sites and equipment to which a given user has access, the software functions available to that user within the site.

The system shall support the following features.

- Access to control and develop functions is protected with Username/ password.

- Individual access privileges covering access to sites, subsystems, and program functions down to individual objects in Plant Viewer.
- Encrypted Passwords.
- Association of users to groups.
- Association of objects to groups.
- Up to 500 users shall be grouped into a single group.
- New users can be defined at runtime.

Every single group shall have the rights to

- Lock a station.
- Shutdown a station.
- Log off.
- Change the password.

4.18 SYSTEM DESIGN

As a decentralized module with autonomous intelligence, the system controller shall be able to process, store and handle a large volume of data. In this way all the demands placed on an advanced control and management system shall be met in full.

4.19 THE COMMUNICATION LEVEL

The controller of the BAS shall be an intelligent module that can be operated autonomously and should not need to be supported/located centrally.

The DDC controller shall co-ordinate the flow of data in both directions, it shall be responsible for the communication upwards to the management station, on the same level with other system controllers and downwards via the interface to the locally operating DDC modules.

4.20 THE DATA EXCHANGE

The interface transmits and receives data both via the DDC bus and via the trunk bus of the System controller.

The tasks of the interface shall include:

- Processing the installed DDC data points.

- Converting local system controller addresses into physical DDC module addresses.
- Monitoring topology and DDC bus communication.
- Optimizing communication between the interface and the system controller.
- Synchronizing date, time, and daylight savings time adjustments in the interface and the DDC modules.

4.0 TECHNICAL SPCIFICATION FOR DIRECT DIGITAL CONTROLLER (DDC)

❖ **DDC CONTROLLERS**:

The IP Based direct digital control (DDC) system shall be designed with functions distributed both physically and functionally over the field controllers.

1. DDC controllers shall be capable of fully "stand- alone" operation i.e. in the event of loss of communication with other DDC's or Control Station, they shall be able to function on their own.
2. The controllers shall consist of a minimum of single 32-bit microprocessors for reliable throughput, based with EEPROM based operating system (O.S.).
3. DDC controller shall have an inbuilt web engine and shall be compatible with TCP/IP communication. Controller providing web access via router/gateway is not acceptable.
4. DDC controller should have onboard graphical user interface.
5. DDC must have facility of data validation locally at controller level.
6. The memory available to the controller board as working space for storage of the Operating system software and data files shall be decided based on the number of points being controlled by them.
7. Controllers requiring nickel-cadmium/lithium battery to support the full operation of the RAM shall have battery back-up up to 12 hours in the event of a localized mains failure. The battery shall not be required to supply power to actuators, valves, dampers etc.
8. In case the memory is stored on EEPROM, the battery backup will not be required.
9. A low battery alarm shall be provided with each Controller and with an indication at the Control Station.

10. The Controllers shall have proportional control, Proportional plus Integral (PI) Control, Proportional plus Integral plus Derivative (PID) Control, Two Position Control and Time Proportioning Control and algorithms etc., all in its memory and all available for use by the user, i.e., all the control modes shall be software selectable at any time and in any combination. The analog output of Proportional Control, PI Control and PID Control shall continuously be updated and output by the program shall be provided. Between cycles the analog output shall retain its last value. Enhanced integral action in lieu of Derivative function shall not be acceptable.

11. Controller shall be equipped with Adaptive control feature. Adaptive control shall examine the control loop output and system response when the PID is active, and continuously adapt the tuning parameters of proportional band and integral time. If there is a large oscillatory response (hunting), the tuning parameters shall be adjusted to make the response slower. If there is a small response and large error, the tuning parameters shall be adjusted to make the response faster.

12. Adaptive control feature shall give following benefits as minimum. The time required for tuning the new control systems shall be reduced or eliminated. The time required to retune control systems due to changes in seasons, loads, or equipment performance shall be eliminated. Equipment life shall be increased, as fewer oscillations cause less wear. Energy use shall decrease with stable control loops. Oscillatory control behavior causes unnecessary preheating or mechanical cooling, which adaptive control shall prevent.

13. The controllers shall have a resident real time for providing time of day, day of week, date, month, and year.

14. Back-up power shall support the clock. Upon power restoration all clocks shall be automatically synchronized.

15. Expansion of I/Os shall be possible either by modular expansion with low I/O density expansion modules, or in rack execution with plug-in cards. The selection of DDC controller shall be as per I/O schedule and the quantity of DDC controller shall be as in the BOQ given here in the specification no deviation shall be expectable.

16. The DDC's shall have **a min 15% spare capacity** (digital/analog input/output) to give flexibility for future expansion.

17. All DDC controllers shall be capable of handling voltage, milli-ampere, resistance, or open and closed contacts inputs in any mix, if required.

    Analog inputs/outputs of the following minimum types shall be supported:

    a. 4-20 mA.
    b. 0-1 volts.
    c. 0-10 volts.
    d. 0-5 volts, and
    e. 2-10 volts.
    f. Resistance Signals (either PTC or NTC)
    g. (PT 100, PT 1000, PT 3000, Balco 500, NI 1000)

18. Digital input/output types to be supported shall be, but not limited to the following:

    a. Normally open contacts.
    b. Normally closed contacts.

19. Controllers requiring fan cooling are not acceptable.
20. The Controllers shall have a self-analysis feature and shall transmit any malfunction messages to the Control Station. For any failed chip the diagnostic tests, printout shall include identification of each and every chip on the board with the chip number/location and whether the chip “Passed” or “Failed” the diagnostic test. This is a desired requirement as it would facilitate troubleshooting and ensure the shortest possible down time of any failed controller. Controllers without such safety features shall be provided with custom software diagnostic resident in the EEPROM. The tenderer shall confirm in writing that all controllers are provided with this diagnostic requirement.

21. Controllers shall have resident in its memory and available to the programs, a relevant library of algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences.

22. In the event of failure of communication between the controllers and/or Control Station terminal, alarms, reports, and logs shall be stored at the controllers and transmitted to the terminal on restoration of communication.

23. In the event of memory loss of a Controller or the expiration of back-up power, on start-up of the unit the necessary database shall be downloaded automatically and

without operator instruction. Controllers requiring a manual intervention for the re-boot of software are not desired.

24. Where information is required to be transmitted between controllers for the sharing of data such as outside air temperature, it shall be possible for global points to be allocated such that information may be transmitted either on change of incremental value or at specific time intervals.

25. The controllers shall be housed in vandal proof boxes to protect them from tampering by any unauthorized personnel. All DDC controllers used in plant room spaces and external applications shall be housed in IP54/IP66 rating enclosures.

26. Controllers must be able to perform the following energy management functions as a minimum,
    a) Time & Event programs
    b) Holiday Scheduling
    c) Maximum and Distributed power demand
    d) Optimum start and stop program.
    e) Night purge
    f) Load reset
    g) Zero energy band
    h) Duty cycle
    i) Enthalpy analysis and control
    j) Run Time Totalization
    k) Sequencing and Optimization
    l) Exception scheduling

Detailed description of software features and operating sequence of all available energy management software shall be submitted with the tender for evaluation by the consultant.

27. The DDC Controllers shall have Adaptive Control capability whereby the control software measures response time and adjusts control parameters accordingly to provide optimum control. The software shall allow self-tuning of the variable control loops (all or any of P, P+I, P+I+D) of the AHU's and chiller system so as to provide the most efficient and optimized controls at different load conditions. The energy management programs shall update their parameters based on past experience & current operating conditions.

28. Alarm Lockout shall be provided to prevent nuisance alarms. On the initial startup of air handler and other mechanical equipment a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating an alarm comparison logic.

29. Tenderers shall indicate their proposed system alarm handling capability & features.

30. Run time shall be accumulated based on the status of a digital input point. It shall be possible to total either ON time or OFF time. Run time counts shall be resident in non-volatile memory.

31. It shall be possible to accommodate Holiday and other planned exceptions to the normal time.

    Programs. Exception schedules shall be operator programmable up to one year in advance.

32. All DDC shall have trend / log storing capacity in built into it. It shall be possible to have stored the data for at least 40 days @ 1-hour sampling time for all the points of the DDC (used or unused).

33. The minimum communication should be 100MBPS for each of the controllers.

34. DDC should be forward compatible type so that any expansion or upgrade of the system required in the future is easily taken care of without scrapping / removing / disturbing the existing working system.

35. DDC should allow users to include graphics, if required, however it shall be of static in nature.

36. All DDC Should be capable of sending email to specific user in the event of alarm, identified by end user / consultants.

❖ **DATA COMMUNICATION**

1. The communication between controllers shall be via a dedicated communication network. The controller's microprocessor failures shall not cause loss of communication to the remainder of any network. All networks shall support global application programs, without the presence of a host PC.

2. Each controller shall have equal rights for data transfer and shall report in its predetermined time slot. There shall be no separate device designated as the communication's master. Those systems using dependent controllers shall be pointed out by the contractor and a dual redundant transmission media with automatic switching and reporting in the event of line faults will have to be provided.

3. The communication network shall be such that:

   a. Every DDC must be capable of communicating with all DDC's.
   b. Network connected devices with no messages to transmit shall indicate "No failure" message each cycle. Lack of this message after successive retirements shall constitute a communication or device failure.
   c. Each controller is to be provided with a communication watchdog to assure that the failure is reported to central station.
   d. Error recovery and communication initialization routines are to be resident in each network connected device.
   e. The communication protocol shall incorporate CRC (Cyclic Redundancy Check) to detect transmission errors.

4. Single or multiple standalone controller failures shall not cause loss of communication between active DDCs connected on the communication network. Full communication shall be sustained as long as there are at least two operational standalone control panels active on the communication network.

5. All the System Integration Units shall be linked together on a Local Area Network.

6. The communication network shall include provision for automatically reconfiguring itself to allow all operational equipment to perform as efficiently as possible in the event of single or multiple failures.

❖ **ENCLOSURES FOR CONTROLLERS PANELS**

All the controllers shall be housed in Lockable Vandal proof boxes which shall either be floor mounted or wall mounted. These shall be free standing, totally enclosed, dust and vermin proof and suitable for tropical climatic conditions.

The panel shall be metal enclosed 14 SWG CRCA sheet steel cubicle with gaskets between all adjacent units and beneath all covers to render the joints dust proof. All doors and covers shall be hinged and latched and shall be folded and braced as necessary to provide rigid

support. Joints of any kind in sheet metal shall be seam welded with welding slag grounded off and welding pits wiped smooth with plumber metal.

The panel shall consist of PVC raceway, MCB, Fuse, Terminal block, internal connecting wiring with ferrules must be considered as per the approved GA drawing by Client/Consultant.

External cable entering the panel shall be with brass single compression gland (for armoured cable), PVC gland for the Flexible cable. End termination of these cable shall have printed ferrules only.

All panels and covers shall be properly fitted and secured with the frame and holes in the panels correctly positioned. Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with nuts. Self-threading screws shall not be used in the construction of control panels. Knockout holes of approved size and number shall be provided in the panels in conformity with the location of incoming and outgoing conduits/cables. Lamps shall be provided to support the weight of the cables. The dimensions of the boxes & internal wiring schematic shall depend on the requirement and the color decided in consultation with the Architect/Consultant.

Note: All panel enclosures used in plant room spaces (IP 54 protection) and external to building shall be suitable for outdoor application; Vendor must dually cross check the panel location before submitting the techno commercial offer.

5.0 TECHNICAL SPCIFICATION FOR FIELD DEVICES

5.1 GENERAL REQUIREMENTS

All controls and filed devices shall be capable of operating in ambient conditions varying between 0-55 deg. C and 90% R.H. non-condensing.

All Control devices shall have a 20 mm conduit knockout. Alternatively, they shall be supplied with Adaptors for 20 mm conduit.

Ancillary Items - When items of equipment are installed in the situations listed below, the BAS contractor shall Include the following ancillary items:

(i) Weather Protection:

All devices required to be weatherproof are detailed in the Schedule of Quantities. IP ratings for the equipment are mentioned in the respective section.

(ii) Pipework Immersion:
Corrosion resisting pockets of a length suitable for the complete active length of the device, screwed ½" (13 mm) or ¾" (20 mm) NPT suitable for the temperature, pressure and medium.

(iii) Duct Mounting (Metal or Builders Work):
Mounting flanges, clamping bushes, couplings, locknuts, gaskets, brackets, sealing glands and any special fittings necessitated by the device.

5.2 TEMPERATURE & RH SENSORS/TRANSMITTER

Temperature sensors for space, pipes and ducts shall be of the Resistance Temperature detector (RTD) type or thermistor. These shall be two wire types and shall conform to the following specifications:

- Immersion sensors shall be high accuracy type with a high resistance versus temperature change. The accuracy shall be at least ± 0.2 ^{o}C and sensitivity of at least 2 ohm/F.
- Immersion's sensors shall be provided with separate stainless steel thermo well. These shall be manufactured from bar stock with hydrostatic pressure rating of at least 10 kgf/cm^2.
- The connection to the pipe shall be screwed ¾ inch NPT (M). And ensure proper heat transfer from the well to the sensor. Terminations to be provided on the head. Flying leads shall not be acceptable.
- Duct temperature sensors shall be with rigid stem and of averaging type. These shall be suitable for duct installation.
- Duct Sensor shall be mounted against the direction of flow.
- Probe length should not be less than 3/4th of the duct size.
- Outdoor air temperature sensor shall be provided with a sun shield.
- The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

The temperature sensors may be of any of the following types:

1) PT 100, PT 1000, PT 3000
2) NI 100, NI 1000
3) Balco 500
4) Thermistor
5) NTC1800

5.3 HUMIDITY SENSORS (Rh)/TRANSMITTER

Space and duct humidity sensors shall be electronic type with capacitance sensing element shall output signal of 0-10V or 4-20mA with an effective sensing range of 10% to 90% RH. Accuracy shall be + 3% or better. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with a housing. The sensor housing shall plug into the base so that the same can be easily removed without disturbing the wiring connections. The sensors shall not be mounted near any heat source such as windows, electrical appliances etc.

5.4 DIFFERENTIAL PRESSURE SWITCH FOR AIR SYSTEMS

Switches shall be supplied with air connections permitting their use as static or differential pressure switches.

The switch shall be of differential pressure type complete with connecting tube and metal bends for connections to the duct or across the filters. The housing shall be IP 54 rated. The pressure switches shall be available in minimum of 3 ranges suitable for applications like Air flow proving, dirty filter, etc.

The switches shall be provided with 4-20mA, 0-5 or 0-10Vdc output proportional to pressure input range compatible with HVAC CONTROL system.

5.5 DIFFERENTIAL PRESSURE SWITCH FOR WATER

These shall be used to measure pressure differential across suction and discharge of pumps. The range shall be as specified in the Bill of quantity. Switch shall be ON with increase in differential. Housing for these shall be weatherproof with IP 65 protection. The pressure switch shall be capable of withstanding a hydraulic test pressure of 1.5 times the working pressure. The set point shall fall in 40-70% of the scale range and shall have differentials adjustable over 10%-30% of the scale range. The switches shall be provided with site adjustable scale and with 2 NO/NC contacts.

5.6 DIFFERENTIAL PRESSURE CUM AIR FLOW TRANSMITTERS

Differential Pressure Cum Air Flow transmitters are engineered for building automation in the HVAC/R industry. The most technologically advanced transmitters on the market, measuring volume flow, velocity, and static and differential pressure. The Series DPT-Flow devices can be connected directly to the pressure measurement points in a centrifugal fan, providing accurate flow measurement of the fan. The smart user interface enables easy selection of settings according to the selected fan or in-duct measurement probe.

5.7 AIR FLOW SWITCHES

Air flow switches shall be selected for the correct air velocity, duct size and mounting attitude. If any special atmospheric conditions are detailed in the Schedule of Quantity, the parts of the switches shall be suitably coated or made to withstand such conditions. These shall be suitable for mounting in any plane. Output shall be 1 NO/NC potential free. Site adjustable scale shall also be provided.

5.8 AIR PRESSURE SENSOR

The pressure sensor shall be differential type. The construction shall be spring loaded diaphragm type. The movement of the membrane in relation to the pressure should be converted by an inductive electromagnet coupling which would give an output suitable for the controller. The pressure sensor shall be in a housing having IP 54 ratings in accordance with IEC 529. Suitable mounting arrangement shall be available on the sensor. The sensor shall come complete with the PVC tubes & probes.

5.9 AIR VELOCITY SENSOR

Air Velocity Sensor shall be integrated Surface / Duct mounted type on the field. These shall work on 24V AC/DC supply with +/- 10% variation, the output being standard type i.e. 4-20 mA / 0- 10 Volts etc., with an accuracy of +/- 3%. It shall be possible to select the different ranges by changing the jumpers on the sensor. At least 3 selection ranges on the sensors are required.

5.10 VARIABLE AIR VOLUME (VAV) BOXES

- These shall of the low velocity variable air volume boxes without re-heat coils and shall be a proprietary line as marketed by a firm specializing in this field. The contractor shall supply and install units to the quantity and locations as specified.

- The VAVs shall be used in standalone mode complete with their own temperature sensor, controller and shall perform the function of maintaining the temperature and airflow. However, the VAVs shall be HVAC CONTROL compatible to enable the network the VAVs to HVAC CONTROL. In this mode all VAV data shall be available at the HVAC CONTROL workstation, and it shall be possible to change set points and flow settings from the HVAC CONTROL workstation. VAVs shall be able to release open protocol Lon works / Back net and to integrate with any third-party Building Management System.

- The unit shall be complete with damper, airflow measurement, DP port across the VAV and solid-state electronic actuator with inbuilt controller which measure air flow and modulate the box to achieve the set air flow automatically.

- Boxes shall be supplied with all internal attenuation treatment and acoustical damped casing necessary to achieve the required noise criteria. Casing shall be of 24SWG minimum fitted with a completely sealed, easily removable means of access to all internal parts. Access to all boxes must be from the underside only.

- The actuator shall be of 24V AC Bi-directional, direct coupled to the damper shaft. The required transformer to step down of the voltage range from 230V to 24V with plug top shall be part of the unit. The UPS power point near the VAV will be provided by Electrical vendor.

- A suitable device shall be provided for the field adjustment of minimum airflow. All boxes shall be initially factory set at a minimum air quantity of 15% of the design requirements. Under shut-off conditions, all boxes shall not have air leakage more than 2% of the maximum air quantity at 75mm static pressure.

- The boxes shall be pressure independent.

6.0 TECHNICAL SPECIFICATION FOR EMS DISPLAY UNITS

❖ **DP Display**

Room mounted Multicolor 3.5" LCD display with power supply for DP duly mounted inside MS box with SS 304 cover as per Approved drawing. Display shall be suitable for mounting in 50mm thick, clean room modular panel. Display Unit shall have IR/Button Type Acknowledge sensor, Buzzer and the value shall be Color Change till it reaches to the normal condition. DP along with in Alert and Action with high- and low-level alarm

set point and Door Open/Close status in Display shall be considered. In case of any parameter goes beyond set limit there shall be an Infra-red/Button type acknowledge button operator will acknowledge the alarm and buzzer will stop wailing but in display value shall be Red/Yellow till the DP returned with in limit.

❖ **Temp & RH Display**

Room mounted Multicolor 3.5" LCD display with power supply for Temp & RH duly mounted inside MS box with SS 304 cover as per Approved drawing. Display shall be suitable for mounting in 50mm thick, clean room modular panel. Display Unit shall have IR/Button Type Acknowledge sensor, Buzzer and the value shall be Color Change till it reaches to the normal condition. Temp & RH along with in Alert and Action with high- and low-level alarm set point and Door Open/Close status in Display shall be considered. In case of any parameter goes beyond set limit there shall be an Infra-red/Button type acknowledge button operator will acknowledge the alarm and buzzer will stop wailing but in display value shall be Red/Yellow till the Temp & RH returned within in limit.

❖ **Temperature Display**

Room mounted Multicolor 3.5" LCD display with power supply for Temperature duly mounted inside MS box with SS 304 cover as per Approved drawing. Display shall be suitable for mounting in 50mm thick, clean room modular panel. Display Unit shall have IR/Button Type Acknowledge sensor, Buzzer and the value shall be Color Change till it reaches to the normal condition. Temp along with in Alert and Action with high- and low-level alarm set point and Door Open/Close status in Display shall be considered. In case of any parameter goes beyond set limit there shall be an Infra-red/Button type acknowledge button operator will acknowledge the alarm and buzzer will stop wailing but in display value shall be Red/Yellow till the Temp returned with in limit.

7.0 SIGNAL CABLE & COMMUNICATION CABLE

The signal cable shall be of the following specifications:

a. Wire : Armored Shielded Multistrand Annealed Tinned Copper

b. Size : 1.0 sq. mm, 14 strands

c. No. of conductors : Two (One pair)

d.	Core color	:	Black and Red
e.	Shielding	:	Overall beld foil Aluminium Polyester shield.
f.	Jacket	:	Chrome PVC
g.	Nominal DCR	:	17.6 ohm/km for conductor, 57.0 ohm/km for shield
h.	Cable color	:	Blue or grey

❖ **COMMUNICATION CABLE**

The communication cable shall be of the following specifications:

a.	Wire	:	Armored Shielded Multistrand Annealed Tinned Copper
b.	Size	:	1.5 sq. mm, 30 strands
c.	No. of conductors	:	One pair (2 conductor)
d.	Core color	:	Black and Red
e.	Shielding	:	Overall beld foil Aluminium polyester Shield.
f.	Jacket	:	Chrome PVC
g.	Cable color	:	Blue or grey

❖ **DRAWING OF CONDUCTORS**

While drawing armoured cable into the Cable tray/conduit, care shall be taken to avoid scratches and kinks, which may cause breakage of conductors. No joint shall be allowed in the breakage of conductors. No joint shall be shaved off like length of the conductors. Insulation shall be shaved off like sharpening of a pencil and it shall not be removed by cutting it square to avoid depression/cutting of conducting material.
Strands of wires shall not be cut to accommodate and connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

No wire shall be drawn into any conduit all work of any nature that may cause injury to wire in completed. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust, dirt, or any other obstruction. Where wires are connected to detectors, or panel, sufficient extra length of wires shall be provided to facilitate easy connections and maintenance.

Only licensed supervisors/wiremen shall be employed for cabling and other connected work. Only approved make of cables shall be used. The cables shall be brought to the site in their original packaging.

8.0 GENERAL SPECIFICATIONS FOR CABLE TRAYS

8.1 General Requirement: -

Cable Tray and Cable Ladder systems are intended for the support and accommodation of cables and possibly other Electrical equipment in Electrical/Instrumentation/Communication systems.

8.2 Perforated Cable Tray: -

The cable tray and all accessories shall be fabricated from sheet steel and must be galvanized against corrosion confirming to EN10346 / ISO1461-1999 for installations in indoor and outdoor applications respectively. Hot galvanization using the dipping method according to DIN EN ISO1461 and coating thickness to DIN ISO 1461 approximate 40-60microns. The cable trays shall be supplied in standard lengths of 3000 mm and the width of the tray shall be as follows.

Width: 100, 150, 200, 300, 400, 500.

All the cable tray accessories like Bend's, TEES's, Crossover's etc. should be designed in accordance with IEC 61537 and should be factory fabricated. The accessories shall be from the same material as of the tray and modular type, it should relate to the trays by using fasteners. Typical details of trays, fittings, and accessories etc., are shown in the enclosed drawings.

For Cable trays designed, tested, and confirming to IEC 61537, thickness of cable tray should be according to the manufacturer's catalogue. For locally fabricated and non-tested tray, thickness should be 2 mm up to span length of 1.5-meter, 2.5 mm for span length between 2 to 3 meter and 3 to 4 mm for span length between 4 and 10 meters.

Safe Working Load (SWL) with a span length up to 5 meters							
Description	Side Height (in mm)	Width (in mm)	Span length (in meters)				
			1.5m	2m	2.5m	3m	4m	5m

			Permitted Load (in kg/meter)					
Perforated tray	60	100-500	150	100	50	-	-	-
	100	150-500	185	130	75	60	-	-

8.3 Cover for Cable Trays:

Cover for trays to protect the cable insulation from falling objects, water droplets, and harmful effects of ultraviolet rays and accumulation of dust. The cover shall be Galvanized sheet steel. The cover for the cable trays shall be of snap fit type.

Mounting Accessories (supports and Brackets): -

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc to form various arrangements required to support the cable trays. Welding of the components at the site shall not be allowed.

8.4 Corrosion Protection: -

The cable tray / ladder/accessories shall be galvanized according to EN10346 / ISO 1461-1999 for installations indoor and corrosive outdoor applications respectively. Sample tray / ladder / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 for > 150 hours & 500 hours. (*155 hours according to class 3 for pre-galvanized surface and 550 hours according to class 6 for Hot dip Galvanized surface as per ISO)

8.5 Testing: -

- Cable tray / Ladder, bend, T Bend, cross, and all supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray/ladder should not deflect more than

1/100th of the span length at SWL in Mid span and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length. The cable tray / cable ladder should be tested up to 1.7 times SWL at minimum and maximum room temperature. The temperature classification of cable tray system should be - 5 to + 150°C.

- Marking, Documentation, Compliance, and Inspection.

9.0 ABBREVIATIONS

AHU	Air Handling Unit
HVAC CONTROL	Building Management System
cGMP	Current Good Manufacturing Practices
DQ	Design Qualification
ENG	Engineering Department
FA	Fresh Air
GEN	General
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air Conditioning
ID	Identification
IQ	Installation and Operational Qualification
MLS	Monitoring & Control System
No.	Number
QAD	Quality Assurance Department
QTY	Quantity
RA	Return Air
Rev.	Revision
RH	Relative Humidity
RPM	Rotation per minute
SA	Supply Air
SOP	Standard Operating Procedure
SVP	Small Volume Parenteral
TR	Tonnes
URS	User Requirement Specification
VFD	Variable Frequency Drive

PART-7

ELV (FAS, ACS, DIS, CCTV & GDS) WORKS

CONTENTS

1.0 GENERAL SCOPE OF WORKS:

The scope of work to be carried out under this contract is illustrated in the IO summary, Technical Specifications, and the Bill of the quantities. The contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the client/consultants. The contractor shall furnish all labor, materials and equipment as listed under the Bill of quantities and specified otherwise, transportation and incidentals necessary for supply, installation, testing and commissioning of the complete ELV system as described in the specifications. This also includes any material, equipment, appliances, and incidental work not specifically mentioned herein or noted in the documents as being furnished or installed. But which are necessary and customary to be performed under this contract and which are required under the Bill of Quantities and the specifications for ELV systems.

1.1 PROJECT EXECUTION AND MANAGEMENT:

- The contractor shall ensure that senior planning and execution personnel from his organization are assigned exclusively for this project. They shall have a minimum of 10 years' experience in this type of installation.
- For quality control & monitoring of workmanship, contractor shall assign at least one full time engineer who would be exclusively responsible for ensuring strict quality control, adherence to the specifications and ensuring top class workmanship for the air-conditioning installation.
- The contractor shall arrange to have mechanized and modern facilities for transportation of materials to the place of installation for speedy execution of work.

1.2 PERFORMANCE GUARANTEE:

- The Contractor shall carry out the works in accordance with the specifications, Bill of the quantities and other documents forming part of the Tender / contract. The contractor shall be fully responsible for the performance of selected items/equipment (installed by him) at the specified parameters and for the efficiency of the installations to deliver the required end results. The contractor shall guarantee that the ELV system as installed shall maintain the parameters required under the BOQ and specifications. The guarantee shall be submitted on the Performa sheet. The contractor shall also guarantee that the performance of various equipment's individually shall not be less than the quoted capacity.

1.3 SHOP DRAWINGS:

- All the shop drawings shall be prepared through AutoCAD system based on the architectural drawings and site measurements. These shop drawings shall contain all information required to complete terminations. These shop drawings shall contain all the information required to complete the project as per specifications and as required by the Client/Consultant. These drawings shall contain details of constructions, size arrangement, operating clearances, performance characteristics and capacity of all items of equipment. Minimum 5 sets of drawings shall be submitted for final sign off.

- Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in under the approved list of makes and quoted by tenderer in technical data part of tender.

- When the Client/Consultant makes any amendment to the above drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints for approval. The contractor shall submit a further 5 sets of the shop drawings.

- Samples of all materials like sensors, field devices, controls, control wires etc. shall be submitted to the client/consultant prior to procurement. These will be submitted in 2 sets of approval and retention by client site representative and shall be kept in their site office for reference and verification till the completion of the project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installations.

- Within four weeks of the approval of the relevant shop drawings the contractor shall submit four copies of a comprehensive variation in quantity statement.

1.4 TESTING AND COMMISIONING:

- Four copies of the certified manufacturer's performance certificates for each piece of equipment, highlighting operational parameters for the project, shall be submitted along with the test certificates. Contractors shall also provide four copies of the record of all safety and automatic control settings for the entire installation.

- The installation shall be tested again after removal of defects and shall be commissioned only after approval by the client site representative. All tests shall be carried out in presence of the representatives of the Client/consultant.

2.0 CODES AND STANDARDS

The fire alarm shall meet the codes and standards cited below and applicable local building and fire codes. All fire alarm equipment shall be referred to Underwriters Laboratory (UL) and Factory Mutual (FM) approved for the type and class of service performed. Design of Fire alarm system should comply with Indian as well as NFPA standards.

Installation & Maintenance of Fire	IS-2189-988
Detection & Alarm System	IS-2175-1988/11360-1985
Copper Wire	IS-694-1977
Silicon Rubber Insulated Single Core	
& Multi Core with Fibre Glass braided &	
Varnished Flexible Cords & Cable	IS-9968 (Pt-1)-1988
PVC Insulated Cables	IS-1554 (Pt-1)-1976

NFPA71	-	Central Station Signalling Systems - Protected Premises Unit
NFPA72A	-	Local Protective Signalling Systems - Protected Premises Unit
NFPA72D	-	Proprietary signalling Systems - Protected Premises Unit
NFPA72E	-	Automatic Fire Detectors National Electric Code Article 760

The control unit and sensors shall conform to the following standards.

UL-50	Cabinets and Boxes
UL-268	Smoke Detectors for Fire Protective signalling Systems
UL-864	Control Units for Fire Protective signalling Systems
UL-268A	Smoke Detectors for Duct Applications
UL-521	Heat Detectors for Fire Protective
UL-228	Door Closers-Holders for Fire Protective signalling Systems
UL- 464	Audible signalling Appliances
UL-38	Manually Actuated signalling Boxes
UL-346	Water-flow Indicators for Fire Protective signalling Systems
UL-1481	Power supplies for Fire Protective signalling Systems.
UL-1076	Control Units for Burglar Alarm
UL-1971	Visual Notification Appliances

UL-318 Clean Room Application (9th Edition)

NFPA-72, 2013 Edition: General System Design Guideline

NBC, 2005: National Building Code of India

Local AHJ: All requirements of Authorities Having Jurisdiction.

Mandatory Approvals

- UL listing
- FM approval

3.0 SCOPE OF WORK

Safety, Security & Surveillance scope of work covers the design of following: -

- Intelligent Addressable Fire alarm panel- Alarm and Detection as per NFPA-72.
- HID card reader-based type Access Control system.
- Standalone Door interlocking system with No touch (Contactless) switch.
- IP based Closed Circuit Surveillance system.
- Standalone type Gas detection System

4.0 DESIGN CRITERIA

A. FIRE ALARM SYSTEM

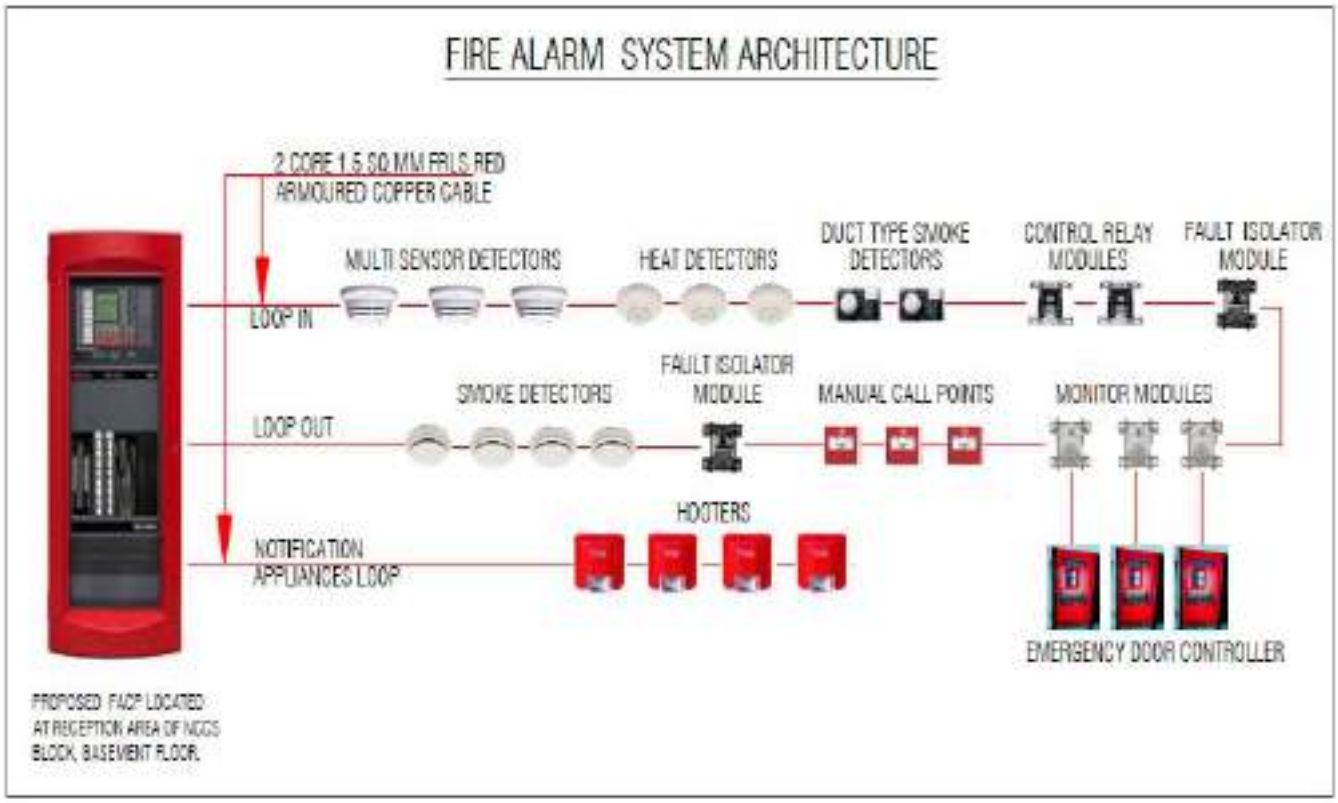
- An Intelligent fire alarm system has several devices working together to detect and warn people through visual and audio appliances when smoke, fire or other emergencies are present. These alarms may be activated automatically from smoke detectors, and heat detectors, or may also be activated via manual fire alarm activation devices such as manual call points. Alarms shall be wall / ceiling mountable sounders or horns. Fire alarm sounders can be set to certain frequencies and different tones including low, medium and high, depending on the manufacturer of the device.
- A dedicated Intelligent addressable Fire alarm control panel (FACP) with suitable loop card capacity is proposed for c-GMP Compliant Mammalian cell Line Repository at NCCS and location is proposed at Basement floor Reception.

- All smoke detectors & devices shall be connected to FAS panel.
- The proposed loop card shall have loop capacity of 250 devices (which includes 125 Detectors and 125 devices), and 80% loading on loop card is considered.
- Intelligent addressable detectors & devices are proposed.
- Intelligent addressable smoke detectors are considered, i.e., above & below false ceiling detectors for areas with false ceiling and true ceiling detectors for areas with true ceiling.
- Response indicators are proposed for above false ceiling detector.
- Intelligent addressable Multi sensor detector with red color LED indication is proposed for the Electrical room, technical area, UPS room, Battery room, & BMS room.
- Intelligent addressable Heat detectors are proposed for Wash & Autoclave areas, etc.,
- Addressable duct smoke detectors with control relay modules are considered for all AHUs.
- Smoke detectors are proposed up to 10 meters of ceiling height.
- Smoke detectors are considered for every 3.5m radius coverage for areas having up to 5mtr ceiling height and 2.5m radius coverage area for 6mtrs to 10mtrs ceiling height.
- Addressable Hooter cum strobe is considered in all corridors for every 15-20 mts. With 82 dBA level at 3mtr distance between the height from occupancy hearing to mounting height.
- Pull down type addressable Manual call points are considered near to entry doors, emergency exit doors and staircase entry.
- Fault isolator modules are considered for isolating shorted, de-wired and loose circuits between two successive faults.
- All Emergency exit doors are fitted with Emergency door controller (local scare alarm). During the normal condition if emergency door is operated then, it shall give local alarm and the same shall be connected to the Fire alarm panel through the Monitor module & Control relay module.

- For looping all the detectors & devices inside the building shall be with Class-A wiring style, 2C 1.5sqmm Armoured ATC FRLS red color sheathed cable confirming to IEC standards and specifications.
- The integration of various systems with fire alarm system is detailed below:

➢ In the event of fire, Fire alarm panel shall directly trip the AHUs through the Control module.

➢ In the event of fire, the control panel shall deactivate all the Access and Door interlocking doors.



Refer to the FAS Layout for Basement Floor Attached as a Separate Annexure: ANNEXURE-I

Refer to the FAS Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-II

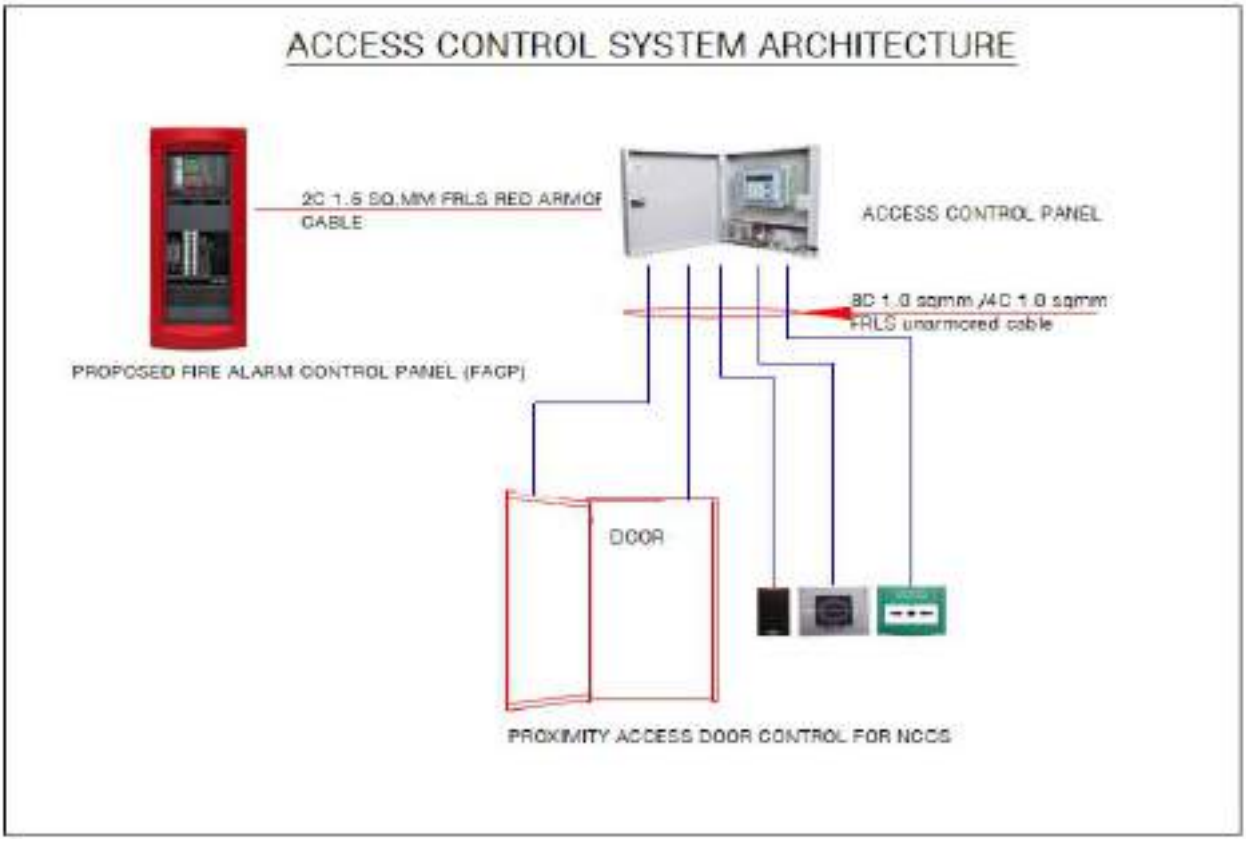
Refer to the FAS Layout for First Floor Attached as a Separate Annexure: ANNEXURE-III

Refer to the FAS Layout for Basement Floor Attached as a Separate Annexure: ANNEXURE-IV

Refer to the FAS Layout for Terrace Floor Attached as a Separate Annexure: ANNEXURE-V

B. ACCESS CONTROL SYSTEM:

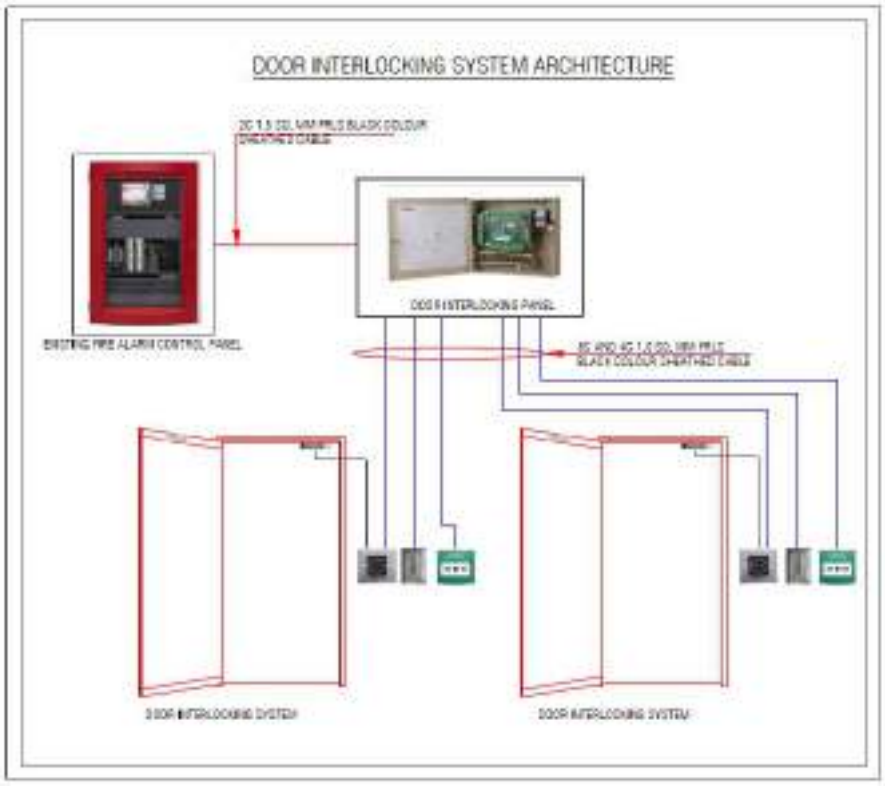
- The Access control system refers to a field controller, electronic card access control system.
- The Electronic Access Control System is to monitor and restrict access to specified general areas and to report on the activity and violations of restricted access in those areas. Access control door shall be integrated with Fire panel such that doors should act like normal door in case of fire emergency.
- The purpose of an access control system is to provide quick, convenient access to those persons who are authorized, while at the same time, restricting access to unauthorized people.
- Electronic Access control panel is considered for c-GMP Compliant Mammalian cell Line Repository at NCCS.
- Biometric Reader is considered for c-GMP Compliant Mammalian cell Line Repository at NCCS for Attendance management.
- Electronic Access reader control panel location is proposed in HUB room, Basement floor and in BMS Room, Second floor.
- From Each doors control cables shall be connected to Electronic Access reader control panel.
- All Electronic Access reader control panels shall be connected to the port switch which is in the HUB rack through Cat 6 cable.
- The emergency switch / Glass is proposed to open all the doors simultaneously in emergency conditions.
- Proximity HID card reader is considered for employee door access. IN shall be through card reader & OUT shall be through exit push button.
- Proximity HID card reader is considered for both IN & OUT for Hub Room & BMS Room.
- 8C and 4C 1.0 Sqmm Armoured ATC FRLS color sheathed cable with FRLS PVC Heavy duty conduit is considered.
- 2C 1.5 Sqmm Armoured ATC FRLS color sheathed cable is proposed from Fire panel to Electronic Access control panel.



C. DOOR INTERLOCKING SYSTEM:

- The Door Interlock System is proposed for airlocks and change rooms - in case of any critical area that requires door access control with additional security.
- Standard standalone Door interlock system is proposed, and logic shall be only one Door opens at a time.
- When the Egress button pressed to open, the door Green LED turns ON for 5 seconds to indicate Door is released and for those 5 seconds on for other doors which are not allowed to open.
- In case of Emergency / Fire, press Emergency button connected to Door interlock system panel, it allows to open all doors simultaneously.
- 600lbs Heavy duty Magnetic lock is proposed for door interlocking system.
- Door controller shall be integrated with Fire panel such that doors should act like normal doors in case of fire emergency.

- Touch less Egress switch is proposed as input switch to access the door by simply passing the hand close to the switch.
- Emergency release push button is proposed to open all the doors simultaneously in emergency conditions.
- 8C and 4C 1.0 Sqmm Armoured ATC FRLS color sheathed Copper cable with FRLS PVC Heavy duty conduit is considered.
- 2C 1.5 Sqmm Armoured ATC FRLS color sheathed cable is proposed from Fire panel to Electronic Access control panel.



Refer to the ACS & DIS Layout for Basement Floor Attached as a Separate Annexure: ANNEXURE-VI

Refer to the ACS & DIS Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-VII

Refer to the ACS & DIS Layout for First Floor Attached as a Separate Annexure: ANNEXURE-VIII

Refer to the ACS & DIS Layout for Second Floor Attached as a Separate Annexure: ANNEXURE-IX

Refer to the ACS & DIS Cable tray Layout for Basement Floor Attached as a Separate Annexure: ANNEXURE-X

Refer to the ACS & DIS Cable tray Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-XI

Refer to the ACS & DIS Cable tray Layout for First Floor Attached as a Separate Annexure: ANNEXURE-XII

Refer to the ACS & DIS Cable tray Layout for Second Floor Attached as a Separate Annexure: ANNEXURE-XIII

D. IP BASED CCTV SYSTEM:

- Closed-circuit television (CCTV), also known as video surveillance, is the method through which video cameras transmit signals to a specific set of monitors at a specific place.
- An IP based Closed-Circuit Television (IP CCTV) system shall be self-operated system used to transmit video signal to a control center in real-time monitoring of images and to record minimum of 30days to later investigation and monitor if required of the images.
- The Proposed CCTV Monitoring station shall be BMS Room, second floor and it shall include operator workstations complete with monitor setup and all other accessories required. The operators will use Video Management System access of the IP CCTV to monitor the allocated areas to them.
- Network Video recorder (NVR) location is considered in HUB room, Basement floor.
- Dome type cameras are considered for Entry/Exit, Corridors, and lab areas.
- PTZ Cameras are proposed for Cell Repository.
- The POE switch location is HUB room, Basement floor.
- Bullet type camera is proposed at Main gate Entry/Exit.
- The POE switch cable shall be connected from the NVR to the server / workstation, which is in BMS room, Second floor.

- CAT 6 cable is proposed for CCTV networking system with in 90mtrs, in case of above the 90mtrs optical fiber cable is proposed.
- A range of 2MP is considered for all cameras.

Refer to the CCTV Layout for Basement Floor Attached as a Separate Annexure: ANNEXURE-XIV

Refer to the CCTV Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-XV

Refer to the CCTV Layout for First Floor Attached as a Separate Annexure: ANNEXURE-XVI

Refer to the CCTV Layout for Second Floor Attached as a Separate Annexure: ANNEXURE-XVII

E. GAS DETECTION SYSTEM:

- Gas detection system has been considered for the c-GMP Compliant Mammalian cell Line Repository at NCCS.
- A standalone type, Electrochemical based Oxygen depletion gas detector is considered for detection of CO2 gas.
- Standalone type, Oxygen depletion gas detectors are considered in Cell Freezing & Cell Repository rooms.
- Pressure Transmitter is considered for Gas Bank area to relay the pressure at the header.
- Standalone Controller with IO is considered for Gas Bank monitoring i.e., having two numbers of pressure transmitter input and one number output to the Hooter. Whenever, there is drop of pressure in gas line, the pressure transmitter sends signal to the controller and the hooter is activated, for the personnel to physically go to the Gas bank area & shall change the cylinder.
- 2C 1.5 Sqmm Armoured ATC FRLS color sheathed cable with heavy duty PVC FRLS conduit is considered.

Refer to the GDS Layout for Ground Floor Attached as a Separate Annexure: ANNEXURE-XVIII

5.0 TECHNICAL SPECIFICATIONS:

5.1 FIRE ALARM SYSTEM:

GENERAL

This section of the specification includes the Design, engineering, installation, and connection of a microprocessor controlled; addressable fire alarm system required to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, Detector, control devices, power supplies, and wiring as per tender drawings and specification.

All basic equipment's proposed & planned shall be formally approved by at least one internationally recognized testing labs and / or approval from all concerned authority for the system offered.

FIRE ALARM SYSTEMS DESIGN

A Fire Indicator Panel (FIP) is probably best described as the 'brains' of a fire detection and alarm system. A fire indicator panel comprises control and indicating equipment (i.e.) that combined form an integrated system. These core components comprise.

- Cabinet
- Primary Power Supply Unit & Battery Charger
- Secondary Power (Batteries)
- Control Electronics
- Visual Interface
- Input Interface & Control
- Input Termination & Monitoring
- Output Termination & Monitoring
- Collective (commonly known as conventional).
- Addressable (sometimes known as Analogue Addressable or Intelligent).

SYSTEM CAPABILITIES:

Analogue addressable microprocessor-based fire alarm system with initiating devices, notification appliances, monitoring and control devices as indicated on the drawings and as specified herein.

The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation.

All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

Panels shall be capable of full system operation during new site-specific configuration download.

Remote panel site-specific software and executive firmware downloads shall be capable of being performed over proprietary fire alarm network communications and via TCP/IP Ethernet network communications. Ethernet access to any fire alarm panel shall be capable of providing access only to authenticated users through a cryptographically authenticated and secure SSL tunnel.

Panels shall automatically store all program changes to the panel's non-volatile memory each time a new program is downloaded. Panels shall be capable of storing the active site-specific configuration program and no less than 9 previous revisions in reserve. A compare utility program shall also be available to authorized users to compare either of the saved programs. The compare utility shall provide a deviation report highlighting the changes between the two compared programs.

Panels shall provide electronic file storage with a means to retrieve a record copy of the site-specific software and up to 9 previous revisions. Sufficient file storage shall be provided for other related system documentation such as record drawings, record of completion, owner's manuals, testing and maintenance records, etc.

The media used to store the record copy of site-specific software and other related system documentation shall be electrically supervised. IF THE MEDIA IS REMOVED TROUBLE SHALL BE REPORTED ON THE FIRE ALARM CONTROL PANEL.

The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event's history. A separate alarm and trouble log shall be provided.

FIRE ALARM CONTROL PANEL (FACP):

The distributed intelligent microprocessor-based Fire Alarm Control Panel (FACP) shall function as a fully stand-alone panel as well as providing a communication interface to the central station. FACP shall have its own microprocessor, software, and memory. In the event of failure of the central or communication breakdown between the central station and the FACP, the FACP shall automatically operate on stand-alone mode without sacrificing any functions.

Microprocessor based Fire Alarm Control Panel (FACP) with LCD color Display/HMI displaying at least 320 or more characters in multiple lines at a time and shall accommodate

the no.of detection loops and the quantity of field devices mentioned in the Bill of quantity. The HMI shall have at least 5 or more customer programmable buttons with LED indication in order to freely configure its programmed response as per project requirement.

Each Detection Loop of FACP shall accommodate, monitor, and control intelligent addressable devices in any combination. The exact combination of the field devices in a detection loop shall be at the discretion of the design consultant based on the project requirement & System Design. However, the System Proposed by the Solution Provider / System Integrator shall accommodate all the field devices / components and shall meet all the requirements mentioned in the BOQ.

FACP shall connect all the field devices (Detectors, MCPs, Control Modules, Monitor Modules, and Hooter cum Strobes etc.), shall fully monitor them and communicate to them for their status and shall be able to take intelligent decision of ALARM, TROUBLE, SUPERVISORY based on the programmed cause-n-effect logic. It should have an interactive HMI (display cum operation interface), with status monitoring LEDs for AC Power, Fire Alarm, System Trouble, System Supervisory, Ground Fault and shall have at least 5 programmable switches with LED for seamless operation & maintenance.

FACP shall be UL and ULC listed, and FM approved.

FACP shall support multiple System Power Supplies and Expansion Power Supplies in cascade to ensure the optimum power as required by the system load and system design.

FACP shall be contained in an enclosure made of a minimum of 16-gauge steel. Access to FACP switches and electronics shall be by key lock. Usage of no other tools should be required. Visual indicators of FSP status for each zone shall be visible without opening the key-locked cover.

FACP shall have the networking capability with the other control panels of same family by adding a network module.

FACP shall have sufficient space for housing the battery as required for the system load. And battery shall have backup for the system for 24hrs in normal operation and 30min during the alarm condition. And the battery shall have the proper, trouble-free charging capacity for them.

FACP shall provide RS-232 ports for printers and other serial port utilities.

Alarm verification with for individual smoke detector shall be provided. During the alarm verification, the panel shall retard the alarm until the end of the period. If the alarm is only a transient smoke alarm, the panel shall automatically reset the alarm. Only a verified alarm shall initiate the alarm sequence for the software zone (Logical Point Group) or point. The final time setting shall be as per approval of the fire authorities. When alarm verification is being performed on a smoke detector, the action shall be printed on the listed printer(s).

It shall be possible to command test, reset and alarm silence from the FACP.

FACP shall support priority setting of various events.

- FACP shall support the Minimum four different password levels will be provided to prevent unauthorized System control or programming.
- FACP switches shall allow authorized personnel to accomplish the following, independent of the central console:
- Initiate a general alarm condition.
- Silence the local audible alarm.
- It shall be possible to acknowledge (Silence the local FACP audible without silencing the alarm indicating devices (hooters).
- Reset all zones (Logical Point Group) / points, after all initiating devices have returned to normal.
- Perform a complete operational test of the microprocessor and memory with a visual indication with each board.
- Test all panel LEDs for proper operation without causing a change in the condition of any zone (Logical Point Group).

Power supply unit of FACP shall have following characters:

The main power supply shall be 230V AC + / - 10%, 50 Hz + /-1% and shall in turn provide all necessary power of the FACP.

It shall provide a battery charger of 48 hours for standby power using dual rate charging technique for fast battery recharge.

Battery shall have backup for the system for 48hrs in normal operation and 30min during the alarm condition.

It shall provide a very low frequency sweep earth fault detect circuit, capable of detecting earth faults on sensitive addressable modules.

It shall be power limiting using Positive Temperature Coefficient (PTC) resistor.

It shall provide indication for battery voltage and charging current.

The FACP should be truly field programmable. This would mean that in the event of change of any logic, detector / zone sequence alteration, the operator can initiate these by use of the alpha-numeric keys on the FACP panel to reconfigure the above parameters. Panels, which require external programming devices to perform the above function, will not be acceptable.

INTELLIGENT ADDRESSABLE PHOTOELECTRIC SMOKE DETECTORS:
(For Below False ceiling, Above False ceiling & True Ceiling Detector)

Typical photoelectrical smoke detector

Smoke detectors shall be microprocessor based, intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops.

Photoelectric Smoke Detector shall offer multiple selectable sensitivity levels from 1.2% Obs/ft to 3.7% Obs/ft in order to customize the sensitivity settings.

The detectors shall use the photoelectric principle to measure smoke density. The detectors shall be ceiling mounted type and shall include a twist-lock standard / built in fault isolation base.

Optical Smoke Detector shall have automatic drift compensation or environmental compensation capability for different contamination levels of different areas in order to counter nuisance alarm.

Optical Smoke detectors shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

The detectors shall also store an internal identifying code, which the control panel shall use to identify the type of detector.

The detector shall have an integral microprocessor, which shall dynamically examine values from the sensor and initiate an alarm based on the analysis of data. Systems using central intelligence for alarm decisions shall not be acceptable.

Optical Smoke Detector shall have an operating temperature range of -9°C to 50°C and humidity range up to 95% RH non-condensing.

Optical Smoke Detector shall be UL & ULC listed, and FM approved.

INTELLIGENT ADDRESSABLE MULTI SENSOR DETECTOR:

Typical multi-sensor detector

The multi sensor detector shall be an intelligent digital photoelectric detector with a programmable heat detector.

Multi Sensor Detector shall offer multiple selectable sensitivity levels from 1.2% Obs/ft to 3.7% Obs/ft in order to customize the sensitivity settings.

Heat Detection shall have two selectable rates of temperature rise thresholds of 8°C per minute & 11°C per minute (or close to this value not deviating by more than 1°C) selectable from the FACP.

Heat Detection shall have two fixed temperature alarm thresholds of 57°C and 68°C (or close to this value not deviating by more than 1°C) configurable from the FACP.

Multi Sensor Detector shall have automatic drift compensation or environmental compensation capability for different contamination levels of different areas in order to counter nuisance alarm.

Multi Sensor detector shall have selectable bases with Response Indicator, Isolator, Sounder, Relay and CO detection capability as an option so that the best fit solution is selected depending on the requirement.

Multi sensor detectors shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

Multi Sensor Detector shall have an operating temperature range of -9°C to 50°C and humidity range up to 95% RH non-condensing.

Multi Sensor Detector shall be UL & ULC listed and FM approved.

INTELLIGENT THERMAL DETECTORS:

Typical picture of Heat detector (thermal)

Heat detectors shall be microprocessor based, intelligent and addressable devices, and shall connect with two wires to one of the Fire Alarm Control Panel loops.

Heat Detector shall have both Rate of Rise Temperature operation and Fixed Temperature operation freely configurable as per Tender BOQ.

Heat Detector shall have two selectable rates of temperature rise thresholds of 8°C per minute & 11°C per minute (or close to this value not deviating by more than 1°C) selectable from the FACP.

Heat Detector shall have two fixed temperature alarm thresholds of 57°C and 68°C (or close to this value not deviating by more than 1°C) configurable from the FACP.

Heat Detector shall have selectable bases with Response Indicator, Isolator, Sounder, Relay and CO detection capability as an option so that the best fit solution is selected depending on the requirement.

Heat detectors shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

The heat detector shall have an integral microprocessor to determine if an alarm condition exists and initiate an alarm based on the analysis of the data. Systems using central intelligence for alarm decisions shall not be acceptable.

Heat Detector shall have an operating temperature range of 0°C to 50°C and humidity range up to 95% RH non-condensing.

Heat Detector shall be UL & ULC listed and FM approved.

ADDRESSABLE MANUAL STATIONS:

Manual call point (pull type)

Manual Pull Station shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Manual Pull Station shall require dual action to generate a manual fire alarm.

The word FIRE shall appear on the front of the stations in raised letters.

Manual Pull Station shall have an operating temperature range of 0°C to 49°C and humidity range up to 93% RH non-condensing.

Manual call stations shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

Manual Pull Station shall be UL and ULC listed, and FM approved.

ADDRESSABLE HOOTER WITH STROBE:

Typical Picture of Electronic hooter

Hooter with strobe should be true addressable/ addressed through the module and software configurable.

Hooter with Strobe unit shall have both audible and visual output units housed within the same device. The audible output shall be multi-tone horn output up to 110db and strobe output shall have selectable intensity of 15, 30, 75 and 110 candelas.

Strobe units shall have a flash rate of 1Hz synchronized throughout the Fire Alarm Network.

Hooter with Strobe unit shall be connected to FACP, and it shall be fully monitored by FACP.

Hooter with Strobe unit shall report its status with configured parameters of each unit (hooter and strobe) to FACP.

Hooter with Strobe unit shall support individual field testing in “Silent Mode” and “Non-Silent Mode” (full operational mode).

Hooter with Strobe unit shall be controlled independently on the same 2-Core NAC as per programmed activation and deactivation criteria or from the FACP. Audible (hooter) and Visible (strobe) outputs shall be independently configurable from FACP for its activation and deactivation criteria as required.

In absence of any specific mention of activation and deactivation criteria, the hooter shall stop at “Alarm Acknowledge” or “Alarm Silence” and the strobe shall stop at “System Reset” or “Panel Reset”. This requirement shall not be deviated from unless otherwise stated cause-in-effect configuration or unless a formal written approval is taken from the design consultant.

It shall be possible to poll each and every hooter with strobe unit from the HMI / Display / Operator Console at FACP, isolate and include in the circuit (NAC), activate and deactivate, view the voltage received by it from the HMI / Display / Operator Console at the FACP & Network Repeater.

Hooter with Strobe unit shall support individual performance check by a hand-held testing tool during in “Silent-Mode” or “Sound-Mode” to facilitate performance check during normal working hour.

Hooter cum Strobe shall have an operating temperature range of 0°C to 50°C and humidity range up to 93% RH non-condensing.

Hooter with Strobe unit shall be UL and ULC listed, and FM approved.

PROGRAMMABLE CONTROL MODULE:

The Control Module shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP.

Control Module shall provide programmable, power limited, potential-free, Form-C, SPDT Relay to control external 3rd party utilities in case of fire alarm.

Control Module shall have minimum contact rating of 2A@24Vdc (resistive) and 1A@24Vdc (inductive).

The Control Module shall have an operating temperature range of 0°C to 49°C and humidity range up to 93% RH non-condensing.

Control module shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

Control Module shall be UL and ULC listed, and FM approved.

PROGRAMMABLE MONITOR MODULE:

Monitor Module shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Monitor Module shall supervise potential-free, NO (Normally Open) dry contacts in order to monitor the status of an external 3rd party device.

Monitor Module shall be configurable to report supervisory signal and alarm signal.

Monitor Module shall have an operating temperature range of 0°C to 70°C and humidity range up to 93% RH non-condensing.

Monitor module shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

Monitor Module shall be UL and ULC listed, and FM approved.

ADDRESSABLE FAULT ISOLATOR MODULE

Fault Isolators shall be addressable and shall sit on the detection loop of the FACP and shall communicate to the FACP to report its status.

Fault Isolators shall be dual port, bidirectional communication isolator so that it isolates the short-circuited wire of any side (left side or right side).

Fault Isolators shall be compatible with isolation from the FACP for the field diagnostic purposes.

Fault Isolator shall power up in isolated mode and shall be directed by FACP to connect the detection loop segment. It shall connect the detection loop segment only if the segment is short-circuited free and acceptable else shall remain in isolated modes to impart short-circuit survivability and tolerance to the remaining detection loop.

Fault Isolator shall be fully monitored and addressable by FACP. It shall report its status to the FACP and shall be controlled by the FACP.

The Fault Isolator shall have an operating temperature range of 0°C to 49°C and humidity range up to 90% RH non-condensing.

Fault isolator module shall have manual DIP switch / rotary switching for addressing, any special tool from manufacturer for commissioning activity and replacing the faulty detector are not acceptable.

Fault Isolator shall be UL and ULC listed, and FM approved.

RESPONSE INDICATOR

Typical Picture of Response indicator point

In addition to detector built-in response indicator in each detector Secondary response indicator of LED type shall be provided for above false ceiling area.

The word FIRE shall appear on the front of the indicator in raised letters.

NETWORK ACTIVE REPEATER PANEL:

Network Repeater panel should be active type where control switches should be available for system acknowledge, Alarm silence & system reset.

A lamp/LCD test should be possible.

The Active Repeater panel should be UL and ULC listed and FM approved.

WIRING & SIGNAL TRANSMISSION

Transmission shall be hard-wired using separate individual circuits for each loop of alarm operation, as required or addressable signal transmission, dedicated to fire alarm service only.

System connections for initiating device circuits shall be Class A.

Initiating device circuits/detection loop shall be wired with 2-core, Copper Conductor, 1.5 sqmm, twisted pair FRLS cable of approved makes.

Notification Appliance Circuits shall wire with 2-core, Copper Conductor, 1.5 sqmm, twisted pair FRLS cable of approved makes.

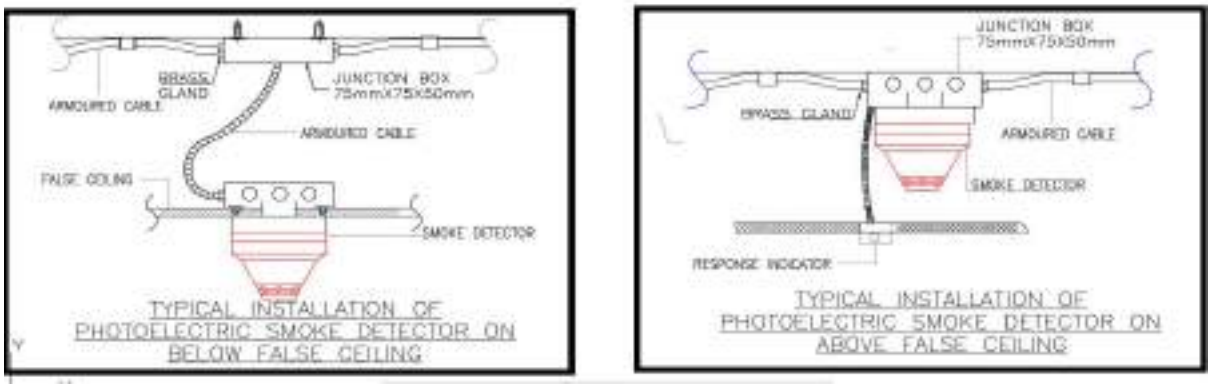
Terminations shall be done with proper brass gland & ATC lugs with insulated sleeves.

Circuit faults shall be indicated by a trouble signal at the FACP. The system shall provide a distinctive indicating audible tone and alphanumeric annunciation.

Addressable Short-Circuit Isolators shall be provided at an interval of every 20 devices on a detection loop as a general thumb rule. However, it shall be ensured that a single short circuit or open-circuit fault on an automatic fire detector circuit/detection loop shall neither disable protection within an area of more than 2,000m²

Circuit faults shall be indicated by a trouble signal at the FACP. The system shall provide a distinctive indicating audible tone and alphanumeric annunciation.

When provided, audio notification appliance circuits shall be supervised during standby by monitoring for DC continuity to end-of-line resistors.



TYPICAL INSTALLATION OF DETECTOR

5.2 ACCESS CONTROL SYSTEM

GENERAL

Access control system is an integrated solution that consists of hardware and software designed to control entry into selected areas and manage movement of Men / Material

within. The system is designed to increase security by defining access permissions based on area and time for each user and maintaining a log of all events.

TECHNICAL SPECIFICATION

- **GENERAL**

- The Access Control System shall be of open-architecture, PC-based system based on Windows Operating Systems, such as Windows 10 OR latest version, Windows Server 2008, or latest version.
- The Access Control System shall comply with strict regulation and adapt state-of-the-art security technologies, the highest level of reliability, and integrate to networking infrastructures such as the Intranet, Internet, LAN/WAN.
- The Access Control System shall be of modular design providing the flexibility to allow the user to add or remove any components and/or controlled functions or in the event when operating requirements change or as the system expands.

- **SOFTWARE**

- There shall be no limitations on the number of PC workstations, readers, and alarm inputs.
- The number of cards/users shall be limited only by memory available in hardware.
- At least 8 access levels per user shall be supported.
- Access levels should be assigned to a user, not to a card, in order to help issue a new card in a fast and easy manner, without reassigning access levels.
- The software shall support at least 4000 holiday dates and has an automatic holiday rescheduling feature.
- The software shall have the ability to perform scheduled automatic database maintenance and backup tasks at user selected intervals and the ability to configure the amount of history stored in the active database.
- The software shall have the ability to produce the following report types: system and alarm event reports, user reports, hardware configuration settings, access level reports, employee time & attendance reports.

- The reports shall be available in Adobe PDF and MS Excel formats.
- Report filters must be convenient and user friendly: allow operator preview user photos, content of access levels, hardware settings and time zone configuration.
- The software shall support an unlimited number of building floor plans.
- All configuration and user changes shall be sent to the controller immediately. The software shall display the progress in percentage as the changes are being downloaded. The downloading shall be done in the background and not affect the normal use of the software in any way.
- Dynamic search function shall be present in all windows of the program: search results shall be narrowed automatically as a key phrase is being entered. i.e., after entering characters “xy” the program shall locate and display all records containing these characters, and after typing in more characters shall refresh the results automatically.
- The software shall use an industry standard database engine released not earlier than 2005 and currently supported by the manufacturer.
- The software shall have the ability to automatically display photos and additional information about users as they enter/exit through doors.
- The software shall be available in the official language(s) of the country where it is being installed. If such language is not included in the standard installation, the software shall support user friendly translation method: simply replacing program text directly in the software (“on the fly”), without the need of sending any files to the manufacturer for compiling.
- The software shall be adapted for operators who have not received any special training related to management of integrated security systems. Graphical user interface shall be intuitive. Introducing the system to the new operator shall not take more than 1 hour.
- In order to reduce the amount of work done by an operator, the software shall incorporate an option to copy objects: users, doors, floor plans, time schedules, access levels and holidays.
- The software shall facilitate integration with other systems of the building.
- The software shall have the ability to transfer entry and exit events to HR systems with the purpose of work time calculation.

- **HARDWARE**

- The hardware shall support all industry standard readers that output information in Wiegand or Clock/Data formats (up to 128 bits).
- There shall be an IP-reader available. The IP-reader shall integrate a contactless card reader and controller in a single body, designed for surface mounting on a wall or a door frame eliminating the need for enclosures.
- Each controller and IP-reader shall have a standard RJ-45 network port for communication with software and other controllers.
- Systems using Ethernet converters, adapters, or terminal servers that enable network connectivity for legacy controllers by tunneling RS-232/485 serial data over Ethernet shall not be acceptable.
- In case communication with the host PC is interrupted, the controller and IP-reader must have enough memory to store at least 5000 latest events.
- The ACS controller shall be housed inside the 14SWG sheet enclosure with key locking arrangement.
- Technical Details

1)	Power supply	:	12-24 VDC
2)	Dimensions	:	To be specified by vendor.
3)	Operating Temp	:	-22°F to +150°F
4)	Operating Humidity	:	0 to 100% non-condensing
5)	Housing protection	:	IP 55
6)	Alarm output	:	Mechanical relay
7)	Read range	:	up to 200M
8)	Frequency settings	:	minimum 5 levels
9)	Sensitivity settings	:	Minimum 10 levels.

The Integrated Access Control & Alarm monitoring System shall be a state-of-the-art computerized system to operate in real time using highly sophisticated software and hardware. The system shall be capable of TCP / IP connectivity.

The system shall be capable of supporting complete Access Control and Alarm monitoring functions.

The system shall be flexible and expandable, to allow the user to customize parameters to the facility and modify parameters to adapt to changing access control and security requirements.

Modification of parameters shall be possible with simple menu driven entries.

The operating system shall be a specially designed one for the Access Control system to provide necessary increased speed and to eliminate time and memory-consuming functions required in a commercially available computer system.

The software shall be highly intuitive with interface to maximize operator efficiency. It shall be able to simultaneously open multiple application windows to eliminate repetitive operations.

The Access Control System shall incorporate state-of-the-art computer technology and software operating systems and shall be of high-performance security management system to provide single seat operation for Access Control operations.

The system shall be modular in nature to permit expansion of both capacity and functionality through the addition of Intelligent Device controllers and Smart Card Readers.

The response time for the system shall be 1 sec.

Entry to the working places shall be thru Biometric fingerprint cum smart card readers. These readers shall be the combination of smart card reader and a slot for placing the finger of an individual. These readers are connected to the door controllers.

Each transaction shall include the card holder's name, date, time, location, and transaction type. It shall be possible to either display or print transactions as they occur.

Each file record of the card holder shall include Number, Name, Address, Department, Designation, Company Name, Qualification, Card Type, Phone Number and Remarks.

It shall be possible to program unique access profiles for each card individually. Systems which only allow defining access profiles by group of cards will not be accepted. It shall be possible

for the operator to extract and display from the central memory sets of assigned parameters for a single card.

The system shall support anti-pass-back (entry/exit).

The feature is associated with IN / OUT card reader operation. When the user badges his card in an “In Reader” and when a valid transaction occurs the status for the card holder using this reader is changed to “IN”. When the cardholder exits his status bit changes to “OUT” card readers can be connected anywhere in the system.

The system shall be able to designate certain readers to control only entry / exit and require a cardholder using a card at any reader to subsequently use it at an exit reader before again entering the secured area. This shall prevent "passing back" a card to an unauthorized second user.

Separate card readers shall be provided near the outer staircase of the building for guard tour verification. Guard tour management software shall also be incorporated as a part of the Access control system.

DOOR CONTROL FROM CONTROL STATION

6. It shall be possible to issue manual keyboard command to lock or unlock any security door momentarily or continuously.
7. In the event of any emergency, it shall be possible to unlock all the security doors by the activation of a console mounted All door open break glass switch in Security Control Centre.
8. Facility shall exist to set the door strike unlock time from 1 sec to 25 sec.
9. All Controllers shall be provided with tamper switches to generate an alarm (tamper alarm) in the event they are tampered with.
10. Each door shall be lockable or unlockable by schedule control. Even if a door is locked under schedule control it shall be unlockable by using a valid card at the reader.

The system shall be able to trace the location of the card holder as well as monitor activities at specific readers and provide a visual display of all transactions.

The system shall allow user-defined names for all doors.

It shall be possible to archive history file on to a back-up tape for a review later.

The system shall have the capacity to provide on-line diagnostics without impairing system operation. The system shall provide the facility for complete data storage and back-up. The back-up shall be performed as an on-line process during which the system shall be fully operational. Should it be necessary to restore the user files from the back-up copies, commands should be available to prompt operator with the procedure.

The system shall be designed with self-diagnostic capability such that the system automatically performs operational checks on power-up or after a transient power interruption to ensure all elements of the system are functional.

The system shall store the following events in the hard disk with time, date and card number and allows the user to select the data to be printed on real-time Alarm Printer according to time zone if desired:

- All valid transactions
- All invalid transactions
- Duress Alarms
- Reader traces, cardholder traces

It shall be possible for the operators to design their own reports based on any fields within the card holder database or any alarm history files. It shall be possible to print out different types of reports covering access control parameters and definitions, card holder listings and data, event message reports, and action reports. The reports shall be printed out on the List Printers as requested by the operator.

A comprehensive range of reports shall be generated at the user's request and be either displayed on the workstation or be printed out at the List printers.

It shall be possible to provide an interface between field devices and the host computer through Intelligent Device Controllers.

The Intelligent Device Controllers shall be of standard units which shall accommodate various combinations of input and output modules.

The Intelligent Device Controller shall communicate with the host computer through serial communication lines and with the field devices through the hard wiring system.

INTELLIGENT DEVICE CONTROLLER (IDC)

The Intelligent Device Controller shall be of an Intelligent Controller which integrated with the Security Management System. It shall be fully featured, modular, and easily expandable.

The IDC shall support up to a maximum of 8 Readers.

It shall store 5000 cards and 50000 history transactions.

It shall also provide 16 time zones, Input /Output linking, output control, timed override, soft in-X-it on a per reader basis and real time reporting capabilities.

In the absence of power, the lead acid battery shall provide power for the real-time clock and RAM for a maximum of 30 days.

The IDC shall be fitted with a UPS battery pack to provide a minimum of 3 hours of power to the panel in the event of power loss.

HID CARD READERS

The HID card reader shall be a contact less reader supporting proximity cards.

The reader shall be capable of two-way communication with IDC and have bi colored LED indication to indicate access granted / denied status.

The readers with pin pad shall support user defined reader keys offering higher security. The reader keys shall be stored in encrypted format in non-volatile memory.

ELECTROMAGNETIC LOCK

The electromagnetic door lock shall be provided on all security doors for locking and unlocking the door. When the current stops the electromagnet is de-energized and the door is unlocked. When the current flows the electromagnet is energized and locks automatically.

DOOR MAGNETIC CONTACTS

Magnetic contacts shall be provided for single leaf security doors, double leaf scrutiny doors. These shall be integrated with access control and an alarm monitoring system to generate door alarm.

Magnetic contact for single leaf door shall consist of one magnetic switch and one magnet, whereas magnetic contacts for double leaf door consist of two magnetic switches and two magnets.

Magnetic switch shall be fixed to door frame and magnet to the door leaf.

When the door is closed, the distance between magnetic switch and magnet shall be equal or less than 5 mm so that magnetic switch shall have a closed contact.

SPECIFICATION FOR PROXIMITY CARD READER

❖ **TECHNICAL DETAILS**

Power supply	:	From the Terminal Controller (4.75-16V DC)
Dimensions	:	To be specified by vendor.
Operating Temp.	:	-22°F to +150°F
Operating Humidity	:	0 to 95% non-condensing
Indication	:	Card reader includes bi-color LED
Color	:	Black/Off-white
Read range	:	3” for security doors.

- 8 Conductors, 1Sqmm, Overall Shielded, PVC for Card Readers

Description	:	Shielded multi conductor control cable.
Conductors	:	Multistrand Tinned Copper
Insulation	:	Color coded FRLS
Color Code	:	Black, white, red, green, blue, and brown.
Shielding	:	100% Aluminium Mylar foil shield overall strand Tinned copper drain wire.
Jacket	:	Gray flame-retardant FRLS
Nominal OD	:	0.205"

- 2 Pair, 1Sqmm, Individually Shielded, Polypropylene Insulated Signal Cable for Intelligent Controller Communication.

Description	:	2 pair individually shielded cable
Conductors	:	Multistrand tinned copper, twisted into 2 pairs
Insulation	:	Color coded polypropylene, 0.008"
Color Code	:	Black with red, Green with white
Shielding	:	Each pair individually shielded with 100% aluminium Mylar foiled shield plus Multistrand tinned copper drain wire.
Jacket	:	Gray flame retardant FRLS
Nominal OD	:	0.170"
Voltage	:	Rated 300 Volts

- 2 Pair, 1Sqmm, Shielded, Multi-pair, Signal Cable for Electrical Bolt Release.

Description	:	3 pair over-al l shielded cable
Conductors	:	Multi Strand tinned copper, twisted into 3 pairs
Insulation	:	Color coded polypropylene
Color Code	:	Black with red, Black with white, and Black with Green
Shielding	:	100% aluminium Mylar foiled shield overall with multi strand tinned copper drain wire.
Jacket	:	Gray flame-retardant PVC 0.020”
Nominal OD	:	0.251”
Voltage	:	Rated 300 Volts

❖ RELAYS:

- Contact material: Silver Alloy.
- Contact Rating: 230V AC / 5 A.
- No. of Operations: Mechanical: 107, Electrical: 105.

❖ ENCLOSURE:

- Enclosure type : MS (Siemens grey)
- Mounting: Wall mounting

❖ POWER*:*

- Power source: 230V, AC 50 Hz (±5%)
- Wattage: 24W

❖ ENVIRONMENTAL:

- Operating Temperature: 0 to 500C.

❖ MECHANICAL:

- Weight: 2.2 Kgs.
- Dimensions: 212 x 172x 75mm

PARTS SPECIFICATION

❖ **I/O Module**

- Supports Maximum of 4 doors.
- LED to indicate Relay status.
- High current protection circuit incorporated.

❖ **PUSH BUTTON STATION**

- Indication facility for Door entry permitted / prohibited.
- Supports an entry switch for opening the door. Long Life LED (Red & Green) for door open/close indication. LED flashing in case if emergency button is pressed.
- SS Bezel with appropriate curvature to prevent resting of dust &powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.

❖ **EMERGENCY STATION**

- Enables Emergency access to configured doors.
- SS Bezel with appropriate curvature to prevent resting of dust & powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.
-

❖ **DOOR STATION MODULE**

- Indication facility for Door opens Status of 15 Doors Max.
- Long Life LED (Green) for doors open indication.
- LED flashing in case if emergency button is pressed.
- SS Bezel with appropriate curvature to prevent resting of dust & powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.

5.3 DOOR INTERLOCKING SYSTEM

GENERAL:

In clean room areas, any person passing through an unclassified area to classified area is required to pass through series of rooms. In each room certain steps need to be followed. This procedure ensures that the person is not carrying external contamination into the process area. Our Door lock controller achieves this by preventing simultaneous access of door /Room by ensuring that when one door for a room is open then other door is closed. Push buttons are available for door access. Emergency stations are available for opening both doors. Delay between each door openings to maintain required pressure.

FEATURES:

- Micro controller based.
- Supports Maximum of 2 doors & 4 Push buttons.
- It can support Emergency Stations.
- Sequence of door interlocking is fixed.
- Delay between door openings by using Dipswitch (Multiples of 4 up to 60 Sec).
- Facility available to read feedback from Magnetic Lock.
- D/I provided feedback from BMS in case of Fire.
- Power on indication.
- Relay status indication.
- Door status indication.

SPECIFICATIONS:

❖ GENERAL:

- Push Button Inputs: 2 No.
- Door Feedback Inputs: 2 No, 24V.
- Door control sequencing: Fixed.
- LED Control Outputs for push buttons: 2 No.
- Status LED: 3mm LED (Red).
- (Power ON, Relay, Door status indication)
- Door control outputs: 2, 24V DC.

❖ RELAYS:

- Contact material: Silver Alloy.

- Contact Rating: 230V AC / 5 A.
- No. of Operations: Mechanical: 107, Electrical: 105.

❖ ENCLOSURE:

- Enclosure type: MS (Siemens grey)
- Mounting: Wall mounting

❖ POWER*:*

- Power source: 230V, AC 50 Hz (±5%)
- Wattage: 24W

❖ ENVIRONMENTAL:

- Operating Temperature: 0 to 500C.

❖ MECHANICAL:

- Weight: 2.2 Kgs.
- Dimensions: 212 x 172x 75mm

PARTS SPECIFICATION

❖ **I/O Module**

- Supports Maximum of 4 doors.
- LED to indicate Relay status.
- High current protection circuit incorporated.

❖ **PUSH BUTTON STATION**

- Indication facility for Door entry permitted / prohibited.
- Supports an entry switch for opening the door. Long Life LED (Red & Green) for door open/close indication. LED flashing in case if emergency button is pressed.
- SS Bezel with appropriate curvature to prevent resting of dust &powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.

❖ **EMERGENCY STATION**

- Enables Emergency access to configured doors.
- SS Bezel with appropriate curvature to prevent resting of dust & powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.

❖ DOOR STATION MODULE

- Indication facility for Door opens Status of 15 Doors Max.
- Long Life LED (Green) for doors open indication.
- LED flashing in case if emergency button is pressed.
- SS Bezel with appropriate curvature to prevent resting of dust & powder.
- Easy mounting arrangement for fixing on Doorframes or on Wall.

❖ ELECTROMAGNETIC LOCK

The electromagnetic door lock shall be provided on all security doors for locking and unlocking the door. When the current stops the electromagnet is de-energized and the door is unlocked. When the current flows the electromagnet is energized and locks automatically.

❖ DOOR MAGNETIC CONTACTS

Magnetic contacts shall be provided for single leaf security doors, double leaf scrutiny doors. These shall be integrated with access control and an alarm monitoring system to generate door alarm.

Magnetic contact for single leaf door shall consist of one magnetic switch and one magnet, whereas magnetic contacts for double leaf door consist of two magnetic switches and two magnets.

Magnetic switch shall be fixed to door frame and magnet to the door leaf.

When the door is closed, the distance between magnetic switch and magnet shall be equal or less than 5 mm so that magnetic switch shall have a closed contact.

❖ SPECIFICATION FOR CABLES

- 8 Conductors, 1Sqmm, Overall Shielded, PVC for Card Readers

Description	:	Shielded multi conductor control cable.
Conductors	:	Multistrand Tinned Copper
Insulation	:	Color coded FRLS
Color Code	:	Black, white, red, green, blue, and brown.
Shielding	:	100% Aluminium Mylar foil shield overall strand Tinned copper drain wire.

Jacket : Gray flame-retardant FRLS

Nominal OD : 0.205"

- 2 Pair, 1Sqmm, Individually Shielded, Polypropylene Insulated Signal Cable for Intelligent Controller Communication.

Description : 2 pair individually shielded cable

Conductors : Multistrand tinned copper, twisted into 2 pairs

Insulation : Color coded polypropylene, 0.008"

Color Code : Black with red, Green with white

Shielding : Each pair individually shielded with 100% aluminium Mylar foiled shield plus Multistrand tinned copper drain wire.

Jacket : Gray flame retardant FRLS

Nominal OD : 0.170"

Voltage : Rated 300 Volts

- 2 Pair, 1Sqmm, Shielded, Multi-pair, Signal Cable for Electrical Bolt Release.

Description : 3 pair over-al l shielded cable

Conductors : Multi Strand tinned copper, twisted into 3 pairs

Insulation : Color coded polypropylene

Color Code : Black with red, Black with white, and Black with Green

Shielding : 100% Aluminium Mylar foiled shield overall with multi strand tinned copper drain wire.

Jacket : Gray flame-retardant PVC 0.020”

Nominal OD : 0.251”

Voltage : Rated 300 Volts

5.4 CCTV SURVEILLANCE SYSTEM

GENERAL:

The CCTV shall provide a high degree of IP based electronic surveillance to the entire Premises at Indoor and Outdoor locations. It is also essential to have recorded images of all cameras to be stored at least 30 days to facilitate investigations of a reported case.

This section of the specification includes the supply, installation, testing & commissioning of IP CCTV system and imparting training to concerned officials in connection with IP CCTV system including all components.

All equipment and materials used shall be standard components from the current line/range of products that are regularly manufactured and used in the system.

SCOPE:

IP cameras and required NVR/servers, switches, storage, workstations, monitors, cables, etc. The proposed locations of cameras and their type is indicated in the layout.

The system shall consist of following main components:

- High resolution IP cameras
- NVR (Network Video Recorder)
- POE switches
- Storage
- HD LED Monitors
- Cables and accessories, etc.

The Contractor will install, test & commission the system. The viewing angles and clarity, etc. shall be shown to the officials of CLIENT to their satisfaction before finalizing the location, zoom and angle, etc. The specifications of all components shall be strictly followed and shall be as per given technical specifications or better.

Network Video Recorder (NVR)

The equipment envisaged is a as per BOQ channel NVR recorder suitable for Megapixel IP cameras with built-in ports for easy connection to compatible IP cameras. It should be equipped with H.264 Video codec encoding. The NVR shall support minimum 32 TB / 30days storage capacity hard drives. It should have HDMI and VGA output for high resolution output to an HD TV or computer monitor.

Real time: It should record all cameras at 1080p and reposition at 25/30 fps per camera without any frame skipping. Further the recording can be motioning activated recording or calendar based recording or manual mode. It should accept 5 MP IP cameras. It should have user selectable recording resolutions: 5 MP, 2 MP, 1.3MP, etc. It should have an adequate input bit rate.

It should be possible to easily configure IP cameras on the same network. It should also be possible to have real-time viewing in HD for all cameras on NVR.

Recording should start on SD card if Network or server fails. The network failure is registered immediately if the failure is longer than 10 seconds. Once the network connection has been restored, gaps in the recording are automatically filled without manual intervention.

Storage must be programmed for a disc management system which will automatically reap old recordings to overwrite with the new ones when maximum usage is reached.

The system shall be able to carry adequate hard disks to achieve at least 32 TB / 30days recording storage. The system shall support dual gigabit Ethernet ports.

The system shall be able to centrally configure all devices and system settings from one interface.

The system shall support system status watchdog and automatically restart the system when abnormal event happens.

The system shall include management server, recording server, metadata server, and client for configuring and viewing.

The management server shall be able to centrally manage all servers in the system including configuration, license management, and event monitor. The system shall support more features by upgrading, without re-installing or re-configuring the whole system.

SL. No.	Description
1	**Operating System:** Embedded Linux
2	**IP Camera Input:** Min 32 Channel
3	**Two-way talk:** 1 Channel O/P and 1 Channel I/P

SL. No.	Description
4	**Video O/P:** 1 HDMI, 1 VGA
5	**Compression:** H.264 / MJPEG
6	**Video Resolution:** 2592 × 1944**,** 2560 X 1920, 2048 X 1536, 1920 X 1080, 1280 X 720
7	**Recording Resolution:** 2592 X 1944
8	**Recording Speed: upto 30 fps per channel**
9	**Video Display Split:** 1/4/8/9/16
10	**Video Detection:** Motion, Video Loss, Camera Blank
11	**Alarm Input:** 4 Channel
12	**Hard Disk:** Min 2 SATA ports, 32TB, Raid (Redundancy)
13	**Smart Phone Surveillance Support:** iPhone, iPad, Android, Windows Phone
14	**Protocol:** IPv4/IPv6, HTTP, TCP/IP, UDP, UPnP, RTSP, SMTP, NTP, DHCP, DNS, PPPOE, DDNS, FTP, IP Filter
15	**Trigger Event:** Recording, Alarm, Email, FTP, Screen tips
16	**Recording Mode:** Manual, Schedule, STOP, Alarm and MD
17	**Search Mode:** Time/Date, Alarm, Motion Detection, Exact Search (accurate to second)
18	**Playback:** Play, Stop, Pause, Rewind, Fast Play, slow play, full screen, backup
19	**Backup Mode:** USB Device / Network
20	**Interface Ports:** USB 2.0 port, USB 3.0 port, 1 RS485, 1 RS232,1 RJ45
21	Ethernet Ports: 1 RJ-45 port (10/100M Base T)
22	Power Supply: AC 100V~240V 50/60Hz
23	Regulatory: CE, FCC, UL
24	Product warranty: at least 2 years
25	Working environment: 0 deg C – 55 deg C

ABBREVIATIONS

AHU	Air Handling Unit
HVAC CONTROL	Building Management System
cGMP	Current Good Manufacturing Practices
DQ	Design Qualification
ENG	Engineering Department
FA	Fresh Air
GEN	General
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air Conditioning
ID	Identification
IQ	Installation and Operational Qualification
MLS	Monitoring & Control System
No.	Number
QAD	Quality Assurance Department
QTY	Quantity
RA	Return Air
Rev.	Revision
RH	Relative Humidity
RPM	Rotation per minute
SA	Supply Air
SOP	Standard Operating Procedure
SVP	Small Volume Parenteral
TR	Tonnes
URS	User Requirement Specification
VFD	Variable Frequency Drive
DI	Digital Input
DO	Digital Output
AI	Analog Input
AO	Analog Output
POT	Portable Operating Terminal

PART-8
NETWORKING WORKS

CONTENTS

1.0 APPLICABLE CODES AND STANDARDS

Applicable Documents:

Reference Standards

Design, manufacture, test, and install data distribution systems per manufacturer's requirements and in accordance with NFPA 70 (National Electric Code), state codes, local codes, requirements of authorities having jurisdiction, and particularly the following ANSI/TIA/EIA Standards.

This Technical Specification and Associated Drawings

ANSI/TIA/EIA-568-B series, Commercial Building Telecommunications Cabling Standard

ANSI/TIA/EIA 568-C.3, Optical Fibre Cabling Components Standard

ANSI/TIA/EIA-569-B, Commercial Building Standard for Telecommunications Pathways and Spaces

ANSI/TIA/EIA-606-A, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

ANSI/J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

Building Industries Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM).

ANSI/TIA-942, Telecommunications Infrastructure Standard for Data Centre's

The Contractor is responsible to determine and adhere to the most recent edition of these standards when developing their responses.

2.0 SCOPE OF WORK

The scope of work for the Networking system design covers the following: -

- Scope shall include both Active & Passive part.
- Cabling works from end user points to floor Hub rack.

- Cabling works from Hub rack to server rack and also from server to Internet service provider (ISP).
- Design and Specifications of Passive rack, patch panels, port switch, face plate, power outlet etc.
- Design and Specifications of Split AC for Server/HUB rack (split AC shall be part of HVAC scope).
- Sizing and Specification of UPS for proposed Server and HUB rack. (UPS Shall be part of Electrical scope).
- IP Based CCTV shall be considered for proposed Server/HUB room. (CCTV shall be part of ELV system scope, and its cabling will be part of networking scope).
- Networking Work contractor scope is to design, engineering, supply, testing, Loading, transfer to site, unloading, shifting to store, installation & commissioning of BOQ material to meet the successful operation & functional requirements as per Local norms, practices and local standards. Handing over and training to the client.
- Preparation of execution drawings with section details and as built drawings in Vendor scope only. Consultant will provide the basic Networking drawings. Networking contractor has to develop drawing further upto the equipment termination with sizing, support structure (From wall or ceiling) & submit the same for approval.
- Co-ordination with other service contractors with respect to the installation activity without affecting the project schedule is in Networking Contractor's scope.

DESIGN CRITERIA

- Two numbers of Internet Service Provider (ISP) are proposed for the c-GMP Compliant Mammalian Cell Line Repository At NCCS, located at Basement floor Server/HUB rack.
- Cable shall be laid from Internet Service provider tower to Internet Service Provider switch (ISP) server room as per site condition. (ISP vendor / Client scope)

- We assumed that Internet Service provider vendor scope shall be supply, laying and end termination of Single Mode Optical Fiber armored cable (OS2) shall run from ISP tower to proposed C-Gmp Compliant Mammalian Cell Line Repository at NCCS ISP & Core rack.
- Proposed ISP switches and Core active switches shall be located in a single rack. This rack location is proposed in Basement floor Server/HUB room.
- Proposed Hub rack shall be located in Basement floor Server/HUB room.
- Data Points are proposed as per below: -
    - For Each workstation.
    - For Lab equipment.
    - Intercom point for two workstations & each lab except for Grade-B classified area & Microbiology lab.
- Data ports are proposed for the following services.
    - CCTV surveillance
    - Printers
    - Access control panel
    - Public address system
    - Analog telephone
- Dedicated Modular / Jack panel are proposed for following services.
    - Work Stations (Data & VoIP).
    - EMS & BMS
    - Lab Equipment's.
    - CCTV
- 12 Core Multi Mode Optical Fiber armored cable (OM3) suitable for 10Gbps is proposed for the Inter Floor Backbone Connectivity from Server rack to HUB rack located at Basement Floor Server / HUB room.
- CAT-6 UTP copper cable is proposed to connect from HUB rack to user points like Desktop, Printer, Projectors, Lab equipment's, Wi-Fi, Access control panel, VoIP, DDC / PLC panel, CCTV, lab equipment, etc.

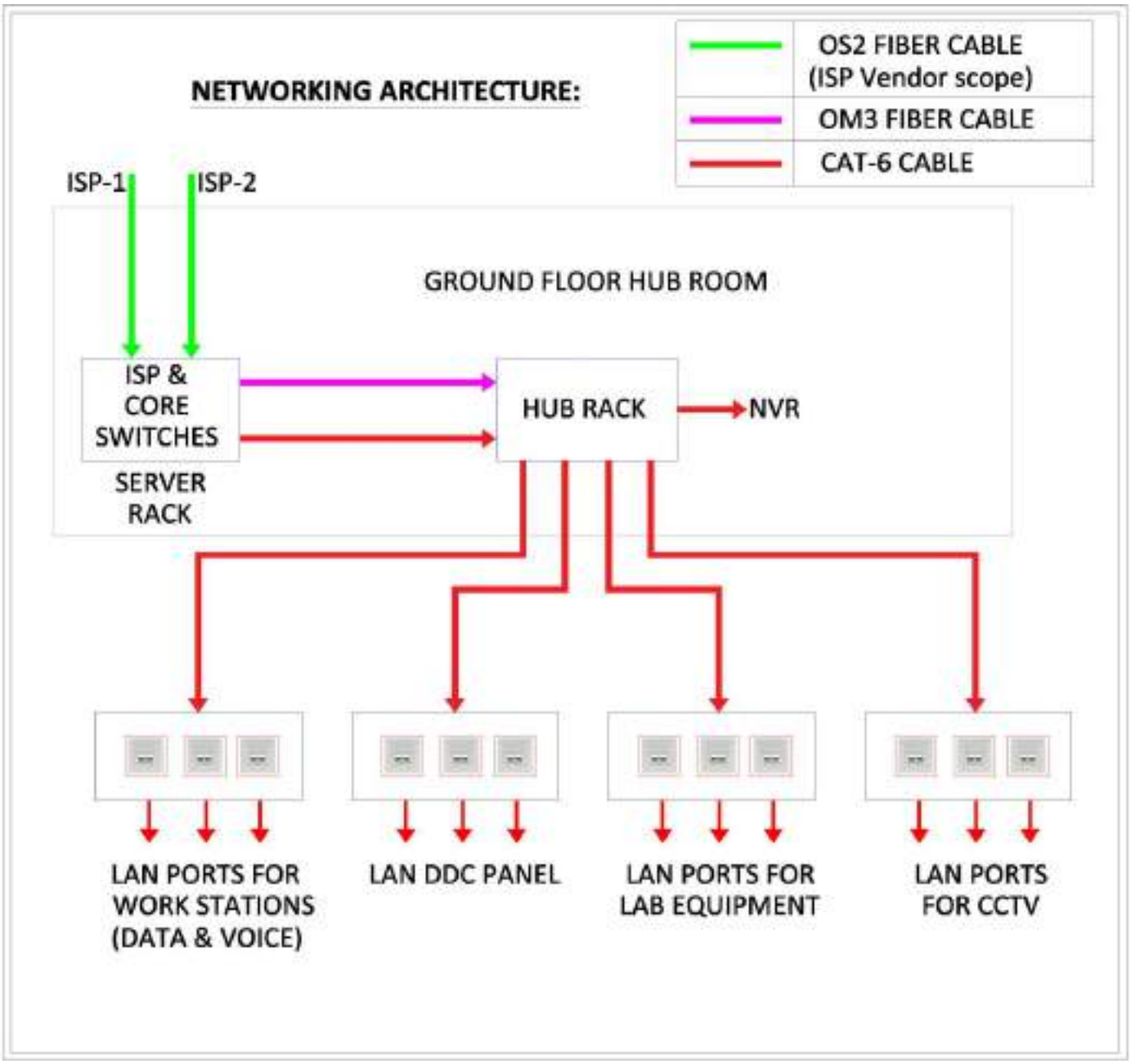
- EPABX (Electronic Private Automatic Branch Exchange) Analog Telephone are proposed for the internal communication.
- Open racks are proposed for Hub Rack.
  - Typical length & Data rate characteristics of cable:

Backbone subsystem	Backbone lengths up to	Data rates up to
Campus/Building back bones (OM3 fibre)	350 metres	10 Gb/s
Category 6 / Class EA	90 meters	1 Gb/s (500MHz)

❖ **Server / Hub Room details:**

- A clear space of 1000mm for racks around/one side flushed to the wall is proposed for maintenance purposes.
- Split A/C is proposed and preferred temperature of NMT 25°C shall be maintained in the server room & relative humidity not controlled.
- Earthing station with suitable copper strips and earth wire is proposed for Server & Hub Room equipment.
- CCTV system is proposed for monitoring the activities.
- Access control system is proposed to convenient access to those persons who are authorized, while at the same time, restricting access to unauthorized people.

Note: -
Two numbers of ISP selection shall be in Client scope & the same shall be selected locally.


NETWORKING ARCHITECTURE:
OS2 FIBER CABLE (ISP Vendor scope)
OM3 FIBER CABLE
CAT-6 CABLE
ISP-1
ISP-2
GROUND FLOOR HUB ROOM
ISP & CORE SWITCHES
SERVER RACK
HUB RACK
NVR
LAN PORTS FOR WORK STATIONS (DATA & VOICE)
LAN DDC PANEL
LAN PORTS FOR LAB EQUIPMENT
LAN PORTS FOR CCTV

3.0 TECHNICAL SPECIFICATION:

This document defines the cabling system and subsystem components to include cable, termination hardware, supporting hardware and miscellany required to supply and to install a complete cabling infrastructure supporting voice and video. The intent of this section is to provide pertinent information to allow the vendor to bid the labour, supervision, tooling, materials and miscellaneous installation hardware and consumables to install a complete system. However, it is the responsibility of the vendor to propose any and all items required for a complete system whether or not it is identified in the specification, drawings and bill of materials attached to this specification.

	Cat 6, U/UTP Cable Box -305 Mtrs.	
	Generic Requirement:	**Complied/ Not Complied**
1	4-pair, Cat 6 U/UTP Cable, Channel performance up to 250 MHz or more, Category-6 U/UTP with ETL 4 connector channel test report as per ISO/IEC 11801, 23 AWG bare solid copper.	
2	Meets ANSI/TIA 568-C.2 Category 6 specifications, Cat 6 U/UTP Solution, ETL 4 Connector channel Test report, Performance ETL Verified Certificate. RoHS Compliant.	
3	Cat 6 Cable shall support a minimum of 4 connector Channel with a minimum 6 dB guaranteed NEXT over and above the standard TIA 568 C.2 & 3rd Party Intertek (ETL) reports for verification of performance parameters for 6 dB NEXT.	
4	Worst Case Cable Skew: 30 nsec/100 meters @ 250 MHz, Characteristic Impendence: 100±6 Ù@ 1-250 MHz or as per ANSI/TIA 568 C.2, DC Resistance Max: 7.61 Ohms/100m, LSZH	
5	Sheath should be LSZH as per flame rating standard IEC60332-3-22, IEC 61034-2, IEC 60754-2, Operational Temp: -20º to 60º Celsius	
6	Insulation Material- Polyolefin, Separator Material-Polyolefin, PAIRS with Standard Color Code & length: 305 Mtrs. (1000 ft.) Cables should have Online Tracking Number to check the Genuity.	

	Angled Jack Panel –unloaded (24 Port)	
	Generic Requirement:	**Complied/Not Complied**
1	The panel shall be angled so that horizontal cable managers are not required.	
2	Each port shall be individually replaceable.	
3	The panel should have an integrated rear cable management bar that allows bunching of 6 cables and properly dressing the cables.	
4	The patch panel type shall be a 1U panel capable of supporting 24 unshielded modular 8-pin connectors compliant with IEC 60603-7 while meeting the Channel Performance.	
5	Shall have a current rating of 1.5A @ 20 degree C	
6	The panel shall be made of High impact, flame retardant, thermoplastic and Power-coated steel.	
7	Shall be UL Listed and shall have an operating temperature of -10 degree C to +60 degree C	

	Cat 6 U/UTP Patch Cord – 1, 2, 3, 7, 10 & 15 feet	
	Generic Requirement:	**Complied/Not Complied**
1	1, 2, 3, 7, 10 & 15-Feet Cat 6 U/UTP Patch Cable, TIA- 568C Category-6, UL-listed / ETL Channel test report as per ISO/IEC 11801, ANSI/TIA 568 C.2, RoHS Compliant.	
2	Patch cords shall be of stranded copper cable with UL/ETL Listed. Conductor Material should be Tinned copper, Plugs shall be designed with an anti-snag latch.	
3	Patch cords sheath shall be LSZH as per IEC 60332-1, IEC 60754-2, IEC 61034-2, Operational Temp: -20º to 60º Celsius	
4	Plug Insertion Life Min. 750 times, Plug Retention Force, Min. 133 N	

	Cat 6 UTP Information Outlet	
	Generic Requirement:	**Complied/Not Complied**

1	Cat 6 UTP Jack PCB based Information Outlet (I/O) RJ45, TIA-568 C.2 Category-6. UL Listed, ETL Channel test report as per ISO/IEC 11801, ANSI/TIA 568 C.2.	
2	high-impact, flame-retardant, UL- RATED 94v 0 thermoplastic – ABS, Plug Insertion Life Min. 750 times as per IEC 60603-7	
3	Contact Resistance: 100 milli ohms; Insulation resistance 500 Mega ohms minimum ;Current Rating : 1.5 A (max) , Contact : 50µ'' gold plating over 100 micron nickel underplate)	
4	The information outlet must support 90-degree cable termination. Plug Retention Force: 133 N minimum between modular plug and jack, Meets and exceeds ISO 9001:2015, RoHS compliant	

	1, 2 & 4 Port Face Plate	
1	Shall be available in 1 port, 2 port and 4 port square versions.	
2	Color: White Height: 115.82 mm (4.56 in) Width: 71.37 mm (2.81 in) Depth: 7.36 mm (0.29 in) The dimensions of the faceplate have been included so that the furniture cutting can be standardized.	
3	Flammability Rating: UL 94 V-0 Safety Standard: UL Listed	
4	Shall be compatible with CAT 5e/CAT 6/CAT 6A information outlets.	

	12 Fiber Multimode Indoor Cable	
1	12-core Multimode OFC, Tight buffered, Gel free, LSZH, Aqua Color.	
2	Fiber Optic Cable: 50/125µm, OM3, TIA-492AAAC (OM3)	
3	Gel-Free cable is in accordance with Telcordia GR-409	
4	Fiber cable Diameter Over Jacket should be maximum 6 mm, Tensile Strength should be 200 N (long term) and 667 N (short	

	term) and Compression of the fiber cable should be minimum of 10 N/mm.	
5	Flame test method, the cable should be compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2.	
6	The cabled attenuation shall be 0.5 dB/km @ 1310nm and 0.5 dB/km @ 1550nm	
7	Installation temp shall be at least between the range of -10 and +60 degree C. Operating Temp shall be at least between the range of -20 and +70 degree C. The storage Temp shall be at least between the range of -40 and +70 degree C.	

	Fiber Multimode Cassettes without Pigtails	
1	Shall be Multimode OM3/OM4	
2	Regulatory Compliance: RoHS 2011/65/EU Safety Standard: UL	
3	Number of Fiber ports: 12 Interface, Front: LC Adapter Color: Aqua	
4	Hinged shutters : Yes	

	Fiber Multimode Pigtails	
1	Shall be Multimode OM3/OM4	
2	Regulatory Compliance: RoHS 2011/65/EU Environmental Space: LSZH (Low Smoke Zero Halogen) as per IEC 60332-3, IEC 60754-2, IEC 61034-2	
3	Number of Fiber: 1 Interface 1, Front: LC Interface 2, Front: Unconnectorized Adapter Color: Aqua	
4	Insertion Loss, Max, Connector A: 0.3 dB	
5	Return Loss, Min, Connector A: 27 dB	
6	Operating Temperature: -10 Degree C to +60 Degree C	
7	Ferrule Geometry: Pre-radiused	
8	Ferrule Material: Zirconia	

	1U Fiber Panel	
1	Shall have 4 slots for various fiber density and type configurations.	
2	Shall have a fiber management trough in the front for patch cord management.	
3	Shall have knockouts on the rear side for incoming trunk cables and for properly securing the cables to avoid any stress during sliding the panel out.	
4	Shall be sliding type for easy access for management.	
5	The panel shall be intelligent upgradable without the removal of patch cords (i.e. there should be no network disruption).	
6	Shall be made of steel and shall have a powder coated finish.	
7	Shall be of 1U size	

	OM4 LC to LC, Fiber Patch Cord, 1.6 mm Duplex, LSZH
1	Shall have LC connectors on both sides
2	The jacket shall be LSZH (Low Smoke Zero Halogen) and shall be compliant to IEC 60332-3, IEC 60754-2, IEC 61034-2.
3	The performance of the trunk cables shall be very high. The insertion loss of the connecters shall not exceed 0.24 dB and the return loss shall be minimum 27 dB.
4	Jacket color should be Aqua as per the colors decided by the standards such as ANSI/TIA-568. 3-D.
5	Shall be compliant to Telcordia GR-409

Fiber LIU Rack-mountable, 1U fully loaded, Single Mode

Specifications	Requirement	Compliance Yes /No	Remarks
Fiber Management shelf	The fiber management shelf shall have compact design and be ideal for high-density front patching applications.		
	Should be fully loaded and factory fitted assembly with no assembling required during installation at site		

Specifications	Requirement	Compliance Yes /No	Remarks
	• High Density: 1U: 12/24/48 Fiber terminations		
	• Should be supplied loaded with LC adapters, splice trays, LC SM Pigtails and fiber management rings		
	• Min 4 cable entry points		
	• Mounting brackets can be placed in different positions		
Drawer style shelf	o Easy access to splicing tray		
	o Easy access to back side of connector		
Accessories	Fiber management guides, radius controls & secure tie downs provided		
	Pre loaded with labeling strips		
	Sealed cable inlets for dust and rodent protection		
Material	Min 1.6mm CRCA Sheet steel with powder coating		
Compact size (mm)	1U/2U x 450 x 320 (HxWxD)		
Pigtails loaded in Shelf			
Type	LCPC Type, SM 1.5 Mtr.		
Attenuation	<=0.3 dB, at 1310 nm		
Return Loss	>= 20 dB		
Cable Info	9/125 um		
Outer Dia	0.9 mm		
Jacket material	LSZH		
Buffer Color	Gold Metallic		
Buffer Material	UV Cured Acrylate		
Warranty	25 year warranty (Performance)		
Compliance	ROHS / ELV Compliant		

Rack Mounted Fiber Optic Patch Panel specifications

Sr No.	Specifications	Compliance	Deviation
1	1U low-profile, high density fiber optic shelf shall be proposed that can be used for a combination of splicing and termination of fiber optic building cable or outside plant (OSP) cables.	Yes / No	
2	The 1U height fully enclosed shelves shall include integrated front cable management trough and features either a fixed tray or slide-out tray for easy access.	Yes / No	
3	The Panel shall accommodate up to 48 fibers to be spliced / terminated	Yes / No	
4	The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.	Yes / No	
5	The front plate of the panel shall be included along with Panel. Panel shall have 4 numbers of slot for fixing of Cartridges or Adapter plates	Yes / No	
6	The alignment sleeve of the LC Duplex adapter shall be of Phosphor Bronze. This allows better retention and alignment of fiber connectors on patch cords and pigtails.	Yes / No	
7	The MM adapter shall support OM3 as well as OM4 fibers / patch cords. SM adapters should support OS2 fibers / patch cords.	Yes / No	
8	The panel shall accommodate fusion splice trays that can support splicing up to 48 fibers	Yes / No	
9	Adequate number of Fusion splice holder trays should be included in the RFP	Yes / No	

LC to LC Patch Cord (MM and SM)

Sr No.	Specifications		Compliance	Deviation
1	The Pigtail shall be assembled with 50µm multimode fiber (OM4) for MM fiber cabling System and with 9µm SM fiber for SM fiber cabling system		Yes / No	
2	The pigtail shall be assembled using 900 micron buffered fiber		Yes / No	
3	The pigtails shall be terminated with MM LC-style connector for MM cabling systems and SM LC-Style connector for SM cabling system		Yes / No	
4	The pigtails shall have a Cable Retention Strength, maximum	3.00 lb @ 90 ° C	Yes / No	
		6.00 lb @ 0 ° C	Yes / No	
5	The LC connector on the pigtail shall meet Optical Components Standard ANSI/TIA-568-C.3. please append data sheet		Yes / No	
6	The Patch cord proposed shall be duplex, 1.6mm jacketed, and shall be of 50µm multimode fiber (OM4) for MM and 9µm SM fiber for Singlemode		Yes / No	

4.0 WARRANTY:

Warranty	Compliance	Deviation
The Extended Product Warranty should cover all passive SCS components (i.e., cable and connectivity components that make up the passive data and telecommunications signal transmission infrastructure).	Yes / No	
In addition to product warranty the Application Assurance shall cover the SCS compliant channels to support operations of the application(s) that the system was designed to support. The supplier warrants that the SCS will be free from defects that prevent operation of the specific application(s) for which the Registered SCS was initially designed as long as the design is in compliance with the SCS Performance Specifications for said applications and is in compliance with all other terms and conditions of this warranty	Yes / No	

The system integrator responding to this RFP should a certified partner of the manufacturer. The details of such bidder to the RFP should appear on the manufacturer's partner locator on the manufacturer's web site.	Yes / No	
The warranty shall be for a minimum of 25 years.	Yes / No	

5.0 ABBREVATION:

IP	Internet Protocol
CCTV	Closed Circuit Television
NVR	Network Video recorder
FRLS	Fire Retardant Low Smoke
FLP	Flame proof
dBA	Decibels
LED	Light Emitting Diode
UL	Underwriters laboratories
FM	Frequency Modulation
LAN	Local Area Network
WAN	Wide area network
IT	Information technology
CAT-6	Category 6 Cable
RJ-45	Registered Jack-45
UTP	Unshielded twisted pair
CCTV	Closed Circuit Television
POE	Power Over Ethernet
ACS	Access Control System
DDC	Direct Digital Controller
EMS	Energy Management System

PART 9

CLEAN ROOM PANEL WORKS

CONTENTS

1. SCOPE OF WORKS

The proposed area shall be provided with a modular Wall Panel & False Ceiling system made of Epoxy Powder Coated Galvanized Sheet Steel with rockwool foam as infill.

2. DESIGN CRITERIA

PURPOSE

The facility shall be constructed with modular wall panels and ceiling panels, the type that is generally used for clean room application but built stronger to withstand rigors of cross contamination.

TYPE

- Modular Clean Room Sandwiched Panel Constructed with Epoxy Powder Coated Galvanized Sheet Steel of min 0.8 mm Thickness infilled with Rockwool foam. Galvanized Iron Frameworks as per design requirements shall be provided as reinforcement to improve the rigidity of the Panel.
- Doors shall be of the same construction as per the Wall Panel with min 1 mm thickness sheet for Door & 1.2mm thickness for Door Frame.

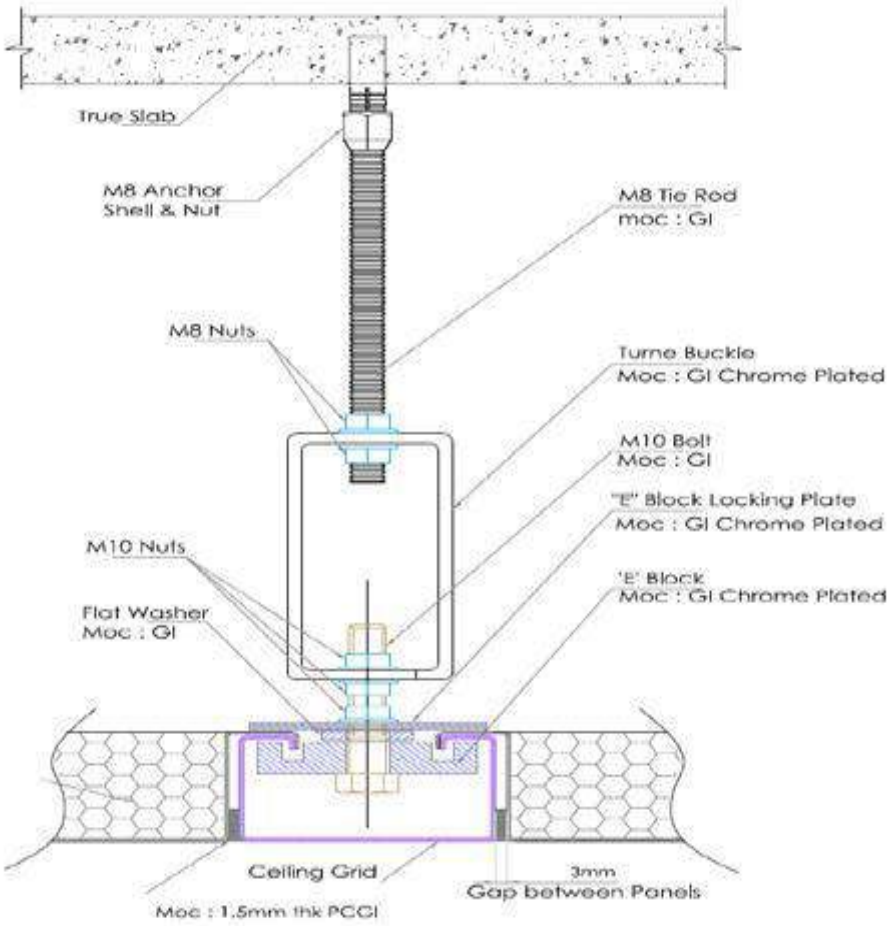
GENERAL DESIGN REQUIREMENT

- The design Facility is under comfort Air Conditioning, Unclassified area without personnel Air Lock entry.
- The view panels, constructed with double glazing, shall be provided for facilitating good visibility.
- The Doors shall be provided with drop seals & side seals to reduce the leakage rate.
- The wall and ceiling panels for facility construction shall be of the type convenient for penetration for the service lines and utilities and at the same time such penetrations, it should be possible for leak proof sealing.
- All joints to be sealed with silicon sealant. Coving profiles to be used where the wall panel meets the Floor & Ceiling.
- Provision for Fixing Diffuser module, Grille modules & Clean Room Light Fixtures shall be provided in the Ceiling Panels.

3. TECHNICAL SPECIFICATION

Ceiling Grid & Panel Structure

Ceiling system, suitable for clean room applications, complying with international statutory regulations, preferably applicable for a semiconductor industry / electronics industry / pharmaceutical/ Biological, shall have double skinned, insulated, walkable type, load bearing modular panels flush on both sides, supported on heavy duty aluminium profile frame forming reticulated grid structure hanged from steel truss/RCC roof through adjustable threaded HDG tension bolts/expansion bolts, turn buckles, slide fits etc., with necessary openings for HEPA filters, filter housing, grills, supply-return ducts, service pipes, power-control cables, sensors and suitable opening for light fixtures, making openings leak proof with necessary framings, sealing of joints with silicon sealant etc. without any crevice/undulations. The design, fabrication/manufacture, installation should be such that essentially all finishes should ensure all products to be manufactured in the proposed facility are protected from contamination and that all surfaces should permit efficient cleaning, minimize moisture penetration during cleaning. All surface finishes should be impervious, smooth, non-shedding and should withstand repeated application of cleaning materials and disinfecting solutions. Standard height of walkable ceiling from floor level is 2.4 mts. However, this may vary according to the requirement of activity being carried out.



Typical Ceiling Support Details

Lower skin of ceiling panel - towards clean room side
Minimum 0.8 mm thick Powder Coated GI sheet (Hot dipped with Zinc coating of 120 gsm), thermo-hardened Epoxy Powder Coated resistant to all mechanical, chemical, climatic aggression, resistant to x-ray or ultraviolet radiation /powder coated with approved colour & finish along with Rockwool foam infill density of 96 +/- 2 Kg/cu mtr.

Upper skin exposed to Attic Space
Minimum 0.8 mm thick PCGI sheet, thermo-hardened Epoxy Powder Coated resistant to all mechanical, chemical, climatic aggression, resistant to x-ray or ultraviolet radiation /powder coated with approved colour & finish.

Ceiling Grid (Only modular type reticulated grid structure)

Heavy duty 16 micron anodised extruded aluminium sections minimum 2.5mm-3.0mm thick, flush with panel on both sides with maximum allowable gap of 4mm filled with silicon, powder coated to match ceiling panel finish with all accessories, clamps, GI/Electroplated nut-bolts etc complete suitable for walkable ceiling with load bearing of 150 - 200 kgs per sq mtrs. All the gaps are to be sealed with silicon sealant and tested for the same. All the gaps above 4mm shall be blanked with similar materials so that the entire ceiling is crevice & projection free. The periphery of the ceiling panel shall be supported on RCC/masonry wall with necessary frames and ceiling joints.

Suspension System
Minimum M8 or M10 threaded Hot Dip Galvanized rods adjustable suspension with HDG turnbuckle for levelling of 3.0- to 4.0-meter-long rods anchored to RCC beam/slab. The entire grid system shall be grounded to earth as directed. Suitable catwalks shall be provided wherever necessary.

Insulation
The ceiling panels shall be 50 to 150 mm thick insulated with self-extinguishing Rockwool 96 +/- 2 kg /cu m inclusive of adhesive/glue with appropriate bonding strength etc complete as specified in BOQ.

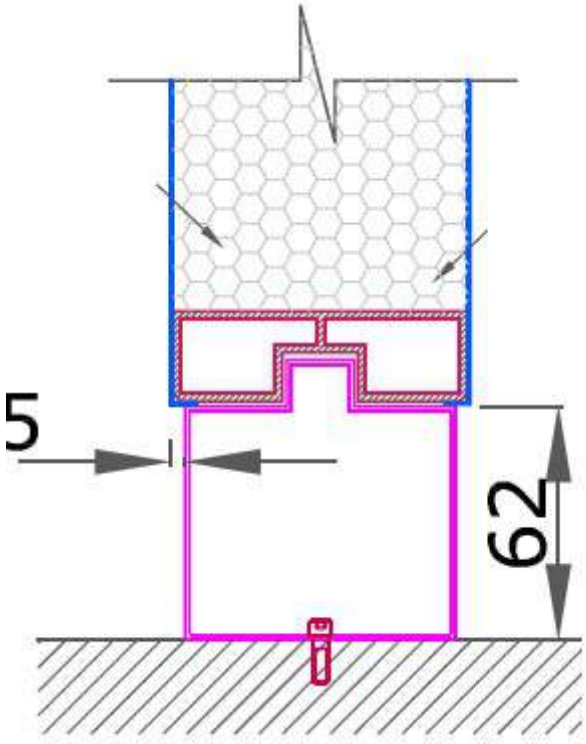
Cut-outs in panels and Co-ordination with other agencies
Cut outs shall be made in the ceiling panel as described above for HEPA filters, micro filters, cables, etc as per the requirement of the HVAC/Utilities contractor and finishing the cut outs with necessary frames, beadings and Neoprene gaskets on both sides sealed with silicon sealants so as to make the cut out totally leak-proof including powder coated aluminium grill matching with ceiling. It shall be the responsibility of the bidder to coordinate his modular partition erection work with HVAC contractor for ducting cut outs and Utilities contractor for all service pipes and cables.

Panels shall be resistant to the action of usual cleaning agents (detergents and disinfectants) used in pharmaceutical industry. Panels to be provided with plastic foil/protective covering in the processing and installation stages to avoid damages and the wall surfaces to be clean of excess color or oil traces. The above false ceiling gaps adjacent to civil wall and between panels shall be properly sealed with aluminium 'L'-angle properly fastened and properly sealed using FDA approved food grade sealant (between wall and wall panel wherever possible). All the gaps between ceiling elements and wall panels shall be properly sealed with FDA approved food grade sealant.

Wall Panel System

Wall Panel System suitable for clean room applications, complying with international statutory regulations, preferably applicable for a semiconductor industry / electronics industry / pharmaceutical/ Biological shall have double skinned, self-supported, load bearing modular panels, flush on both sides, supported on heavy duty aluminium profile frame forming reticulated grid structure supported on RCC floor by anchoring heavy duty aluminium profile runner, levelling, fixing coving minimum 75mm high to receive flooring, with intermediate vertical, horizontal and corner frames, top frame connected to ceiling grid along with coving with necessary openings for doors, windows, pass boxes, material hatch, equipment cut out, return/supply ducts, grills, service pipes, power-control cables, sensors, switches etc complete and making openings leak proof with necessary framings, sealing of joints with silicon sealant etc complete rendering the surface crevice and projection free.

The panel shall be thoroughly checked for Vertical Straightness with IR Beams, shall be easy to remove and refit without disturbing the adjoining wall & ceiling panel. Minimum space between two skins of wall panel shall be 50mm for without Inbuilt Raiser & 100 / 150 mm for Inbuilt Raisers. The bidder shall fill the hollow space with Rockwool material of suitable density structure to make the panel rigid, sturdy and free of vibrations; and the infill shall be rockwool of suitable density. It shall be possible to run wires/cables through hollow box wall frames and fixing of switches. Bidders may please note that panels with tongue & grove joints without box frame shall not be accepted.



Typical Wall Panel Supports Details

Wall Panel Frame Double skin wall panel (sandwiched Construction)

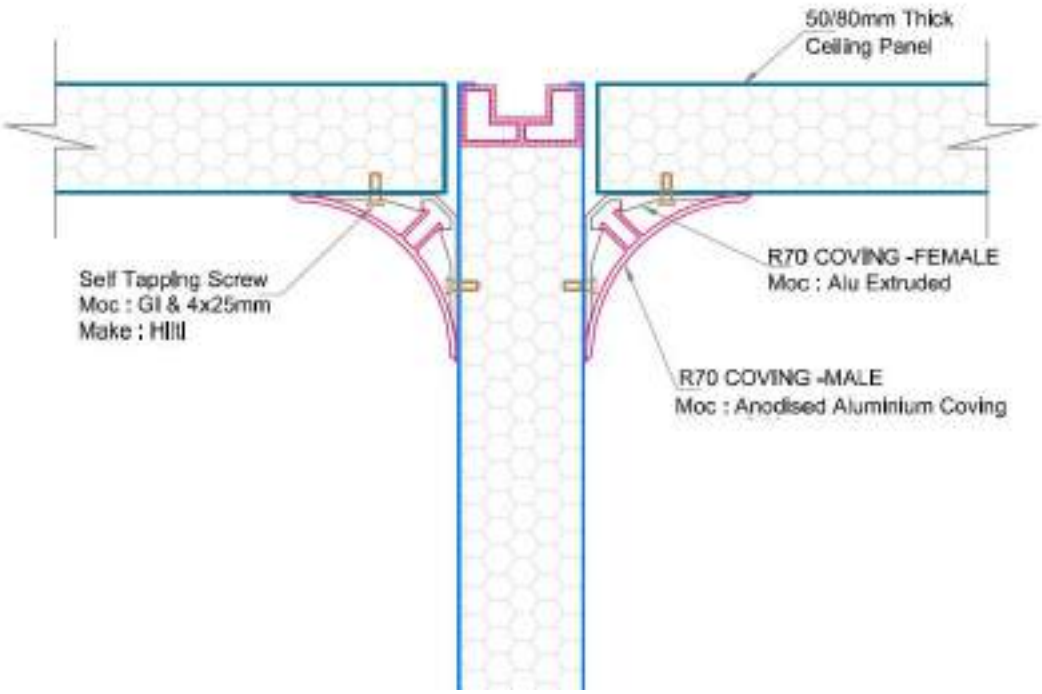
Minimum 0.8mm thick PCGI sheet, thermo-hardened Epoxy powder coated paint resistant to all mechanical, chemical, climatic aggression, resistant to x-ray or ultraviolet radiation /powder coated with approved colour & finish all the gaps above 4mm shall be blanked with similar materials so that entire panel is crevice & projection free.

Cut-outs in panels and Co-ordination with other agencies

Cut outs shall be made in the wall panel as described above for doors, windows, cables, service pipes, pass box, hatch, return duct etc as per the requirement of the HVAC/Utilities contractor and finishing the cut outs with necessary frames, beadings and Neoprene gaskets on both sides sealed with silicon sealants so as to make the cut out totally leak proof including powder coated aluminium grill matching with wall panel for return duct. It shall be the responsibility of the bidder to co-ordinate his modular partition erection work with HVAC contractor for ducting cut outs and Utilities contractor for all service pipes and cables.

Covings

All joint between wall and wall and wall and ceiling shall be covered with powder coated aluminium coving (color same as the color of the wall and ceiling panel, powder coating shall be 60-80 microns)/anodized aluminium/PVC (wherever specified) as specified with section of radius in range of 50-60 mm. The thickness of coving shall be NLT 2mm. Joint between coving and surface shall be sealed with FDA approved food grade silicon sealant for all areas The coving shall also include 3 D types, both concave and convex sections for connections between 3-way wall panels at the top and wherever specified bottom side of the clean rooms.



Typical Coving Details

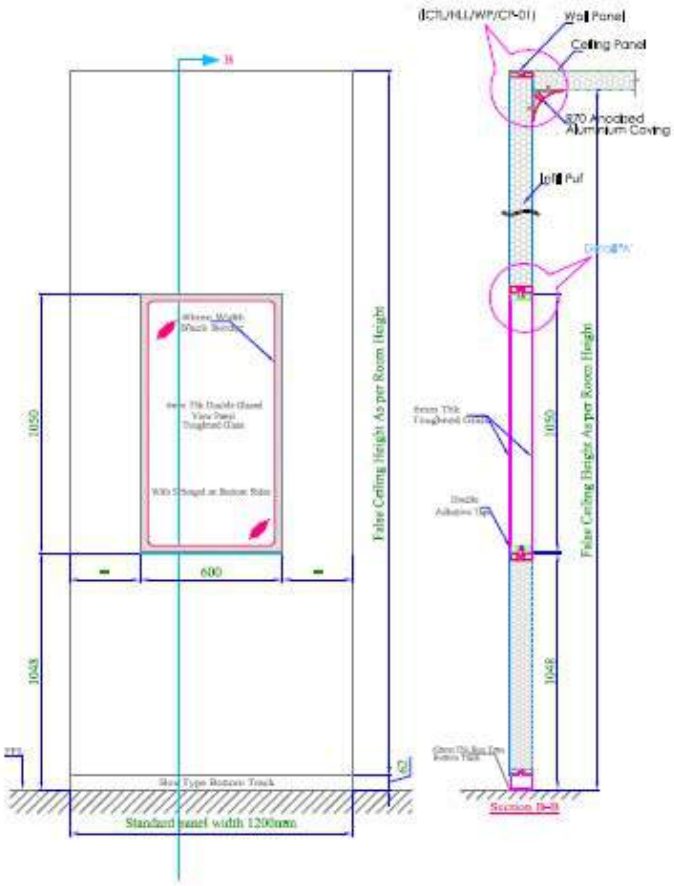
False Wall Panel Column/Drop ways/Service Panels.

Bidders shall fabricate, supply and erect false columns or drop ways for electrical cables, service pipes, return air, panelling around RCC column etc wherever required with similar material specification as specified under 'Wall Panel System' with round covings and round column edges flush on all sides. The false column shall have (for service panel) two open-able door panels for an easy opening in case of inspection or maintenance. The false panel may be in the corner, side or free standing in a room. The frame shall be heavy-duty aluminium and sturdy.

Enough to support service pipe clamps. The rate shall include all material, fixtures, labour cost. It shall be paid in square meter.

Windows:

All windows/view panels with extruded aluminum frame shall be double-glazed and designed to fit flush into the wall panel system on both side with two minimum 6mm+6mm stratified safety laminated glasses. The plain glass shall be toughened or laminated with transparent film to prevent splattering of glass pieces in case of explosion/breaking. The gap between the glasses shall have an anti-moisture (double Glazed View Panel shall be Vacuum Sealed) system with all around micro-perforation profile with inside silica gel granules / molecular sieve. Glazing shall be perfectly flush with the outer surface of the frame and panels. All joints shall be taped and sealed by silicon sealant. The glass assembly shall be factory assembled and shall be from approved manufacturer. The windows shall be around 1000mm high with 1100mm windowsill and 2100mm window top from finish floor level. This shall be measured in square meters. View Panels shall be coated of approved colour to prevent entry of Ultraviolet light with factory fitted aluminum frame/housing.



Typical Windows Details

Modular Clean Room Doors - Single Leaf / Double Leaf

Modular doors leaves shall be made from both side Epoxy Powder coated (60-80 microns) 0.8 mm thick G.I sheets (hot dipped with zinc coating of 120 gsm) with rockwool as infill of density not less than 96 +/- 2 Kg/m3. Specific doors in washing area shall be with PCGI (Powder coated (60-80 microns) 0.8 mm thick G.I sheets (hot dipped with zinc coating of 120 gsm)) +PSS (0.8 mm thick Plain SS 304 sheet smoothed to 240 grit) skins. Door Frame will be made of 1.2 mm thick epoxy powder coated GI sheet or anodized aluminium. Doors shall be provided with necessary stiffeners and rounded aluminium edging to avoid the build-up of particles and to allow the whole surface to be kept perfectly clean.

The panel sides will be reinforced with a perimetral anodized aluminium frame for enhancing the rigidity of the panel. Door profiles to be designed such that no seal joint is

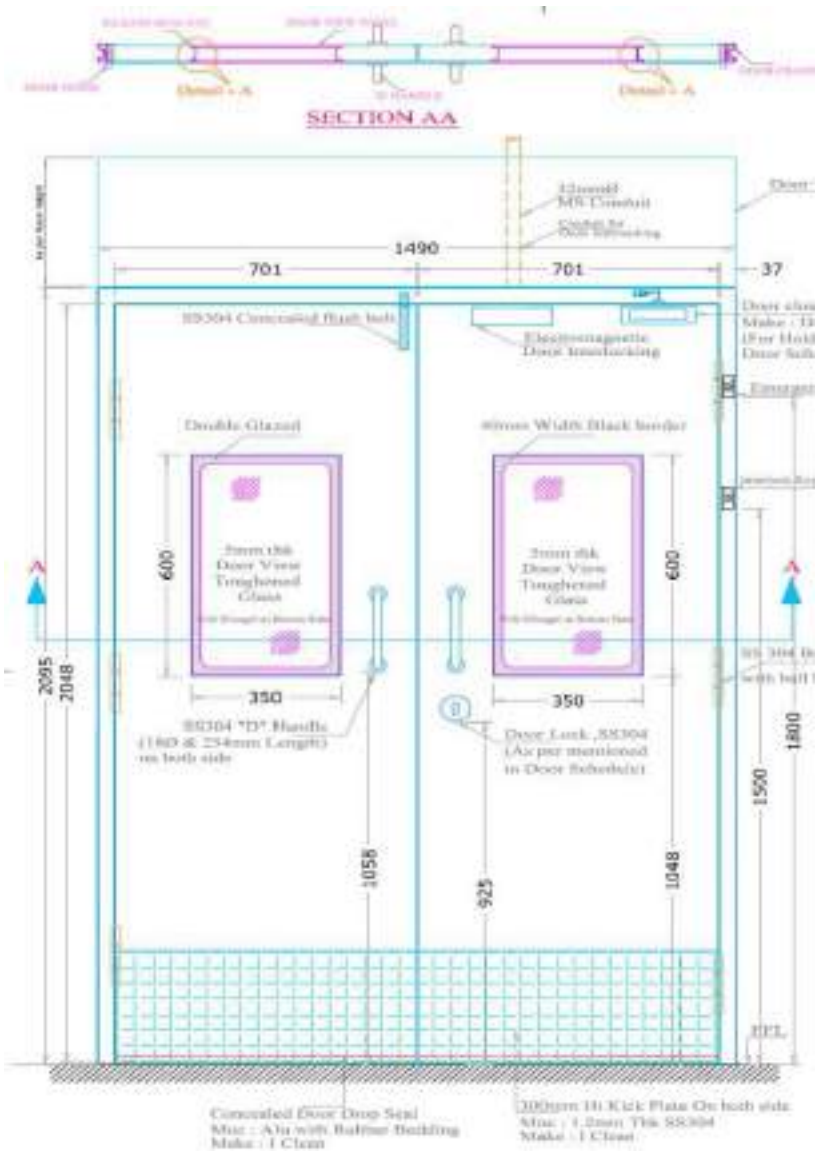
needed all around. To minimize the presence of leaks and the accumulation of particles the joint with two points of contact is preferred.

Internal hinges in a 3/4-part construction made from SS 304 with butt ball bearing and counter sunk screw shall be provided. The door will be opened manually and will be closed slowly by a hydraulic retracting mechanism. The door closure shall have a stainless-steel finish/anodized aluminium and should be suitable to work against differential pressure of up to 25 Pascal and lockable at 90° (Dorma make model TS 71 or suitable), the requirement shall be based on the site conditions.

Doors requiring interlocks will be provided with electro-magnetic interlocks. Door leaves shall be provided with bottom drop seals and the same shall be properly concealed and securely fixed at the bottom of door leaves.

All the doors shall be provided with SS 304 smoothened to 240 grit "D" handles of 18 mm diameter and 254 mm length shall be utilised. Wherever specified lock and key, not less than 1.2 mm thick SS304 smoothened to 240 grit factory fitted kick plates to be provided on both sides to avoid foot shocking. The gap between the frame and the door leaf and the door bottom and the floor shall not be more than 2mm to avoid excess ex-filtration/Infiltration of air from the rooms.

As specified fully flushed double glazed view panel in aluminium framework of minimum 450x600mm size with 6 mm toughened glass (with 4 sided bevelled and smooth edges) & moisture traps using silica gel between panes shall be provided.
All joints between view panel and door panel to be sealed using FDA approved food grade silicon sealant. Double face VHB tapes of required thickness or using FDA approved food grade silicon sealant to be provided on the periphery of the view panel frame to avoid any play between view panel frame and the slot in the door leaf.
In case of damage the window/view panel should be changeable without removing the door panels. The doors shall be provided with tags mentioning the name of the room.
Frosting of the glass/doors without glass to be considered for dress change rooms. View panels with automatic (electrical) frosting shall be considered in need to have basis.
Additional accessories such as push plate, concealed tower bolt for double doors etc. shall be considered as per the client's requirements.



Modular Emergency Doors (Red Color):

Emergency doors shall be made from both side Epoxy Powder coated (60-80 microns) 0.8 mm thick (1.2 mm thick for civil wall) G.I sheets (hot dipped with zinc coating of 120 gsm) with rockwool as infill of density not less than 96 +/- 2 Kg/m3. Door Frame will be made of 1.2 mm thick (1.6 mm thick for civil wall) epoxy powder coated GI sheet or with anodized aluminium. Doors shall be provided with necessary stiffeners & rounded aluminium edging to avoid the build-up of particles and to allow the whole surface to be kept perfectly clean. To minimize the presence of leaks and the accumulation of particles the joint with two points of contact is preferred. The panel sides will be reinforced with a perimetral anodized aluminium frame for enhancing the rigidity of the panel.

Internal hinges in a 3/4-part construction made from SS 304 with butt ball bearing and counter sunk screw shall be provided. The door will be opened manually and will be closed slowly by a hydraulic retracting mechanism. The door closure shall be suitable to work against differential pressure of up to 25 Pascal and lockable at 90° (Dorma make model TS 71 or suitable).

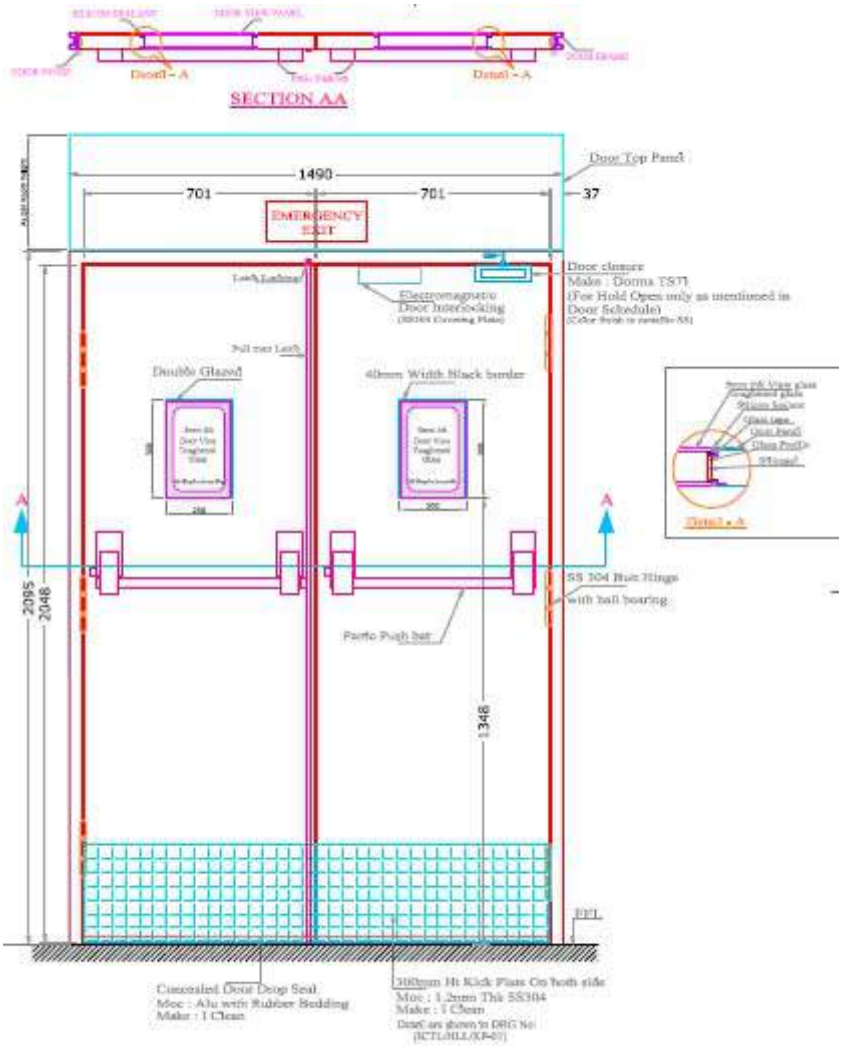
Door leaves shall be provided with bottom drop seals and the same shall be properly concealed and securely fixed at the bottom of door leaves.

All the doors shall be provided with anodized aluminium panic push bars (for double doors pull man latch with rods and lever handle on the other side of the inactive door). Wherever specified not less than 1.2 mm thick SS304 smoothened to 240 grit factory fitted kick plates to be provided on both sides to avoid foot shocking. Double Doors shall be provided with pull man latch and rod, the fastening of the latch to be on the top frame only. The gap between the frame and the door leaf and between the door bottom and the floor shall not be more than 2mm to avoid excess ex-filtration/Infiltration of air from the rooms.

Fully flushed double glazed view panel in aluminium framework of 200x300mm size with 5mm toughened glass (with 4 sided bevelled and smooth edges) & moisture traps using silica gel between panes shall be provided.

All joints between view panel and door panel to be sealed using FDA approved food grade silicon sealant. Double face VHB tapes of required thickness or silicon sealant to be provided on the periphery of the view panel frame to avoid any play between view panel frame and the slot in the door leaf. In case of damage the window/view panel should be changeable without removing the wall panels. The doors shall be provided with tags mentioning the name of the room.

The doors shall be provided with tags mentioning the EMERGENCY EXIT signage in fluorescent sticker/signage from polypropylene sheets/any clean room compatible material.



Typical Emergency Doors Details

Modular Doors

Door's shutter /leaf of 46 mm thickness shall be made from both side Epoxy Powder coated (60-80 microns) 1.2 mm thick G.I sheets (hot dipped with zinc coating of 120 gsm) with Rockwool foam as infill of density not less than 96 Kg/m3. Door's shutter /leaf of 46 mm thickness shall be made from both side Epoxy Powder coated (60-80 microns) 1.2 mm thick G.I sheets (hot dipped with zinc coating of 120 gsm) with rockwool as infill of density not less than 96 +/- 2 Kg/m3. Door Frame will be made of 1.6 mm thick epoxy powder coated PCGI sheet/anodized aluminium. Doors shall be provided with necessary stiffeners and rounded aluminium edging to avoid the build-up of particles and to allow the whole surface to be kept perfectly clean. To minimize the presence of leaks and the accumulation of particles the joint with two points of contact is preferred. The panel sides will be reinforced with a perimetral anodized aluminium frame for enhancing the rigidity of the panel.

The clean door panels should meet the euro classes' minimum reaction A2-s1, d0: non-combustible for Rockwool.

Internal hinges in a 3/4-part construction made from SS 304 with butt ball bearing and counter sunk screw shall be provided. The door will be opened manually and will be closed slowly by a hydraulic retracting mechanism. The door closure (MOC SS 304) should be suitable to work against differential pressure of up to 25 Pascal and lockable at 90°wherever specified.

Doors requiring interlocks will be provided with electro-mechanic interlocks wherever specified.

Door leaves shall be provided with bottom drop seals and the same shall be properly concealed and securely fixed at the bottom of door leaves.

All the doors shall be provided with SS 304 smoothened to 240 grit "D" handles shall be utilized. Wherever specified lock and key, not less than 1.2 mm thick SS304 smoothened to 240 grit factory fitted kick plates to be provided on both sides to avoid foot shocking.

The insulation considered may be sodium silicate film or any other intumescent. Silica gel/suitable desiccant shall be introduced between glazing to arrest humidity. It shall be flush mounted with the wall panel (view panels should be inset within the doors as a single entity).

View Panels on Doors

View panel with extruded aluminium frame shall be double-glazed and designed to fit flush both side of the door with two minimum 6mm+6mm stratified safety glasses as specified in windows section. The sill level of the door view panel shall match the windowsill height. All

the doors shall be fitted with heavy-duty anodized aluminium mat finish/powder coated or stainless-steel hardware, handles, locks, hinges, concealed door closure of approved make and size. For double doors, only the active door panel shall be provided with door closure. Gaskets made of approved material running on three sides inside the frame shall be provided for tightness. The doors may be required to swing 90° degrees on opening. Wherever specified, doors shall be interlocked with other doors.

Doors Interlocking System

Provision for Door Interlocking System shall be provided by the Panel Vendor. Since Door Interlocking System is in Instrumentation scope of works. Panel bidder shall coordinate with Instrumentation Vendor for execution of Door Interlocking.

Emergency Break Panel

Emergency View Glass shall be made in anodized aluminium framework made from double glazed tempered / toughened glass of min 5 mm thk. Glass shall be properly fixed to the frame with VHB tapes, silica gel shall be introduced b/w glazing to avoid ingression of humidity. The total frame shall be properly fastened to the modular panels & all joints shall be sealed with FDA approved food grade silicon sealant. A glass breaking tool of SS304 / Anodized Aluminium shall be provided along with this door & fixed near to the glass on both sides of the room.

PERFORMANCE REQUIREMENTS OF WALL AND CEILING PANELS:

Acoustics: Noise level inside clean rooms shall be less than 55 ± 5 dBA and in other areas IS 65 ± 5 dBA.

Mechanical Strength: The wall panel system should be sturdy enough to withstand a Hanging load of 200 kg /lm.

Surface Resistivity: The surface Resistivity should not be more than 10-12 ohms /sq, essentially to avoid static build up during cleaning of panels resulting in the panel surface attracting the dust particles.

Air Tightness: The clean room system should comply with the pressure drop of not more than 0.0035 cfm /sq ft in a range of 10 to 25 Pa and 0.065 in the range of 25 to 50 Pa.

Colour Retention:

There should be no change in the color of the panels and entire assembly after testing for 1000 hrs at 70 - 80 * C.

ABBREVIATIONS

PUF	Poly Urethane Foam
PCGI	Powder Coated Galvanized Iron

PART 10

LAB FURNITURE WORKS

CONTENTS

1.0 PROJECT OVERVIEW

- National Centre for Cell Science (NCCS) is a premier autonomous research institute, under the Department of Biotechnology, Govt. of India located at Savitribai Phule Pune University Campus, Ganeshkhind, Pune 411007.
- Under the aegis of the National Biopharma Mission, NCCS has be entrusted with responsibility to establish a state-of-the-art National cGMP-compliant mammalian cell line repository in the existing building of NCCS at Jidnyasa, near Vanaz Engineers Ltd., S.No. 85/1, Paud Road, Kothrud, Pune – 411038.
- The plot area of the site is approximately 14500 sq.ft. The building is basement plus 3 floors with a total built up area of approximately 13850 sq.ft. The approximate area available on an average per floor is 3500 sq. ft. The building is a complete empty shell with no activities presently.
- The proposed repository would be required to be established in par with international cell repositories using global benchmarks, stringent quality control parameters in GMP as per national (DGCI-CDSCO-India) and International (FDA-US & EMA-EU) regulatory requirements along with compliance with Environmental norms.

2.0 LAB FURNITURE WORKS

2.1.1 SCOPE OF WORKS

Scope of work includes design of laboratory furniture's for the Manufacturing block in the First Floor and QC, Microbiology Facility in the second floor.

- SS floor mounted Base Cabinets with SS Bench top type of Lab Furniture shall be provided on the first-floor manufacturing block and on the second floor Pilot plant area & Virus-cell culture area. CRCA Epoxy Powder Coated floor mounted Base Cabinets with Granite Bench top type of Lab Furniture shall be provided on Analytical QC area & Physiochemical laboratory and Instrumentation rooms of QC cell culture area.
- All the lab furniture shall be made of SS304 with 180 grit matte finish in the First floor & Pilot plant area, Virus-cell culture area on the second floor.
- Lab Furniture shall be designed with different width & Height as per individual Lab / Equipment's requirements.
- All the sinks, cupboards, overcoat/apron storage cabinets, cross over benches shall be made of SS304 with 180 grit matte finish.
- Snorkel exhaust with CAV dampers shall be provided above HPLC & GC equipment's.
- Snorkel exhaust shall pass through Dry Scrubber positioned on Third Floor service area.

- Anti-Vibration table with suitable elastomeric mounts shall be considered for the sensitive equipment like analytical balance in Weighing room and Microscope in Virus Culture room.

2.1.2 DESIGN CRITERIA

a. PURPOSE

It is the Intent of the work to provide high quality worktables with Cabinets and desired work top as mentioned in above scope of works.

b. TYPE

SS304 with 180 grit matte finish Base Modular Cabinets of Floor Mounted type with 1.6 mm SS304 top Work Bench. Back Splash for Work Top shall be SS304 material. Floor to Base Cabinet shall be provided with Epoxy Covings by flooring vendor. This is for first floor manufacturing block. Pilot plant area & Virus-cell culture area on the second floor.

CRCA Epoxy Powder Coated Steel Base Modular Cabinets of Floor Mounted type with 20mm Granite top slab plus Work Bench. Back Splash for Work Top shall be Granite material. Floor to Base Cabinet shall be provided with PVC Covings. This is for Analytical QC area & Physiochemical laboratory and Instrumentation rooms of QC cell culture area.

c. GENERAL DESIGN REQUIREMENT

- The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled Workmanship to meet the intended quality and quantity for the project.
- All cabinet bodies shall be of over closing design with fully knock down and having a main and add on construction to avoid any gaps in between two units. All units to be with interlocking type of construction to form a rigid integral structure.
- All cabinets shall have a cleanable smooth interior. And shall be positioned on Pedestal Frame legs same shall be covered with Epoxy coving to ensure no dust & moisture enters below the cabinets.
- Thickness of Steel used in the construction of cases shall be as per specification enclosed.

2.3.1 GENERAL SPECIFICATON

The steel frames, panels & shutters should be made from Prime Quality CRCA (Cold Rolled

Cold Annealed) Steel and SS304 as mentioned in the Lab Furniture scope of works & design criteria. All cabinet shall be complete welded construction complying SEFA 8M standards.

Floor cabinets made of hollow tubular square cross sections would not be acceptable. Single units should be complete welded construction complying with SEFA 8M Standards & units should be placed side by side to form the entire table.

Under Bench Free Standing PLINTH Mounted Cabinets & Sink Base Unit.

Free Standing PLINTH Mounted Cabinets mounted & Sink Base Unit should be flush face construction with doors in the same plane as the cabinet face frame, without overlap.

All cabinets shall be flush front construction. Exterior corners shall be spot welded with heavy back up reinforcement at exterior corners. All face joints shall be welded and ground smooth to provide a continuous flat plane.

Thickness of CRCA / GI powder coated with minimum 60 to 80 microns high chemical resistant epoxy powder or 80 to 100 microns Polyurethane powder coating steel used in construction of cases shall be 1.2mm thk. Also for SS304 construction of cases shall be 1.2mm thk.

Base moulding to be provided for the free-standing base units. Base moulding shall be sealed at the bottom to prevent dust accumulation beneath the cabinet.

Support struts shall consist of two 1.6mm thk channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 2.6mm thk, 1- 37.5mm x length required formed from galvanized steel. Struts shall be furnished to support drain troughs, and to support worktop at plumbing space under fume hood superstructures or other heavy loads.

The sinks should be with self-draining base and should be suitable for mounting on top or underside of the work benches. Sinks shall have bottle trap.

Internal size of PP & SS Single Moulded Sinks –shall be defined in the Technical BOQ.

Polyethylene cup drains shall be moulded in one-piece of acid-resistant polyethylene. They shall have an integral mounting flange and an integral tailpiece with 38mm I.P.S. male straight thread outlet with Bottle Trap.

2.3.2 UNDER BENCH CABINETS

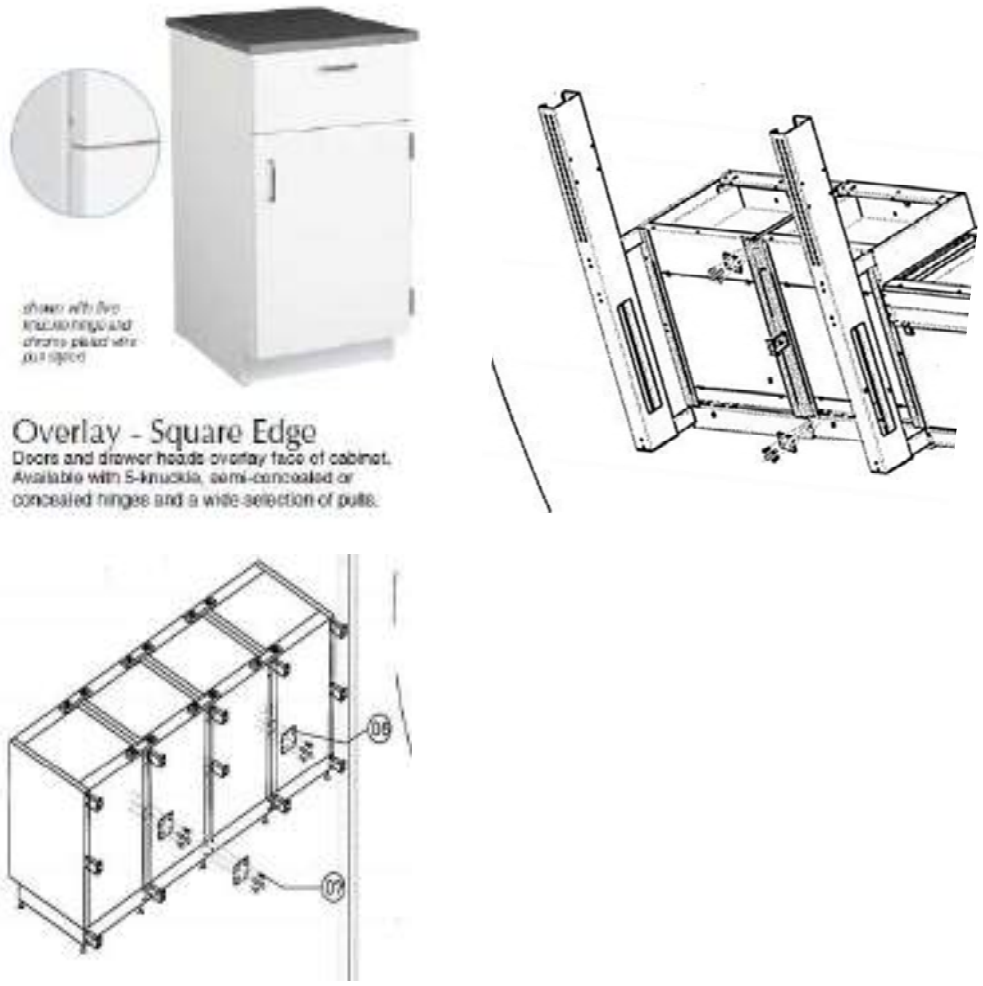


FIG: 01 TYPICAL UNDERBENCH SUPPORTING DETAILS

Under bench cabinets should be flush face construction. Thickness of CRCA with high chemical steel used in construction of cases shall be 1.2 mm thick except as follows:

Case and drawer suspension channels, 2 mm thk.

Top and intermediate front horizontal rails, table aprons, hinge reinforcements, and reinforcement gussets, 1.6mm thk.

Drawer assemblies, door assemblies, bottom, bottom back rail, toe space rail, and adjustable shelves, 1mm thk.

The overall load carrying capacity of under bench cabinet should be 80 kg of UDL (40kg on the

shelf and 40kg on the bottom)

Door shutters and drawer's facias shall be bent to 19mm thick square edges, recessed aluminum pull, offering a comfortable handgrip, shall be securely fastened to doors and drawers with screws. All pulls shall be satin finish aluminum, with a clear, lacquer finish. In case of SS Furniture all pulls shall be in SS material only.

Drawer cabinets shall be made in one-piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 19mm thick drawer head.

Drawer slides shall consist of high precision, fully extendable, double extension slides with minimum 40 kg load carrying capacity. Drawer slides shall be equipped with soft closure mechanism by air suspension, self-closing when the drawer reaches 80% closure. Drawer channels shall maintain alignment of drawer and provide an integral stop, but the drawer shall be removable without the use of tools. Drawers shall provide minimum 340mm front to back clearance when fully extended. Drawers shall rise when opened thus avoiding friction with lower drawers and/or doors.

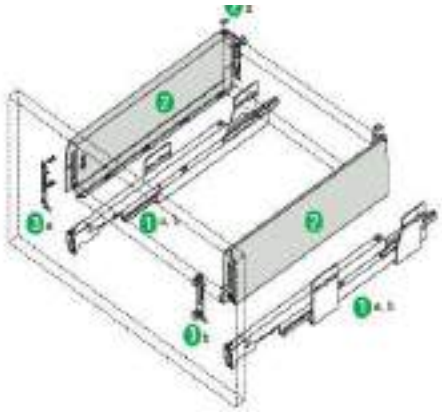


FIG: 02 TYPICAL DRAWER SLIDES DETAILS

Hinges shall be made of Type 304 stainless steel 2.2mm thick, 62.5mm high, with brushed satin finish with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to the door or case shall not be accepted. Doors under 900mm height shall be hung on one pair of hinges, and doors over 900mm high shall be hung on 3 hinges.

Handles shall be anodized aluminum, recessed type- 100mm x 50mm size. In case of SS Furniture all pulls shall be in SS material only.

All storage units except sink units shall be provided with locks. Locks shall be a 5-disc tumbler with heavy duty interchangeable cylinder and 2 sets of keys

A two-piece heavy-duty cam action positive catch shall be provided on all base cupboard doors and shall be positioned near the pivoting edge of door to provide a clean unobstructed opening. Main body of the catch shall be confined within an integral cabinet divider rail, while latching post shall be mounted on the hinge side of door. Nylon roller type catches are not acceptable

Adjustable shelves shall be formed down 19mm, returned back 22.5mm and up 6.5mm into a channel formation front and rear; formed down 19mm at each end, shelves over 1050mm long shall be further reinforced with a channel formation welded to underside of shelf. Shelf adjustment clips shall be nickel-plated steel.

Shelves and Drawers: CRCA / GI powder coated with minimum of 60 to 80 microns high chemical resistant epoxy powder /80 to 100 microns Polyurethane powder coating steel shelves and drawers shall have a load bearing capacity of 40kg of UDL. In case of SS Furniture finish shall be 180 grit matte finish.
Configuration of Storage Units: The storage units should be available in three configurations:

Storage unit with one/two shutters and one adjustable shelf

Storage unit with one drawer, one/ two shutters and one adjustable shelf Storage unit with

4 drawers

All storages are fitted with 10 levers, 180-degree cam locks when not specified. Hinged back

panel (as shown in diagram) for easy access to services behind.

2.3.3 ANTI-VIBRATION TABLE

Anti-Vibration Table (AVT) should be designed for use in analytical laboratory to provide suitable working conditions for high accuracy (0.0001 g) analytical balances that are sensitive to vibrations and shocks. The vibrations from the floor due to electricity fittings and other structural vibrations are responsible for producing errors in the measurement. Therefore, the AVT should be provided with suitable elastomeric mounts to isolate the vibrations and provide an error free vibration less surface for the analytical balance. The AVT should be made up of 80mm x 80mm tubular frame with 80mm thick granite on top & vibration pads. Fabrication of all structure should be in accordance with IS: 800 (latest). Welding of the structure should be as per IS: 800 and IS: 816

Geometric Profile of Anti-Vibration Table: Anti- Vibration Table should be an overall Rectangular Working Surface of min. 600 X600 mm and with a height of 750/ 900 mm.

Granite Geometric Profile: Granite geometry should be as per IS Standards IS 7327: 1991. Of 80mm Thickness.

Dimensions: 600 (W) x 600 (D) x 900 (H) mm/ 600 (W) x 600 (D) x 750 (H) mm.

Some of the Anti- vibration tables to be provided with Enclosure cabinets as shown in the below drawing. Sliding laminated glass door at Front, Toughened glass at sides, CRCA Powder coated sheet at Rear side.

FIG: 03 TYPICAL AVT WITH ENCLOSURE

2.1 Above Bench 2 stage reagent shelves

Reagent shelves shall be complete modular design consisting of 2 stage horizontal storage shelves. The ends and intermediate vertical supports should be 1.2mm and Horizontal shelves of 10mm thickness of Toughened Glass supported on 2mm thick aluminium extrusion with MS brackets of 2mm thick. Each shelf should have a load bearing capacity of 50 kg of UDL for a length of 1000mm with SS 316 retaining rods.

FIG: 08 Reagent Shelves

2.2 WATER TAP:

FIG: 09 Single Way Fittings with Swivelling GOOSENECK Spout

In case of PP sink, Water Tap shall be made up of Metal Handle & Brass with surface protected by Epoxy/Polyester Powder Coating RAL 7035/ Incase of SS sink water tap shall be made of SS304 only, having male connection thread G3/8" & G1/2". Waterflow capacity of around 30 l/mn at 3 bar pressure & working temperature range of 0 to 70°C with test pressure 9 bars & max working pressure of 10 bar. The fittings must be supplied with a 2x360° open/close

function rubber headwork for fine regulation. The sealing must be made of EPDM and the lubrication must be silicone-based. The fittings should be capable of operating at maximum operating pressure of 10 bar (145 psi). The water fittings should be delivered with a flange and anti-rotational safety pins in order to keep the fitting fully locked in its position and to prevent unintentional turning that would result in leaks. The handles of the valve must be mounted with "zero gap" on the spindle of the headwork. The handle should be made of polypropylene/SS304 and the handle must have a clear closing/opening indication. The fittings must be equipped with a hose nozzle according to DIN 12898. Depending on user requirement and preferences, the hose nozzle be made of polypropylene or powder coated brass or SS304 and can be either fixed or removable type.

2.3 TWIN CUP EYE WASH:

FIG: 10 TYPICAL TWIN CUP EYE WASH

Twin cup eye wash shall comprise of the following:

All water-bearing parts made of brass: PA, POM, TPE, Metals: SS, AISI 316 and Rubber: EPDM handle with integrated, adjusting activation made of plastics, valve not self- closing high-performance spray heads made of brass, for large-scale dispersion of water, chemical resistant powder coated, largely scale-free, with rubber sleeves and sealed dust caps integrated flow regulation 14 litre / minute integrated backflow preventer stainless steel covered hose, length 1.5-meter, water inlet 12.5mm dia. female, DIN-DVGW tested and

certificated table mounting accessories M28x1,5x80mm made of brass, incl. fastening-parts kit with nut M28x1,5mm and 2 screws M5 for mounting difficult to access, chrome-plated rosette, sealing to table surface with O-Ring sign for eye shower according to DIN 4844-2-D and BGV A8, self-adhesive PVC-film, 100 x 100 mm

Twin cup eye wash shall conform to the following codes; DIN 1988 und DIN EN 1717, DIN EN 15154-2:2006 and ANSI Z358.1-2004 Manufacturer: Broen or Water saver.

2.4 SAFETY STATION:

Emergency Shower: total height 2300 mm, projection 655 mm, should be capable of delivering water at a min 75 litres /min & Eye wash at a minimum of 11 litres /min with min working pressure of 1.5 bar, conforming to the following specifications:
Flange plate with 4 mounting holes made of Stainless Steel, chemical resistant orange powder coated, dimensions 230 x 230 mm Vertical standpipe 2300mm height, 150mm dia made up of Galvanized steel, chemical resistant orange powder coated, with 25mm chrome plated brass stay-open ball valve. Valve is made with chrome plated brass ball and Teflon® seals. Furnished with stainless steel actuating arm and 29" stainless steel pull rod. DIN-DVGW tested and certificated pull rod made of steel, chemical resistant green powder coated, length 700 mm high-performance shower head made of chemical resistant plastic, with improved spray pattern, corrosion resistant, largely scale and maintenance-free, very robust, self-draining integrated automatic flow regulation 50 l/min. for a spray pattern according to the norms at a specified operating range of 1.5 to 3 bar dynamic water pressure eye / face wash unit with bowl body and bowl made of UV and impact resistant ABS plastic activation by pressing the big push plate made of stainless steel. High-performance spray heads made of brass, for large-scale dispersion of water, chemical resistant powder coated, largely scale-free, with rubber sleeves and sealed dust caps integrated flow regulation valve water inlet 1 ¼" Female, water outlet 1 1/4'' Female height 203mm, width 445 mm, depth 300 mm according to DIN EN 15154-1:2006, DIN EN 15154-2:2006, ANSI Z358.1- 2004 and DIN 12899-3:2009

FIG: 11A TYPICAL FLOOR MOUNTED SAFETY STATION

2.5 Sinks:

Two types of sinks made up of injection moulded from pure polyolefin/ co-polymer material or SS304 single piece moulded material as mentioned in the scope of works & design criteria section are used in the facility. Sink should be with inside corners coved, rectangular without border, having good resistance to organic solvents. Overall size (L x W x D) vary as per the BOQ.

- **Pegboard:**

Single faced stainless-steel pegboard having a tray hole for water drainage and detachable pegs. The essence is made up of 1 mm thick stainless steel (SS 304) whereas the pegs are made up of polypropylene and are adjustable with a minimum 10mm distance between each peg (L x W x H is 750 x 750 - 33 Pegs). SS 316L tray with 90 deg bend tube up to sink.

- **Bench Mounted/Suspended Laboratory Fittings**

The laboratory fitting manufacturer shall be certified to ISO 9001 / EN 29001 / BS 5750 Part 1, or equivalent.

The manufacturer should guarantee the availability of spare parts and replacement products for a period of minimum 10 years.

All external surfaces of the fittings shall be surface treated with a chemical resistant polyester powder coating that shall be highly resistant to most chemicals and provides excellent light fastness. Minimum thickness of coating shall be 50µm.

The fittings should be delivered with an "easy-to-mount" inlet connection, where it is possible to connect hoses, Cu-, SS-, or PEX pipes directly into the inlet of the valve, depending on the applications. Handle of the fittings to be metal.

The fittings should be delivered with color and media indication in accordance with EN 13792:2002.

Every fitting should be leak-tested before leaving the factory. Certificate of leak testing of each fitting to be provided.

Laboratory fittings must be supplied with an integrated service ball valve to provide the features Pre-setting of media flow, Local shut-off for maintenance purpose & Safety lock.

- **Laboratory Fittings for Water**

The fittings must be supplied with a 2x360° open/close function rubber headwork for fine regulation. The sealing must be made of EPDM and the lubrication must be silicone-based. The fittings should be capable of operating at maximum operating pressure of 10 bar (145 psi).

The water fittings should be delivered with a flange and anti-rotational safety pins in order to keep the fitting fully locked in its position and to prevent unintentional turning that would result in leaks.

The handles of the vale must be mounted with "zero gap" on the spindle of the headwork. The handle should be made of metal and the handle must have a clear closing/opening indication.

The fittings must be equipped with a hose nozzle according to DIN 12898. Depending on user requirement and preferences, the hose nozzle be made of polypropylene or powder coated brass and to be removable type.

- **Laboratory Fittings for Non-burning 2.0 Gases**

The fittings must be supplied with a fine regulating needle headwork having 3x360 degrees open/close operation for fine regulation of media flow. The sealing must be made of

FKM/FPM and the lubrication must be Perfluoropolyether based. The fittings should be capable of operating at maximum operating pressure of 16 bar (232 psi).

The 2.0 non-burning fittings should be delivered with a flange and anti-rotational safety pins in order to keep the fitting fully locked in its position and to prevent unintentional turning that would result in leaks.

The handles of the valve must be mounted with "zero gap" on the spindle of the headwork. The handle should be made of metal and the handle must have a clear closing/opening indication.

The fittings must be equipped with a hose nozzle according to DIN 12898. Depending on user requirement and preferences, the hose nozzle be made of polypropylene or powder coated brass and to be removable type.

- **Laboratory Fittings for Vacuum**

The fittings must be supplied with a high-flow headwork having 1.5x360 degrees open/close operation for high-flow regulation of media flow. The sealing must be made of FKM/FPM and the lubrication must be Perfluoropolyether based. The valves should be capable of handling an operating pressure of -1 to16 bar (-14.5 to 232 psi).

The vacuum fittings should be delivered with a flange and anti-rotational safety pins in order to keep the fitting fully locked in its position and to prevent unintentional turning that would result in leaks.

The handles of the valve must be mounted with "zero gap" on the spindle of the headwork. The handle should be made of metal and the handle must have a clear closing/opening indication. The fittings must be equipped with a hose nozzle according to DIN 12898. Depending on user requirement and preferences, the hose nozzle be made of polypropylene or powder coated brass and to be removable type.

- **Laboratory Fittings for Burning Gases**

Fittings must be delivered with a ceramic press/turn safety headwork with 90° open/close function, which prevents from unintentional opening of the valve. The sealing of the fittings for burning gases must be made of Nitrile and the lubrication must be mineral oil based. Fittings for burning gases should be capable of operating at maximum working pressure of 7

bar (100 psi).

The burning gas fittings should be delivered with a flange and anti-rotational safety pins in order to keep the fitting fully locked in its position and to prevent unintentional turning that would result in leaks.

Fittings for burning gases must be delivered with a metal handle with “POP-UP “indication buttons that make it possible visually to observe if the valve is open. Handles must be painted with the same quality polyester powder coating as the valve bodies.

Outlet must be equipped with a fixed metal serrated hose nozzle according to DIN 12898.

3.0 ELECTRICAL ACCESSORIES:

3.1 General Requirements power sockets:

All sockets, 5A/6A & 6A/16A ratings, shall be of modular type, flush mounting type with Tiny Trip design of the same rating as that of the sockets. All sockets outlet shall be of 3 pin / 5 pin type. The socket shall be of high-quality polycarbonate with pins made of brass alloy and plated with a noble metal. Sockets shall be provided with PVC surface outlet plates with round corners and beveled edges. All the sockets shall be provided with plug tops of approved quality and design.

3.2 Industrial type sockets:

Industrial type sockets shall be provided wherever specifically called for. Industrial sockets shall be totally metal clad with porcelain base incorporating the pins. Sockets shall have 3 pins for single phase applications and 4 pins and scraping earth of 3 phase applications. The sockets shall be provided with suitable metal clad plug top with suitable cable entry. Sockets shall have metal covers with chain. It shall have a suitable interlocked switch. Industrial type sockets shall be provided with a suitable sheet steel housing made of 16 gauge with the socket mounted in flush with cover of the housing.

3.3 Installation of switches, sockets & accessories:

All the switches shall be wired on phases. Connections shall be made only after testing the wires for continuity, cross phase etc., with the help of a megger. Switches, sockets fan regulators etc., shall be housed in proper GI factory boxes. The arrangement of switches and sockets shall be neat and systematic. Covers for enclosure shall be moulded accommodating switches, sockets etc., Outlets shall be terminated into a ceiling rose for fan points. For wall plug sockets, the conductor may be terminated directly into the switches and sockets. The outlets point control boxes etc. shall be set out as shown on the drawings. Before fixing these, the contractor shall obtain clearance from the Architect / consultant / project manager with regard to their proper locations. The enclosure of sockets and 3rd pin of the sockets shall be connected to the ground through a proper size earth continuity wires.

4.0 FITTINGS

- **Laboratory Service Fittings:**

Service fittings shall be laboratory grade, and water faucets and valve bodies shall be cast red brass alloy or bronze forgings, with a minimum content of 85%.

Plastic Coated Finish (Sepia Bronze):

When specified, laboratory service fittings shall have an acid resistant plastic coating applied over a fine sand-blasted surface. Surfaces shall be sprayed and baked three times with a minimum thickness of .0005 to .0010 mils.

Service Indexes:

Fittings shall be identified with service indexes with colour coding:

- **PERFORMANCE:**

Maximum Line Pressures:
Laboratory Ball Valves (Gas and Air) 75 PSI Needle Point Cocks (Gas and Air) 65 PSI Vacuum 28.5" Mercury

Hot and Cold Water	80 PSI
Steam	30 PSI

PART 2 — EXECUTION

- **SITE EXAMINATION**

Agency shall visit site before bidding for the tender and get himself acquainted with site conditions, type of buildings, lifts and leads and scope of work and no claim shall be entertained on this ground at later date. The work shall be executed as per direction of Engineer in charge.

- **INSTALLATION**

- **Preparation:**

Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.

➢ **Coordination:**

Coordinate the work of the Section with the schedule and other requirements of other work being prepared in the area at the same time both with regard to mechanical and electrical connections to and in the caseworks and the general construction work.

- **Performance:**

➢ **Casework:**

Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.

Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1.5mm tolerance.

Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board. Abut

top edge surfaces in one true plane. Provide flush joints not to exceed 3mm.

- **Work surfaces:**

Where required due to field conditions, scribe to abutting surfaces.

Only factory prepared field joints, located per approved shop drawings, shall be permitted.

Secure the joints in the field, where practical, in the same manner as in the factory.

Secure work surfaces to casework and equipment components with materials and procedures recommended by the manufacturer.

- **Adjust and Clean:**

Repair or remove and replace defective work, as directed by CLIENT representative upon completion of installation.

Adjust doors, drawers and other moving or operating parts to function smoothly. Clean shop finished casework; touch up as required.

Clean work surfaces and leave them free of all grease and streaks. Casework to be left broom clean and orderly.

- **Protection:**

Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.

Advise CLIENT representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

- **Testing Procedure:**

Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 30mm dia. watch glass, convex side down to confine the reagent. Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 60ml wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of the test period, the reagents shall be flushed from the surface with water, and the surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after the reagents are removed, the test surface shall be scrubbed with a damp paper towel and dried with paper towels.

- **Test Evaluation:**

Evaluation shall be based on the following rating system.

Level 0 – No detectable change.

Level 1 – Slight change in colour or gloss.

Level 2 – Slight surface etching or severe staining.

Level 3 – Pitting, catering, swelling, or erosion of coating. Obvious and significant deterioration.

After testing, panel shall show no more than three (3) Level 3 conditions.

Test Reagents

Test No	Chemical Reagent	Test Method
1	Acetate, Amyl	Cotton ball & bottle
2	Acetate, Ethyl	Cotton ball & bottle
3	Acetic Acid, 98%	Watch glass
4	Acetone	Cotton ball & bottle
5	Acid Dichromate, 5%	Watch glass
6	Alcohol, Butyl	Cotton ball & bottle
7	Alcohol, Ethyl	Cotton ball & bottle
8	Alcohol, Methyl	Cotton ball & bottle
9	Ammonium Hydroxide, 28%	Watch glass
10	Benzene	Cotton ball & bottle
11	Carbon Tetrachloride	Cotton ball & bottle
12	Chloroform	Cotton ball & bottle
13	Chromic Acid, 60%	Watch glass
14	Cresol	Cotton ball & bottle
15	Dichlor Acetic Acid	Cotton ball & bottle
16	Dimethylformanide	Cotton ball & bottle
17	Dioxane	Cotton ball & bottle
18	1Ethyl Ether	Cotton ball & bottle
19	Formaldehyde, 37%	Cotton ball & bottle
20	Formic Acid, 90%	Watch glass
21	Furfural	Cotton ball & bottle
22	Gasoline	Watch glass
23	Hydrochloric Acid, 37%	Cotton ball & bottle
24	Hydrofluoric Acid, 48%	Watch glass
25	Hydrogen Peroxide, 3%	Watch glass
26	Iodine, Tincture of	Watch glass
27	Methyl Ethyl Ketone	Cotton ball & bottle
28	Methylene Chloride	Cotton ball & bottle
29	Mono Chlorobenzene	Cotton ball & bottle
30	Naphthalene	Watch glass
31	Nitric Acid, 20%	Watch glass
32	Nitric Acid, 30%	Watch glass
33	Nitric Acid, 70%	Watch glass

Test No	Chemical Reagent	Test Method
34	Phenol, 90%	Cotton ball & bottle
35	Phosphoric Acid, 85%	Watch glass
36	Silver Nitrate, Saturated	Watch glass
37	Sodium Hydroxide, 10%	Watch glass
38	Sodium Hydroxide, 20%	Watch glass
39	Sodium Hydroxide, 40%	Watch glass
40	Sodium Hydroxide, Flake	Watch glass
41	Sodium Sulfide, Saturated	Watch glass
42	Sulfuric Acid, 33%	Watch glass
43	Sulfuric Acid, 77%	Watch glass
44	Sulfuric Acid, 96%	Watch glass
45	Sulfuric Acid, 77% and Nitric Acid, 70%, equal parts	Watch glass
46	Toluene	Cotton ball & bottle
47	Trichloroethylene	Cotton ball & bottle
48	Xylene	Cotton ball & bottle
49	Zinc Chloride, Saturated	Watch glass

* Where concentrations are indicated, percentages are by weight.

- **Performance Test Results (Heat Resistance):**

Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 180 per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from the hot water treatment.

- **Performance Test Results (Impact Resistance):**

A one-pound ball (approximately 50mm diameter) shall be dropped from a distance of 300mm onto the finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in the finish due to impact upon close eye-ball examination.

- **Performance Test Results (Bending Test):**

A 1.2mm thk steel strip, finished as specified, when bent 180o over a 12.5mm diameter mandrel, shall show no peeling or flaking off of the finish.

- **Performance Test Results (Adhesion):**

Ninety or more squares of the test sample shall remain coated after the scratch adhesion test. Two sets of eleven parallel lines 1.5mm apart shall be cut with a razor blade to intersect at right angle thus forming a grid of 100 squares. The cuts shall be made just deep enough to go through the coating, but not into the substrate. They shall then be brushed lightly with a soft brush. Examine under 100 foot-candles of illumination. Note: This test is based on ASTM D2197 68, "Standard Method of Test for Adhesion of Organic Coatings".

- **Performance Test Results (Hardness):**

The test sample shall have a hardness of 4 H using the pencil hardness test. Pencils, regardless of their brand are valued in this way: 8 H is the hardest, and next in order of diminishing hardness are 7 H, 6 H, 5 H, 4 H, 3 H, 2 H, F, HB, B (soft), 2 B, 3 B, 4 B, 5 B (which is the softest).

The pencils shall be sharpened on emery paper to a wide sharp edge. Pencils of increasing hardness shall be pushed across the paint film in a chisel like manner until one is found that will cut or scratch the film. The pencil used before that one that is, the hardest pencil that will not rupture the film is then used to express or designate the hardness.

- **Liner Tests – Chemical Spot Tests – 24 Hours:**

Chemical spot test shall be made by applying 10 drops (approximately 1/2 cc) of each reagent to the surface to be tested. Each reagent (except those marked **) shall be covered with a 38mm diameter watch glass, convex side down to confine the reagent. Spot tests of volatile solvents marked ** shall be tested as follows: A 1” or larger ball of cotton shall be saturated with the solvent and placed on the surfaces to be tested. The cotton ball shall then be covered by an inverted 60ml, wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire 24-hour test period and at a temperature of 77 degrees F. + 3 degrees F.

At the end of the test period, the reagents shall be flushed from the surfaces with water and the surface scrubbed with a soft bristle brush under running water, rinsed, and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Spots where dyes have dried shall be cleaned with a cotton swab soaked in alcohol to remove the surface dye. The test panel shall then be evaluated immediately after drying.

5.0 EXECUTION METHODOLOGY

- **SITE EXAMINATION**

Bidder is requested to examine the site and installation work shall be taken up as per site availability and as per installation schedule approved by the Engineer in charge.

- **INSTALLATION**

➢ **Preparation:**

Prior to beginning installation of fume hood, check and verify that no irregularities exist that would affect quality of execution of work specified.

➢ **Coordination:**

Coordinate the work of the Section with the schedule and other requirements of other work being performed in the area at the same time both with regard to mechanical and electrical connections to and in the fume hoods and the general construction work.

➢ **Performance:**

Install fume hoods, plumb, level, rigid, securely anchored to building and adjacent furniture in proper location, in accordance with manufacturer's instructions and the approved shop drawings. Provide filler panels between top of hood and ceiling. Securely attach access panels but provide for easy removal and secure reattachment. Do not install any damaged units.

➢ **Adjust and Clean:**

After installations are complete, adjust all moving parts for smooth operation.

Remove all packing materials and debris resulting from this work and turn over the fume hoods to the Owner clean and polished both inside and out.

Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.

➢ **Protection:**

Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.

Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

- **Certification:**

Fume Hood Manufacturer shall field test a random sample of 10% of the installed units using ANSI/ASHRAE 110-1995 to a control level of Al 0.01 ppm or better and witnessed by the consultant & CLIENT representative.

Project substantial completion shall be withheld until all required fume hood certification letters, tests, and reports have been submitted to and approved by the Consultant.

Integration: Fume hood exhaust need to be integrated with the supply of conditioned/fresh air required, balancing of air and testing, demonstration and commissioning complete as per site conditions and as per direction of Engineer in charge. The quoted rates as per BOQ items shall include the integration and nothing extra shall be payable for the same.

6.0 QUALITY ASSURANCE PLAN (QAP)

Below are the basic QAP points listed, Vendor has to submit detailed QAP plan along with the offer for review & approval.

Vendor has to study all the GFC drawings & prepare the Shop drawing.

Vendor has to integrate all the services part of Lab furniture in the Shop drawing.

Vendor has to provide the Technical data sheet for all the critical items. After receiving approval from Client & Consultant, should go ahead for procurement.

Vendor has to check the sample & cross-check the Shop drawing.

Site supervisor has to cross check all the items received as per approved Shop drawing.

Site supervisor has to check all the site installation as per the approved shop drawing & performance as per the technical specification & standards.

7.0 ABBREVIATIONS

CRCA	Cold Rolled Cold Annealed
SEFA	Scientific Equipment and Furniture Association.
NFPA	National Fire Protection Association
UL	Underwriters Laboratories
FM	Factory Mutual
PCGI	Powder Coated Galvanized Iron
MS	Mild Steel
FDA	Food & Drug Administration
UV	Ultraviolet.

PART 11 – COLD ROOM WORKS

CONTENTS

1.0 SCOPE OF WORK

To comply with Indian GLP requirements, this equipment shall meet these general requirements:

- ♣ The contact surface shall not be reactive, additive or absorptive to such an extent that it will affect the quality of the product.
- ♣ The material of construction should not share particles and should be compatible to stressed condition of the process.
- ♣ The equipment shall not contribute any particulate contamination or lubricant oil to the product processed in the equipment.
- ♣ The equipment shall have the facility of cleaning of its contact and non-contact parts.
- ♣ There should not be dust-accumulating location like crevices.
- ♣ All instruments used in the equipment should be supplied, calibrated with traceability to any national standard.
- ♣ The equipment design shall consider the process, environment and operator safety.

2.0 BASIS OF DESIGN

Type of Cold Room	Walk in Cold Room
Ambient Temperature [in °C]	43 deg C (Pune Ambient condition)
Designed Room Temperature [± 2 °C]	2 to 8 deg C
Product to be stored	For storage of material
Room Size, External [m]	3.5 L x 2.5 W x 2.6 H (Mtrs)
Type of refrigeration system	Split Type
Type of Cooling	DX Type
Capacity of Refrigeration system [kW]	5 kW (2 TR) 1 Working
Type of Refrigerant	R404a
Type of Compressor	Hermetic
Type of Condenser	Air-Cooled
Type of Evaporator	Ceiling mounted

3.0 TECHNICAL SPECIFICATION

Wall & Ceiling	Sandwiched PIR metallic panel of 60mm thick, Manufactured of CFC & HCFC free closed cell Polyisocyanurate foam with a minimum density of 40kg/m^3 with PPGI min 0.6 mm thick Plain (Non-Corrugated) Sheet on both sides. Extruded Aluminum powder coated Coving has to be included for wall to wall and wall to ceiling joinery, wall to floor, and coving for the Column projecting Inside the cold room. All the panel joineries shall be applied with silicon Sealant. **Vendor to confirm the Wall Panel, Flooring thickness considered is sufficient or as per the Design temperature (2 to 8°C).**
Floor	The floor preparation shall be with 250-micron 1 mm polythene vapor barrier sheet, 2mm Tarfelt for sealing all joineries & on which 60 mm PIR floor panel is laid and finished with VDF flooring with vinyl 2 mm thickness to be provided for the cold room dimension. All joints Should be sealed so that no Ingress of dirt & moisture takes place.
Door size:	PIR Hinged door or sliding door as per site Layout drawings enclosed, With (1000 X 2100) clear opening. Thickness and lamination shall be same as wall panel, Flush-fit doors Aesthetic with view panel and efficient, heavy-duty flush-fit doors with FRP door Perimeter. Accessories like anti-condensation door heater, pad lock system, human safety release knob, door closer, Sweep gasket, Electrical safety buzzer switch with illumination 2 no's hooter (one near the cold room & one near the central designated area (BMS station))
Design features:	1. Cold room should be maintained with the temp range from 2° to 8°C 2. No RH control required in proposed cold room. 3. Product incoming temperature is assumed to be 30° C. 4. Air-cooled DX type industrial duty Refrigeration unit with Semi Hermetic reciprocating compressor (1 working only) for cold room, using Environmental friendly refrigerant.

	5. Evaporator size indicated in the tender drawing are tentative & the vendor should ensure it fits into nearly the same size. 6. Light fitting to meet 300 lux level inside the cold room at 2°C indoor temperature (at 1.2 mtrs from the GL). Necessary interconnecting cabling works and the Light Switch located near the door to be provided. Vendor to provide for lux level calculations for each cold room & should demonstrate lux level achieved at site. 7. Condensing unit shall be kept adjacent to cold room. The Condensing units will be mounted on powder coated MS stand. Please refer tender drawing for tentative condensing unit locations. Vendor to provide refrigerant pipe size calculation based on the position of the indoor / outdoor, as indicated in the tender drawing. 8. The drain from the evaporators shall be taken from cold room and left to the nearest drain point in floor. Please refer tender drawing for drain locations, as indicated in the tender drawing.
Refrigeration System:	The Refrigeration System shall be Split type of suitable capacity with Air Cooled Condensing unit. Location of condensing units for cold room will be adjacent to cold room. (Refer tender drawings for locations). The SS304 Evaporator shall be located inside the room with interconnecting copper piping and cabling works. Cold Room is envisaged with only 1 working system. The Condensing Unit shall house, suitable capacity Hermetic Reciprocating Compressor, Condenser coil (corrosion protected) with fans and interconnecting refrigerant piping with necessary valves fittings, solenoid Valves, Filter drier, accumulator, oil separator and should be having the necessary canopy for weather protection. The refrigerant piping shall be routed as per the tender drawings and shall be suitably insulated. The refrigerant piping shall be run in covered powder coated trays neatly dressed. The Evaporator casing shall be constructed off SS304 material with the coil being of copper tubes and Al fins. The fin spacing shall be suitable enough to allow sufficient frost build up to enable longer operation hours between

	defrost. The Defrost shall be settable time-based Auto Off cycle for Cold Rooms. The Drain Tray has to be provided with additional heaters to avoid ice buildup. The Compressor On/Off shall be based on the Load which shall be controlled by a microprocessor based digital Temperature Controller. The Microprocessor Controller shall also control the defrost cycle, /On /off of Fans, Fault indications and controlling the entire Refrigeration System. Separate Electrical/control Panel for Cold Room with Temperature display to be Provided near the Cold Room. One raw power incomer along with one UPS power point for the controllers shall be provided from Client at this panel. Vendor shall consider suitable Electrical panel with necessary starters, contactors, proper electric safety protections and cabling between their panel to Indoor and outdoor units as is required for the completion of the project. All Power and Control Cable required for the Project and the refrigerant Piping has to be included and quantified. And no variation will be entertained unless the location of the equipment is changed from the agreed location.
Operator and environmental safety	All the Light fittings, Operating panel, control panel with Air cooled capacity to be located in service area.
Cleaning requirement	Cold-room shall be cleaned in place with water mopping or by vacuum cleaner.
Utility requirement and availability of Power. Utility to be confirmed with user.	Electricity for AC, Lights etc. both Raw & UPS power.415 Volts, 3phase, 50 Hz,

Accessories:	• Strip curtains for door. • Temperature deviation system with audio visual alarm. • Hooter for alarm one near the Cold room and one in the command center in Engineering maintenance room. • Lock for the door. • Digital temperature controller with display. • Data logger for continuous recording of temperature. • Alarm in case the door is opened continuously for more than 30 seconds. (Time must be user adjustable). • Emergency Release button. • UPS point for data logger. • Additional port for centralized data logger.

4.0 OPERATIONAL REQUIREMENT

Operator involvement	Material movement and cleaning.
Power failure and restart requirement	The system will have to stop automatically upon loss of electricity and should not require operator intervention to re-start.
Data and security	Emergency opening from inside.
CFR part 11 compliance	Optional. If required in future to be added
Temperature distribution study in scope of supply:	• Dual temperature sensor incases if one fails. Temperature distribution study to be done by vendor for each Cold room and for a period of 3 days for empty chamber & full load Temperature mapping & validation for empty chamber & loaded chamber for 72 Hours. Also cool down time study, Power failure recovery study, Door opening study and hold over time to be considered. • No. of probes 12-17 based on QA recommendation. Data back up to Central BMS required.
Performance qualification:	Required for empty & full load.
Temperature over shoot alarm & indication:	Required. **To be provided with locally and remote.**

Unit to be suitable to operate 24 x 7:	Required.
Provision to install stand by compressor:	Required with auto change over. (Provision Only, To be installed at latter date)

5.0 ENVIRONMENT

Allocated floor space with allocated area around the periphery of the equipment	Sufficient area for the men and material movement.
Vertical clearance	Suitable for easy movement.
Operating environment **Room Temperature** **RH** **Hazard level:**	Please refer Annexure-01 for cold room parameters

6.0 SUPPORT REQUIRED FROM VENDOR

Pre-installation support	Required
Documentation [Softcopy to be provided wherever applicable]	
Material of Construction test certificate:	Yes
Radiography test for weld joints:	NA
Factory Acceptance Test specification and test report:	NA
Installation and Operation Qualification protocol:	Yes
Wiring diagram of control panel:	Yes

Following documents are required for PLC validation:	As applicable

Note:

- **Available power supply – 3ph+N+e /. Total power requirement to be specified by vendor.**
- **Test and calibration certificate of MOC, measuring and monitoring instruments to be provided.**
- **Product and brought out items manuals to be provided.**
- **List of critical spares to be given with cost.**
- **3 sets of operation & maintenance manual & soft copy required.**
- **List of similar installation details with contact person for feedback to be provided.**
- **Delivery schedule to be provided.**
- **Preventive maintenance schedule, operation procedures and training to be given.**
- **Energy efficiency and saving features to be mentioned.**
- **All the guarantee, warrantee and test certificates to be provided which is required as per standards.**
- **External & internal –GI powder coated panel to be considered with approved color from client.**
- **Al Chequred plate floor (3 mm thick) to be considered.**

7.0 DOCUMENTATION:

- Technical Specification
- Brief description of the system
- General Arrangement drawings
- Specific power consumptions at various loads.
- Technical data sheet for ODU' & IDUs
- Consumption of the Utilities
- List of performance tests to be conducted at manufacturer's facility and site.
- Details of similar job executed with contact person for feedback to be given.
- Energy efficiency and saving features to be mentioned.

~~8.0 PART 11 - ANNEXURE - 1 – TENDER DRAWINGS~~

- ~~MJ 437 - BL - DR – 2000 - BASEMENT FLOOR LAYOUT~~

PART 12

UTILITY PIPING & ETP DRAIN WORKS

CONTENTS

1.0 SCOPE OF WORK:

The scope of work shall cover supply, storage at site, transportation to the place of erection, fabrication/assembly, laying/erection, painting, testing, and commissioning of the industrial tubing & piping system for **GAS & UTILITIES** for the project as a whole with necessary supports and supporting structures. The erection work shall be carried out as per the instructions of manufacturer and working drawings to be prepared by the Contractor and duly approved by the owner/consultant.

1.1 DISTRIBUTION SYSTEM

The contractor should offer leak free gas controller and distribution system for laboratory gases, such as Carbon dioxide, Compressed air & Liquid nitrogen etc. The distribution system shall include all the necessary tubing's, tube fittings, cylinder connections with accessories, point of use pressure regulator, isolation valves, pressure gauges etc,. Required to feed from gas bank to the laboratory work benches. All the tubing should be supported in aesthetically colored, anodized and power coated aluminum casings.

In the gas distribution system for the main piping, the tube-to-tube joints and branches should be joined by the way of orbital welding and compression fittings.

The gas distribution shall consist of:

a. Semi Auto Change over Panel.
b. Gas distribution lines for indicated gases with color coding.
c. Line regulators.
d. Mounting the brackets, clamps, supports cases, etc, for aesthetically laying for the gas lines.

1.2 TUBING:

Gas tubing shall be 1/4", 3/8", 1/2",3/4",1" or any other sizes shall be seamless tubing, bright annealed SS316 or SS304 stainless steel shall be factory cleaned for the use of high purity gas services. The tube shall have the wall thickness as mentioned in BOQ.

1.3 TUBE FITTINGS

The fittings shall be compression type & orbital weld type for all sizes. The fitting shall hold the working pressure without any leak. All the fitting end connections shall be compatible to the supplied tubing. The fittings should be nut ferrule and shall be made from SS316 and SS304. All the fittings shall be factory cleaned suitable for laboratory high purity gas service.

1.4 BALL VALVES:

Ball valves of required size shall be installed at each source point of the service. The valve shall be SS with reinforced PTFE seat material with working pressure of 0 to 25 bar for inside lab.

1.5 PRESSURE GAUGE:

Pressure gauge shall be stainless steel pressure gauges of 2- or 2.5-inch dial size to be installed in the purification panel, control panel semi-automatic change over system and cylinder regulator. Pressure gauge shall be 0 to 10.5 bar or suitable for laboratory gas service. The material of construction shall be SS316.

1.6 HIGH PRESSURE SEMI AUTO CHANGE OVER SYSTEM

The Semi auto changeover system shall be manual to the gas distribution system. The Gas change over system shall be compact and preferably enclosed model designed for easy change of gas cylinders while in operation. The Gas change over system shall have provision to clean or purge lines before adding a new cylinder. Semi auto change over system is for CO2.

The gas changeover system shall have two diffusion resistant pressure regulators in a single body. The primary changeover regulator shall connect to an active and reserve cylinder.
The gas changeover system shall be a complete unit with Vent Valve, Inlet Pressure Gauge, Inlet Valve, Outlet Pressure Gauge and Outlet Valve, etc for the intended use.

2.0 TECHNICAL SPECIFICATIONS FOR GAS TUBING WORKS:

2.1 GENERAL:

The erection of tubing's and valves & fittings shall be carried out according to the latest engineering practices and according to the working drawings, specifications, erection and instructions.
The Contractor shall carry out the works in the presence and/or as per the instructions of site engineers/ supervisory personnel deputed by the OWNER. The erection shall be carried out by highly skilled workmen.

The Contractor shall take care of positioning, leveling and laying/joining of all tubing's and cylinder bank as well as supporting structures within the required accuracy and tolerance limits. It shall be deemed as a contractual obligation that the tubing's are not thrown out of alignment or lifted off during commissioning and subsequent operation.

There may be more than one contractor working in the area at the same time. As such the work has to be carried out in proper co-ordination and consultation with the OWNER and all other parties concerned with the work. The Contractor shall take due notice of the working conditions, practices and agreements prevalent in the area of the plant site and satisfy himself before quoting.

The Contractor shall be responsible for paying strict attention to statutory regulations for prevention of accidents and to other safety rules. The regulations for prevention of accidents shall be displayed at appropriate places and should be distinctly visible to all personnel working in the area.

The Contractor shall supply all required consumables, construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compounds, tapes, brazing and soldering materials, welding sets, tube bending machines, cables, clamping tools, gauges, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand and emery paper etc as required for satisfactory completion of work.

The Contractor shall make his own arrangement for handling the tubes & fittings at the stores and transporting it to the site of installation.

In addition to the above, the Contractor shall follow all the relevant erection clauses/conditions stated under various chapters of this specification and erection/laying instructions provided by the manufacturer/supplier.

2.2 TECHNICAL SPECIFICATIONS - BOUGHT OUT ITEMS:

- Tubes shall be laid using poly amide box clamps on mounting rail supports.
- Bending of tubing shall be made with a tube bender. Bending radius shall be for 1" and ¾"-4D, ½" and ¼"-3D. All tube bends must be uniform with no kinks, flats, or wrinkles.
- All the threaded joints shall be applied with oxygen compatible PTFE anaerobic thread sealant (Approved by fittings supplier).
- Compression/ Face seal fittings shall be installed as per manufacturer's recommendations. Above ½" fittings shall be swaged with hydraulic/ pneumatic swaging machine.
- Once tubing installation is completed, the system shall be flushed with nitrogen (99.999%) to remove all foreign matters from inside the tubes and in acceptance with commissioning Engineer. Bypass or remove purifiers or other equipment that could be adversely affected before nitrogen flush out.
- All the completed lines shall be maintained in +ve pressure with Nitrogen (99.999%) to avoid contamination.

- Required gases should be arranged by the contractor.
- Pipes / Tubes passing through masonry walls, beams, underground, foundations etc. Shall be taken through cut-outs. If any pipe/ tube requires embedded sleeve, the material of sleeve shall be SS-304 to avoid corrosion.
- Spacing between parallel runs of tubes carrying different services should be individually clamped and aligned as per the requirements.
- The clamps & supports shall be ensured to safely carry the weight of pipes.

2.3 WELDING:

- All tubing headers shall be of seamless construction with joints welded using automatic orbital welding machine with argon gas purging.
- Tube to Tube or Tube to fittings/valves welding shall be done using automatic GTAW welding.
- Isometric drawing shall be prepared before start of welding work.
- Quality System of the Tubing Manufacturer shall have approval from ASME quality system certificate as material organization.
- Tubing shall be clearly marked with heat code, lot code, outer diameter and wall thickness as in the inspection certificate.
- Tubing sizes up to 1" OD shall be bright annealed. Tubing with outside diameter larger than 1" OD shall be supplied in annealed and pickled condition.
- Tubing shall have carbon content < 0.030%
- All cutting and welding equipment should be cleaned of any impurities or particulates.
- Clean area shall be provided for welding. The room should be maintained clean at all times.
- All piping and fittings should be cleaned prior to and after welding.
- Proper edge preparation before welding different tubes / fitting, while carrying out the weld joints to ensure no cutting/welding burrs, other contaminants etc enter into the tubes.
- Assemblies should be bagged after welding and the bags removed just prior to making field welds.

- Welding and fitting technicians should use overshoes and clean room gloves. The gloves are worn to prevent fingerprint oils from getting onto the pipe.
- The use of a clean area and clean area procedures will project the welds and reduce the defect incidents associated with contaminations in the welding areas.
- Procedure needs to be qualified for welding machine, WPS, PQR, WPQR, etc... as per Section IX & X of the ASME
- Daily, the first and last production joint needs to go through external visual examination then cut open axially and check welding.
- Each qualified welder should be formally qualified with a certificate qualifying him or her for a certain type of weld, as per welding procedure for welder qualifications mentioned in American Society of Mechanical Engineers (ASME) & American Welding Society (AWS).

2.4 MODE OF MEASUREMENTS TUBINGS:

Mode of Measurement for payment of items of tubing's shall be as follows:

2.5 TUBINGS & SUPPORT:

Shall be measured in units of length of installed tubes & fittings, Gi rail, threaded rod, stuff clamps, expansion bolts, nuts & washers etc shall be measured in no's of installed. The quoted rates shall include sourcing of all such items viz. welding machine, tool and tackles, other support items etc. that are required to complete the work in all respects.

2.6 GUARANTEE:

The contractor shall guarantee that the materials and workmanship of the entire system are of a first-class quality. All the equipment's / apparatus shall be guaranteed to yield the specified ratings of discharge and quality. Any defective equipment / material / workmanship found short of the specified quality shall be rejected. Guarantee certificate of equipment's from suppliers / manufacturers shall be handed over to the owner.

2.7 DEFECTS AND LIABILITY:

All the equipment's / materials and the system shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning to the Owners along with all relevant documentation. The contractor shall repair, rectify, and replace all the defective materials,

components free of cost. In addition, normal maintenance shall be carried out periodically during the defects and liability period including replacement of spares, as required.

TESTING:

The entire segment of main, branch header and individual line connection piping will be flushed with Air or Nitrogen gas as specified before pressure testing is carried out. All compressed gases and compressed zero air lines that are connected with double compression joints and weld joints should be flushed with 99.99% pure compressed Nitrogen gas for ½ hrs. For all the compressed air lines, that are connected with double compression joints and weld joints should be flushed with compressed air as the media and should be flushed for ½ hrs.

While flushing keep open all the taps. By doing these the entire lengths of tubing will be flushed and will be cleaned with dust particles. While carrying-out the flushing operation pressure regulators, diaphragm valves etc. which are inline should be removed / bypassed.
The flushing has to be done in pressurized condition. During flushing intermittent valve opening and closing has to be done at all the final termination points.

After through flushing, the entire segment of main header, branch header and individual line connection piping will be pneumatically tested. At least 1.5 times the working pressure. (For e.g., 10 bar AWP, 15 bar ATP). The line will be considered free of leakage only if the Pressure does not drop over a period of 24 hrs. With line locked by specific testing gas as mentioned under:

- For Compressed air, Liquid Nitrogen, Carbon Dioxide and other inert gases the end connections will be double compression ferrule or threaded (NPT / BSP-P) type fittings.
- For Hydrogen and other flammable and toxic gases the end connections will be butt welded or face seal or threaded (NPT / BSP-P) type and the final termination will be double compression ferrule fittings.

All the butt weld joints will be carried out by means of Orbital weld technique (Automatic TIG welding with Argon 99.999% as inert gas).
Supply of compressed air/ other gases required for testing and commissioning shall be in the scope of this tender and the same will not be provided by Client / PMC. No payment shall be made to the contractor on this account.

2.8 REGULATORS:

a) Capacity of the respective regulators to be checked by varying:
Inlet pressure from 15 bars to 140 or 200 bars in case of Primary Regulators, maintaining constant pressure for range from 6 to 12 or 50 or 100 or 200 bars (as needed) on the downstream.

Inlet pressure from 0 bars to 30 bars in case of gas Secondary Regulators, maintaining constant pressure for ranges from 0 to 10 bars on the downstream.

Inlet pressure from 0 bars to 15 bars in case of air Pressure Regulators, maintaining constant pressure for ranges from 0 to 10 bars on the downstream.

b) All tests will be carried out in the Regulator manufacturer's premises using compressed nitrogen gas, and for gases other than compressed nitrogen, the Supplier / Contractor should indicate "equivalent air / gas flow rates" to be maintained during performance testing, corresponding to the actual flow rates indicated in the BOQ and P&ID'S.

c) The Tenderer should furnish a clear plan for the set-up and procedure that they propose to adopt for performance testing.

d) While every Primary Regulator will be subjected to performance test, 20% of the total number of Secondary Regulators in a given category will be taken up for performance testing. This number can be increased as may be decided by the Clients / PMC / consultant representative witnessing the tests, in case any regulator within the lot is found deviating from the specifications.

2.9 INSTRUCTION MANUAL / COMPLETION DRAWINGS / TRAINING:

The contractor shall furnish detailed instruction and operation manual of the system in Quadruplicate. The contractor shall also furnish detailed completion drawings inclusive of control schematics, in quadruplicate if any. The contractor shall train the Owners Personnel in the operation and maintenance of the system.

3.0 CODES & STANDARDS FOR GAS TUBING WORKS AND DRAINAGE SYSTEM:

All piping works covered under this specification shall comply with currently applicable statutes, regulations and safety codes. They shall comply in all respects with the requirements of the latest editions of the codes and standards. In case of conflict between codes and standards referred to in this specification or documents enclosed with specification.

3.1 IMPORTANT RELEVANT IS CODES FOR THIS SPECIFICATION ARE LISTED BELOW:

For design of the utility systems various international standards and codes, as applicable will be used. Below mentioned gives the list as applicable:

- American Society for Testing and Materials (ASTM)

A269 Seamless and Welded Austenitic Stainless-Steel Tubing for General Service TP 316

A370 Standard Methods and Definitions for Mechanical Testing of Steel Products

A632 Seamless and Welded Austenitic Stainless-Steel Tubing (Small Diameter) for General Service

A-262 Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

ASME B31.8 Clause 841.126 Gas Safety Code

ASME G93 level C OXY Cleaning

IS-2379: 1990 (R2006), (R2007-05) Pipe Colour Code

- American National Standards Institute (ANSI)

B31.1 Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping

B31.3 Process Piping

- American Society of Mechanical Engineers (ASME)

Section IX Welding Qualification

- Welding Procedure/Qualification:

ASME B 31.3/31.8, ASME Sec IX & IS: 817

- ASME Sec IX & IS: 814:

Material Specifications, Welding rods, Electrodes & filler wire etc.

- ANSI-B-16.5:

Pipe Flanges & Flanged Fittings:

- ASME/ANSI-B-16.10:

Face-to-Face & End-to-End Dimensions of Valves

- ANSI-B-18.2.1:

Square & Hex Bolts & Screw.

- ANSI-B-18.2:

Stud & Nuts.

- IS Standard or Equivalent:

Gauges

3.2 LIQUID NITROGEN PIPING:

- Liquid Nitrogen to be connected as utility to LN2 tank for their process requirement from the proposed Liquid Nitrogen (LN2) yard
- LN2 shall be transferred safely in controlled manner to the required user point through Vacuum Insulated Pipes.
- SS304 Seamless pipe shall be considered for transfer, covered with outer pipe having super insulation and evacuation of annular space.
- Bayonet joints (flange type) shall be provided for vacuum jacketed Pipe to Pipe connectivity
- Helium leak test to be done with Mass Spectro Meter for all the pipes.
- For end terminations/connections SS braided flexible hose with super insulation shall be provided for ease of terminal connection.

- At LN2 yard outlet from LN2 bullet an ON/OFF valve is used to control the flow and cut off the flow at time of emergencies. The valve shall be operated through a controller which is located inside the control room.
- Globe valve screwed ends with long stem and Pressure gauge with long stem Needle valve are to be used.

3.3 DRAINAGE SYSTEM:

- Process drain from Ground, first and Second floor are collected through SS304 pipes and connected to 2KL tank.
- Hvac drain from Air handling Units are connected to nearer STP chamber available at site by using CPVC pipe.

4.0 TECHNICAL SPECIFICATIONS FOR NB PIPING WORKS:

4.1 GENERAL:

The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the working drawings, specifications, erection and instructions of equipment manufacturers.

The Contractor shall carry out the works in the presence and/or as per the instructions of site engineers/ supervisory personnel deputed by the OWNER. The erection shall be carried out by highly skilled workmen.

The Contractor shall take care of positioning, leveling and plumbing of all pipelines and equipment as well as supporting structures within the required accuracy and tolerance limits. It shall be deemed as a contractual obligation that the pipes are not thrown out of alignment or lifted off during commissioning and subsequent operation.

There may be more than one contractor working in the area at the same time. As such the work has to be carried out in proper co-ordination and consultation with the OWNER and all other parties concerned with the work. The Contractor shall take due notice of the working conditions, practices and agreements prevalent in the area of the plant site and satisfy himself before quoting.

The Contractor shall be responsible for paying strict attention to statutory regulations for prevention of accidents and to other safety rules. The regulations for prevention of accidents shall be displayed at appropriate places and should be distinctly visible to all personnel working in the area.

The Contractor shall supply all required consumables, construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compounds, tapes, brazing and soldering materials, welding sets, pipe

bending machines, cables, clamping tools, gauges, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand and emery paper etc as required for satisfactory completion of work.

The Contractor shall make his own arrangement for handling the equipment and pipelines at the stores and transporting it to the site of installation.

In addition to the above, the Contractor shall follow all the relevant erection clauses/conditions stated under various chapters of this specification and erection/laying instructions provided by the manufacturer/supplier of plant & equipment.

4.2 PIPING INSTALLATION:

Tender drawings indicate schematically the size and location of pipes. The contractor, on the award of the work, shall prepare detailed working drawings, showing the cross section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air auto vent valves, and all pipe supports. He must keep in view the specific opening in buildings and other structures through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finished coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between spacing of pipe supports shall not exceed the following:

Pipe Size	**Spacing between supports**
Up to 12mm	1.5meter
15 to 25 mm	2.0 meter
30 to 150 mm	2.0 meter
Over 150 mm	2.5 meter

Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 15 mm

thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest paint and air vent at the highest point.
Pipe sleeves, 50 mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.

All pipes work shall be carried out in a workman like manner, causing minimum disturbance to the existing services, building, rods and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipe and pressure testing for each area shall be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes are indicated in the drawing. Contractor shall carefully examine the cut-outs provided and clearly point out where ever the cut- outs shown in the drawings, do not meet with the requirements.

The contractor shall make sure that the clamps, brackets, clamps saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes, and include expansion Loop where required.

All pipes shall be accurately cut to the required sizes in accordance with IS 554 and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In vertical pipes, concentric reducers shall be used.

Flanged inspection pieces 1.5 meters long with bolted flanges on both ends, shall be provided no more than 30 meters centers wherever shown in approved for construction to facilitate future cleaning of all welded pipes.

4.3 TESTING & BALANCING:

All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but not less than 10 kg per sq. cm gauge for a period of not less than 24 hours. All leaks and defects in joints re-welded during the testing shall be rectified and gotten approved at site.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped, then retested for entire system.

The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulations, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications. He shall bear all expenses for carrying out the above rectifications, including the tearing up and re-finishing of floors and walls as required.

The contractor shall provide all materials, tool, equipment, instruments, services and labor required to perform the test and to remove water resulting from cleaning and after testing.

After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted or as directed, to individual air handling units and fan coil units cooling coil.

Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.

Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents.

Exposed Pipes & insulation surface/ cladding shall be provided the approved color along with name & arrows marked distinctly in service areas.

4.4 ERECTION OF FITTINGS:

4.4.1 VALVES:

Before erection of valves, it shall be ensured that: -

i. All grit and foreign matter are removed from the inside of the valves before connecting the pipes.

ii. All the faces are thoroughly cleaned and coated with a thin layer of mineral grease.

It shall be ensured that adequate support is provided for the pipeline and valve. The valve should never carry the weight of the pipeline. Hangers or supports placed near the valve shall be provided.

The connecting pipeline should be cleaned and flushed of sediments, sand and other foreign matter before installing the valves.

Unless it is operationally critical butterfly valves shall be mounted with the shaft horizontal and as per the direction of flow indicated on the valve.

Sluice valves shall normally be installed with the spindle vertical except on vertical pipes where the spindle shall be horizontal. On slopes, the sluice valves may preferably be kept vertical if slope is nominal and gradient can be adjusted with the help of pipes on both sides.

The valves should be tightly closed when being installed, to prevent any foreign matter from getting in between the working parts of valves.

The gasket shall be lubricated with graphite or other recommended lubricant.

It shall be ensured that the joining material sits squarely between the flanges of valves and pipelines without obstructing the waterway.

4.4.2 LAYING AND JOINTING OF PIPELINES:

Pipes shall be laid to lines and levels as shown in the drawings. Laying and jointing of welded pipes shall be as per the latest revision of IS: 5822. For making welded joints, the welding shall be performed by the manual shielded metallic arc process or TIG as required.

All welding including the proposed procedure and the qualification of welders and welding operations shall be done according to power piping code ASME B 31.1 and ASME Section IX or approved equivalent. Piping for butt welded run shall be supplied with ends beveled by machining or grinding.

The ends of the pipe -to-pipe, pipe-to-fitting and fitting-to-fitting joints shall be aligned as accurately as is practical within the existing commercial tolerance on pipe diameters, wall thickness and out- of -roundness. Alignment shall provide the most favorable conditions for weld deposition of the root bead. Welds shall be full penetration, continuous without defects.

As a rule, butt-welding shall be carried out without interruption until the entire joint is welded. In any case, however, welding of butt joints must not be interrupted till at least 50% to 60% of welding thickness is completed.

If there is an unscheduled interruption in such work, it is necessary to ensure slow and uniform cooling of metal by covering it with asbestos or by other means to eliminate the possibility of sharp zonal cooling of metal. Before starting the welding again, it is necessary to heat the butt up to the required temperature and maintain this temperature till the butt welding is completed.

Besides systematic inter-operational control, the quality of welded joints shall be controlled by visual inspection and mechanical tests in conformity with the provisions of applicable standard codes.

4.4.3 ABOVE GROUND PIPING:

The Contractor shall supply/fabricate and install piping and fittings in strict compliance with the detailed engineering drawings. Deviations if considered necessary to suit site conditions could however, be permitted in consultation with and with prior approval of OWNER.

All openings in the piping shall be kept effectively closed until assembled in the system to avoid foreign matter entering into the system.

All piping shall follow the general arrangement shown, shall be cut accurately to measurements established for the work by the Contractor and shall be installed without strain.

All piping shall be installed with adequate clearance for lighting, bracing, doors, windows and other openings.

Piping shall be arranged in the straightest possible runs with minimum number of fittings. Flanges of the pipelines, fittings, etc., must be so mounted that top bolt holes are symmetrical about the vertical axis of the flange.

Joints should be as far as possible located at one-third span from supports and must be avoided in the middle of the span.

Openings provided in the walls for pipelines must be closed with bricks or mortar with 10 to 20 mm clearance between the brick work and pipe. The clear space must be stuffed and caulked with felt or asbestos and grouted at both the ends of the wall surfaces.

The Contractor shall supply/fabricate and install as per their design drawings duly approved by OWNER/ CONSULTANT.

Pipe supports and all that is necessary to completely support all the piping and piping components including but not limited to beam clamps, pipe clamps, fabricated structural supports, guides and anchors, brackets, saddles, U-bolts, etc.

Also supporting members required in addition to building structure shall be furnished and installed. Concrete pedestals with plate inserts on top surface for supporting the pipes as well as valves are also included in the Contractor's scope of work.

The jointing of pipes and fittings shall be made as described under underground piping.

4.4.4 PIPE HANGER & BRACKET ETC.:

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths from ceiling / masonry wall / columns / trusses. The hangers and brackets shall be fabricated from suitable M.S rolled sections for Non –Process areas and SS material for Process areas.

The hangers and brackets shall be of adjustable heights and painted with red oxide primer, clamps collars and saddles to hold pipes shall be provided with suitable gaskets / washers.

The brackets and hangers shall be designed to safely carry the weight of pipe. All pipes and fittings shall be secured near every joint and half way through every pipe length unless otherwise specified. M.S. Plates to be used in system shall conform to IS 226 ST 42 S. MS supports used are to be galvanized.

4.4.5 INTERCONNECTING PIPELINES:

Interconnecting pipelines shall consist of all the pipelines for various services from different units to the equipment and between the units of the pumping system.

The quantity of piping including valves and specials shall be as required to suit the site conditions and the approved piping layout for the plant. All the piping systems shall be designed to handle the maximum quantity of the respective fluids at the specified parameters.

All piping systems shall be provided with /as per approved drawings:

- Necessary isolating/Regulation & control valves
- Air release/ball float valves as required.
- Drainpipes with valves
- Supports/trestles/thrust blocks as required.
- Pipe fittings such as elbows, bends, reducers, tees, flanges, nipples, expansion joints, specials etc.
- R.C.C. encasing pipes at roads.
- Dismantling/flexible joints for maintenance/ replacement of header/ valves.

Piping system shall be designed with a high degree of reliability so that the system performs the duty of fluid handling without any failure under all conditions of plant operation.

Piping layout must follow good engineering practice. Proper attention shall be paid to obtain full functional requirement of the piping system with a layout which provides sufficient clearance for other equipment and operating personnel, convenient supporting points and neat appearance.

Complete design of piping system (If required) shall be subject to approval by the OWNER/CONSULTANT.

The design shall take into account the effort of internal/external pressures, thermal expansion, self-weight of piping, support reactions, surge and water hammer, earthquake and wind effects at site, corrosion and erosion etc., and any other effects dictated by good engineering practices and piping standards and codes.

Piping system shall not impose undue forces on equipment terminals/flanges.

Mild steel pipes shall be used in general for water supply facilities and special quality pipes such as GI for drinking water and PVC/MS rubber lined/HDPE pipes for corrosive fluids and S.S pipes and fittings for DM water. For further details refer data sheet enclosed.

The pipe network shall be provided with air release valves at high points and drains valves at the lower points.

Each of the branch connections taken from the main network shall be provided with an isolation valve.

Pipelines passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.

All the pressure pipes shall be laid with nominal slope and the gravity network with slopes for self-cleaning velocities.

Except where otherwise specified, all piping shall have butt welded connections with a minimum of flanged joints for connections to equipment. Branches shall in general be formed by welding.

Unions/nipples or flanges as required for connecting to equipment, valves, instruments, etc., shall be installed in the piping works to facilitate dismantling for maintenance.

For GI pipes, jointing shall be done by screwed and socket joints.

Provision shall be made for branches for cleaning and flushing of pipelines wherever necessary.

Provision shall be made for support of piping, which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional support being required.

Pipe supports shall be capable of supporting the pipelines under all conditions of operation.

4.4.6 WELDING:

Welders and welding procedures shall be qualified in accordance with the requirements of relevant ASME specifications, and any latest alterations, modifications thereof. This will be modified where appropriate for other materials and may be relaxed or varied by order of Consultant, provided other materials and

may be relaxed of varied by order of Consultant, provided the contractor has made a reasonably comprehensive request for an alternate.

a. All welding shall have full thickness penetration and shall be done by the following methods :

i. Welding of SS pipes : GTAW process with Argon (Process & Utilities) purging

b. Type of electrode to be used:

Base Metal	Root	Fill up	Cap	Purging Gas
IS 1239	E 6013	E 6013	E 6013	Nil
IS 3589	E 6013	E 6013	E 6013	Nil
SA 106 Gr. B (25 NB)	E 7018	E 7018	E 7018	Nil
SA 106 Gr. B (>25 NB & <8mm thick)	ER70S2	E 7018	E 7018	Nil
SA 333 Gr. 6	E 7018 - 1	E 7018 - 1	E 7018 -1	Nil
SA 312 TP 304	ER 308	ER 308	ER 308	Argon
SA 312 TP 304L	ER 308L	ER 308L	ER 308L	Argon
SA 312 TP 316	ER 316	ER 316	ER 316	Argon
SA 312 TP 316L	ER 316L	ER 316L	ER 316L	Argon

For stainless steel welding processes such as inert gas shielded, tungsten arc process as stipulated in the specifications and/or recommended by the Consultant shall be employed. Special efforts should be made at all times to keep stainless steel surfaces from coming into contact with other metals. For cleaning, only clean stainless-steel wool and brushes should be used. All grinding of stainless steel should perform with aluminium oxide or silicon carbide grinding wheels bonded with resin or rubber and not previously used on other metal. Proper identification and correct marking of the types of material should be done during fabrication and welding stage.

c. GAS WELDING shall NOT BE used UNLESS OTHERWISE particularly specified.

d. In multiple pass, welding, the next layer shall be applied only when the previous layer is ensured free from slag and is clean. Any defects shall be chipped off before application of next layer.

e. Peening shall be done, if necessary. Next run of weld should be carried out only after thorough preparation and inspection.

f. The completed weld shall be cleaned of slag and spatter metal of all surfaces.

g. No undercutting of pipe adjacent to the completed weld will be permitted.

h. Finished welds shall project not less than 1.5 mm but not more than 3mm from the outer surface of the pipe.

i. The welding electrodes used shall have suitable coating and comply with relevant standards as per IS / ASME.

j. The electrodes used shall be stored in a damp proof enclosure. All electrodes should be dried in an oven prior to issue for welding.

k. All metal welds shall be hammer tested and subjected to visual inspection.

l. In case of defect, such as leakage etc., the defective area shall be marked with accepted colour code and similar system shall be employed for corrected defect areas.

m. All consumables used by the Contractor shall be approved by the Consultant/Site Engineer.

4.4.7 MODE OF MEASUREMENTS:

Mode of Measurement for payment of items of piping & their insulation shall be as follows:

4.4.8 PIPING:

Shall be measured in units of length along the center line of installed pipes including all pipe fittings, flanges (with gaskets and nuts and bolts for jointing), unions, bends elbows, tees, concentric and eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the center line of installed pipes and no special rates for these accessories shall be permitted.

The quoted unit rates for center line linear measurements of piping shall include all wastage allowances, wooden haunches nuts and check nuts, vibration isolator suspension where specified or required, and cost of excavation, bedding, back filling and finishing as required to complete the piping installation as per the specification. None of these items will be separately measured nor paid for. However, all valves (gate/globe/butterfly/check/balancing/purge/drain etc), strainers, orifice plates,

temperature gauge, pressure gauges shall be separately measured and paid as per their individual unit rates, which shall also include their insulation as per specifications, piping measurements shall be taken before application of the insulation. The cost shall also include any excavations and making masonry valve chamber with steel cover etc.

4.4.9 GUARANTEE:

The contractor shall guarantee that the materials and workmanship of the entire system are of the first-class quality. All the equipment's / apparatus shall be guaranteed to yield the specified ratings of discharge and quality. Any defective equipment / material / workmanship found short of the specified quality shall be rejected. Guarantee certificate of equipment's from suppliers / manufacturers shall be handed over to the owner.

4.4.10 DEFECTS AND LIABILITY:

All the equipment's / materials and the system shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning to the Owners along with all relevant documentation. The contractor shall repair, rectify, and replace all the defective materials, components free of cost. In addition, normal maintenance shall be carried out periodically during the defects and liability period including replacement of spares, as required**.**

4.4.11 TESTING:

The Contractor shall arrange to test the entire system as per the procedure enumerated under particular specifications, after the erection is completed. The results of the tests shall be submitted to the Owners personnel in the operation and maintenance of the system.

All pumps shall be tested at manufacturer's works in accordance with IS: 10961- 1988/IS: 5129-1977.At site free running pumps shall be carried out before commissioning the system.

All pipes with valves fittings & accessories after erection shall be hydraulically tested for a pressure of 1.5 times the maximum working pressure & duration of the test shall be minimum for 4 hours.

4.4.12 INSTRUCTION MANUAL / COMPLETION DRAWINGS / TRAINING:

The contractor shall furnish detailed instruction and operation manual of the system in Quadruplicate. The contractor shall also furnish detailed completion drawings inclusive of control schematics, in quadruplicate if any. The contractor shall train the Owners Personnel in the operation and maintenance of the system.

5.0 CODES & STANDARDS FOR NB PIPING WORKS:

All piping works covered under this specification shall comply with currently applicable statutes, regulations and safety codes. They shall comply in all respects with the requirements of the latest editions of the codes and standards. In case of conflict between codes and standards referred to in this specification or documents enclosed with specification.

5.1 STATUTORY REGULATIONS

The tenderer shall follow all statutory regulations of Government of India and Government of Karnataka currently in force such as

- Indian Factories Act
- Indian Electricity Rules
- Static & mobile unfired Pressure Vessel Rules-1981
- Central water and Air Pollution Acts
- Karnataka Government regulations for prevention and control of water and air pollutions.
  Statutory regulations with latest amendments shall be binding on the tenderer and all approval required under these regulations shall be the sole responsibility of the tenderer. Any modifications for meeting these regulations shall be carried out by the tenderer without any extra claims.

5.2 STANDARDS

The equipment and components of all equipment shall be designed, manufactured/fabricated, assembled, tested erected & commissioned in accordance with the latest standards of Bureau of Indian Standards/ International Standards.

In cases where suitable Indian Standards are not available, relevant International Standards and codes shall be followed.
In cases where the offer deviates from the specified standards, the tenderer shall indicate clearly in his offer the standards proposed to be adopted and the details thereof.
Some of the relevant standards relevant to this specification are listed below:

5.3 PIPES

- **Steel Pipes & Fittings**

- IS: 1239 – 1990 : Tubes, Tubular & Part-I other wrought steel fittings.
- IS: 1978 - 1982 : Line pipes API-5L, Gr-B-1995
- IS: 3589 - 2001 : Seamless (or) electrically welded steel pipes for water, gas & sewage.
- IS: 5504 - 1997 : Spiral welded pipes.
- IS: 1239 (Part-2): M.S. Tubes, tubular and (1992) wrought Steel fittings.)
- IS: 11428-1985 : Wrought carbon steel butt (Part 1 to 3)
- ASME : B 16.5- 1988 welding pipe fittings.

- **Others:**
- **American Society for Testing and Materials (ASTM)**

➢ A269 Seamless and Welded Austenitic Stainless Steel Tubing for General Service TP 304

➢ A370 Standard Methods and Definitions for Mechanical Testing of Steel Products

➢ A632 Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service

➢ A-262 Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

- **American National Standards Institute (ANSI)**

➢ B31.1 Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping

➢ B31.3 Process Piping

➢ American Society of Mechanical Engineers (ASME)

➢ Section IX Welding Qualification

➢ Welding Procedure/Qualification: ASME B 31.3/31.8, ASME Sec IX & IS: 817

➢ ASME Sec IX & IS: 814: Material Specifications, Welding rods, Electrodes & filler wire etc.

➢ ANSI-B-16.5: Pipe Flanges & Flanged Fittings

➢ ASME/ANSI-B-16.10: Face-to-Face & End-to-End Dimensions of Valves

➢ ANSI-B-18.2.1: Square & Hex Bolts & Screw.

➢ ANSI-B-18.2: Stud & Nuts.

➢ IS Standard or Equivalent: Gauges

➢ IS: 4038 - 198: Foot valves for water works purpose.

➢ IS: 2685 - 1971: Code of practice for selection and installation of sluice valves.

➢ IS: 2825 – 1969: Code of unfired pressure vessel.

➢ IS: 4682 – 1974: Code of Practice for lining of vessels

a) Vessels - 4.5 mm thick (3 x 1.5)

b) Piping - 3.0mm thick (2 x (1.5) shore hardness 65 + 5A.

➢ IS: 6392 – 1971: Steel pipe flanges. ASME: B 16.5- 1988

➢ IS: 1363 - 1992: Hexagon head bolts, (Part - 1 to 3) screws and nuts of product Grade-C

➢ IS: 1364 - 1983: Hexagon head bolts, screws and nuts of product Grade A & B.

- IS: 2062 Gr.A & B- : Steel for general structural purpose.1992
- IS: 5822 – 1994: Code of practice for laying of electrically welded steel pipes for water supply.
- IS: 10221 – 1982: Code of practice for coating and wrapping of underground M.S. pipe lines.
- IS: 554 – 1985: Dimensions for pipe threads.
- IS: 778 – 1984: Specification for copper alloy gate, globe and check valves for water works purpose.
- IS: 780 – 1984: Specification for sluice valves for water works purpose.
- IS: 781 – 1984: Specification for cast copper alloy screw down bid taps and stop valves for water services.
- IS: 5312: Specification for (Part-1 & 2) 1984/86 swing check reflux valves - single/multi door pattern.
- API – 594: Check valves: wafer, wafer-lug, and double flanged type.
- IS: 13095 - 1991: Butterfly valves for general purpose.
- IS: 1703 – 2000: Specification for copper alloy float valves for water supply fittings.
- IS: 9890 - 1981: General purpose ball valves.
- IS: 5290 - 1993: Specification for landing valves.
- IS: 2712 - 1998: Compressed asbestos fibre jointing.
- IS: 7318 - 1974: Approval tests for welders (Part-1) when welding procedure is not required.
- IS: 7307 - 1974: Approval tests for welding procedures.
- IS: 814 – 1991: Covered electrodes for manual metal are welding.
- IS: 816 – 1969: Code of practice for use of metal arc welding for general construction in M.S.
- IS: 7810 – 1999: Approval test for welders working to approved welding procedures.
- IS: 5 – 1994: Colours for ready mixed paints and enamels.
- IS: 2379 – 1990: Colour code for identification of pipe lines.
- IS: 800 – 1984: Code of practice for general construction in steel.
- IS: 7215 – 1974 : Tolerance for fabrication of steel structure
- IS: 456 – 2000: Code of practice for reinforced concrete.

6.0 DATA SHEETS & SPECIFICATIONS:

6.1 GENERAL SPECIFICATION FOR SS TUBING:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION:**

1. Seamless tubing shall be made of SS material and cold drawn instrumentation type. Tubing should be dual certified as TP 316 / 316L or TP 304 / 304L .
2. Seamless tubing should have a minimum of 2.5% molybdenum so as to ensure high resistance to corrosion.
3. Seamless tubing should have carbon content ≤ 0.030%.
4. Seamless tubing hardness should be max of HRB 90.
5. Seamless tubing sizes up to 1" OD should be bright annealed. Tubing with outside diameter larger than 1" OD should be supplied in annealed and pickled condition.
6. Seamless tubing shall have Tolerance on Wall Thickness ±10%.

- **DESIGN & MANUFACTURE:**

- Seamless tubing manufacturer should have ISO 9001/9002 certification and as well as product approvals from TUV and JIS.
- Quality System of the Tubing Manufacturer should have approval from ASME quality system certification as material organization.
- Tolerance for 316/316L or 304/304L tubing from 6 to 42mm OD as per DIN/2391/ED 10305-l & tolerance on wall thickness should be +/-10%.
- Seamless tubes shall be certified as per NACE/ MR0175 for Hardness.
- Tubing shall be manufactured in an integrated Mill with hot extrusion process.

- **INSPECTION & TESTING:**

1. Testing of the Tubing should be in accordance with SS142353/142343, DIN 17456/58, NFA 49 – 117/217, ASTM A213, ASTM A269, ASTM A312, and EN 10216-5.
2. Tubing supplier should furnish an "INSPECTION CERTIFICATE" indicating:
   - Material description
   - Steel making process
   - Heat code
   - LOT code
   - Leak test: Eddy current test according to ASTM A-450

- Test result of chemical composition, tensile test, hardness test, flaring test and flattening test.

- **TEST REPORTS & CERTIFICATES:**

The manufacturer should supply material compliance certificates.

- **MARKING, PACKING & SHIPMENT:**

1. All tubing must be clearly marked with heat code, lot code, outer diameter and wall thickness as in the inspection certification.
2. Tubing shall be supplied with plugged ends.
3. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
4. Items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.2 GENERAL SPECIFICATIONS FOR SS TUBE FITTINGS:

All the items shall meet the following specifications.

- **MATERIAL OF CONSRTUCTION**

1. Fittings shall be manufactured from the following materials: -

➢ Bar stock shall be SS 316 or SS 304 material as per ASTM A276/ASME SA 479, EN 1.4401 having carbon content less than 0.05% to provide increased resistance to corrosion.

➢ Forgings shall be SS 316 or SS 304 material as per ASTM A182/ASME SA182 EN 1.4401.

2. The fittings end connections shall be compatible with SS tube of hardness ≤ HRB 90.
3. The stainless-steel material, from which tube fitting bodies and components are made, will be restricted to a minimum chromium content of 17.0 % and a minimum nickel content of 12.0% for improved corrosion resistance and to a maximum carbon content of 0.05 %, which provides better corrosion-resistant weld ability.
4. All component parts of the fittings shall be of the same material.
5. The ferrule material shall be able to withstand an atmosphere of natural gas, oil and moisture without rusting.
6. Every Component of fitting including front and back ferrule should be etched.

Pipe for Gases:

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Pipe (SCH.10)	
2	MOC	SS 316 or SS304	
3	Ref. Standard	ASTM A 312 TP 316 or SS304	
4	Size	50mm, 40mm, 25mm, 20mm & 15mm	
5	Make		
6	Origin	Indian	
7	Working Pressure	15 Bar	
8	End Connection	Plain	

- **DESIGN & MANUFACTURE**

1. All fittings shall be designed in conformance with the requirements of ASME B31.3 and applicable standards. Area classification applicable for all items shall be Class-1, Division-1, Group-D as per NEC Zone-1 Group-IIA/ II-B as per IS/ IEC specification or equivalent specification. All fittings shall be designed so that all parts/ components meet the requirements for the specified area classification.
2. The tube fitting shall consist of the following precision machined parts: a) body, b) front ferrule, c) back ferrule and d) nut. The design configuration of all components shall present surface-to-surface contact, one part to another, keeping unit stresses below galling levels, for use on SS tubes conforming to ASTM A269 TP316 or TP304.
3. Fittings shall be rated for at least the design pressure stipulated in the material requisition. The design of the fittings shall ensure that they shall be capable of holding full tube burst pressure after only one and a quarter turn pull up of the nut.
4. The threaded end of the fittings shall be NPT as per ASME B1.20.1, SAE AS 71051.
5. The fittings shall hold the tube with collecting action producing a firm grip on the tube without substantially reducing the tube wall thickness.
6. The fitting body shall not have any machined stop or shoulder to preclude additional tightening in subsequent make-up.
7. Fittings shall not torque the tubing during original or subsequent make-up of the connection and use geometry for inspection before and after make up the fittings shall not require disassembly for inspection before or after makeup.
8. All tube fittings shall be Gaugeable for sufficient pull up after one and quarter turn. All tube fittings shall have a gauge able shoulder and there will be no radius at the point where the shoulder meets the neck of the fitting body. A Gap Inspection Gage shall be used to check for insufficient pull-up.

9. The gap inspection gauge shall be easily insertable at finger tight position of nut. The gap inspection gauge shall not be insertable between the nut and shoulder of the fitting after completing only one and a quarter turn pull up of the nut.
10. The tube seat counter bore in the body shall be faced flat 90° to the axis of the tubing to minimize tube expansion and subsequent galling.
11. The sealing and gripping power of the fitting shall be controlled such that the action between ferrules will overcome commercial variations in tubing wall thickness, hardness, and diameter.
12. Front Ferrule
    - The front ferrule shall provide a long, smooth repeatable seal by contact with body.
    - The front ferrule shall remain in an elastic condition to compensate for thermal stresses and to Accomplish repeated make and break.
13. Back Ferrule
    - The rear ferrule shall collet the tubing surface, improving the performance of the tubing in the systems of high impulse or vibration.
    - The back ferrule will have a uniform surface hardening. This surface hardening will be a low-temperature carburization, avoiding carbide formation. It will follow a disclosed and auditable process procedure.
    - The rear ferrule shall have a machine recess on the inside diameter and shall have complete surface hardening so as to substantially remove the required pull up torque. Both the requirements i.e. complete surface hardness and machined recess shall be met for all rear ferrules.
14. Nuts shall have silver plated threads to act as a lubricating agent to avoid galling and to reduce tightening torque.
15. Manufacturer shall be able to offer tube fittings with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for Oxygen.
16. All tube fittings provided by the supplier shall be NACE MR0175 certified by default.

- **INSPECTION & TESTING**

The manufacturer shall submit typical type test reports for the following test carried out on random samples of two ferrule fittings: -

1. Hydrostatic Pressure Test: Fittings should undergo testing conducted to evaluate the tube gripping ability of assembled tube fittings to sustain hydraulic over pressure, attaining up to 3.5 times working pressure without hydraulic leakage and up to 4 times the working pressure without fitting material rupture or tube slippage.

2. Helium Proof / Nitrogen Re-make Test: Fittings should undergo testing conducted to evaluate the performance of tube fittings with 1.5 times the working pressure with Helium and at rated working pressure with Nitrogen after every re-make for 25 such re-makes.
3. Helium Leak Test: Fittings should undergo testing to ensure that leakage is not in excess of 1.0×10^{-9} atm-cc/sec with the test assembly evacuated to approx. 20 millitorr while maintaining a differential pressure of 1 atm between the inside and outside of the assembly.
4. Sodium Chloride Stress Test: Fittings should undergo testing conducted to evaluate the effect of an environment that promotes stress corrosion cracking (SCC); conducted as per ASTM B117-95 standards.
5. Rotary Flex Test: Fittings should undergo testing conducted to evaluate the fatigue endurance reliability of tube fittings when installed on tubing subjected to fully reverse rotary beam flexure.
6. Vibration Test: Fittings should undergo testing conducted to evaluate the amount of cantilever deflection that can be applied to a tube and fitting assembly and still pass through 10,000,000 cycles without failure.
7. Tube Burst Test: Fittings should undergo testing conducted to evaluate the grip of tube fittings on tubing at the burst pressure of the tubing.
8. Fire (Burn) Test with water quench: Fittings should undergo testing conducted to evaluate the performance when exposed to a 1,500°F burn and a water quench based on API 607 standards.
9. High Impact Shock Test: Fittings should undergo testing conducted to evaluate the performance when subjected to shock test conducted as per ASTM F1387-99 standards. Should satisfy the requirements of ASTM F1387 Standards. The above shall be witnessed and certified by the U.S Department of Navy.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer should provide material compliance certificates.
2. Fittings manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED and also the most stringent fitting specification ASTM F1387, witnessed by the US Navy.

- **MARKING, PACKING & SHIPMENT**

1. Heat code traceability number shall be etched on both body and nut of each fitting. All fitting shall be etched to identify manufacturer and material.
2. Replacement nuts and ferrules shall be packaged in a manner so as to allow safe and simple replacement.
3. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.

4. Items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.
5. Local Stock: Manufacturer or authorized distributor shall carry significant amount of stock to the tune of 500 nos of the tube fittings each in their local stocks.

- **DOCUMENTATION**

1. All documents shall be furnished in English language only.
2. At the time of bidding, bidder shall submit following documents:
   - Reference list of the previous supply for similar items, giving following details:
     - Name of the customer.
     - Specification of the item i.e. size & pressure and temperature rating.
     - Service
     - Quantity
     - Year of Supply
     - Test procedures and typical certificates to be submitted as per clause 5.3 and 5.4 of this specification.
     - Manufacturer Quality Control Plan and sampling plan.
     - Copy of ISO 9000 certification for supplier/ manufacturer.
     - The manufacturer should supply material compliance certificate.

- **WARRANTY**

Manufacturer & its authorized distributors should offer a comprehensive Warranty covering the performance of the product against any defects in material or workmanship for 1 years of the product. A certificate to this effect must be issued on their respective Company letter head.

6.3 GENERAL SPECIFICATION FOR SEMI AUTOCHANGEOVER REGULATORS:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION**

1. The Regulator body, stem & range spring shall made of SS 316.
2. Material of construction of the diaphragm shall be Alloy X-750
3. Material of construction of seat shall be either PCTFE or PEEK depending on the pressure rating of the regulator.
4. All wetted lubricants must be PTFE based.

DESIGN & MANUFACTURE

1. All Semi auto changeover manifolds shall ensure continuous gas delivery by automatically switching between sources to extend gas supply.
2. Diaphragm sensing regulators enable precise pressure regulation. In order to achieve greater sensitivity and longer life, a convoluted diaphragm shall be used.
3. All semi auto changeover manifolds must have a Supply Pressure Effect of approx. 0.01%.
4. All semi auto changeover manifolds shall be supplied as a complete system with tube fittings, inlet/outlet/vent valves, pressure gauges & suitable single & double stage pressure reducing regulators mounted suitably on a SS 304 panel, except for manifolds supplied for Oxygen service. All regulators used must comply with the specifications listed below.
5. All regulators shall have a two-piece design that offers linear load on the diaphragm seal when the cap ring is tightened, eliminating torque damage to the diaphragm during assembly.
6. The diaphragm of the pressure regulator shall have a convoluted, no perforated design ensuring greater sensitivity and longer life.
7. All pressure reducing regulators must include a 25µm filter that is held in the inlet port to prevent any foreign particles from entering the regulator. In addition, the filter must be supported by a retainer ring to prevent it from accidently falling out.
8. The poppet must be supported by a poppet damper to keep the poppet aligned thereby reducing vibration & resonance.
9. The diaphragm shall be supported by a braced stop plate to protest against a ruptured diaphragm.
10. All auto changeover manifolds & all components for Oxygen system shall be suitably cleaned for Oxygen service and quoted accordingly.
11. Manufacturer shall be able to Regulators with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
12. All Regulators used must meet the technical specification listed in the earlier part of this document.

- **INSPECTION & TESTING**

1. Shell testing shall be performed on all components to a requirement of no detectable leakage with a liquid detector at 80 psig (5.5 bar) nitrogen.
2. All regulators must be 100 % factory tested for changeover pressure.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer shall supply material compliance certificate.
2. Regulator manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on Regulator body to facilitate traceability. All Regulators shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged and package separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.4 GENERAL SPECIFICATION FOR BALL VALVES:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION**

1. The valve shall be of Single piece design with forged / machined body made of material conforming to ASTM A479 & A276 Type SS 316 or SS 304.
2. Material of construction of ball stem shall confirm to ASTM A276 Type SS 316 or SS 304.
3. Material of construction of packing shall be Modified PTFE / D1710 type 1, Grade 1, Class B.
4. Manufacturer shall be able to provide multiple options for seat packing materials Reinforced PTFE, Alloy X-750, Carbon/glass PTFE, PEEK & UHMWPE.
5. Manufacturer shall be able to provide multiple options for stem packing materials maintenance kits and color handle kits.

Ball Valve:

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Ball Valve	
2	MOC	SS 316 or SS 304	
3	Flow Pattern	2 Way Shut off, Straight Pattern	
4	Size	1/4” OD	
5	Make		
6	Origin	India	
7	Design Pressure	20 Bar	
8	End Connection	OD CF	

- **DESIGN & MANUFACTURE**

1. Valve shall employ a live-loaded packing system that reduces need for packing adjustment improves thermal cycle performance and compensates for wear.
2. Packing shall be a single-piece design constructed of modified PTFE which reduces potential leak points and has virtually no dead space. Valve sizes above 3/8" shall have standard PTFE packing.
3. Manufacturer shall be able to offer Ball Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
4. Design pressure shall be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the ball valves.
5. The back ferrule of Ball Valves' end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼" to 1" OD & 6mm to 25mm OD.
6. All Ball Valves with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.
7. Single piece ball Valve shall employ a balanced trunion, patent –pending design that supports packing volume, minimizing thermal effect.

- **INSPECTION & TESTING**

1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.
4. Valves are helium leak tested at a pressure of 1 x 10–4 Torr. The maximum allowable leak rate is 4 x 10–9 std cm3/s.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on valve body to facilitate traceability. All valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.

3. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.5 GENERAL SPECIFICATION FOR NEEDLE VALVES:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION**

1. All 316 SS Needle valves body to conform to ASTM A182/ A479 and stem material, packing nut to conform with 316 SS or SS 304.
2. Material of construction of Upper and lower packing shall be PFA/D3307.
3. Manufacturer shall be able to provide multiple options for seat packing materials kits, Lockable handles and colour handles kits.
4. Manufacturer should be able to provide multiple options for stem packing materials, O-ring maintenance kits and colour handle kits.
5. Manufacturer shall be able to provide multiple options for O ring materials like Buna C, Buna N, Ethylene propylene & Karlez.
6. All Needle Valves with SS Nut & Ferrule end fittings shall have a gauge able shoulder.

- **DESIGN & MANUFACTURE**

1. Manufacturer shall be able to provide needle valves either with Integral bonnet / Union bonnet design.
2. The back ferrule of Needle Valves' end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼" to 1" OD & 6mm to 25mm OD.
3. Manufacturer shall be able to offer Needle Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
4. All Needle Valves with SS Nut & Ferrule end fittings shall have a gauge able shoulder.
5. Manufacturer shall be able to offer atleast 3 types of stem tip designs to suit for different applications parameters.

- **INSPECTION & TESTING**

1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.
2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Needle valves.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on valve body to facilitate traceability. All valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.6 GENERAL SPECIFICATION FOR CHECK VALVES:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION**

1. Check valve body and poppet to conform to 316 SS or SS 304.
2. If the check valve has an elastomer as a wetted component, a variety of sealing materials shall be made available.
3. Manufacturer shall be able to provide multiple options for Seal kits.
4. For corrosive gases If the check valve has an elastomer as a wetted component, a variety of sealing materials including Kalrez and Teflon shall be made available.
5. All Check Valves with SS Nut & Ferrule end fittings shall have a gauge able shoulder.

Non Return Valve /Check Valve:

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Non-Return Valve / Check Valve	
2	MOC	SS 316/SS 304	
3	Flow Pattern	1 Way Flow	
4	Size	¼”	
5	Make		
6	Working Pressure	230 Bar (As per BOQ), Cracking	

		Pressure 0.5 Micron	
7	End Connection	NPTFxM	
8	Service	All Gases	

- **DESIGN & MANUFACTURE**

The back ferrule of Check Valves' end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼" to 1" OD & 6mm to 25mm OD.

1. Manufacturer shall be able offer Check Valves with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
2. All Check Valves with SS Nut & Ferrule end fittings shall have a gauge able shoulder.
3. Check Valve with fixed pressure, are cycled six times prior testing, every check valve is tested to ensure it seals within 5's at the appropriate seal pressure.

- **INSPECTION & TESTING**

1. The valve shall be factory tested with Nitrogen at 1000 psig (69 bar). Maximum allowable seat leakage shall be 0.1 std cc/min.
2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Check valves.

- **TEST REPORTS & CERTIFICATES**

1. Manufacture should provide material compliance certificates.
2. Valve manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on valve body to facilitate traceability. All Check Valves shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged and packaged separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.7 GENERAL SPECIFICATION FOR HOSE:

All the items shall meet the following specifications.

Hose:

SR NO	DESCRIPTION	SPECIFICATION	
1	Tech. Name	Hose	
2	MOC	SS 316 or SS 304	
3	Ref. Standard	ASME B 16.34	
4	End Connection	1/4" NPTF x 1/4" NPTF 3/4" BSPF(LH) x 3/4" BSPM(LH) (For LPG)	
5	Service	All Gases	
6	Working Pressure	230 Bar	
7	Make		

- **MATERIAL OF CONSTRUCTION**

1. Manufacturer should able to offer Hose with 304 SS over braid.
2. Manufacturer shall provide 316L SS core & 304L SS braided hoses where permeation is undesirable.
3. All SS316 or SS304 Hoses end connections for the hose assembly can be permanent (crimped) design or reusable (compression style).

- **DESIGN & MANUFACTURE**

1. Manufacturer shall be able to provide multiple cover options without changing hose technical data.
2. Manufacturer shall provide an option of carbon black filled PTFE core for applications that require static dissipation.
3. All Hoses with SS Nut & Ferrule end fittings shall have a gauge able shoulder. There will be no radius at the point where the shoulder meets the neck of the fitting body. The gaugeable shoulder will allow a Gap Inspection Gage to be inserted between the nut and shoulder; 180 deg. flush around the neck of the fitting, to check for insufficient pull-up. The Gap Inspection Gage will not fit between the nut and shoulder of a sufficiently pulled-up fitting on the initial pull up and it must be consistently reliable.
4. All Hoses with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

- **INSPECTION & TESTING**

1. Every assembly is pressure tested with water at room temperature for 30 seconds to a requirement of no detectable leakage. Testing is performed at 1000 psig (69 bar), or 225 psig (15.5 bar) if an end connection is rated below 1000 psig (69 Bar).

2. Design pressure should be at least twice the working pressure & Burst pressure may be almost four times the working pressure of the Hoses.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer shall supply material compliance certificate.
2. PTFE material complies with FDA regulation 21CFR Part 177.1550, USP <88> Class VI, and 3-A.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on hose to facilitate traceability. All Hoses shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
3. Each item shall be properly tagged and packaged separately to facilitate easy identification.
4. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

6.8 GENERAL SPECIFICATION FOR FILTERS:

All the items shall meet the following specifications.

- **MATERIAL OF CONSTRUCTION**

1. Filter body, bonnet & bonnet nut to conform to 316 SS / A479.
2. The minimum nominal pore size of filter element shall be 0.5µm.
3. The filter element shall be of grade SS 316.
4. Maintenance kits shall be made available for field replacements.
5. All Filters with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

Inline Filter:

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Inline Filter	
2	MOC of Contact Part	SS 316 or SS 304	
3	End Connection	1/4” NPTF x 1/4” NPTM	
4	Make		
5	Micron	0.5 Micron	
6	Working Pressure	150 Bar	

- **DESIGN & MANUFACTURE**

1. All filters with SS Nut & Ferrule end fittings shall have a gauge able shoulder. There will be no radius at the point where the shoulder meets the neck of the fitting body. The gauge able shoulder will allow a Gap Inspection Gage to be inserted between the nut and shoulder; 180 deg. flush around the neck of the fitting, to check for insufficient pull-up. The Gap Inspection Gage will not fit between the nut and shoulder of a sufficiently pulled-up fitting on the initial pull up and it must be consistently reliable.
2. The back ferrule of filter's end fitting shall have a machined recess on the inside diameter and shall have complete surface hardening to substantially reduce the required pull up torque. Both the requirements i.e., complete surface hardness and machined recess shall be met for all rear ferrules of sizes ranging from ¼" to 1" OD & 6mm to 25mm OD.
3. Manufacturer shall be able to offer Filters with specially cleaned and packed to ensure compliance with product cleanliness requirements stated in ASTM G93 Level C for oxygen service.
4. Design pressure shall be at least twice the working pressure & Burst pressure may be almost four times the working pressure of Filters.
5. All Filters with SS Nut & Ferrule end fittings shall have a gaugeable shoulder.

- **INSPECTION & TESTING**

1. Every Filter shall be factory tested with Nitrogen at 1000 psig (69 Bar) to a requirement of no detectable leakage with liquid leak detector.

- **TEST REPORTS & CERTIFICATES**

1. The manufacturer shall supply material compliance certificate.
2. For Sour Gas service - Materials for wetted components are selected in accordance with NACE Specification MR0175 for sulfide stress cracking resistant materials.
3. Filter manufacturer should have ISO 9001 certification and as well as product approvals from TUV, ASTM, ASME, BSI, DNV, GOST, Lloyds Registrar of Shipping & PED.

- **MARKING, PACKING & SHIPMENT**

1. Heat code shall be marked on Filter to facilitate traceability. All Filters shall be etched to identify manufacturer and material.
2. All the items shall be suitably wrapped and packaged to withstand rough handling during ocean shipment and inland journey.
2. Each item shall be properly tagged separately to facilitate easy identification.

3. All items shall be wrapped and packaged in such a way that they can be preserved in original as new condition.

- **OTHER MANDATORY REQUIREMENTS**

a) The bidders must enclose a client list, contact details, relevant brochures and compliance certificate (Annexure I) with the tender.

b) The bidders should be well established firms preferably leaders in the application stated above and must have a proven track record of completing atleast 5 Projects with product supply valued > 20L each. Firms should be in existence for atleast 2 years.

c) Bidders to submit their reference list of Tubing, Pressure Regulators, Valves and Tube fittings and accessories as mentioned in the tender, supplied for similar services along with offer.
The reference list must include the following:
   - Proven Track Record
   - Process fluid type, outlet temperature rating.
   - Year of supply
   - Client' s name & address
   - Client contact details

d) Established commitment to technical support in India, preferably Bangalore should be demonstrated.

e) The Suppliers must have one stop shop for all Fluid components including Fittings, Valves, Tubing, Hoses, Regulators, Gauges, Manifolds, Filters and Quick Connectors etc…

f) Products should have an average leak rate close to zero as evident from Leak surveys for lower operating costs.

g) The Supplier should have Proven track record for Excellent technical support, Help in product selection, training, Technical update etc..

h) The authorized representative of the manufacturer shall have the ability to conduct Installation Training Program & with a past record of having conducted more than 5 such programs during the previous 1 year period.

i) The authorized representative of the manufacturer shall have the ability to conduct Leak Audits and with a past record of having conducted more than 5 such programs during the previous 1 year period.

6.9 SYSTEM COMPONENTS.

M. S. fabricated support framework for in Cylinders and Manifolds

Construction : Arc Welding and Bolting.
Finish : One Coat of Primer & two Coates Synthetic enamel paint.
Material Used : MS. Channel /Angle/ Plate as per IS: 808/1730 / 1731

Cylinder Brackets with Chain

MOC : Powder coated M.S. with powder coated G.I. chain
Aesthetically designed gas cylinder brackets with powder coated chain suitable for holding the cylinder securely in upright position.

SERVICE MEDIA		CA					
DESIGN		BASE MATERIAL : STAINLESS STEEL SS -304					
CONDITIONS		RATING & FACING: 150 #.					
		CORROSION ALLOWANCE : NIL					
		MAX W.P : 5.0 KG/CM2 (G)		MAX TEMP: 50 ° C MIN.TEMP: -- 30° C			
ITEM	**SIZE**	**TYPE**	**MATERIAL**	**DIMENSIONS**	**THK/ RATING**	**ENDS**	**REMARKS**
	NB - MM						
	FROM TO						
PIPE	15 40	ERW	A312 TP 304	ANSI B 36.19	SCH. 40S	P.E	
	50 150	ERW	A312 TP 304	ANSI B 36.19	SCH. 10S	B.E	
FLANGES	15 150	SORF	ASTM A182 F304	ANSI B 16.5	150 #	R.F	
BLIND	15 40	PLATE	ASTM A182 F304	ANSI B 16.5	150 #	R.F	
ELBOW	15 40	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
ELBOW	50	WELDED	A 403 GR WPW	ANSI B 16.9	SCH. 10S	B.E	

	150		304				
REDUCER	15 40	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
ECC	50 150	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 10S	B.E	
REDUCER	15 40	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
CONC	50 150	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 10S	B.E	
TEES	15 40	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
TEES	50 150	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 10S	B.E	
CAPS	15 40	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
CAPS	50 150	WELDED	A 403 GR WPW 304	ANSI B 16.9	SCH. 10S	B.E	
STUB	15 40	SMLS	A 403 GR WPW 304	ANSI B 16.9	SCH. 40S	B.E	
ENDS	50 150	SMLS	A 403 GR WPW 304	MSS.SP 43	SCH. 10S	B.E	
GASKETS	15 150	RING TYPE	PTFE	ANSI B 16.21	3 MM		
BOLTING	ALL	STUDS & HEAVY	A 193 GR B8	ANSI B 1.1	FULLY		
BOLTING	ALL	HEX NUTS	A 194 GR 8	ANSI B 18.82	THREADED		

Cylinder Bracket with Chain:

SR NO	DESCRIPTION	SPECIFICATION	
1	MOC	GI	
2	Specifications	Aesthetically designed gas cylinder brackets with powder coated chain suitable for holding the cylinder securely in upright position.	
3	Make		

Nut Bullnose

Specifications : ¼" NPTM X 5/8" BSP RH /LH nut suitable for individual gas.
MOC: Bullnose: SS 304 or SS 316
Nut : Barstock Brass

Nut Bullnose:

SR NO	DESCRIPTION	SPECIFICATION	
1	Tech. Name	Nut Bullnose	I 
2	MOC	SS 316 or SS 304	
3	Specification	¼" NPTM X 5/8" BSP RH /LH nut suitable for individual gas. A sintered filter of 25 micron is inbuilt in bull-nose connector to prevent entry of dust / impurities in gas handling system.	
4	Service	Suitable for all gases	
5	Working Pressure	230 BAR	
6	Make		

6.10 GENERAL SPECIFICATION FOR SS304 PIPES:

- **GENERAL SPECIFICATION FOR SS304 VALVES**

SL NO	TYPE	BALL VALVE (SS 304)	SL NO	INFO	
1	BODY	ASTM A182Gr F-304	17	VACUUM	PARTIAL VACUUM
2	ENDS	NB 15-25 mm SCREWED TYPE/NB ≥ 40 mm SORF	18	PACKING	PTFE
3	FLANGE HOLES	AS PER ANSI.B.16.5	19	STUDS & NUTS	SS 304/316
4	MFG. STD		20	MAX TEMP	50 °C
5	RATING	150 # RATING	21	MIN TEMP	15 °C
6	BORE	REGULAR PORT	22	MAX PRES	10 Bar g
7	BALL	SS 304	23	MIN PRES	FV
8	BODY GASKET	PTFE VIRGIN	24	MAKE	

9	TRIM	AISI 304/316-CF 8/CF8M	25	Hydro test	
10	SEATING	PTFE VIRGIN	26	BODY	30 bar g
11	LEVER	SS304	27	Hyd seat	21 bar g
12	STEM	SS304	28	Pneumatic	7 bar g
13	STEM SEAL	PTFE RENEWABLE	29	BODY TYPE	3 PIECES
14	GLAND	SS304	30	OTHERS	STEM BLOW OUT PROOF
15	HANDLE	SS 304			
16	SERVICE	PROCESS			

- **SPECIFICATION OF PRESSURE GAUGE:**

SL NO	SPECIFICATION		DESCRIPTION
1	**Model no.**	:	To be specified by vendor
2	**Dial size**	:	4”
3	**Bottom entry size**	:	1/2” BSP
4	**Diaphragm**	:	SS 316
5	**Contact parts**	:	SS316/SS316 Teflon Lined/Haste alloy
6	**Movement**	:	SS 316
7	**Block**	:	SS 316
8	**Design range**	:	Upto 15 Kg/cm²
9	**Operating range**	:	As per BOQ
10	**Accuracy**	:	+ / - 1 % of range span

11	**Over range protection**	**:**	125 %
12	**Case & bezel**	**:**	SS 304 with screwed Bezel of ABS plastic.
13	**Mounting**	**:**	Direct with bottom entry
14	**Standard fitments**	**:**	Micro adjustable pointer (internal) blow out disc.
15	**Documentation**	**:**	Calibration certificate traceable to National Standard.

- **NON-RETURN OR CHECK VALVE SPECIFICATIONS:**

Sl	**Descriptions**		**Data**
1	Body	:	SS304
2	Ends	:	Spring type ASA 150 flanges
3	Flange holes	:	As per ANSI.B.16.5
4	Mfg. Std	:	API 6D/API 594
5	Rating	:	150 # RATING
6	Bore	:	Full port
7	Disc	:	CF 8
8	Hinge	:	CF 8
9	Trim	:	CF 8
10	Sealing ring	:	EPDM
11	Free open pressure	:	< 0.2 bar g
12	Spring	:	SS 316
13	Service	:	Compressed Air
14	Vacuum	:	Na
15	Studs & nuts	:	SS 304
16	Maximum temperature	:	150 °c
17	Minimum temperature	:	-20 °c
18	Maximum pressure	:	10.5 bar g

19	Minimum pressure	:	*
20	Make	:	*
21	Hydro test pressure	:	
	Body	:	30 bar g
	Seat	:	23 bar g
22	Location	:	Pressure line
23	Size	:	As per BOQ
22	OTHERS	:	Valve to be epoxy painted

- **GENERAL SPECIFICATION FOR CA REGULATOR:**

AIR FILTER DATA SHEET			
SL	**DESCRIPTIONS**		**DATA**
1	SERVICE	:	AIR
2	TYPE	:	DIAPHRAGM, RELIEVING
3	ADJUSTING SCREW	:	REQUIRED
4	DRAIN	:	MANUAL
5	REGULATION	:	OUTLET PRESSURE VARIATION NOT MORE THAN 1% FROM SET VALUE FOR INLET PRESSURE VARIATION OF 10%
6	OVER RANGE PROTECTION	:	150 % OF INLET PRESSURE
7	OUTLET PRESSURE GAUGE	:	REQUIRED
8	GAUGE DIAL SIZE	:	50 mm
9	GAUGE COLOR DIAL/ NUMERALS	:	WHITE/BLACK
10	GAUGE ACCURACY	:	± 2%
11	CASE	:	IP54 AS PER IS 13947(P-1)
12	COLOR	:	MFG STD, EPOXY FINISH
13	MOUNTING BRACKET	:	REQUIRED
14	HOUSING(BODY) MATERIAL	:	DIE CAST ALUMINUM/BRASS (NICKEL/CHORME PLATED)
15	DIAPHRAGM MATERIAL	:	BUNA N, NYLON REINFORCED
16	INSTRUMENT VALVE	:	SS 316/SS 304

17	SPRING MATERIAL	:	SS 316/SS 304
18	INNER VALVE MATERIAL	:	SS 316/SS 304
19	TRIM MATERIAL	:	SS 316/SS 304
20	PACKING MATERIAL	:	TEFLON/BUNA N
21	GAUGE PRESSURE ELEMENT/MOVEMENT MATERIAL	:	PHOSPHOR BRONZE
22	GAUGE HOUSING MATERIAL	:	ALUMINUM/BRASS (NICKEL/CHORME PLATED)
23	GAUGE RING MATERIAL	:	ALUMINUM/BRASS (NICKEL/CHORME PLATED)
24	GAUGE GLASS	:	SHATTER PROOF/CLEAR ACRYLIC SHEET
25	INLET CONNECTION	:	1/2" /3/4" NPT(FEMALE)
26	OUTLET CONNECTION	:	1/2" /3/4" NPT(FEMALE)
27	APPLICABLE CODES AND STDS	:	1.IS-319, ANSI-B.1.20.1, ASTM-D-454
28	TESTS	:	
29	DIMENSIONAL AND THREAD CHECK	:	100 % ITEMS
30	AIR LEAK TEST	:	AT 1.25 TIMES THE DESIGN PRESSURE ON 100 % ITEMS
31	FUNCTIONAL TESTS		FOR 100 % ITEMS
	NOTE:		
1.)	VENDOR TO PROVIDE ALL MATERIAL & OTHER TEST CERTIFICATES FOR PURCHASER'S REVIEW & RECORDS		
2.)	AIR LEAK TEST & FUNCTIOAL TEST SHALL BE DONE BEFORE & AFTER SEISMIC TEST WHEN SPECIFIED		
3.)	UNDER RELIEVING OPERATION, LEAKAGE FROM PRV SHALL NOT EXCEED 5 CC / MIN.		

- **GENERAL SPECIFICATION FOR AIR FILTER:**

AIR FILTER DATA SHEET			
SL	**DESCRIPTIONS**		**DATA**
1	SERVICE	:	PROCESS AIR
2	TYPE	:	CARTRIDGE
3	HOUSING TYPE		F-FLANGED HOUSING

4	CARTRIDGE GRADE	:	GENERAL PURPOSE PROTECTION "GP"
5	DRAIN	:	MANUAL
6	FILTER AREA	:	12 TIMES PIPE AREA
7	FILTER PERFORMANCE	:	1 MICRON DUST PARTICLES, OIL
8	AIR FLOW @ 7 bar g		*cfm
9	DIFFERENTIAL PRESSURE GAUGE	:	REQUIRED
10	MOUNTING BRACKET	:	REQUIRED
11	HOUSING(BODY) MATERIAL	:	WELDED MILD STEEL VESSELS
12	FINISH		EPOXY PAINTED
13	CONDENSATE DRAIN		AUTOMATIC
14	FILTER MATERIAL	:	MACHINE PLEATED WITH GLASS MICROFIBRE
15	PACKING MATERIAL	:	TEFLON/BUNA N
16	INLET CONNECTION	:	DN 40 FLANGE TYPE
17	OUTLET CONNECTION	:	DN 40 FLANGE TYPE
18	BOWL LIQUID LEVEL GAUGE		YES
19	APPLICABLE CODES AND STDS	:	ISO 8573.1 QUALITY 2
20	MAXIMUM OPERATING PRESSURE bar g		16 bar g
21	MAX OPERATING TEMP ° C		66° C
22	MIN OPERATING TEMP ° C		1° C
23	DIMENSIONAL AND FLANGE CHECK	:	100 % ITEMS
24	AIR FLOW AT 50 % CLOGGING	:	90 % OF RATED FLOW
25	AUTO DRAIN FUNCTION CHECK		YES
26	FUNCTIONAL TESTS		FOR 100 % ITEMS
1.)	**NOTE:** VENDOR TO PROVIDE ALL MATERIAL & OTHER TEST CERTIFICATES FOR PURCHASER'S REVIEW & RECORDS		
2.)	AIR FLOW TEST & FUNCTIOAL TEST SHALL BE DONE		

- **SPECIFICATIONS FOR CPVC PIPES, VALVES AND FITTINGS:**

SLNO	PRODUCT		DESCRIPTION
1	**CPVC Pipes**	:	1. CPVC 4120 SDR 11/CPVC SCH 40 As per ASTM F 441 pipeline with necessary slope. 2. Manufacturer should have ISO 9001 certification and as well as product approvals. 3. Sizes range from 150mm to 15mm
2	**CPVC End Caps & CPVC/Metal Clamps**	:	1. CPVC end caps confirming to ASTM D2846/PVC AS PER ASTM D2466 STD 2. CPVC /Metal clamps confirming to ASTM D2846/PVC AS PER ASTM D2466 STD 3. Manufacturer should have ISO 9001 certification and as well as product approvals. 4. Sizes range from 150mm to 15mm
3	**CPVC Couplings/Equal Tees/Reducing Tees/90°Elbow**	:	1. CPVC couplings confirming to ASTM D2846/PVC AS PER ASTM D2466 STD. Sizes range from 150mm to 25mm. 2. CPVC equal tee confirming to ASTM D2846/PVC AS PER ASTM D2466 STD. Sizes range from 80mm to 25mm. 3. CPVC reducing tee confirming to ASTM D2846/PVC AS PER ASTM D2466 STD. Sizes range from 200mm to 25mm. 4. CPVC 90°elbow confirming to ASTM D2846/PVC AS PER ASTM D2466 STD. Sizes range from 200mm to 15mm. 5. Manufacturer should have ISO 9001 certification and as well as product approvals.
4	**Male Adapter**	:	NPT Male adapter confirming to ASTM STD.
5	**CPVC Ball Valve**	:	CPVC Ball valves as per ASTM STD

- **SPECIFICATIONS FOR HDPE PIPES, VALVES AND FITTINGS:**

Slno	Product		Description
1	**Service media**	:	Drain piping for aqueous & non-aqueous solvents
2	**Design**	:	MOC- HDPE (High Density Polyethylene) PIPING CLASS: 150#FF
3	**Pipe Rating**	:	PN6, PN10, PN16, PN20

4	**Max Working Pressure**	:	20 kg/sqcm
5	**Max Temperature**	:	93°C
6	**Min Temperature**	:	-5°C

	OUTSIDE DIAMETER	**mm**	20	25	32	40	50	63	75	90	110	160	225	250	280	315	355	400	450	500	560
PIPE	Thickness (mm / inch)		PE 100																		
	Schedule number / thickness		10 kg/cm2 Pr. Rating																		
	Material		HDPE Gr. PE – 100																		
	Ends		Plain ends																		
	Dimension standard		IS: 4984 – 1995																		
	Pipe to pipe joint		Heat & compression butt weld																		
FLANGES	Type		Sandwich flanges with steel reinforcement, SOFF																		
	Rating		150#																		
	Material		HDPE																		
	Dimension standard		ANSI B 16.5																		
ELBOWS	Type		Plain ends to suit pipe thickness (Fabricated)																		
	Rating		10 kg/cm2 Pr. Rating																		
	Material		HDPE, IS: 8008 – 95, Gr. PE – 100																		
	Dimension standard		IS: 8360																		

FITTINGGS	Type	Plain ends injection molded HDPE
	Rating	10 kg/cm2 Pr. Rating
	Material	HDPE
	Dimension standard	IS 8008
STUB END	Type	Short length
	Rating	10 kg/cm2 Pr. Rating
	Material	HDPE
	Dimension standard	IS 8008
GASKETS	Type	Full face to suit pipe thickness (fabricated)
	Thickness / Rating	3 mm / 150#
	Material	Teflon / grafoil
	Dimension standard	ANSI B16.21

BOLTING	Stud / bolt	Fully threaded with 2 washers
	Material	IS 1367 CL 4.6, GI
	Nuts	Hexagonal
	Dimension standard	IS 1367 CL 4.6, GI

- **GENERAL SPECIFICATION FOR SS316 PIPES:**

SERVICE MEDIA	H2, AGRON, HELIUM, O2, CO2, METHANE, N2, etc.
MATERIAL	SS316
CONDITIONS	W.P: 1100 kPa g / MAX. TEMP. 200° C :MIN TEMP. -29° C
	CORROSION ALLOWANCE: 1.5 MM
	MAX W. P: 15KG/CM2 (G) MAX TEMP: 170°C / MIN.TEMP: -29°C
LINE JOINTS	≤40 mm SW, ≥65 mm BW.

ITEM		SIZE-NB LOW	SIZE-NB HIGH	TYPE	MATERIAL	DIM.STD	THK\RTG	ENDS	REMARKS
PIPES		15	40	ERW	A312 TP 316	ANSI B 36.9	SCH.40S	P. E	
		50	150	ERW	A312 TP 316	ANSI B 36.9	SCH.10S	B. E	
FLANGES		15	150	LAP JOINT	IS 2062	ANSI B16.5	300#	R. F	PLATE TYPE.SERR. FINISH
BLIND FLANGES		15	40	PLATE	A240 GR.316	ANSI B16.5	300#	R.F	
		50	150	LINED	IS2062	"	"	"	
ELBOW		15	40	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH 40S	B.E	
		50	150	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH.10S	B.E	* -BUTT WELDED
RED.ECC		15	40	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH 40S	B.E	
		50	150	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH.10S	B.E	
FITT									
	RED.CONC	15	40	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH 40S	B.E	
		50	150	WELDED	A 403 GR	ANSI B16.9	SCH.10S	B.E	

I N G S				*	WPW 316				
	TEES	15	40	WELDED	A 403 GR WPW 316	ANSI B16.9	SCH 40S	B.E	
		50	150	WELDED	A 403 GR WPW 316	ANSI B16.9	SCH.10S	B.E	
	CAPS	15	40	WELDED	A 403 GR WPW 316	ANSI B16.9	SCH 40S	B.E	
		50	150	WELDED *	A 403 GR WPW 316	ANSI B16.9	SCH.10S	B.E	
STUB		15	40	WELDED *	A 403 GR WPW 316L	ANSI B16.9	SCH 40S	B.E	
ENDS		50	150	WELDED *	A 403 GR WPW 316L	ANSI B16.9	SCH.10S	B.E	
GASKETS		15	150	RING	IS 2712	ANSI B16.21	3MM	-	
				TYPE	GR.W/1				
BOLTS				STUDS &	A193 GR B7	ANSI B 1.1	FULLY		REFER NOTE -2
		ALL	HEAVY HEX		A194 GR 2H	ANSI B 18.8.2	THREADED		WITH 2 NOS.WASHERS
				BOLTS					
NOTES:									
1	USE COLD PULLED BEND (R=5D) FOR PIPE SIZE UPTO & INCLUDING 25 NB WHENEVER POSSIBLE.								
2	BOLTS AND NUTS SHALL BE GALVANISED TO IS 1367.								

- **Tube Fitting:**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Equal Tee	
2	MOC	SS 316/SS 304	
3	Ref. Standard	ASTM A 269	
4	Size	¼"	
5	Make		
6	Origin	Indian	
7	Design Pressure	20 Bar	
8	Service	All Gases	

- **End Cap:**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	End Cap	
2	MOC	SS 316/SS 304	
3	Size	¼”	
4	End connection	Compression End	
5	Make		
6	Origin	Indian	
7	Design Pressure	20 Bar	
8	Service	All Gases	

- **Union:**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Union	
2	MOC	SS 316/SS 304	
3	Size	¼”	
4	End connection	Compression End	
5	Make		
6	Origin	Indian	
7	Design Pressure	20 Bar	

- **Regulator with Connector:**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Regulator	
2	MOC	SS 316/Brass chrome plated	
3	Size & Connection of Regulator	1/4” NPTF	
4	Pressure Range	Inlet Pressure 14 Bar Outlet Pressure 1 to 10 Bar	
5	Connector Size for Regulator	¼” OD CF x ¼” NPTM	
6	Flow	50 LPM	
7	Make		

8	Origin	Indian	
9	Services	All Gases s	

CO2 Heater

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	CO2 Heater	
2	Make	Indian	
3	Working Pressure	150 Bar	
4	Service	CO2	

- **Cylinder Isolation Valve:**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Cylinder Isolation Valve	
2	MOC of Contact Part	Brass	
3	End Connection	3/4” NPTM x Bullnose Connection	
4	Make	Vanaz/Indigenous	
5	Origin	India	
6	Working Pressure	150 Bar	

- **Flash Back Arrestor**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Flash Back Arrestor	
2	MOC	Brass (Housing)	
3	Ref Standard	EN 730-1, ISO 5175	
4	End Connection	3/8” NPTM(LH) x NPTM(RH)	
5	Make	Messer	
6	Working Pressure	10 Bar	

- **Tube Holding Clamp**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Tube Holding Clamp	
2	MOC	Polypropylene	
3	Size	1/4" ID	
4	Make		
5	Origin	Indian	
6	Service	For All Tubes	

- **Tagging**

SR NO	DESCRIPTION	SPECIFICATION
1	Tech. Name	Tagging
2	Construction	Acrylic
3	Standards	ASME 13.1- 2007
4	Make	

- **Manifold Block**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Manifold Block (60mm x 60mm)	
2	MOC	SS 316 or SS 304	
3	Size	3/4" NPTF x 1/4" NPTF x 1/2" NB SW 1/2" NB SW x 5/8" BSPF 1/2" NB SW x 1/4" NPTF 1/2" NB SW x 3/4" NPTF 3/4" NPTF x 5/8" BSPF	
4	Make		
5	Origin	Indian	
6	Service	For All Tubes	

- **Aluminum Profile**

SR NO	DESCRIPTION	SPECIFICATION	IMAGE
1	Tech. Name	Aluminium Profile	
2	MOC	Aluminium	
3	Size	27.5 mm	
4	Make		
5	Origin	Indian	
6	Service	For All Tubes	

- **Unistrut Support:**

SR NO	DESCRIPTION	SPECIFICATION	
1	Tech. Name	Unistrut Support (Slotted /Without Slotted)	
2	Construction	GI Channel along with Bolting System, Size 41 x 41 x 2 mm Thk/	

		41 x 41 x 1.5 mm Thk.	
3	Raw Material	GI Unistrut, L Bracket, Washer & Nut, Spring Nut & M10 GI Threaded Rod	
4	Make	Indian	

- **Hose:**

SR NO	DESCRIPTION	SPECIFICATION	
1	Tech. Name	Hose	
2	MOC	SS 316 or SS 304	
3	Ref. Standard	ASME B 16.34	
4	End Connection	1/4" NPTF x 1/4" NPTF 3/4" BSPF(LH) x 3/4" BSPM(LH) (For LPG)	
5	Service	All Gases	
6	Working Pressure	230 Bar	
7	Make	Indian	

- **GENERAL SPECIFICATION FOR AUTO MOISTURE TRAP:**

Compressor performance) *	2.5 m^3/min
Refrigeration dryer performance) *	5 m^3/min
Filter performance) *	25 m^3/min
Operating pressure min/max.	0,8/16 bar (g)
Housing	fibreglass-reinforced plastic, aluminium
Material membrane	AU
Ambient temperature	+1/+60 °C
Weight	0,8 kg
Condensate inlet	G½ [optional: NPT-Adapter]
Condensate outlet (hose connection)	1 X G¼ hose connector; di = 8-10 mm
Electrical connection, standard	95...240 VAC ±10% (50...60 Hz) / 100...125 VDC ±10%
Electrical connection, option	24...48 VAC ±10% (50...60 Hz) / 18...72 VDC
Power input	P = 0,6 … 3 VA (W)

Housing protection	IP 67
Cable cross section	0,75 … 2,5, mm² (AWG 14…20)
Fuse protection	recommended 0.5 A/mt

7.0 SHOP DRAWINGS:

The drawings enclosed herewith are for the general guidance to the Contractor. The contractor shall upon the award of the work, furnish detailed and coordinated shop drawings necessary to carry out the work at site. These shall be submitted to the Consultant & client for the approval and the work shall be commenced only after the approval of drawing by the Consultant & client.

Drawing/Information Required from Successful contractor on award of work:

1. Piping layout, Cross sectional, Isometric drawings, P & ID, MTO.
2. Necessary civil scope drawing for the system.
3. Bar chart showing engineering, manufacturing and dispatch of each equipment and erection services.
4. Drawing, literature and technical data sheet of all bought out items.
5. Schedule for valves and piping material.

8.0 QUALITY PLAN:

Contractor shall furnish the quality plan for site works; Quality plan shall include Fabrication, Installation methods.

For All works, Proper storage of Items, Installation supervision. Quality plan shall be submitted to Client & PMC & approval shall be taken.

PART 13

FPS WORKS

CONTENTS

1.0 SCOPE OF WORK

1.0 SCOPE:

The Scope covers the Fire Protection System which includes, Hydrant System, Pumps.

The scope of work for the Fire protection System design covers the following: -

- New Fire hydrant system including terrace Pump,Tank.

2.0 BASIS OF DESIGN: -

Fire protection System is designed as per NBC guidelines for Fire hydrant system, we are proposing new pump room with above ground storage tanks to meet Hydrant and sprinkler requirement. Fire hydrant piping running mostly on above ground & wherever required road crossing shall be laid underground with suitable wrapping and coating.

- Proposed building is considered as ordinary hazard category for Fire protection system design.
- One Fire hydrant Main electrical Pump is considered with Fire control panel. Main Pump capacity is 450 lpm., 40 m Head 5KL HDPE OHT water storage capacity.
- Fire hydrant tank is terrace floor level with pump located Adjacent with Positive Suction .

Pump Outlet Shall have pressure Switch operate based on Emergency .

- Fire Hydrant ring main shall feed External Hydrant points & Building internal points Hydrant ring main is with 150 nb pipe size, same ring main shall be used to connect to sprinkler system for the buildings.
- Hydrant Ring main proposed all around the existing building with external hydrant valves & hose boxes.
- Isolation valves are provided as per necessary for maintenance of system. Ring main are interconnected so water can flow from either side in case of emergency.

3.0 SYSTEM DESCRIPTION: -

Riser with landing valves shall be provided for each floor, at each staircase landing. Yard hydrant points shall be provided at every 30m for outside building protection.

System shall be pressurized continuously to normal working pressure. System shall consist of Hydrant pumps, pressurization arrangement, water mains network, hydrant valves, landing valve, hoses, branch pipes, nozzle, hose boxes, central hose house etc.

Hydrant ring mains shall be provided all around building. Isolation valves between various ring mains shall be provided so that ring mains can be interconnected and water from any of the ring main can flow to other mains.

All hydrant pipe mains/pipelines shall be routed over ground on RCC pedestals or pipe trestles. Within the main plant area where over ground routing of pipes is not possible, pipes shall in RC trenches with pre-cast RCC covers Road, Rail or pipe trench crossing shall be through RCC Hume pipes of appropriate pressure class and the pipelines shall be provided with coating and wrapping as per specification.

4.2.1 OPERATION: -

Fire Hydrant system water supply header & main pipe up to Hydrant valve/ landing valve shall be kept pressurized by pump which shall start automatically on receiving the impulse from Pressure switch in case of any pressure drop in the header.it shall stop at a preset pressure as soon as pressure builds up in header.

For smaller fires, first aid hose reel would be used. While Hydrant valve would be used for bigger fires.

In the event of fire breakout, opening of hydrant valve/hose reel will result in fall of

Pressure in header and electrical motor driven fire pump shall come into operation automatically through the impulse from the pressure switch. The fire pump shall be stopped manually only.

In case the electrical driven main fire pump fails to start, the diesel engine pump shall come into action automatically on further fall of pressure and receiving impulse from pressure switch.

The Setting of the pressure switches shall be done keeping the above sequence in consideration.

4.2.2 Pumps:

A. Motor driven Fire pump:

End Suction type, horizontally mounted centrifugal pump (as per IS 5120), each capable to deliver 450 lpm of clear water at minimum M TDH, coupled to a suitably electrical motor mounted on a common base frame and anti-vibration pads coupling, coupling guard and fixing bolts etc. Motor HP to be suitably selected to suit minimum discharge and residual head at the top most hydrant.

The characteristic curve should have large range of discharge points for different heads.

4.0 FIRE PROTECTION WORKS SPECIFICATIONS:

The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the working drawings, specifications, erection, and instructions of equipment manufacturers.

The Contractor shall carry out the works in the presence and/or as per the instructions of site engineers/ supervisory personnel deputed by the OWNER. The erection shall be carried out by highly skilled workmen.

The Contractor shall take care of positioning, leveling, and plumbing of all pipelines and equipment as well as supporting structures within the required accuracy and tolerance limits. It shall be deemed as a contractual obligation that the pipes are not thrown out of alignment or lifted off during commissioning and subsequent operation.

There may be more than one contractor working in the area at the same time. As such the work has to be carried out in proper co-ordination and consultation with the OWNER and all other parties concerned with the work. The Contractor shall take due notice of the working conditions, practices, and agreements prevalent in the area of the plant site and satisfy himself before quoting.

The Contractor shall be responsible for paying strict attention to statutory regulations for prevention of accidents and to other safety rules. The regulations for prevention of accidents shall be displayed at appropriate places and should be distinctly visible to all personnel working in the area.

The Contractor shall supply all required consumables, construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compounds, tapes, brazing and soldering materials, welding sets, pipe bending machines, cables, clamping tools, gauges, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton wastes, sand, and emery paper etc as required for satisfactory completion of work.

The Contractor shall make his own arrangement for handling the equipment and pipelines at the stores and transporting it to the site of installation.

In addition to the above, the Contractor shall follow all the relevant erection clauses/conditions stated under various chapters of this specification and erection/laying instructions provided by the manufacturer/supplier of plant & equipment.

5.1 TECHNICAL PARAMETERS:

The scope of work shall cover supply, storage at site, transportation to the place of erection, fabrication/assembly, laying/erection, painting, testing and commissioning of the complete equipment

& industrial piping system for **Fire Protection System** for the project as a whole with necessary supports and supporting structures. The erection work shall be carried out as per the instructions of equipment manufacturer and working drawings to be prepared by the Contractor and duly approved by the owner/consultant. Supply and design, fabrications, erection, painting, labeling, testing and commission of fire protection system with mechanical and electrical equipment, instrumentation, pipes, valves, fitting, supports, cables etc. complete.

5.2 PUMPS:

5.2.1 Motor driven Fire pump:

End Suction type, horizontally mounted centrifugal pump (as per IS 5120), TAC approved each capable to deliver 450 lpm (As per BOQ) of clear water at minimum *(As per BOQ) M TDH, Coupled to a suitably electrical motor mounted on a common base frame and anti-vibration pads coupling, coupling guard and fixing bolts etc. Motor HP to be suitably selected to suit minimum discharge and residual head at the top most hydrant.

The characteristic curve should have large range of discharge points for different heads.

Note:-

A. Above pump hall be capable of furnishing not less than 150% of rated discharge capacity at a head of not less than 65% of the rated head. The shut -off head shall not exceed 120% of rated head.

B. Diesel engine/motor shall be of continuous rating type and its rating shall be at equivalent to the maximum horse power required as per curve requirement.

C. The pump sets with cushy foots shall have to be installed on RCC floor already constructed and cost of the required civil works viz chipping of floor & concrete base etc (as required) shall be included in the quoted price of respective pump sets.

D. The pump base frame shall be erected on prepared foundation and leveled with shims and wedges with the help of precision levels and other instruments. After leveling, grouting of foundation bolts shall be completed. When tightening the foundation bolts the base plate levels should not get affected. Final level achieved should be of the order of 0.05mm per meter.

The pump and motor shall be placed on their respective machined pads ensuring that their feet make full contact. Normally a 0.002-inch feeler strip should not pass between the feet and the pad when the pump and motor are freely placed.

The coupling if not supplied fitted with the pump and drive unit should be carefully fitted with a pusher or by means of heating in an oil bath of approximately 180 deg F. The coupling shall never be hammered onto the shaft as this may cause serious damage to bearings and mechanical seals. Run-out on a coupling after fitment should be between 0.05 mm and 0.1 mm TIR. Before proceeding with any alignment, the pump and motor bearings should be thoroughly cleaned and flushed with recommended grade of lubricant and the individual units should be checked for freeness of rotation.

The coupling shall be aligned radically and angularly using two dial gauges. Connection of suction and delivery pipes shall be made in such a manner that the connection to the pump flanges do not develop any undue stress and the weight of the pipes is not transmitted to the pump.

After completion of the pipe work, the pump set shall be grouted up to the flanges of the base frame. Grouting should be filled from inside the base frame and all cavities filled up. After the grout has set the alignment should be re-checked and compared with the values recorded prior to grouting.

During manual rotation, before coupling the motor to the pump, it shall be ensured that the direction of rotation of the motor corresponds to that of the pump indicated by the manufacturer/supplier.

VALVES:

Before erection of valves, it shall be ensured that: -

i. All grit and foreign matter are removed from the inside of the valves before connecting the pipes.

ii. All the faces are thoroughly cleaned and coated with a thin layer of mineral grease.

It shall be ensured that adequate support is provided for the pipeline and valve. The valve should never carry the weight of the pipeline. Hangers or supports placed near the valve shall be provided.

The connecting pipeline should be cleaned and flushed of sediments, sand and other foreign matter before installing the valves.

Unless it is operationally critical butterfly valves shall be mounted with the shaft horizontal and as per the direction of flow indicated on the valve.

Sluice valves shall normally be installed with the spindle vertical except on vertical pipes where the spindle shall be horizontal. On slopes, the sluice valves may preferably be kept vertical if slope is nominal and gradient can be adjusted with the help of pipes on both sides.

The valves should be tightly closed when being installed, to prevent any foreign matter from getting in between the working parts of valves.

The gasket shall be lubricated with graphite or other recommended lubricant.

It shall be ensured that the joining material sits squarely between the flanges of valves and pipelines without obstructing the waterway.

METHODOLOGY OF PIPING:

5.3.1 EARTH EXCAVATION:

Trench/Underground excavation shall include the removal of all materials including the haul of excess material to disposal area and usable material to a stockpile area up to a distance of 1 kilometer/as instructed site in charge. Excavation in both earth and rock material shall be carried out to the lines and grades shown on the approved drawings, unless otherwise specified. In the event that trench is constructed to a width or depth greater than that permitted above (or) as per IS: 5822 through Contractor's error, the Contractor shall furnish the necessary material, labor and equipment to correct such error as decided by the OWNER. Shoring and bracing shall be used to support the sides of trenches wherever necessary. When closed sheeting is required, it shall be so driven as to prevent adjacent soil from entering trenches either below or through sheeting and bracing shall be removed after they have served their purpose.

5.3.2 DISPOSAL OF MATERIALS:

Excavation materials deemed suitable by the Owner for any purpose shall be stockpiled in required quantities in the vicinity of the excavation sites involved, as per the approval/directions of the Owner, up to a lead of 100 meter. Unsuitable or excess excavation material and debris shall be transported to spoil areas, as directed and approved by the Owner. Material shall be end dumped and graded at these areas.

5.3.3 BACKFILL:

Backfill shall contain no ashes, rubbish, combustible, or decomposable material, nor any other material which the Owner deems unsuitable for this purpose. If the excavated material is deemed unsuitable by the owner for use as backfill, the Contractor shall backfill with material approved by the Owner which shall be obtained from locations to be specified. Prior to the lowering and laying of pipe in any trench or excavation, the Contractor shall backfill and compact the bottom of the trench or excavation to provide an acceptable bed for placing the pipe.

Placing of backfill about the pipe shall be done after conducting necessary tests only in the presence of the Owner after his final inspection and acceptance.

Immediately after placing and aligning the pipe in the trench and before completing the joint, loose back fill shall be placed about the pipe to a depth of about 150 mm above the pipe, except at field joints. This back fill shall consist only of fine soil, sand or other selected backfill.

If rocks or other hard objects occur in the back fill along any section of the pipeline, such back fill shall be screened before being placed about the pipe or at the option of the Contractor, suitable back fill from other places may be transported to and placed around the pipe in such sections.

Settlement of back fill in the trench shall be by means of flooding, pudding, tamping or jetting. Poking with metal rods will not be permitted.

5.3.4 LAYING AND JOINTING OF PIPELINES:

Pipes shall be laid to lines and levels as shown in the drawings. Laying and jointing of welded pipes shall be as per the latest revision of IS: 5822. For making welded joints, the welding shall be performed by the manual shielded metallic arc process or TIG as required.

All welding including the proposed procedure and the qualification of welders and welding operations shall be done according to power piping code ASME B 31.1 and ASME Section IX or approved equivalent. Piping for butt welded run shall be supplied with ends beveled by machining or grinding.

The ends of the pipe -to-pipe, pipe-to-fitting and fitting-to-fitting joints shall be aligned as accurately as is practical within the existing commercial tolerance on pipe diameters, wall thickness and out- of -roundness. Alignment shall provide the most favorable conditions for weld deposition of the root bead. Welds shall be full penetration, continuous without defects.

As a rule, butt-welding shall be carried out without interruption until the entire joint is welded. In any case, however, welding of butt joints must not be interrupted till at least 50% to 60% of welding thickness is completed.

If there is an unscheduled interruption in such work, it is necessary to ensure slow and uniform cooling of metal by covering it with asbestos or by other means to eliminate the possibility of sharp zonal cooling of metal. Before starting the welding again, it is necessary to heat the butt up to the required temperature and maintain this temperature till the butt welding is completed. Besides systematic inter-operational control, the quality of welded joints shall be controlled by visual inspection and mechanical tests in conformity with the provisions of applicable standard codes.

WELDING

The two ends of MS/GI pipes shall be cut to the perfect level with the machine. Both the ends of the pipe shall be chamfered in-ordered to achieve a V groove at the welding joint. The tack welding shall be done first at required points. After checking the perfect level and alignment continuous welding

shall be done. Contractor to clear all the carbon formations on the pipe surface and make the joint shiny.

5.3.5 ABOVE GROUND PIPING:

The Contractor shall supply/fabricate and install piping and fittings in strict compliance with the detailed engineering drawings. Deviations if considered necessary to suit site conditions could, however, be permitted in consultation with and with prior approval of OWNER.

All openings in the piping shall be kept effectively closed until assembled in the system to avoid foreign matter entering into the system.

All piping shall follow the general arrangement shown, shall be cut accurately to measurements established for the work by the Contractor and shall be installed without strain.

All piping shall be installed with adequate clearance for lighting, bracing, doors, windows, and other openings.

Piping shall be arranged in the straightest possible runs with minimum amount of fittings. Flanges of the pipelines, fittings, etc., must be so mounted that top bolt holes are symmetrical about the vertical axis of the flange.

Joints should be as far as possible located at one-third span from supports and must be avoided in the middle of the span.

Openings provided in the walls for pipelines must be closed with bricks or mortar with 10 to 20 mm clearance between the brick work and pipe. The clear space must be stuffed and caulked with felt or asbestos and grouted at both the ends of the wall surfaces.

The Contractor shall supply/fabricate and install as per their design drawings duly approved by OWNER/ CONSULTANT.

Pipe supports and all that is necessary to completely support all the piping and piping components including but not limited to beam clamps, pipe clamps, fabricated structural supports, guides and anchors, brackets, saddles, U-bolts, etc.

Also supporting members required in addition to building structure shall be furnished and installed. Concrete pedestals with plate inserts on top surface for supporting the pipes as well as valves are also included in the Contractor's scope of work.

The jointing of pipes and fittings shall be made as described under underground piping.

Wherever laying of pipelines underground is not possible, pipelines shall be laid over ground, supported from below by PCC pedestals, building columns, side walls etc.

Compensators shall be provided on the over ground pipe network to take care of thermal expansion.

Wherever pipelines crossroads and railway tracks, they shall be laid on pipe bridges with bottom elevation not less than 6 meters to provide the necessary clearance for the traffic movement. This should take into account the various types of vehicles likely to move in the plant.

Valves provided on the pipe network shall be provided with steel structural platforms and access ladders.

The maximum permissible spacing between pipe supports shall be followed are indicated below:

25	2.0	2.7
40	2.5	3.2
50	3.0	4.0
65	3.5	4.2
80	4.0	4.7
100	4.5	5.2
150	5.0	6.4
200	6.0	7.3
250	6.5	8.0
300	7.0	9.0
350	7.5	9.5
400,450	8.0	10.0
500,600	9.0	10.0
700,800	10.0	12.0
900,1000	12.0	14.0

5.3.6 PIPE HANGER & BRACKET ETC.:

Sturdy hangers, brackets and saddles of approved design shall be installed to support all pipe lengths from ceiling / masonry wall / columns / trusses. The hangers and brackets shall be fabricated from suitable M.S rolled sections for Non –Process areas and SS material for Process areas.

The hangers and brackets shall be of adjustable heights and painted with red oxide primer, clamps collars and saddles to hold pipes shall be provided with suitable gaskets / washers.

The brackets and hangers shall be designed to safely carry the weight of pipe. All pipes and fittings shall be secured near every joint and half way through every pipe length unless otherwise specified. M.S. Plates to be used in system shall conform to IS 226 ST 42 S. MS supports used are to be galvanized.

5.3.7 INTERCONNECTING PIPELINES:

Interconnecting pipelines shall consist of all the pipelines for various services from different units to the equipment and between the units of the pumping system.

The quantity of piping including valves and specials shall be as required to suit the site conditions and the approved piping layout for the plant. All the piping systems shall be designed to handle the maximum quantity of the respective fluids at the specified parameters.

All piping systems shall be provided with /as per approved drawings:

- Necessary isolating/Regulation & control valves
- Air release/ball float valves as required
- Drain pipes with valves
- Supports/trestles/thrust blocks as required
- Pipe fittings such as elbows, bends, reducers, tees, flanges, nipples, expansion joints, specials etc.
- R.C.C. encasing pipes at roads.
- Dismantling/flexible joints for maintenance/ replacement of header/ valves.

Piping system shall be designed with a high degree of reliability so that the system performs the duty of fluid handling without any failure under all conditions of plant operation.

Piping layout must follow good engineering practice. Proper attention shall be paid to obtain full functional requirement of the piping system with a layout which provides sufficient clearance for other equipment and operating personnel, convenient supporting points and neat appearance.

Complete design of piping system (If required) shall be subject to approval by the OWNER/CONSULTANT.

The design shall take into account the effort of internal/external pressures, thermal expansion, self-weight of piping, support reactions, surge and water hammer, earthquake and wind effects at site, corrosion and erosion etc., and any other effects dictated by good engineering practices and piping standards and codes.

Piping system shall not impose undue forces on equipment terminals/flanges.

Mild steel pipes shall be used in general for water supply facilities and special quality pipes such as GI for drinking water and PVC/MS rubber lined/HDPE pipes for corrosive fluids and S.S pipes and fittings for DM water. For further details refer data sheet enclosed.

The pipe network shall be provided with air release valves at high points and drains valves at the lower points.

Each of the branch connections taken from the main network shall be provided with an isolation valve.

Pipelines passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.

All the pressure pipes shall be laid with nominal slope and the gravity network with slopes for self-cleaning velocities.

Except where otherwise specified, all piping shall have butt welded connections with a minimum of flanged joints for connections to equipment. Branches shall in general be formed by welding.

Unions/nipples or flanges as required for connecting to equipment, valves, instruments, etc., shall be installed in the piping works to facilitate dismantling for maintenance.

For GI pipes, jointing shall be done by screwed and socket joints.

Provision shall be made for branches for cleaning and flushing of pipelines wherever necessary.

Provision shall be made for support of piping, which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional supports being required.

Pipe supports shall be capable of supporting the pipelines under all conditions of operation.

5.3.8 UNDERGROUND PIPELINES:

Pipelines, which are not routed through over ground shall be laid underground.

As far as possible all the pipelines shall be laid together along the piping corridor. The piping corridor shall be predominantly parallel to and by the side of the roads.

All the underground pipelines shall be laid as far as possible at a depth of about 1.0 to 1.5 m below ground level (i.e., the top of the pipelines shall be 1.0 to 1.5 m below the finished ground level) (or) more unless otherwise specifically indicated.

Isolation/control valves drain valves and air release valves provided on the underground pipe network shall be housed in suitably sized covered valve pits and valve pits shall be of self-draining type.

Wherever pipes pass through RCC walls below ground level sleeve inserts shall be provided with necessary caulking/packing for water tightness with asbestos fiber socked in bitumen. It is preferable to provide the pipe of same size with required projected length as pipe inserts in the wall.

Wherever the underground pipelines crossroads and railway tracks they shall be suitably encased with mild steel pipes or NP3 or NP4 reinforced concrete encasing pipes and the different sizes of the encasing pipes shall be as given below.

Encased pipe diameter (mm)	Encasing pipe diameter for	
	RCC-NP3 pipe size (mm)	M. S. Welded pipe size (mm)
Up to 100	300	250
150	450	300
200	500	400
250	600	400

The RCC encasing pipes shall be joined by collar rings and grouted with cement mortar of 1: 4

In case a number of pipes are crossing a road or a railway track, these pipes shall be laid in a reinforced concrete culvert having easy access.

5.3.9 PROTECTIVE COATING FOR UNDERGROUND PIPING:

Underground steel pipes shall be wrapped and coated generally as per IS: 10221 hot applications. The outer surface of the pipeline shall be given two coats of coal tar primer followed by a layer of FRP tissue covering and a coat of coal tar finish enamel paint. Over this one more layer of FRP tissue & one coat of coal tar enamel paint shall be applied and covered by a polyethylene film sheet. The total thickness of the external coating shall not be less than 4 mm.

Cold application could be followed with specific permission from the Owner by using polyethylene-based coating and wrapping system. One coat of rubberized asphalt primer and one wrap of polyethylene film covered anticorrosive tape/membrane of 4 mm thickness made of non-woven polyester mat core sandwiched in the layers of polymeric mix.

The testing of wrapping and coating shall also be as per latest IS: 10221.

5.3.10 OVER GROUND PIPING:

All vertical pipelines shall be supported at the base of the riser with a duck foot bend support and at intervals of approx. 3 to 3.5 m for pipes of size 50mm & larger and at 2m for pipes size 40 mm & smaller.

5.3.11 PIPING INSTALLATION:

Tender drawings indicate schematically the size and location of pipes. The contractor, on the award of the work, shall prepare detailed working drawings, showing the cross section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air auto vent valves, and all pipe supports. He must keep in view the specific opening in buildings and other structures through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, stands, clamps, and hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.

Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finished coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between supports
Up to 12mm	1.5meter
15 to 25 mm	2.0 meter
30 to 150 mm	2.0 meter
Over 150 mm	2.5 meter

Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 15 mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest paint and air vent at the highest point.

Pipe sleeves, 50 mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.

All pipes work shall be carried out in a workman like manner, causing minimum disturbance to the existing services, building, rods and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipe and pressure testing for each area shall be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes are indicated in the drawing. Contractor shall carefully examine the cut-outs provided and clearly point out where ever the cut- outs shown in the drawings, do not meet with the requirements.

The contractor shall make sure that the clamps, brackets, clamps saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion Loop where required.

All pipes shall be accurately cut to the required sizes in accordance with IS 554 and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In vertical pipes, concentric reducers shall be used.

Flanged inspection pieces 1.5 meters long with bolted flanges on both ends, shall be provided no more than 30 meters centers wherever shown in approved for construction to facilitate future cleaning of all welded pipes.

All buried pipes shall be cleaned and coated with Zinc chromate primer and bitumen paint, then wrapped with three layers of fiberglass tissue, each layer laid in bitumen.

Insulted buried pipes shall be cleaned, de rusted, then coated with epoxy primer. Insulation shall be applied as per the section 'Insulation' wrapped with GI wire and covered with polythene sheet. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in schedule of quantities, buried insulated pipes shall be waterproofed using coat of shalibond, or approved adhesive, over the plastered surface: wrapping one layer of fiberglass RP tissue and one layer of roofing tar felt with sufficient overlaps, set and sealed with adhesive, held in position by 16 gage GI wire tied at 15 cm intervals.

Auto/ Manual air vent valves shall be provided at all specified points in the piping system for air venting. All valves shall be of 20 mm /15 mm pipe size, provided with drain connection & non-return valve for ease of maintenance.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges with CS/Gun metal gate valves as specified under section "Automatic Controls and Instruments", shall be provided at the suction and discharge of chilled water pumps supply and return at air handling units, at chillers, as shown on the drawings and included in schedule of quantities. Care shall be taken to protect pressure gages during pressure testing.

Temperature gauge as specified under section "Automatic Controls and Instruments" shall be provided at each Air handing units Supply & Return Chilled water line, at chillers, as shown on drawing and included in schedule of quantities.

5.3.12 TESTING & BALANCING:

All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but not less than 10 kg per sq. cm gauge for a period of not less than 24 hours. All leaks and defects in joints re-welded during the testing shall be rectified and gotten approved at site.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped, then retested for entire system.

The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulations, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications. He shall bear all expenses for carrying out the above rectifications, including the tearing up and re-finishing of floors and walls as required.

The contractor shall provide all materials, tool, equipment, instruments, services and labor required to perform the test and to remove water resulting from cleaning and after testing.

After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted or as directed, to individual air handling units and fan coil units cooling coil.

Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.

Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents.

Exposed Pipes & insulation surface/ cladding shall be provided the approved color along with name & arrows marked distinctly in-service areas.

5.3 MODE OF MEASUREMENTS:

Mode of Measurement for payment of items of piping & fitting shall be as follows:

5.4.1 Piping:

Shall be measured in units of length along the center line of installed pipes including all pipe fittings, flanges (with gaskets and nuts and bolts for jointing), unions, bends elbows, tees, concentric and eccentric reducers, inspection pieces, expansion loops, ceiling/floor mounted supports etc. The above accessories shall be measured as part of piping length along the center line of installed pipes and no special rates for these accessories shall be permitted.

The quoted unit rates for center line linear measurements of piping shall include all wastage allowances, pipe supports includes hangers, MS channel, wooden haunches nuts and check nuts,

vibration isolator suspension where specified or required, and cost of excavation, bedding, back filling and finishing as required to complete the piping installation as per the specification. None of these items will be separately measured nor paid for. However, all valves (gate/globe/butterfly/check/balancing/purge/drain etc.), strainers, orifice plates, temperature gauge, pressure gauges shall be separately measured and paid as per their individual unit rates, which shall also include their insulation as per specifications, piping measurements shall be taken before application of the insulation. The cost shall also include any excavations and making masonry valve chamber with steel cover etc.

Above Ground Piping:

- Cost of respective pipes and specials.
- Laying, fixing and jointing with necessary clamps.
- Cutting holes and chases in walls, floors, etc. And inserting pipe sleeves, filling up the gap between pipe sleeves and crossing pipe with insulating materials like fiber glass / thermocol.
- Testing and making good the defects if any.
- Painting the completed line with one coat of primer and two coats of synthetic enamel paint of approved color and make

Below Ground Piping:

- Cost of respective pipes and specials.
- Earthwork excavation, back filling, consolidation.
- Laying, fixing, aligning, and jointing.
- Anticorrosive treatment.
- Providing pipe sleeves across foundations and filling up the gap between pipe sleeve and crossing pipe with insulating materials like fiberglass / thermocol.
- Testing and making good the defects, if any.

5.4.2 Valves, Flanges and Accessories:

These shall be as per number only and shall include: -

- Cost of material and jointing materials.
- Fixing and jointing with necessary bolts, nuts, rubber insertion, etc.
- Testing and making good the defects if any.

5.4.3 Piping Insulation:

Shall be measured in units of length along the center line of the installed pipe, strictly on the same basis as the piping measurements described above.

The linear measurement shall be taken before the application of the insulation, it may be noted that for piping measurements, all valves, orifice plates and strainers are separately measurable, and their quoted unit rates shall include the insulation cost in the valve required and as specified.

5.4.4 Painting:

The equipment & piping system which is covered in the specification like strainers, piping Pumps &other steel items shall be in general given two coats of epoxy primer and two coats epoxy finish paint of quality & approved by the owner after due surface preparation unless otherwise specified elsewhere. The finish coat can be given at works and necessary touch-up & second final coat shall be given at site after completion erection & testing.

5.4.5 Guarantee:

The contractor shall guarantee that the materials and workmanship of the entire system are of the first-class quality/As per Good Engineering Practices. All the equipment's / apparatus shall be guaranteed to yield the specified ratings of discharge and quality. Any defective equipment / material / workmanship found short of the specified quality shall be rejected. Guarantee certificate of equipment's from suppliers / manufacturers shall be handed over to the owner.

5.4.6 Defects and liability:

All the equipment's / materials and the system shall be guaranteed against defective material and workmanship for a period of 12 months from the date of commissioning to the Owners along with all relevant documentation. The contractor shall repair, rectify, and replace all the defective materials, components free of cost. In addition, normal maintenance shall be carried out periodically during the defects and liability period including replacement of spares, as required.

5.4 Testing & commissioning

5.5.1 Testing:

The Contractor shall arrange to test the entire system as per the procedure enumerated under particular specification, after the erection is completed. The results of the tests shall be submitted to the Owners personnel in the operation and maintenance of the system.

All pumps shall be tested at manufacturer's works in accordance with IS: 10961- 1988/IS: 5129-1977.At site free running pumps shall be carried out before commissioning the system.

All pipes with valves fittings & accessories after erection shall be hydraulically tested for a pressure of 1.5 times the maximum working pressure & duration of the test shall be minimum for 4 hours.

5.5.2 Instruction Manual / Completion Drawings / Training:

The contractor shall furnish detailed instruction and operation manual of the system in Quadruplicate. The contractor shall also furnish detailed completion drawings inclusive of control schematics, in quadruplicate if any. The contractor shall train the Owners Personnel in the operation and maintenance of the system.

5.5 Procurement & Installation:

5.6.1 Technical Submittal:

Technical Submittal of all items shall be submitted to consultant & approval shall be taken.

Along with Data sheet & approved make Relevant Product Catalogs shall be submitted.

5.6.2 Approved make: -

Vendor Shall procure product of approve make/Brand only, any alternative make /brand requirement need to approved consultant /Client prior to Procurement.

5.6.3 Sample approval: -

The Contractor shall ensure all key/Critical items like Valve, Hydrant accessories, Instruments, detector, Panel,

Sample shall be submitted to Client Project team & PMC, get the approval prior to procurement & installation in site.

If Sample Is not approved by Client /PMC & items installed, then Client /PMC have Authority to reject installation.

Vendors need to Get approval & re install the Item free of cost within project Time line.

5.6 SHOP DRAWINGS:

The drawings enclosed are for the general guidance to the Contractor. The contractor shall upon the award of the work, furnish detailed and coordinated shop drawings necessary to carry out the work at site. These shall be submitted to the Consultant & client for the approval and the work shall be commenced only after the approval of drawing by the Consultant & client.

Drawing/Information Required from Successful contractor on award of work:

- Fire hydrant External & Internal Plans, Section.
- Pump GA and Cross-sectional drawings.
- Performance curve for the pump.
- Necessary civil scope drawing for the system.
- Bar chart showing engineering, manufacturing and dispatch of each equipment and erection
    - services.
- Drawing, literature, and technical particulars of all bought out items.
- Control logic diagram for the pump to start.
- Schedule for valves and piping material.

5.7 QUALITY PLAN: -

Contractor Shall furnish the quality plan for site works, Quality plan shall include Fabrication, Installation methods

For All works, Proper storage of Items, Installation supervision. Quality plan shall be submitted to Client & PMC

& Approval shall be taken.

5.0 CODES & STANDARDS

All piping works covered under this specification shall comply with currently applicable statutes, regulations, and safety codes. They shall comply in all respects with the requirements of the latest editions of the codes and standards. In case of conflict between codes and standards referred to in this specification or documents enclosed with specification.

Important relevant IS Codes for this Specification are listed below:

6.0 DATA SHEET & SPECIFICATIONS:

7.3 BOOSTER PUMP.

A	Qty	:	01
B	Location	:	PUMP ROOM
C	Type	:	Horizontal, centrifugal
D	Design Standard	:	IS5120\IS:12469(LATEST).
E	Dimension Standard	:	*
F	Capacity	:	450 lpm
G	Diff head required	:	40 m
H	Make	:	Kirloskar/Mather& Platt/Armstrong/Grundfos/Johnson
I	Service	:	Water
J	Operating Temp	:	Ambient
K	Specific gravity	:	~1
L	Suction pressure	:	Atmospheric
M	NPSH available	:	Flooded
N	End connection type		
	For 25 nb & above	:	Flange connection as per ANSI 16.5 RF ASA 150#
	For 20 nb & below	:	Screw to BSPT(F)
O	Noise Level	:	Less than 72 dB
P	Type of Construction		
	Casing	:	Single volute, back pullout
	Casing Mounting	:	Horizontal
	Impeller type	:	Closed
	Lubrication	:	Oil lubrication
	Base plate	:	Fabricated
	End connection		ANSI B 16.5 SORF ASA 150#
Q	Material construction		

	Casing /impeller	:	IS 210 Gr.FG 260
	Impeller/casing wear rings	:	IS 210 Gr.FG 260
	Shaft	:	EN 19
	Shaft Sleeve	:	AISI 304
	Casing /nozzle gasket	:	Asbestos free
	Gland plate	:	IS 210 Gr.FG 260
	Base frame	:	IS 2062 Fabricated.
	Foundation Bolts		EN 8
	Coupling Guard(zero access)		Aluminum
	Nuts & bolts		SA 193 Gr.B7/SA 194 Gr.2H, Galvanized.
R	Drive Specifications:		
	Type	:	Squirrel cage induction motor
	Enclosure	:	TEFC,IP-55, 'F' Insulation,**EFF1**
	Transmission	:	Directly coupled.
	Coupling type	:	RRS spacer coupling.
	Coupling Make		love joy
	Power supply	:	415 ±5%V, 3 Phase, 50 ±3% Hz.
	Motor rating kw/poles		*
	Motor Frame size		*
	Motor Make		ABB/Siemens/CGL
	Motor Efficiency%		*
S	Performance details		
	NPSH required in mtrs		
	Efficiency %		
	BKW @duty		
	BKW @ max capacity		
	Pump speed(rpm)		
	Impeller dia(mm)		
	Performance curve no		
	Safe minimum flow(m3/hr.)		
	Shut off head(meter)		

	Other details :-		
	Overall Size		
	Weight of pump set (kgs)		
	Nozzle size (NB)		
	Suction		
	Discharge		

7.1 FLOW SWITCH.

A	Body	:	Brass
B	Paddle	:	SS 304
C	Bellows	:	Bronze
D	Max. line pressure	:	10 bar
E	Mounting	:	Horizontal

7.2 AIR RELEASE VALVE

A	Type	:	Single ball type, flanged end 150#
B	MOC	:	SS 304
C	Service	:	Water
D	Vacuum	:	Full
E	Vapor	:	N.A.
F	Op. Temperature	:	Ambient
G	Op. Pressure – Min/Max (kg/cm²(g))	:	1 to 7
H	End	:	Flanged RF
I	Flange rating	:	ANSI B16.5,ASA 150#
J	Material of Construction		
	Body	:	SS 304
	Seating	:	13 % Cr Renewable
	Ball	:	Rubber

7.3 NON-RETURN VALVE:

A	Type	:	Check valve, Swing check
B	MOC	:	Cast iron
C	Design standard	:	API 594
D	Dimension Standard	:	ANSI B16.5
E	Service	:	Water
F	Op. Temperature	:	Ambient
G	Op. Pressure – Min/Max (kg/cm²(g))	:	1 to 7
H	End	:	Between Flanges.
I	Flange rating	:	ANSI B16.5, ASA 150#
J	Material of Construction		
	Body	:	IS 210 Gr. FG 260
	Seating	:	13% Cr Renewable.
	Disc	:	ASTM A276 Gr 410
	Hinge	:	ASTM A276 Gr.410
	Trim	:	ASTM A276 Gr.410
	Sealing Ring	:	EPDM
	O Ring	:	EPDM /PTFE
	External surface	:	Epoxy painted
	Special Requirement	:	Valve shall be tested for lower pressure also.

7.4 HYDRANT LANDING VALVE:

A	Type	:	Hydrant landing valve
B	MOC	:	Oblique & Morris pattern (ISI Marked)
C	Design standard	:	IS 5290 (Latest)/Type ‘A ‘& ‘B’
D	Dimension Standard	:	ANSI B16.5
E	Service	:	Water
F	Op. Temperature	:	Ambient

G	Op. Pressure – Min/Max (kg/cm²(g))	:	1 to 7
H	End	:	Inlet Flanged to 80 NB size and Outlet to 63 mm size Female instantaneous coupling with spring plunger lugs
I	Flange rating	:	ANSI B16.5, ASA 150#
J	Material of Construction		
	Body	:	SS304/Brass/Gun metal (MOC As per BOQ)
	Hand wheel	:	Carbon steel
	Hardware	:	Brass
	External surface	:	Epoxy painted

7.5 CONTROLLED PERCOLATED FIRE HOSE PIPES:

A	Type	:	Unlined Flexible
B	MOC	:	Flax Canvas
C	Design standard	:	IS 8423
D	Size	:	63 mm Dia
E	Service	:	Water
F	Length	:	15 M
G	Accessories	:	Pair of 63 mm Dia SS male % female Instantaneous Coupling with Serrated ends to IS 903
H	Test Pressure	:	23 kg/cm2

7.6 RRL FIRE HOSE PIPES:

A	Type	:	“A “ Flexible
B	MOC	:	Reinforced Rubberized Fabric Lined
C	Design standard	:	IS 636 (Latest)
D	Size	:	63 mm Dia
E	Service	:	Water
F	Length	:	15 M

G	Accessories	:	Pair of 63 mm Dia SS male % female Instantaneous Coupling with Serrated ends to IS 903
H	Test Pressure	:	23 kg/cm2

7.7 HYDRANT BRANCH PIPE WITH NOZZLE:

A	Type	:	Standard universal length
B	MOC	:	SS 304
C	Design standard	:	IS 903 (ISI Marked)
E	Service	:	Water
F	Op. Temperature	:	Ambient
G	Op. Pressure – Min/Max (kg/cm²(g))	:	-1 to 12.5
H	Inlet Size & connection	:	63 NB Male instantaneous Coupling
	Nozzle Size & connection	:	50 N.B. Male Inlet Screwed on to Reducing Branch and Having 20 N.B. Jet Spray beveled Nozzle Outlet.
	Test Pressure		21 k/cm2

7.8 MS FABRICATED HOSE BOX:

A	Type	:	Standard universal length
B	MOC	:	MS 16 SWG C.R.C.A. Sheet, fabricated duly anti-corrosive painted.
C	Size	:	600 mm X 750 mm X 250 mm.(External) 600mm X 750 mm X 250 mm (Internal)
D	location	:	Outdoor /indoor installation weather proof construction.
E	Door opening	:	Single or Double leaves, hinged, Glazed & lockable.
F	Glazing of doors	:	3 to 5 mm thick Transparent glass

G	Locking of Doors	:	Universal Type key, with additional key to be provided in one door, leaf Glazed key box which is visible & in front side.

7.9 OS & Y VALVE

A	Type	:	OS & Y Type, Cast iron, END 150#
B	MOC		
	Body	:	IS 210 Gr. FG 260
	Bonnet	:	IS 210 Gr. FG 260
	Disc	:	CA15
	Stem	:	A182 Gr. F304
	Gland Flange	:	Carbon steel -Galvanized
	Gland Packing	:	Grafoil
	Gasket	:	Spring wound SS304 with Grafoil filled.
	Hand wheel	:	Malleable iron
	Hardware	:	A193 Gr.B7/A194 Gr.2H(Galvanized)
C	Design Standard	:	API 600/IS:780
D	Dimension Standard	:	ANSI B16.1
E	Service	:	Water
F	Vacuum	:	Full
G	Op. Temperature	:	Ambient
H	Test pressure As per API 598		
	Body –Hydraulic (kg/cm^2)	:	31
	Seat –Hydraulic (kg/cm^2)	:	23
	Seat–pneumatic (kg/cm^2)	:	7
I	End	:	Flanged, RF
J	Finish	:	Epoxy painted/Fire Red color

7.10 BUTTERFLY VALVE

A	Type	:	Wafer type, Gear operated
B	MOC		
	Body	:	C.I./Ductile Iron ASTM A-536 (MOC as per BOQ)
	Liner	:	EPDM
	Shaft	:	Stainless Steel
	Disc	:	Ductile Iron (Painted)
	Bushing	:	Brass
	O-Ring	:	Nitrile
	Gasket	:	.
	Hand wheel	:	Malleable iron
	Hardware	:	
C	Design Standard	:	API 600/IS:780
D	Dimension Standard	:	ANSI B16.1
E	Service	:	Water
G	Op. Temperature	:	Ambient
H	Test pressure As per API 598		
	Body –Hydraulic (kg/cm^2)	:	31
	Seat –Hydraulic (kg/cm^2)	:	23
	Seat–pneumatic (kg/cm^2)	:	7
I	End	:	Flanged, RF
J	Finish	:	Epoxy painted/Fire Red color

7.11 PRESSURE SWITCH:

A	General		
	Type	:	Differential pressure switch
	set point repeatability	:	±1% of full scale range
	Enclosure	:	Die cast aluminum, epoxy powder coated, gasketed
	Shock	:	****millisecond duration
	Set band	:	Single & dual set point.
	Vibration	:	*** G, 5-500 Hz
	Zero Adjustment	:	Required externally
	Accuracy	:	± 1% of FSD
	Enclosure Classification		Designed to meet enclosure type 4X requirements with M900 option (watertight conduit fitting)
	Switch output		One SPDT snap action switch; switch may be wired "normally open" or
	Process connections		½ ''BSPT(F)
	Pressure range		0 TO 16 KG/CM^2
	Over range protection		130% OF RANGE SPAN
	Electrical rating		15 A 125/250/480 VAC resistive. Electrical switches have limited DC capabilities.
	Weight	:	**
	Electrical connection	:	**
	Pressure equipment Directive, Compliant to PED		
C	ACCESSORIES		
			**
			**

7.12 PRESSURE GAUGE:

A			
	Type	:	Diaphragm/Bourdon Sensing pressure gauge
	Range	:	0-16 kg/cm2
	Set pressure kg/cm^2	:	1 to 5 kg/cm^2 differential setting arrangements
	Dead Band	:	± 0.5 % Adjustable.
	Contact	:	SPDT Snap acting micro switch
	Contact rating	:	2A, at 24VDC
	Process connection	:	½ ''BSPT(M)
	Cable entry		Single black marking on white background
	Accuracy		± 0.5 % of Range
	Housing		Weather proof IP 65
	Service conditions		Water
	Over range protection		130% OF RANGE SPAN
	Blow out disc		REQUIRED(NEOPRENE)
B	MOC		
	Housing	:	Die cast Aluminum, Epoxy painted
	Diaphragm/Bourdon	:	SS 316
	Wetted parts	:	SS 316
A	General		
	Type	:	Bourdon Sensing Pressure Gauge
	Dial Size	:	150 mm
	Case	:	Weatherproof IP-55, Die cast Aluminum
	Glass	:	Toughened, Shatter proof
	Pointer	:	Micrometer type, Aluminum black
	Zero Adjustment	:	Required externally
	Accuracy	:	± 1% of FSD

	Dial		Single black marking on white
	Bezel ring		Screwed type /Bayonet type
	Process connections		½ ''BSPT(M)
	Pressure range		0 TO 16 KG/CM2
	Over range protection		130% OF RANGE SPAN
	Blow out disc		REQUIRED(NEOPRENE)
B	MOC		
	Bourdon	:	SS 316
	Socket	:	SS 316
	Movement	:	
	Case	:	
	Bezel Ring	:	
C	ACCESSORIES		
	SYPHON	:	½ ''BSPT(F)X ½ ''BSPT(M),Pig tail,SS 304
	SNUBBER	:	½ ''BSPT(M)X ½ ''BSPT(F),SS 304

7.13 SPRINKLER:

A	Style	:	Pendent, Upright
B	Nominal K-Factor	:	As per BOQ
C	Nominal Thread Size	:	20 mm BSP or 3/4" NPT
D	Max. Working Pressure:	:	12.5 Bar/175 psi
E	Min. Operating Pressure	:	0.5 Bar/7 psi
F	Temperature Ratings	:	68° C, 80° C, 115° C, 160° C
G	MATERIAL SPECIFICATIONS	:	
	Upright Deflector	:	Bronze per UNS C22000
	Pendent Deflector	:	Bronze per UNS C51000
	Bulb	:	Glass with glycerin solution
	Bulb Nominal Diameter		
	Standard		5.0 mm

	Quick Response		3.0 mm
	Load Screw		Bronze per UNS C65100
	Pip Cap		Bronze per UNS C65100
	Seal		Teflon* tape
	Spring		Beryllium nickel
	Frame		Die cast brass 65-30
	Lodgment Spring:		Stainless steel per UNS S30200
H	Finishes:		Chrome plated
			UL, ULC Listed/ FM Approved

7.14 PIPE & PIPE FITTING SPECIFICATION: -

SL. NO	ITEM	SPECIFICATION	SIZE(NB)
A	Pipes	Galvanized iron Pipes as per IS 1239 part 1, ERW. Heavy plain Ends	25-150
		Galvanized iron Pipes as per IS 3589, minimum 6.3 mm thk, plain ends	200-600
	Ductile Iron pipe	Ductile Iron pipe, K9 Class	25-200
B	Elbows 90^{o}	CS,90^{o} Elbow R=1.5d, socket weld end, Dimension as per ANSI B 16.11 300 Class Rating, Material as per ASTM A105	25-50
		CS,90^{o} Elbow R=1.5d, Plain End, Dimension as per ANSI B 16.9	50-200
C	Elbows 90^{o}	Spec same as above but 45^{o}	25-600
D	Reducers	Reducing coupling, socket weld ends, dimensions as per ANSI B 16.11, 300 Class rating	25-50
		Concentric reducer dimension as per ANSI B 16. 9	25-200
		Fabricated Concentric reducer from IS 3589, ERW pipes, thickness as per pipe thickness	200-600

SL. NO	ITEM	SPECIFICATION	SIZE(NB)
E	Reducers (ECC)	Spec same as above but Eccentric	25-600
F	Equal tee	Equal tee, socket weld ends, dimensions as per ANSI B 16.11 ,300 Class rating	25-50
		Equal tee plain end dimension as per ANSI B 16. 9	25-200
		Equal tee plain end dimension as per ANSI B 16. 9	80-600
G	Unequal tee	Spec same as above but Unequal tee	25-600
H	Coupling(half)	Half coupling dimension as per ANSI B 16.11 300 class material as per ASTM A 105	25-200
I	Coupling(full)	Full coupling dimension as per ANSI B 16.11 300 class material as per ASTM A 105	25-200
J	Nipple (one end threaded)	One end threaded nipple, dimension as per pipe with BSPT Thread And 100 Mm Long, Material is 1239 part 1, ERW, heavy	15-25
K	Nipple (both ends threaded)	Both end threaded nipple, dimension as per pipe with BSPT Thread And 100 Mm Long, Material is 1239 part 1, ERW, heavy	15-25
L	Plug	Plug dimension as per BSPT(M), Material Carbon Steel ASTM A 105	15-25
M	Flanges	Slip on, raised face, serrated finish flange dimension as per ANSI B 16.5, 150 class, Material to IS 2062 Gr.A	15-600
N	Blind flanges	Blind, raised face, serrated finish flange dimension as per ANSI B 16.5, 150 class, Material to IS 2062 Gr.A	15-600
O	Gasket	Nonmetallic ring gaskets, asbestos free 3 mm thk, suitable for insertion between raised face of ANSI B 16.5, 150 class flange.	15-600
P	Nuts	C.S. Black hexagonal headed, Machined Bolts, Fully Threaded with Heavy	All sizes

SL. NO	ITEM	SPECIFICATION	SIZE(NB)
	Bolts	Hexagonal nuts with pair of washer. Dimension to suit IS 1364, material shall be IS 1367Gr.8/8.8 duly galvanized.	All sizes
Q	Protection for underground piping	Wrapping & coating as per IS: 10221 with single coat of 4mm thk. Anticorrosion epoxy primer type	
R	Protection for underground piping	Two coats each of red oxide primer & finish P.O. Red enamel paints, each 75-micron thk.	
S	Paint	SHADE SUITABLE TO IS:5	

7.0 SYSTEM WIRING

GENERAL SPECIFICATIONS FOR CABLE LYING ON CABLE TRAYS:

1. Cables used on the system shall be of 1.1 KV grade, Copper multi stranded conductor, PVC insulated, PVC sheathed, flat / round GI wire armoured, and overall PVC sheathed.
2. Cable identification tags shall be done by ferruling for proper cable identification.
3. Cables shall be neatly arranged on trays and neatly clamped / tied to prevent sagging.

DRAWING OF CONDUCTORS

While drawing insulated armoured cable into the Cable tray/conduit, care shall be taken to avoid scratches and kinks, which may cause breakage of conductors. No joint shall be allowed in the breakage of conductors. No joint shall be shaved off like length of the conductors. Insulation shall be shaved of like sharpening of a pencil and it shall not be removed by cutting it square to avoid depression/cutting of conducting material.

Strands of wires shall not be cut to accommodate and connect to the terminals. Terminals shall have sufficient cross-sectional area to take all the strands.

No wire shall be drawn into any conduit all work of any nature that may cause injury to wire in completed. Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. Where wires are connected to detectors, or panel, sufficient extra length of wires shall be provided to facilitate easy connections and maintenance.

Only licensed supervisors/wiremen shall be employed for cabling and other connected work. Only approved make of cables shall be used. The cables shall be brought to the site in original packing.

SIGNAL CABLE (Armored Cable)

The signal cable shall be of the following specifications:

Cables used on system shall be of 1.1 KV grade, aluminium/Copper stranded, PVC insulated, PVC sheathed, flat / round GI wire armoured, and overall PVC sheathed.

- Wire : Multi strand Copper
- Size : 1 Sq.mm, Multi strand
- No. of conductors : Two (One pair)
- Shielding : Overall Belt Foil Aluminum Polyester Shield.
- Jacket : Chrome PVC

~~**ANNEXURE - 1 – TENDER DRAWINGS**~~

- ~~MJ 437 – FPS – DR – 3100 – SITE PLAN & GROUND FLOOR FPS LAYOUT~~
- ~~MJ 437 – FPS – DR – 3101 – BASEMENT FLOOR FPS LAYOUT~~
- ~~MJ 437 – FPS – DR – 3102 – FIRST FLOOR FPS LAYOUT~~
- ~~MJ 437 – FPS – DR – 3103 – SECOND FLOOR FPS LAYOUT~~
- ~~MJ 437 – FPS – DR – 3104 TERRACE FLOOR FPS LAYOUT~~

CLIENT: M/s. NATIONAL CENTRE FOR CELL SCIENCE	TECHNICAL CONSULTANTS : MJA PHARMATECH PRIVATE LIMITED	LEAD CONSULTANT: M/s. SHRIYATA LIFETECH PVT LTD.,
PROJECT : ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE		DATE : 03.08.2023 REVISION : R0 DOC NO: MJ437 - CR DOC - TDS - 7125
TECHNICAL DATA SHEET FOR COLD ROOM (FOR 2-8°C)		

SI NO	DESCRIPTION	SPECIFICATION	COLD ROOM VENDOR
1	Dimension (External)	As per the Tender Specification	
2	Dimension (Internal)	As per the Tender Specification	
3	Ambinet Temp	40 Deg C	
4	Room Temp (cold room inside)	2-8 Deg C(No RH control)	
5	Product to be stored	Research product	
6	Product incoming temp	30 Deg C	
7	Incoming product qty/ day	~300 Kg	
8	Pull Down time	8 - 10 Hours	
9	Door opening per day	6 times	
10	Material of insulation	To be confirmed by Vendor	
11	Thickness of insulation	To be confirmed by Vendor	
12	Lamination of panels (wall & ceiling)	To be confirmed by Vendor	
13	Type of floor insulation	To be confirmed by Vendor	
14	Thickness of floor insulation	To be confirmed by Vendor	
15	Door details	Flushed Door as per the Tender Specification	
16	Kick Plate	Required	
17	Thickness of door	To be confirmed by Vendor	
18	View panel on door	Required	
19	Ref System & Model	To be confirmed by Vendor	
20	No. of Ref System	1 Working	
21	Total capacity of Refg	To be confirmed by Vendor	
22	Refrigerant	To be confirmed by Vendor	
23	Type of De frost	NA	
24	HP/LP Switch	To be confirmed by Vendor	
25	Control Panel	To be confirmed by Vendor	
26	Condensing unit make	To be confirmed by Vendor	
27	Type of Compressor	To be confirmed by Vendor	
28	Type of condensing unit & model	To be confirmed by Vendor	
29	Stand for condensing unit	Required	
30	No.of condensing unit	To be confirmed by Vendor	
31	Evaporator Make & Model	To be confirmed by Vendor	
32	No.fo Evaporator unit	To be confirmed by Vendor	
33	MOC of Evaporator unit	To be confirmed by Vendor	
34	Electrical panel for ref. System	To be confirmed by Vendor	
35	Type	To be confirmed by Vendor	
36	Temperature Indicator com controller	Required	
37	SMS alert	Required	
38	Type of light fitting	Required	
39	No.of lights	To be confirmed by Vendor	
40	Strip Curtain	Required	
41	Emergency hooter	Required	
42	High / Low temp audiable alarm	Required	
43	Covings	Required	
44	Data Logger	Required	
45	Power supply	will only provide up to control panel, balance cabling in vendor scope	
46	BMS interface / mapping in system	Required	
47	Validation / temp mapping	Required. 72 hours consecutive temperature mapping in load and no load condition, cool down, door opening, power failure & hold over time	
48	Documentation	Required Documents & Drawings 1.As Built Drawings 2. O&M Manuals along with calibration certificates 3.DQ/IQ/OQ/PQ	

DESIGN EVALUATION FOR NCCS BUILDING, PUNE

TECHNICAL REPORT

DHIRENDRA GROUP OF COMPANY

A-3027, OBEROI GARDEN ESTATE, ANDHERI (EAST),

MUMBAI 400072 | EMAIL: info@dgc24.com | www.dgc24.com

JULY 2023

Contents

1. INTRODUCTION

NCCS Building is an RCC-framed structure with B+3 levels, located in Kothrud, Pune. DGC Engineering Pvt. Ltd was approached for conducting the condition assessment of the same building for accommodating additional load on the floors.

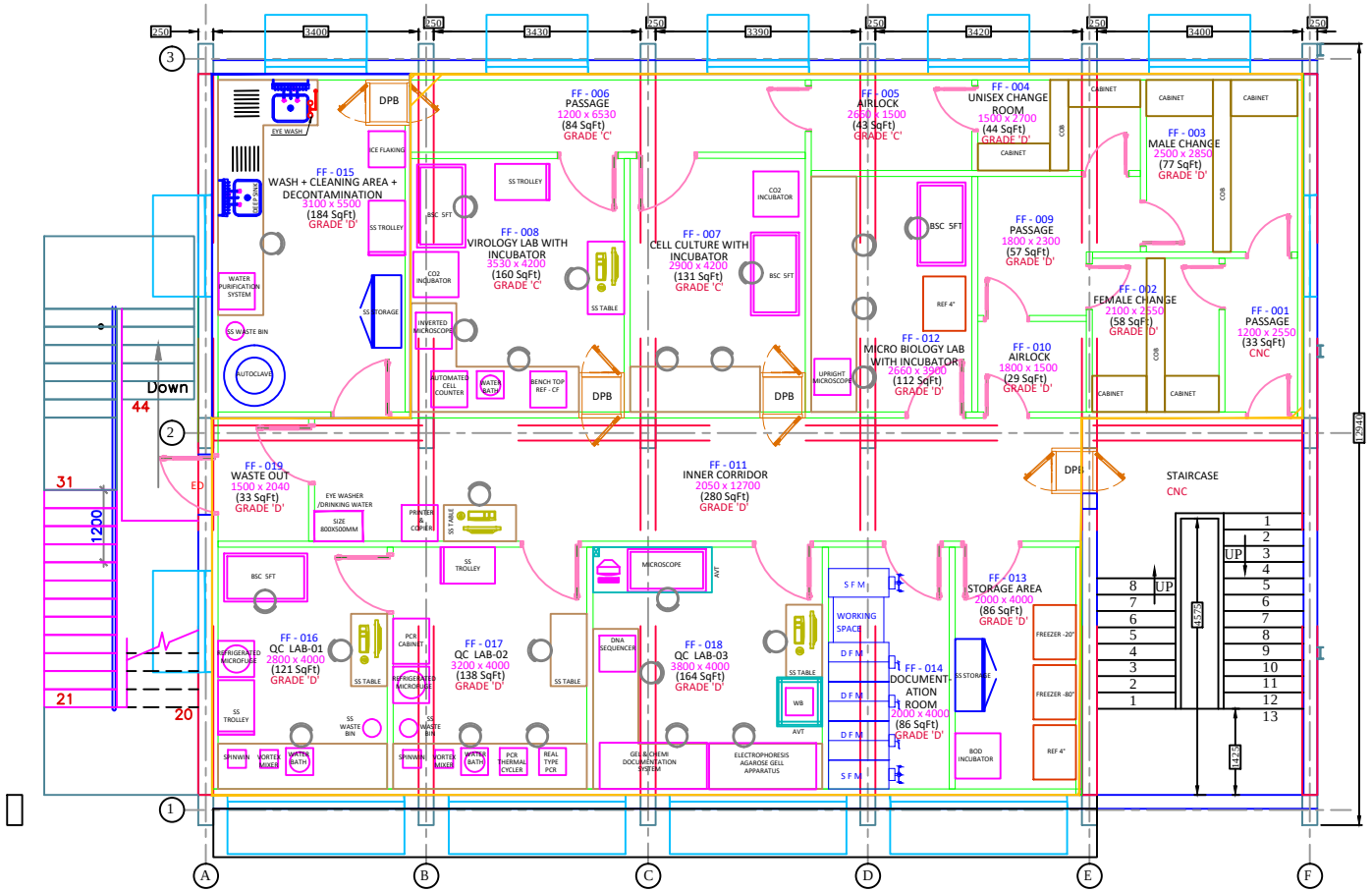
This report presents a structural assessment of the building based on the NDT test results provided by the Client

Figure 1.1: NCCS Building, Pune

1.1 INPUT FROM CLIENT

The following details are obtained from client;

- Drawings of Existing floor level
- NDT Report by KBP (**Annexure I**)



FIRST FLOOR

S E W N

REVISIONS :			
NO	DESCRIPTION	DATE	BY

LEGEND:	
	250 KG/SQMTR
	500 KG/SQMTR

TECHNICAL CONSULTANTS:

MJA PHARMATECH PVT. LTD.,
#45, 1st Floor, 5th Cross, 8th Main Road,
Vasanthanagar, Bangalore - 560 052.
Tel: +91-80-2220 4636/222 84583 /41131518

LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
B-1702, BRIGADE GATEWAY, 26/1, DR. RAJKUMAR ROAD,
MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

FIRST FLOOR IMPOSING LOAD LAYOUT

DATE	27.12.2022	
DRAWN	MD SAIF	
CHECKED	HPP	REVISION
APPROVED	MJA	R0
SCALE	NTS	PAGE - A2
DRAWING NO.	MJ 437 - FFL - 2022	

2. FEA ANALYSIS

As a preliminary step, the building frame analyzed with extra load on the Floor. For Structural analysis, ETABS Software is used. Details of Analysis discussed on this chapter;

2.1 GENERAL DETAILS

2.1.1 Building Configuration

The building consists of B+3 levels

The Conventional beam & slab arrangement is taken as the framing system

2.1.2 Structural Standards and Codes

All structural elements are analyzed in accordance with the applicable requirements and recommendations of the reference codes and standards. They are regarded as minimum criteria and the values specified in this document are adopted where these prove more onerous.

Reference Codes & Standards (latest editions and amendments)

IS: 456-2000	Plain and reinforced concrete - code of practice.
IS 875 part-1	Code of practice for design loads (other than Earth quake) for buildings and structures- dead loads — unit weights of building materials and stored materials.
IS 875 part-5	Code of practice for design loads (other than earthquake) for buildings and structures-special loads and combinations.
IS: 1786 – 2008	Specifications for high strength deformed steel bars and wires.
SP: 16	Design aids for reinforced concrete to I.S: 456- 1978.

2.1.3 Construction Material: -

Concrete shall comply with IS 456:2000. Unless noted otherwise concrete is to be normal-weight, with a typical dry density of 25 KN/m^3.

Compressive Strength As per NDT Report by KBP:

- Columns 22 N/mm^2
- Slabs and Beams 20 N/mm^2

The reinforcement used in the construction is of high strength deformed bars conforming to IS 1786. (**Fe500**).

Column Size (From Dwg provided)	250*500 mm
Longer Span Beam Size (As per NDT Report KBP)	250*750 mm
Shorter Span Beam Size (As per NDT Report KBP)	250*450 mm
Slab Thickness (As per NDT Report DGC)	150 mm

2.2 LOADING:

The building is analyzed for the following basic load cases: -

- Dead Load
- Live Load
- Earthquake Load
- Wind Load

2.2.1 Dead Load: -

The dead load comprises of self-weight of the structure and loading due to finishes and floorings etc. which are permanent in nature. The dead load of self-weight, partitions, ceiling, flooring etc. are applied as either area loads to slabs or line loads to beams.

The following parameters are considered as per IS 875 part – I 1987

Finishes including services load	1.5 KN/m^2
Density of Concrete	25 KN/m^3
Partition walls	1.2 KN/m^2

2.2.2 Live (Imposed) Load:

4.5 kN/m^2 given to all floor levels

1.5 kN/m^2 given to roof level

2.2.3 Earthquake Load:

Zone	III	as per IS 1893 : 2016, Fig.1
Zone Factor	0.16	Table.3, Cl.6.4.2, IS:1893 - 2016
Response Factor	5	Table.9,IS:1893 - 2016: SMRF
Importance Factor	1.0	Table.8, Important Building
EARTHQUAKE LOAD IS DEFINED AND AUTOGENERATED IN ETABS as per IS 1893:2016		

2.2.4 Wind Load:

WIND LOADS ARE DETERMINED FROM IS: 875 (PART 3) – 2015 [Clause 6.3]

Basic Wind Speed, Vb	: 39 m/s
Terrain category	: 1
Building Class	: C
Risk Coefficient (50 years design life)	: k_1 = 1.06
Terrain factor	: k_2 = varies with height
Topography factor	: k_3 = 1.0
Importance factor	: k_4 = 1.0

2.2.5 Load Combinations

The individual members of the frame shall be designed for all desired combinations of loads. These include combinations for limit state of strength of members as well as limit state of serviceability as per IS 456: 2000 and IS 875: 1987 (Part5). The combinations are auto generated in ETABS from the library and are tabulated below:

Limit state of Strength	1.5DL	**Limit state of Serviceability**	DL+LL
	1.5(DL + LL)		DL+EL/WL
	1.2(DL + LL ± EL/WL)		DL+0.8(LL+EL/WL)
	1.5(DL ± EL/WL)		
	1.2(DL+LL)+0.6(EL/WL)		

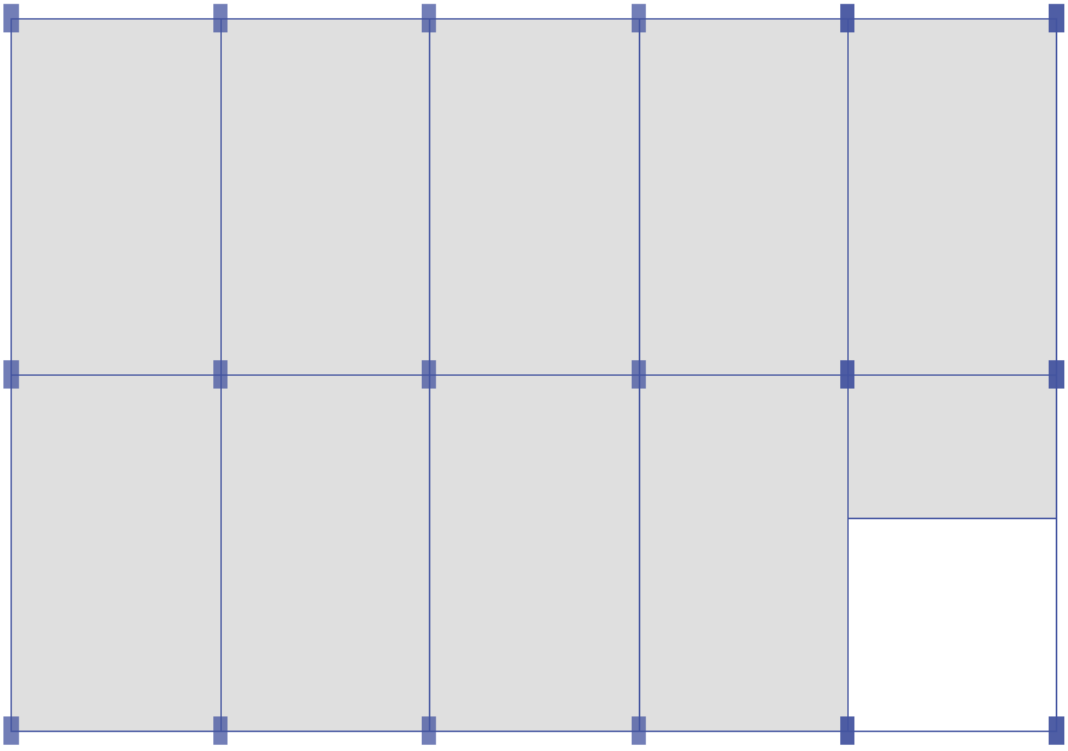
2.3 ANALYSIS & DESIGN

2.3.1 Analysis: -

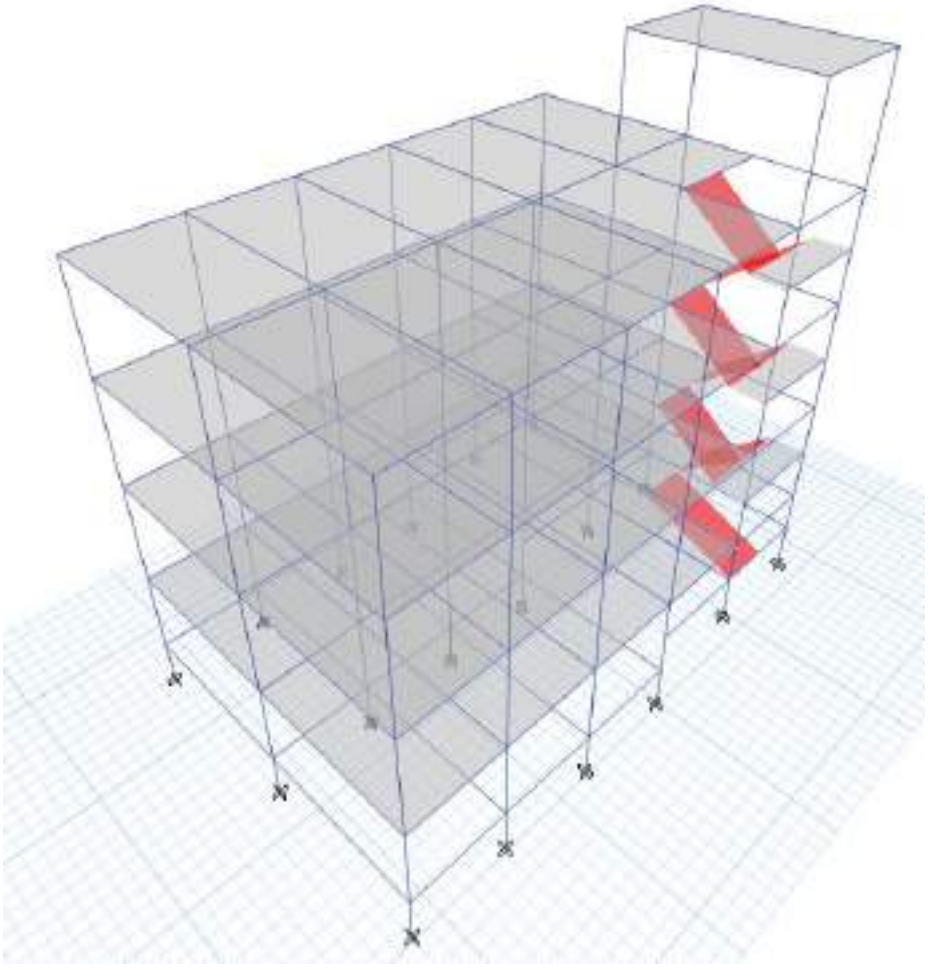
The ETABS 18 software is used to analysis the structure and also to design the columns and beams.

2.3.2 Design Concepts: -

Reinforced cement concrete (RCC) is adopted for the design of all members. The environmental exposure condition for the structure is taken as **"moderate"** as per I.S.456. The fire resistance of the structure is taken as **2 Hrs**. All the covers to the reinforcement bars are taken as to suit the mentioned parameters.



Plan - ETAB Model



3D View of Building - ETAB Model

2.4 ANALYSIS FINDINGS

2.4.1 Columns

All existing columns were checked for updated axial load and moments, which were obtained from ETABS analysis. For design, the grade of concrete considered is M20, and the grade of rebar is Fe500.

From NDT Result,

Column Rebar: 10- 12T

In total 63 columns have failed under the new design loads. Below are the details of the columns that require strengthening:

TABLE 1: NCCS PUNE-COLUMN DESIGN LOAD

Sr. No.	COLUMN GRID ID	COLUMN ETAB ID	LEVEL	EXISTING COLUMN SIZE			% OF STEEL PROVIDED	% OF STEEL REQUIRED (FROM ETAB)
				B	D	H		
				mm	mm	mm	%	%
1	B-1	C2	FOOTING TO BASEMENT	250	500	1500	0.90	1.00
2	C-1	C3	FOOTING TO BASEMENT	250	500	1500	0.90	0.95
3	D-1	C4	FOOTING TO BASEMENT	250	500	1500	0.90	1.05
4	E-1	C29	FOOTING TO BASEMENT	250	500	1500	0.90	1.25
5	A-2	C7	FOOTING TO BASEMENT	250	500	1500	0.90	1.28
6	B-2	C8	FOOTING TO BASEMENT	250	500	1500	0.90	1.40
7	C-2	C9	FOOTING TO BASEMENT	250	500	1500	0.90	1.33
8	D-2	C10	FOOTING TO BASEMENT	250	500	1500	0.90	1.48
9	E-2	C21	FOOTING TO BASEMENT	250	500	1500	0.90	1.75
10	F-2	C27	FOOTING TO BASEMENT	250	500	1500	0.90	1.41
11	B-3	C14	FOOTING TO BASEMENT	250	500	1500	0.90	1.01
12	C-3	C15	FOOTING TO BASEMENT	250	500	1500	0.90	0.97
13	D-3	C16	FOOTING TO BASEMENT	250	500	1500	0.90	0.99
14	E-3	C23	FOOTING TO BASEMENT	250	500	1500	0.90	0.96
15	A-1	C1	BASEMENT TO GF	250	500	3050	0.90	1.01
16	B-1	C2	BASEMENT TO GF	250	500	3050	0.90	1.05
17	C-1	C3	BASEMENT TO GF	250	500	3050	0.90	1.01
18	D-1	C4	BASEMENT TO GF	250	500	3050	0.90	1.00
19	E-1	C30	BASEMENT TO GF	250	500	3050	0.90	1.06
20	A-2	C7	BASEMENT TO GF	250	500	3050	0.90	1.18
21	B-2	C8	BASEMENT TO GF	250	500	3050	0.90	1.36
22	C-2	C9	BASEMENT TO GF	250	500	3050	0.90	1.29
23	D-2	C10	BASEMENT TO GF	250	500	3050	0.90	1.32
24	E-2	C22	BASEMENT TO GF	250	500	3050	0.90	1.69
25	F-2	C28	BASEMENT TO GF	250	500	3050	0.90	1.38
26	A-3	C13	BASEMENT TO GF	250	500	3050	0.90	1.01
27	B-3	C14	BASEMENT TO GF	250	500	3050	0.90	1.06
28	C-3	C15	BASEMENT TO GF	250	500	3050	0.90	1.02
29	D-3	C16	BASEMENT TO GF	250	500	3050	0.90	0.96
30	E-3	C24	BASEMENT TO GF	250	500	3050	0.90	0.97
31	A-1	C1	GF TO 1ST	250	500	3050	0.90	1.19
32	B-1	C2	GF TO 1ST	250	500	3050	0.90	1.13
33	C-1	C3	GF TO 1ST	250	500	3050	0.90	1.09
34	D-1	C4	GF TO 1ST	250	500	3050	0.90	1.14
35	E-1	C5	GF TO 1ST	250	500	3050	0.90	1.18
36	F-1	C6	GF TO 1ST	250	500	3050	0.90	1.12
37	A-2	C7	GF TO 1ST	250	500	3050	0.90	1.24
38	B-2	C8	GF TO 1ST	250	500	3050	0.90	1.10
39	C-2	C9	GF TO 1ST	250	500	3050	0.90	1.07
40	D-2	C10	GF TO 1ST	250	500	3050	0.90	1.17
41	E-2	C11	GF TO 1ST	250	500	3050	0.90	1.30
42	F-2	C12	GF TO 1ST	250	500	3050	0.90	1.11
43	A-3	C13	GF TO 1ST	250	500	3050	0.90	1.21
44	B-3	C14	GF TO 1ST	250	500	3050	0.90	1.16
45	C-3	C15	GF TO 1ST	250	500	3050	0.90	1.11
46	D-3	C16	GF TO 1ST	250	500	3050	0.90	1.09
47	E-3	C17	GF TO 1ST	250	500	3050	0.90	1.16
48	F-3	C18	GF TO 1ST	250	500	3050	0.90	1.17
49	A-1	C1	1ST TO 2ND	250	500	3050	0.90	1.07
50	B-1	C2	1ST TO 2ND	250	500	3050	0.90	0.92
51	D-1	C4	1ST TO 2ND	250	500	3050	0.90	0.97
52	E-1	C5	1ST TO 2ND	250	500	3050	0.90	1.08
53	F-1	C6	1ST TO 2ND	250	500	3050	0.90	0.96
54	A-2	C7	1ST TO 2ND	250	500	3050	0.90	1.12
55	D-2	C10	1ST TO 2ND	250	500	3050	0.90	0.97
56	E-2	C11	1ST TO 2ND	250	500	3050	0.90	0.99
57	F-2	C12	1ST TO 2ND	250	500	3050	0.90	0.91
58	A-3	C13	1ST TO 2ND	250	500	3050	0.90	1.09
59	B-3	C14	1ST TO 2ND	250	500	3050	0.90	0.95
60	C-3	C15	1ST TO 2ND	250	500	3050	0.90	0.91
61	D-3	C16	1ST TO 2ND	250	500	3050	0.90	0.90
62	E-3	C17	1ST TO 2ND	250	500	3050	0.90	0.98
63	F-3	C18	1ST TO 2ND	250	500	3050	0.90	1.03

2.4.2 Beams

Width of longer Span Beam (As per NDT KBP)	=	250 mm
Depth of longer Span Beam (As per NDT KBP)	=	750 mm
Reinforcement provided at bottom (As per NDT KBP)	=	3-16T
Area of Reinforcement provided at bottom	=	603 mm^2
Concrete cover (As per NDT)	=	30 mm

Existing Moment Capacity of Beam at Midspan

$$M = 0.87 f_y A_{st} d(1 - A_{st} f_y / bd f_{ck})$$

M_b = 173 kN-m

BMD of Beam from ETAB Analysis

Design Moment at Midspan of beam from Analysis (Grid E1-E2) = 96.7 kN-m

Design Moment is less than Capacity.

2.5 DESIGN CHECK FOR SLAB

Slab designed for additional load. The thickness and existing rebar details were determined using core cutting

Grade of concrete (As per NDT)	=	M20	
Grade of steel (Assumed for a Conservative design Side)	=	Fe415	
Area of steel Provided (Main Bar-10T @ 120)	=	654.00	mm^2
Area of steel Provided (Distribution Bar-8T @ 250)	=	201.00	mm^2

2.5.1 Type of slab

Centre to centre distance of longer span,	Ly =	6200.00	mm
Centre to centre distance of shorter span,	Lx =	3650.00	mm
Ly/Lx	=	1.7	

Therefore, it is a two-way slab of Two Adjacent edge discontinues

2.5.2 Load on slab

Thickness of slab	=	150.00	mm
Clear cover		25.00	mm
Since 10 mm dia bars Provided;			
Effective cover	=	120.00	mm
Weight of slab	=	3.75	KN/m^2
Super imposed dead load	=	1.50	KN/m^2
Live load	=	4.50	KN/m^2
Partition Wall Load	=	1.20	KN/m^2
Total design load = 1.5*(3.75+1.5+4.5+1.2)	=	16.42	KN/m^2

Refer table 27 of IS 456:2000 and read out the moment coefficients

	a_x	a_y
+ve moment at midspan	0.1112	0.0388

$M_{ux}(+ve) = a_x \times W_u \times L^2_{ex}$ = 24.32 KNm

$M_{uy}(+ve) = a_y \times W_u \times L^2_{ex}$ = 8.49 KNm

2.5.3 *Required Rebar As per Design Moment*

Area of rebar required at bottom along shorter Direction = 630.81 mm^2

Area of rebar required at bottom along Longer Direction = 220.89 mm^2

2.5.4 *Check for Existing Capacity of Slab*

Area of steel Provided (Main Bar-10T @ 120) = 654.00 mm^2

Area of steel Provided (Distribution Bar-8T @ 250) = 201.00 mm^2

$$M_b = 0.87 f_y A_{st} \mathrm{d}(1 - A_{st} f_y / \mathrm{bd} f_{ck})$$

Moment capacity of section at bottom along shorter Direction = 25.14 kNm/m

Moment capacity of section at bottom along Longer Direction = 7.75 kNm/m

2.5.5 *Check for Deflection (IS.456.2000)*

span to depth ratio required for continues slab (cl.23.1) = 26.00

Modification factor for Existing rebar (Figure 4) = 1.2

Permissible limit for Span to depth ratio (26*1.2) = 31.2

Actual span to depth ratio (3650/120) = 30.42

Hence within the permissible limit

2.6 DESIGN CHECK FOR FOOTING

Following 4 nos of footings checked for new axial load and results are discussed below;

Sr. No.	GRID ID	EXISTING FOOTING SIZE AS PER NDT BY DGC		Design Axial Load from Column (ETAB Result)	SBC	Required Area of Footing	Provided Area of Footing	Size Check
		L	B					
		mm	mm	(DL+LL)	kN/m^2	m^2	m^2	
1	B2	2200	1310	1254	600	2.30	2.88	OK
2	C2	2500	1300	1187	600	2.18	3.25	OK
3	D2	2500	1590	1317	600	2.42	3.98	OK
4	B1	1800	1310	851	600	1.56	2.36	OK

2.6.1 Footing Check for Shear

From NDT Report by DGC, for the footing under column on grid A1;

Length of Footing (L)	=	1400 mm
Breadth of Footing (B)	=	1000 mm
Average Depth of Footing (d)	=	325 mm
Reinforcement Details	=	10T @ 100
Average Compressive Strength of Concrete	=	21 MPa

From Etab Analysis

Axial Load from Column (DL+LL)	=	685 kN
Safe Bearing Capacity of soil	=	600 kN/m^2

Considering 10 % for Self weight + Back fill

Bearing Pressure	=	685*1.1/1.4*1.0
	=	5385 kN/ m^2 <600
Factored Bearing Pressure	=	538.5*1.5
	=	807.71kN/ m^2

check for one way shear

shear at a distance 'd' from column face

Cover for footing	=	80.00	mm
For 10 mm dia bars for reinforcement			
effective cover of footing (325-80-5)	=	240	mm

Required Shear Capacity of Footing

$$\zeta v = (0.808 \times 1000((1400 - 500)/2 - 240))/(1000*240)$$

ζv = 0.70 N/mm^2

Percentage of steel provided is 0.33

ζc for M20 concrete (Table 19 IS 456.2000)	=	0.40	N/mm^2

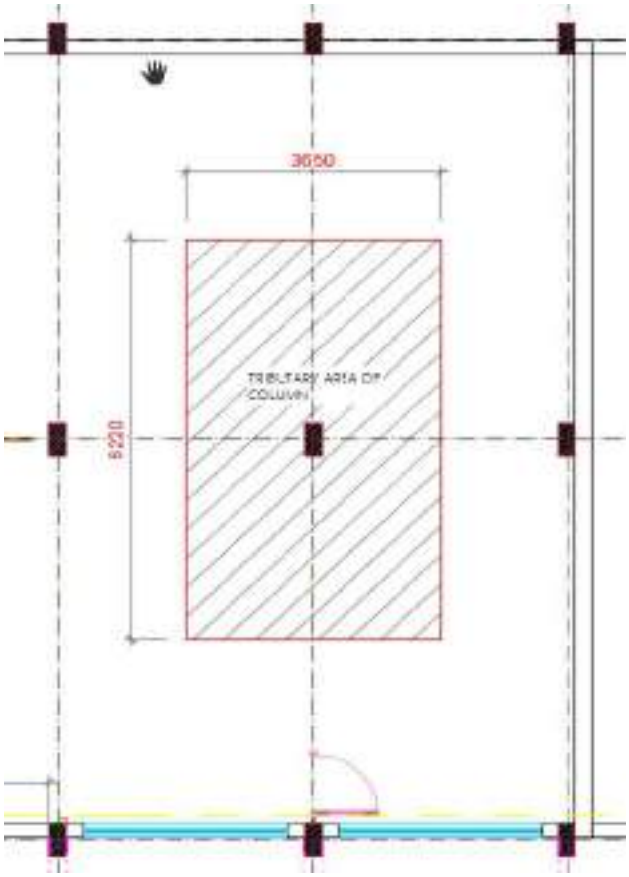
Hence Footing not safe in shear

Percentage of deficiency in Shear = 75 %

2.7 EXISTING LOAD CARRYING CAPACITY OF BUILDING

To determine the load-carrying capacity of a building, we calculated and assessed the maximum load that an interior column can support. This evaluation was conducted in accordance with the existing concrete grade and reinforcement specifications, ensuring compliance with design requirements

2.7.1 Calculation of Loads on Interior Column



Tributary Area of Column	=	22.70	m^2
height of Column	=	3.85	m
Weight of slab	=	3.75	kN/m^2
Super imposed dead load	=	1.50	kN/m^2
Partition wall load	=	1.20	kN/m^2

Maximum Live Load on Floor	=	1.20	kN/m^2
Live Load on Roof	=	1.50	kN/m^2
Self-weight of Beam (0.25*(0.75-0.15)*25*(3.65+6.22)	=	37.01	kN
No of Floors	=	4.00	
Total Axial load on Colum Due to SDL (22.7*1.5*4)	=	136.2	kN
Total Axial load on Colum Due to Partition wall Load (22.7*1.2*3)	=	81.72	kN
Total Axial load on Colum Due to Floor Live Load (22.7*1.2*3)	=	81.72	kN
Total Axial load on Colum Due to Roof Live Load (22.7*1.5*1)	=	34.05	kN
Total Axial load on Colum Due to Slab Self weight (22.7*3.75*4)	=	340.5	kN
Total Axial load on Colum Due to Beam Self weight (37.01*4)	=	148.04	kN
Total Axial load on Colum Due to Self-weight (0.25*0.5*3.85*25*4)	=	48.12	kN
Total Design Axial load = 1.5*(136.2+81.72+81.72+34.05+340.5+148.04+48.12)	=	1306	kN

2.7.2 Design Check for Column

Column is Designed for a axial Load of 1306 kN with M22 grade of concrete and existing reinforcement (10-12T) results discussed below;

SPREADSHEET OF DESIGN OF RECTANGULAR COLUMN SECTION BY LIMIT STATE METHOD for AXIAL COMPRESSIVE LOAD & BIAXIAL BENDING MOMENTS, INCLUDING SLENDERNESS EFFECT, AS PER IS:456-2000

Calculates range of safe loads for a Column Section with given Concrete grade and Reinforcement and checks adequacy of the section for the given loads.

NOTES FOR USERS:
1. Figures and text in white cells only are to be filled as inputs. For any case without inputs, inputs for that case are to be left blank by using 'Delete' key.
2. Concrete grade can be any grade as per IS:456-2000.
3. Yield strength of steel, fy = 415 N/mm^2 or 500 N/mm^2 for HYSD bars.
   = 240 N/mm^2 or 250 N/mm^2 for M.S. bars.
4. For notes on input preparation, refer to worksheet on 'Notes'.

Column Dimensions:

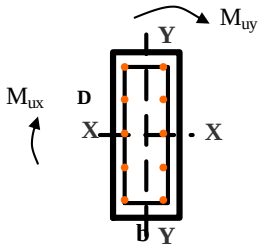
Breadth, 'b' =	250	mm
Depth, 'D' =	500	mm
Concrete Grade =	M 22	
Yield Strength of Steel, fy =	500	N/mm^2
Concrete Cover to main bars =	40	mm

Details of Reinforcement:

Diameter of bars =	12	mm
No. of bars on 250 mm face =	2	
No. of bars on 500 mm face =	5	
Total number of bars =	10	

Total A_{st} = 1130 mm^2

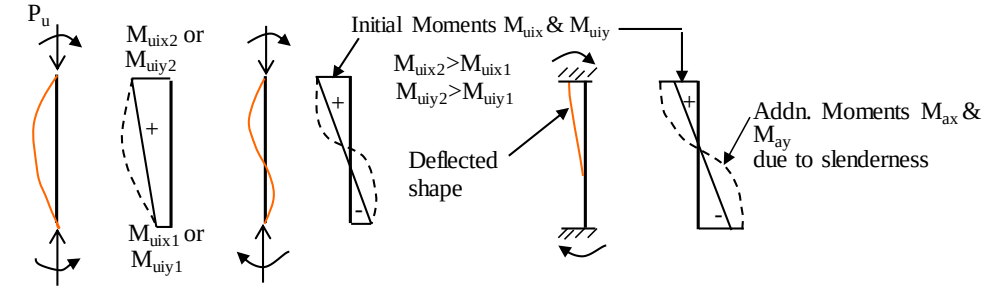
Percentage of Reinforcement = 0.904 < 4% O.K.



COLUMN SECTION

(Max. nos. of bar that can be shown in the section at each face =6 only)

Col. Mk.	Applied Ultimate Loads (See figures on next page) Axial Load Pu (kN)	Initial Moment M_{uix}(kNm) $M^*_{uix1(+ or -)}$	$M_{uix2\ (+ only)}$	Initial Moment M_{uiy}(kNm) $M^*_{uiy1(+ or -)}$	$M_{uiy2\ (+ only)}$	Effective Length l_{ex} (m)	l_{ey} (m)	Unsupported Length l (m)	Column Type Braced or Unbraced
C1	1306	0		0		2.503	2.503	3.850	Braced
									Braced



For calculations of Final Design Moments, see worksheet on 'Slenderness eff.'.

Summary of Results:

Col. Mk.	Axial Load (kN)	Final Design Moments M_{ux}(kNm)	M_{uy}(kNm)	Permissible Moments M_{ux1}(kNm)	M_{uy1}(kNm)	Max. Tensile Stress in Steel (N/mm^2) f_{sx}	f_{sy}	$\left[\frac{Mux}{Mux1}\right]^{\alpha_n}+\left[\frac{Muy}{Muy1}\right]^{\alpha_n}$ to be less than 1.0	Status
C1	1306	31.82	26.12	63.08	32.21	62.15	0.00	0.919	Section O.K.

So maximum Load carrying Capacity of Floor for Existing Building Condition is

1.2+1.2= **2.4 kN/m^2**

3. CONCLUSION

Based on the detailed design assessment for the required loading, following are the conclusions drawn.

- The slab requires nominal flexural strengthening at the bottom along Longer directions to withstand 4.5 kN/m^2 live load.
- Columns require strengthening for their axial and moment capacity represented in terms shortfall in Ast required (refer table no. 1). However, the percentage shortfall is ranging from 0.91 to 1.75
- Footing required to be strengthened for their shear capacity. The percentage requirement is 75%
- Maximum Load Carrying capacity of floor for Existing Building Condition is 2.4 kN/m^2

3.1 Recommendations

- The distress in the structure such as cover delamination of RC member, corrosion in reinforcing bar and honeycombs if in the structural members should addressed with appropriate methods before strengthening the element.
- The short fall of reinforcement in longer span found in the analysis should be balanced by strengthening the slab using CFRP method of strengthening.
- The capacity of the columns in terms of axial and moment for the required floor load increment shall be achieved by CFRP wrapping.
- Footings are failing under shear criteria. it can be strengthened by RCC jacketing over the existing footings.

ANNEXURE 1: NDT REPORTS

DIAGNOSTIC EVALUATION TO ASSESS PHYSICAL CONDITION OF NATIONAL CENTRE FOR CELL SCIENCE (NCCS)

KOTHRUD, PUNE

TECHNICAL REPORT

JULY 2023

M/s DGC ENGINEERING PVT.LTD.

Office Address: - A-3030, Oberoi Garden Estate,
Besides Chandivali Studio,
Powai,
Andheri (East), Mumbai-400072.
Email: info@dgc24.com / www.dgc.com

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1. INTRODUCTORY REMARKS

DGC Engineering Pvt. Ltd was approached for conducting the condition assessment of National Centre for Cell Science (NCCS) Complex, Pune University Road, Ganeshkhind, Pune, Maharashtra.

Features to be noted:

- It is RCC frame structure mainly used for lab research.
- It is a 30 years old structure, having soft storey as a ground floor with 2 storeys above.
- All the floors are connected by stairs with proper orientation of doors and windows for ventilation and all the rooms are detailed in accordance with the research centric environments.

The structures have shown signs of distress in the reinforced concrete members. It was, therefore decided to carry out a detailed assessment of the building to have an expert technical opinion on their current structural and sub-surface soil conditions and suggest suitable remedial measures in the deficient areas.

The diagnostic evaluation to assess the physical condition of the building was carried out and all the structural elements were thoroughly inspected. The stages for diagnostic evaluation involve various Non-Destructive Testing following the IS Codes.

2. SCOPE OF WORK

The extent of distress in the reinforced concrete structural members is quantified using following test as per the Indian Standards as below.

- Rebound hammer test ascertains the compressive strength of concrete (as per IS 516 part-5/ sec-4).
- UPV testing to ascertain the quality of concrete in terms of density, homogeneity and uniformity of concrete structures (as per IS 516 part-5/ sec-1).
- Core testing ascertain the actual concrete compressive strength (as per the provisions of IS:1199 and IS:516).

- Rebar mapping test for locating and inspecting the reinforcement, spacing, initiation of spalling and cover for the desired structural member.
- Foundation testing (Ground Penetrating Radar Testing) is used to detect subsurface objects, changes in material, voids and cracks.
- Analysis of foundation to determine the exact condition of the footing along with the reinforcement detailing of bottom mesh above PCC bed and footing reinforcement.
- Soil bearing capacity test performed to determine the current bearing capacity of the soil, type of soil, additional precautionary measure to strengthen the foundation to distribute the load on full area of soil underneath will be taken after SBC test.
- Investigate the deterioration of the structural health of the structure based on the above NDT tests and visual inspection.
- Submission of a detailed report on the structural condition of the structure and recommend appropriate remedial measures.

3. DETAILS OF TEST PORTAL

DIAGNOSTIC EVALUATION TO ASSESS PHYSICAL CONDITION OF NATIONAL CENTRE FOR CELL SCIENCE (NCCS)		
SR.NO	**DESCRIPTION OF TEST PERFORMED**	**NO.OF POINTS**
1.	Rebound Hammer Test	10
2.	Ultrasonic Pulse Velocity Test	10
3.	Core Test	02
4.	Rebar Mapping	05
5.	Foundation Testing (Ground Penetrating Radar Testing)	02
6.	Analysis of foundation	02
7.	Soil Bearing Capacity Test	02
8.	Structural Analysis	01

4. SITE INSPECTION AND TESTING

4.1 Rebound Hammer Test:

A rebound hammer test is done to find out the likely compressive strength of concrete by using a rebound hammer as per IS 516 (Part 5 sec 4): 2020. The underlying principle of the rebound hammer test is "the rebound of an elastic mass depends on the hardness of the surface against which its mass strikes". When the plunger of the rebound hammer is pressed against the surface of the concrete, the spring-controlled mass rebounds and the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and therefore, the rebounds were taken to be related to the compressive strength of the concrete. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index. The compressive strength can be read directly from the graph provided on the body of the hammer.

The objective of the Rebound Hammer Test:

As per the Indian code IS 516 (Part 5 sec 4): 2020, the rebound hammer test has the following objectives:

- To determine the compressive strength of the concrete by relating the rebound index and the compressive strength.
- To assess the uniformity of the concrete.
- To assess the quality of the concrete based on the standard specifications.
- To relate one concrete element with another in terms of quality.
- Rebound hammer test method can be used to differentiate the acceptable and questionable parts of the structure or to compare two different structures based on strength.

4.2 Ultrasonic Pulse Velocity

This test helps in assessing the quality of concrete. The time of travel for an ultrasonic pulse through a given path length of concrete is measured. For this purpose, two probes (transducers) are used one transmitting and the other receiving.

Thus,

Ultrasonic Pulse Velocity (UPV) = Path Length/travel time (1)

It is best to have the two probes on opposite faces of concrete members. Thus, the signal passes through the entire thickness of the member. This is the direct (D) method of testing and the same was used for the investigations of the RCC elements. On the other hand, when only one face of the structural element is available the two probes are kept on the same inspected face. This is the indirect (ID) method and the

same was used when both sides of the reinforced concrete member were not accessible.

The indirect method is not as efficient as the direct method due to reduced signal amplitude and the test results are greatly influenced by the surface layers of concrete which may have different properties from that of concrete inside the structural member. As per IS 516 (Part 5 sec 1): 2018, the measured indirect velocity is invariably lower than the direct velocity on the same concrete element. This difference may vary from 5 to 20 percent depending largely on the quality of the concrete under test. The UPV depends on the quality of concrete and is affected by all its ingredients.

The IS 516 (Part 5 sec 1): 2018 uses only qualitative interpretation as given in Table 4.2

Table 4.2 Concrete Quality Grading Based on Ultrasonic Pulse Velocity Measurements as per IS 516 (part 5 sec 1):2018

Sr. No.	**The average value of pulse velocity by cross-probing (km/s)**	**Concrete quality grading**
a)	Below 3	Poor
b)	3 to 3.75	Doubtful
c)	3.75 to 4.4	Good
d)	Above 4.4	Excellent

4.3 Core Test:

Code of Reference: IS 456, IS 516, IS 1199, BS 1881 Part 120.
70mm diameter cores are taken on-site using state-of-the-art core cutting machines. The cover meter is used to locate the reinforcement steel before core cutting. This prevents structural damage to the RCC member by avoiding the reinforcement. These cores are dressed in our lab and tested using standard compression testing methods to determine the compressive strength and arrive at the equivalent cube strength of concrete.

Test basis:
A core sample is the actual representation of the material used in the structural element. When processed and subjected to load, it fails at a particular load, giving a fair idea of its compressive strength.

Figure 1: Core cutting machine sample

Figure 2: Extracted core

` **Applications**

- Assessment of strength.
- Study of aggregates used in the mix design.
- Assessing probable causes of failures/problems.

Procedure

Step1: Reinforcement Mapping.

By using a special instrument, based on eddy currents, the reinforcements are mapped in the structural member.

Step 2: Core cutting.

Cores are taken using special diamond cutters of 70 mm diameter. Locations are selected to avoid steel to minimize the damage to the structure.

Step 3: Dressing.

The edges of the core are smoothened using grinding and cutting wheels and epoxy mortar is applied on both sides for capping. This ensures that the area of the end is approximately 90% of the axis and is within 0.05 mm of plainness.

Step 4: Immersion in water

The core samples are immersed in water for 48 hours. The cores are weighed before and after immersion.

Step 5: Compression testing. The cores are then subjected to compression forces on a compression testing machine. The breaking point is observed.

Step 6: Reporting Based on the lab report, sizes of the core, etc. equivalent cube strength are calculated for the concrete by applying necessary correction factors. The density, core strength, and equivalent cube strength are reported.

Influencing factors:

- Core diameter and length (h / d ratio)
- Proper capping and hydration of the cores as per IS code.
- Old/new/Mixed (jacketed) concrete.

4.4 Rebar Mapping:

Rebar mapping is an ideal system for locating and inspecting the reinforcement without damaging the existing structure. The system is a quick test method to examine the spacing, initiation of spalling and cover for the desired structural member. The test is the best solution to gather information for the multi-layer reinforcements.

4.5 Foundation testing (Ground Penetrating Radar Testing):

The **Ground Penetrating Radar (GPR)** method as applied to foundation testing is primarily used to map rebar in foundation tops and to measure the depths of abutments, mats, spread footings, and other relatively shallow concrete foundations. The method can also be used to locate and map shallow buried foundations without excavation. The GPR method receives and measures the reflections of radio waves sent down through the soil or concrete. These waves bounce off of embedded objects such as rebar, and off of the foundation top and/or bottom if it is not deeper than the maximum penetration depth of the antenna being used. The method can be used to determine both the depth and location of reflectors within the foundation.

Another application of the GPR method to foundation testing is Borehole GPR, where a borehole-type antenna is used to look outward from the borehole to examine the material surrounding it, including any nearby foundations. This application of GPR can be used to measure foundation depth and offset distance from a borehole.

It should be noted that GPR, unlike X-Raying, does not require any evacuation or other safety precautions because the electromagnetic field produced is not harmful.

4.6 Soil Bearing Capacity of Soil (Standard Penetration Test):

1) The Standard penetration test (SPT) is widely used to get the bearing capacity of soil directly at a certain depth. The consistency of clayey soils can often be estimated from this test.
2) The number of blows required for 12 inches penetration resistance of the soil. It is generally referred as the 'N' value and measured in blows/unit penetration.
3) When a borehole is extended to a predetermined depth, the drill tools are removed, and the sampler (split spoon) is lowered to the bottom of the borehole.
4) The sampler is driven into the soil, by hammer blows to the top of the drill rod. The standard weight of the hammer is 62.3 N the number of blows required for spoon penetration of three "6" inches (15 cm) intervals is recorded.
5) The number of blows required for the last two intervals are added to give the standard penetration number at that depth.

   SPT process as follows:

   - Erect the tripod over the test hole and assemble the unit.
   - Allow the spoon to rest on the bottom of the hole.
   - Drive the spoon with blows from the hammer falling 75 cm (30 inches), until either 45 cm (18 inches) have been penetrated or 100 blows have been applied.
   - Record the number of blows required to effect each 15 cm (6 inches) of penetration. The first 6 inches is considered as seating drive.
   - The number of blows required for the second and third 15 cm (6 inches) of drive added is recorded as the penetration resistance value N of the soil.

4.7 Analysis of foundation:

The Analysis of foundation is done to determine the current condition of sub-structure which comprises of classification of footing, the bottom reinforcement mesh their reinforcement details along with the condition of the soil underneath which sustain ultimately all loads coming from super structure. The foundation gets deteriorated or loses its functional capacity due to loss of bearing capacity of soil, increase in water table, aging which required proper remedial measures. If there is need to expand the floors above the footing need to be strengthen that's when analysis of foundation comes into play.

5.NON-DESTRCUTIVE TESTING RESULTS

5.1 Rebound Hammer Test Results:

Sr. No	Level	ID	Structural Member	Impact	Remark	Compressive Strength (MPa)
1.	Stilt	A1	Column	Horizontal	-	43.33
2.	Stilt	B1	Column	Horizontal	-	47.50
3.	Stilt	C1	Column	Horizontal	-	49.33
4.	Stilt	D1	Column	Horizontal	-	45.00
5.	Stilt	F1	Column	Horizontal	Hollow	37.50
6.	Stilt	A5	Column	Horizontal	-	46.50
7.	Stilt	C5	Column	Horizontal	Hollow	35.83
8.	Stilt	D5	Column	Horizontal	-	45.33
9.	Stilt	E5	Column	Horizontal	-	42.67
10.	Stilt	F5	Column	Horizontal	-	35.67

5.2 Ultrasonic Pulse Velocity Test Results:

Sr. No.	Level	ID	Impact	Element	Velocity (km/s)	Quality of Concrete
1.	Stilt	A1	Indirect	Column	2.42	**Poor**
2.	Stilt	B1	Indirect	Column	3.68	Doubtful
3.	Stilt	C1	Direct	Column	3.57	Doubtful
4.	Stilt	D1	Direct	Column	3.49	Doubtful
5.	Stilt	F1	Indirect	Column	2.40	**Poor**
6.	Stilt	A5	Indirect	Column	3.65	Doubtful
7.	Stilt	C5	Indirect	Column	3.05	Doubtful
8.	Stilt	D5	Indirect	Column	2.50	**Poor**
9.	Stilt	E5	Indirect	Column	1.49	**Poor**
10.	Stilt	F5	Indirect	Column	3.47	Doubtful

5.3 Core Test Results:

Sr. No	ID	Element	Length (mm)	Diameter (mm)	Weight (g)	Load (kN)	Corrected Strength (MPa)	Equivalent Cube Comp. Strength (MPa)
1	F1	Footing	119.13	68.13	1.083	64	18.07	22.6
2	F2	Footing	121.28	68.23	1.047	60	16.85	21.1

5.4 Analysis of Rebar Mapping:

1) Rebar Mapping of C1:

Element	Floor	Diameter of bar in longitudinal direction	No of Bars	Spacing of bar in X-direction (Main Bar)	Diameter of bar in transverse direction	Spacing of bar in Y-direction (Stirrups)	Cover to the reinforcement
Column (C1)	Ground	12 mm	8	80mm	8 mm	150mm	45 mm

2) Rebar Mapping of C2:

Element	Floor	Diameter of bar in longitudinal direction	No of Bars	Spacing of bar in X-direction (Main Bar)	Diameter of bar in transverse direction	Spacing of bar in Y-direction (Stirrups)	Cover to the reinforcement
Column (C2)	Ground	12 mm	8	80mm	8 mm	150mm	55 mm

3) Rebar Mapping of D1:

Element	Floor	Diameter of bar in longitudinal direction	No of Bars	Spacing of bar in X-direction (Main Bar)	Diameter of bar in transverse direction	Spacing of bar in Y-direction (Stirrups)	Cover to the reinforcement
Column (D1)	Stilt	12 mm	10	90mm	8 mm	150mm	50 mm

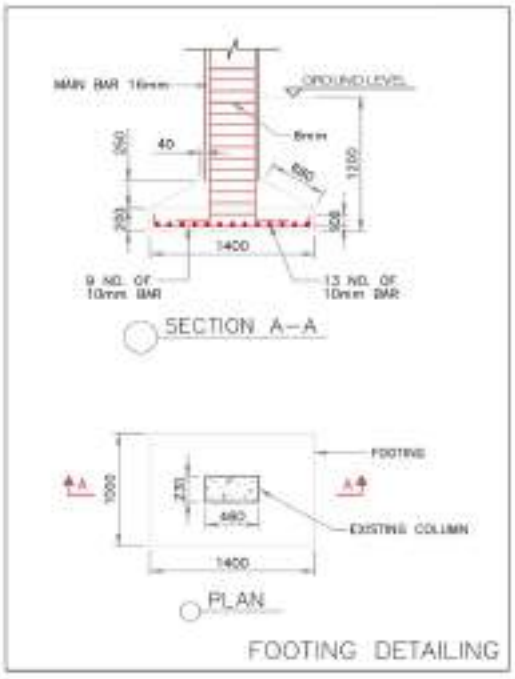
4) Rebar Mapping of E1:

Element	Floor	Diameter of bar in longitudinal direction	No of Bars	Spacing of bar in X-direction (Main Bar)	Diameter of bar in transverse direction	Spacing of bar in Y-direction (Stirrups)	Cover to the reinforcement
Column (E1)	Stilt	12mm	10	100 mm	8 mm	150mm	55 mm

5) Rebar Mapping of D2:

Element	Floor	Diameter of bar in longitudinal direction	No of Bars	Spacing of bar in X-direction (Main Bar)	Diameter of bar in transverse direction	Spacing of bar in Y-direction (Stirrups)	Cover to the reinforcement
Column (D2)	Stilt	12 mm	10	95mm	8 mm	150mm	45 mm

5.5 Analysis of Footing:



- Column Size – 230mm x 460mm
- Main Longitudinal Reinforcement – 16mm
- Lateral Ties – 8mm
- Footing Size – 1.4 m x 1m
- Depth of Foundation below ground level – 1.2 m

Bottom mesh of footing details

- Main bar – 9 no's of 10 mm bars @ 100mm c/c
- Distribution bar - 13 no's of 10 mm bars @ 100mm c/c
- Cover – 80mm
- Up to Column face – 250mm
- Depth – 200mm
- For Formwork placing width – 40mm

5.6 Geotechnical Investigation:

5.1 Sub Soil Profile:

Sub-soil conditions described below are based on drilling and sampling in two boreholes. The stratification can be classified in various layers as detailed below. The layers may not be in the same order as mentioned. In the following table thickness of each layer along with RQD range is reported.

A. For BH – 1:

Layer I: Filling material layer consists of rock and concrete pieces. This layer was encountered from ground surface existing at the time of investigation up to 1.2m depth.

Layer II: Highly To Moderately Weathered Brownish/Greyish Amygdaloidal/Compact Basalt. This layer was encountered below layer I up to 4.5m depth. Recovery (Rec.) varies from 40% to 72% and Rock Quality Designation (RQD) varies from 0% to 36%. Based on RQD quality of rock can be considered as poor. Unconfined compression strength varied from 119kg/cm2 to 268kg/cm2. Based on strength the rock can be classified as average.

Layer III: Slightly Weathered to Fresh Compact/Amygdaloidal Basalt

This layer was encountered below layer II up to 10.0m that is the maximum depth reached. Recovery (Rec.) was 81 to 99% and Rock Quality Designation (RQD) varies from 76% to 99%. Based on RQD quality of rock can be considered as good. Unconfined compression strength varied from 245Kg/cm^2 to 431Kg/cm^2. Based on strength the rock can be classified as average.

B. For BH – 2:

Layer I: Filling Material Layer consists of concrete pieces

This layer was encountered from ground surface existing at the time of investigation up to 1.2m depth.

LayerII: Highly to Moderately Weathered Brownish/Greyish Amygdaloidal/Compact Basalt. This layer was encountered below layer I up to 10.0m depth. Recovery (Rec.) varies from 23% to 72% and Rock Quality Designation (RQD) varies from 0% to 62%. Based on RQD quality of rock can be considered as very poor to fair. Unconfined compression strength varied from 102Kg/cm^2 to 239Kg/cm^2. Based on strength the rock can be classified as average.

Table 5.6.1: Stratification Observed in Boreholes along with Thickness

Borehole No.	Layer I	Layer II		Layer II	
	Thick	Thick	RQD	Thick	RQD
BH 1	1.2	3.3	0-36	5.5	76-99
BH 2	1.2	8.8	0-62	-	-

Following table defines the quality of rock mass (IS 13365 – Part II: 1992 clause 3.1.1).

Table 5.6.2: Relation between RQD and In-Situ Rock Quality

RQD Designation	RQD (%)
Excellent	91 to 100
Good	76 to 90
Fair	51 to 75
Poor	26 to 50
Very Poor	0 to 25

5.2 Ground Water Level:

Table 5.6.3: Ground Water Level Intruded in Borehole

Borehole No.	Depth (M.)
BH 1	4.5
BH 2	6.0

5.3 Engineering Analysis:

Table 5.6.4: Net Safe Bearing Capacity for Foundation Placed on Weathered Rock

Borehole No.	Location	Depth of Foundation (m)	Net Safe Bearing Capacity (T/m^2)
BH 1	Footing 1 – F1	1.5	60
		3.0	80
		4.5	120
		6.0	180
BH2	Footing 2 – A5	1.5	35
		3.0	60
		4.5	85
		6.0	100

1. BH-1 (Depth of Foundation 3.0m)

Table 5.6.5: Parameters and Reading

Parameter	Value	Rating
Strength of intact rock	26.83	4
Rock quality Designation %	36	8
Spacing of discontinuities	Close	8
Conditions of discontinuities	-	10
Ground water condition	Wet	7
Adjustment for joint orientation	Fair	-7
Total		30

According to IS 12070 (table 5.6.1) classification of rock is IV. Safe bearing pressure will vary from 48T/m2 to 135T/m^2. By linear interpolation safe bearing pressure will be 89T/m^2.High crushing strength values ignored.

Average rock crushing strength is 268Kg/cm^2. Using correction factors given in IS code gross safebearing pressure will be 268T/m^2.

Recommended value is 80T/m^2.

2. BH-2 (Depth of Foundation 3.0m)

Table 5.6.6: Parameters and Reading

Parameter	Value	Rating
Strength of intact rock	20.06	2
Rock quality Designation %	37	8
Spacing of discontinuities	Close	8
Conditions of discontinuities	-	10
Ground water condition	Wet	7
Adjustment for joint orientation	Fair	-7
Total		28

According to IS 12070 (5.6.1) classification of rock is IV. Safe bearing pressure will vary from 48T/m^2 to 135T/m^2. By linear interpolation safe bearing pressure will be 80T/m^2.High crushing strength values ignored.

Average rock crushing strength is 200Kg/cm^2. Using correction factors given in IS code grosssafe bearing pressure will be 200T/m^2.

Recommended value is 60T/m^2.

5.4 Laboratory Test Results- Rock Core Testing Summary :

Table 5.6.7 Rock Core Testing Summary

Sr. No.	BH No	Depth (m)	PC. NO.	Specific Gravity	Water Absorption	Porosity	Corrected Unconfined Comp. Strength	Corrected Point Load	Uniaxial Comp. Strength	Remark
					%	%	(kg/cm^2)	(kg/cm^2)	(kg/cm^2)	
1	1	1.20-1.50	2	2.54	2.67	6.78	N.A.	0.71	15.64	POINT LOAD
2		1.50-3.00	19	2.56	2.03	4.31	119.96	N.A.	N.A.	UCS
3		3.00-4.50	37	2.63	1.47	3.17	268.31	N.A.	N.A.	UCS
4		4.50-6.00	45	2.68	1.13	3.04	327.52	N.A.	N.A.	UCS
5		6.00-7.50	49	2.72	0.70	1.89	431.07	N.A.	N.A.	UCS
6		7.50-9.00	56	2.69	1.33	3.57	307.09	N.A.	N.A.	UCS
7		9.00-10.00	64	2.65	1.49	3.25	245.33	N.A.	N.A.	UCS

8		1.20-1.50	2	2.57	1.42	3.66	N.A.	1.44	31.60	POINT LOAD
9		1.50-3.00	8	2.56	1.53	2.53	N.A.	0.71	15.71	POINT LOAD
10		3.00-4.50	14	2.63	0.84	1.83	200.63	N.A.	N.A.	UCS
11		4.50-6.00	26	2.65	0.82	2.18	239.85	N.A.	N.A.	UCS
12		6.00-7.50	35	2.67	0.86	2.29	224.95	N.A.	N.A.	UCS
13	2	7.50-9.00	45	2.59	1.81	4.69	102.70	N.A.	N.A.	UCS
14		9.00-10.00	48	2.61	1.75	4.56	N.A.	29.66	652.50	POINT LOAD

5.7 GPR Survey:

Purpose of the GPR survey was to locate depth and location of footing of columns at respective location.

The survey was carried out by using Radio Detection RD1500 GPR instrument.Survey was done for four columns within stilt floor area as per below details,

- Column No E2.
- Column No D2
- Column No C2
- Column No D1

The data is collected by instrument is represented in scale line diagram.

The RCC footing placed over natural hard strata is surrounded by back filling in excavation pit. Beyond the excavation pit, the soil stratification remains intact. The scan images show distinct discontinuity in soil stratification at footings.

The identified footing is marked in red rectangle. The scan diagram for lines passing along the column face show full extent of footing. Some of the lines terminated at column face. The scan diagram for these show only part of footing. The footing is seen to be resting at about 1.10m depth. Size of footing is about 1.0m to 1.30m.

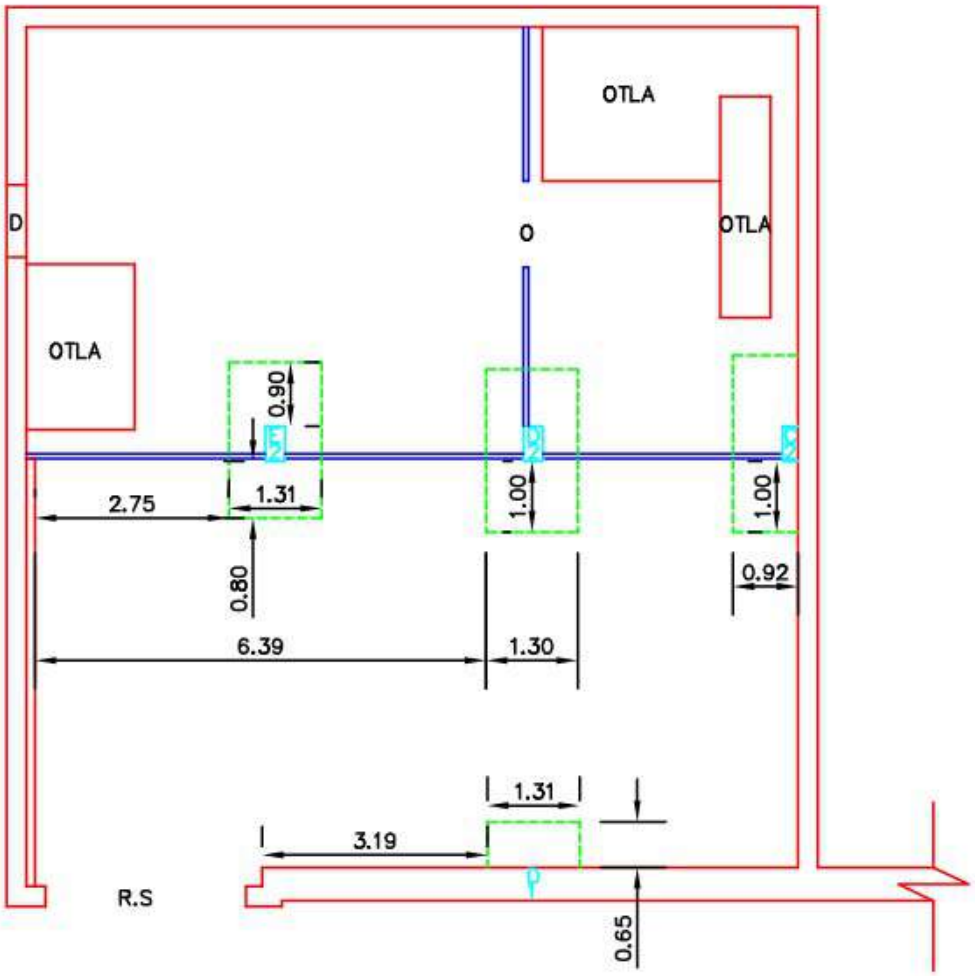


Figure 5.7.1: Layout of Footing

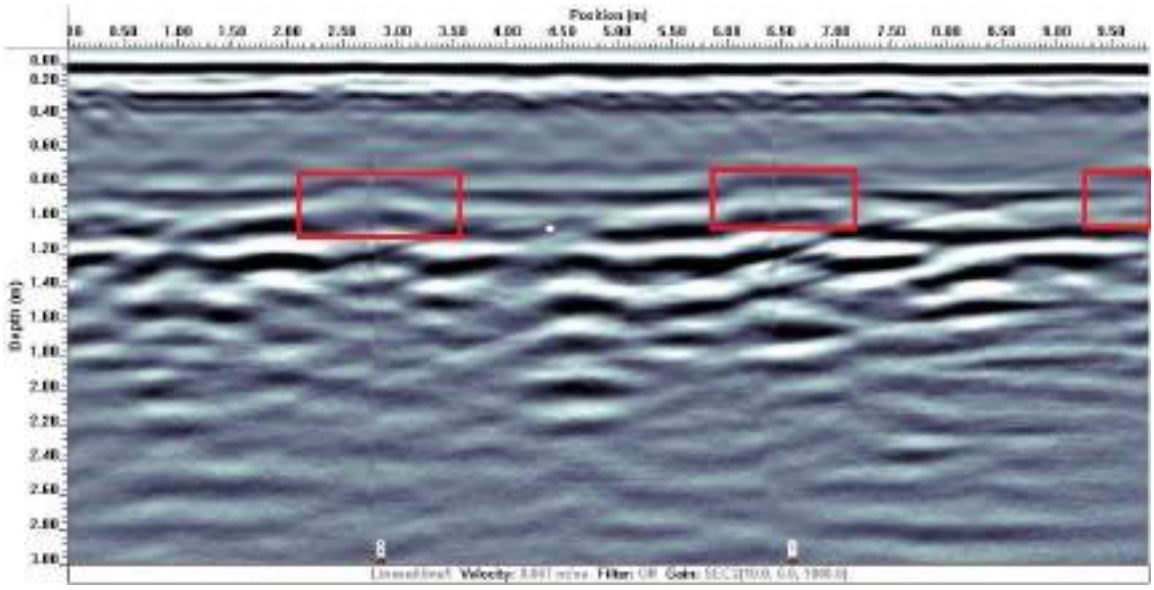


Figure 5.7.2: Line 1

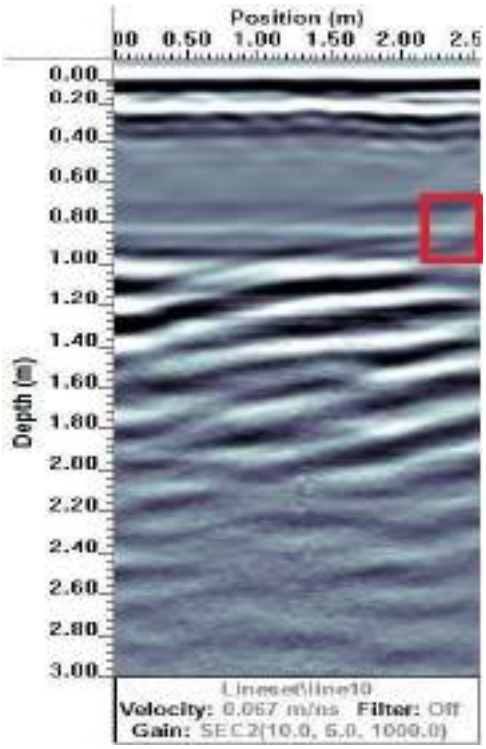


Figure 5.7.3: Line 10

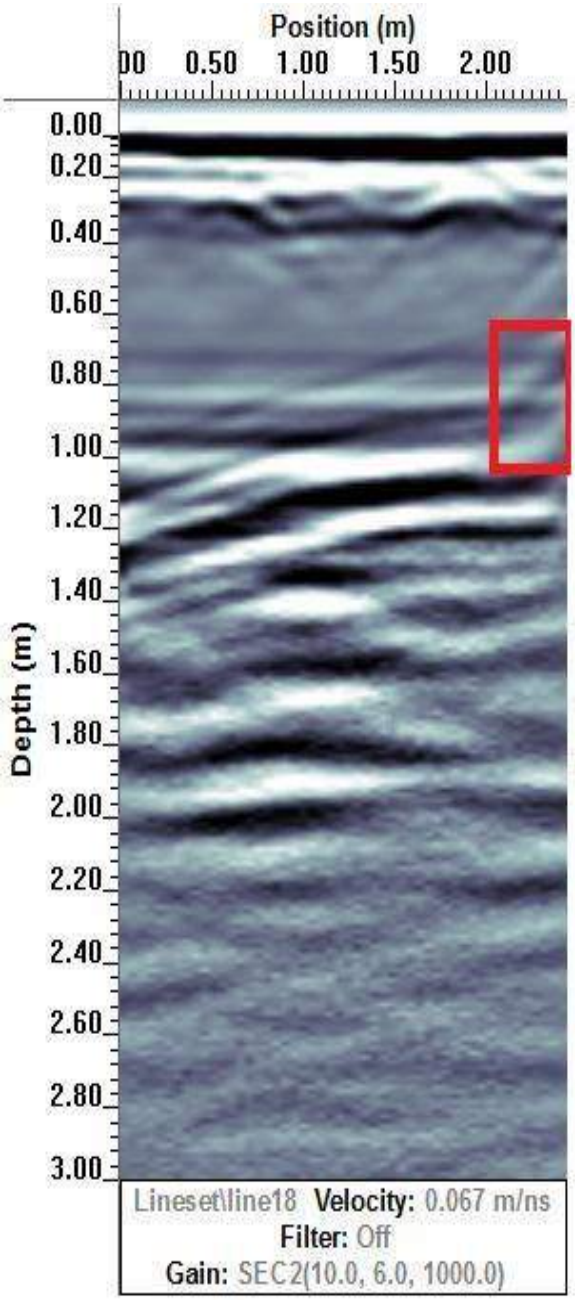


Figure 5.7.4: Line 18

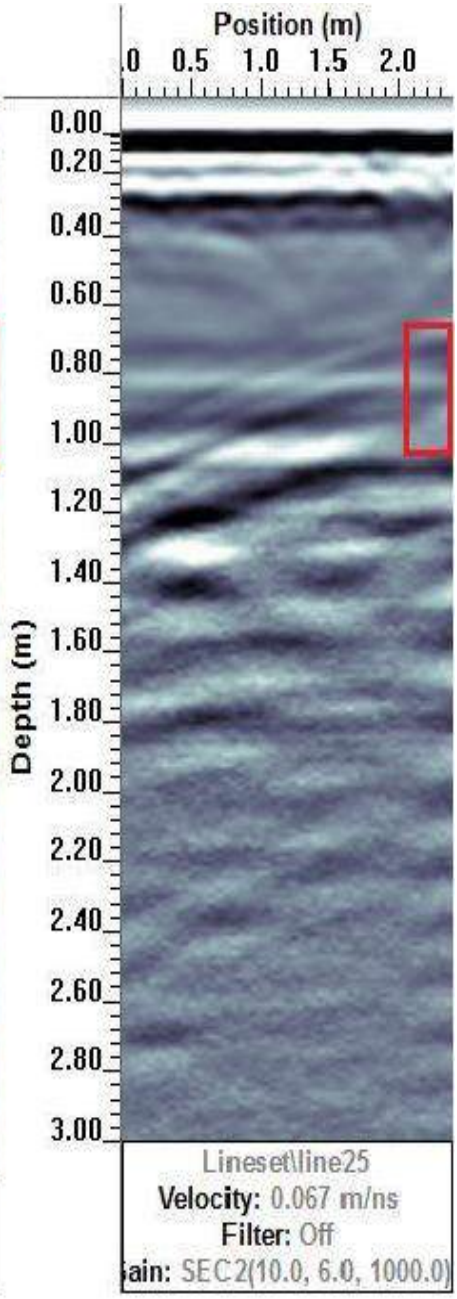


Figure 5.7.5: Line 25

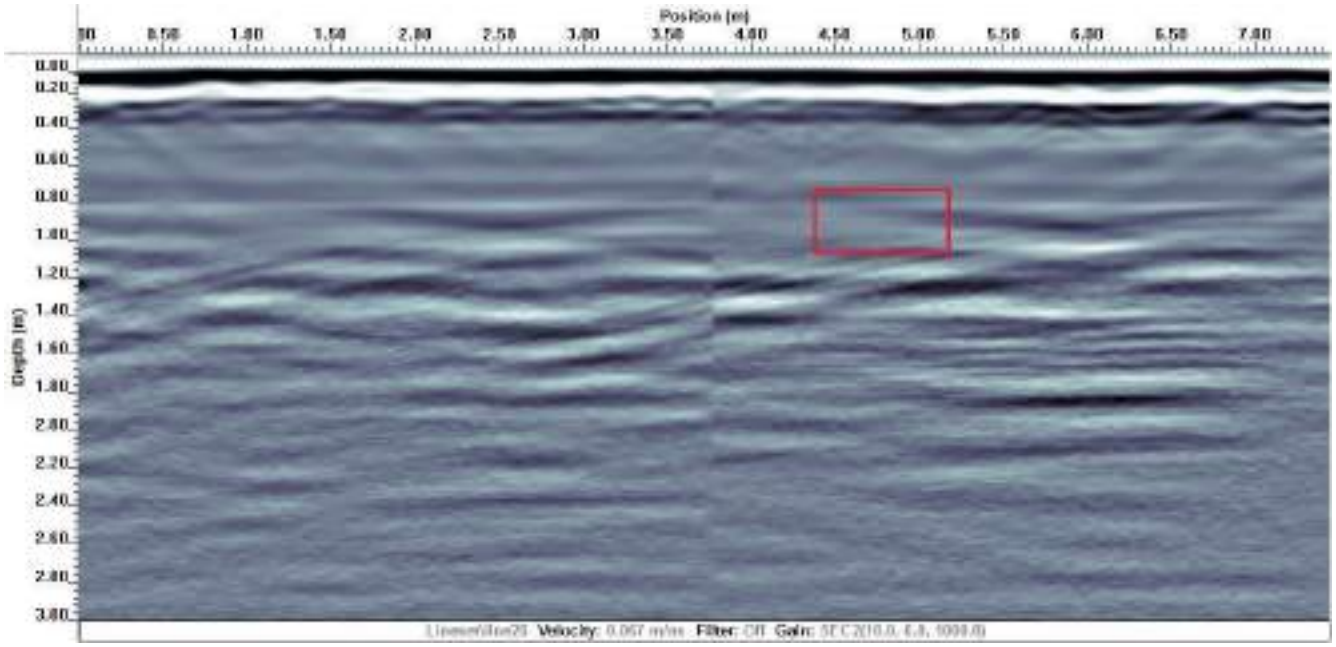


Figure 5.7.6: Line 26

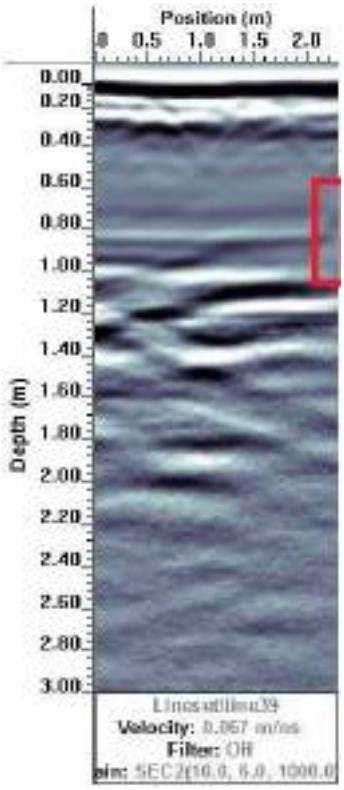


Figure 5.7.7: Line 39

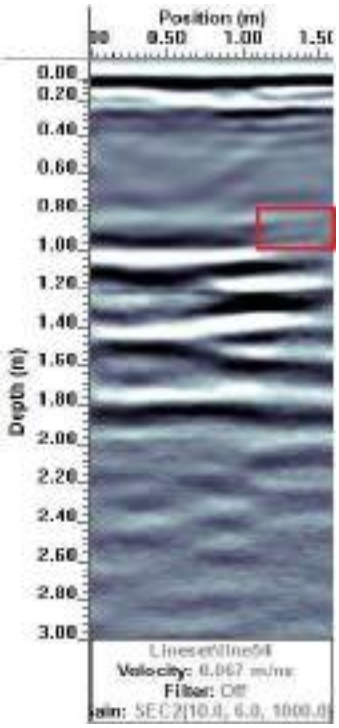


Figure 5.7.8: Line 39

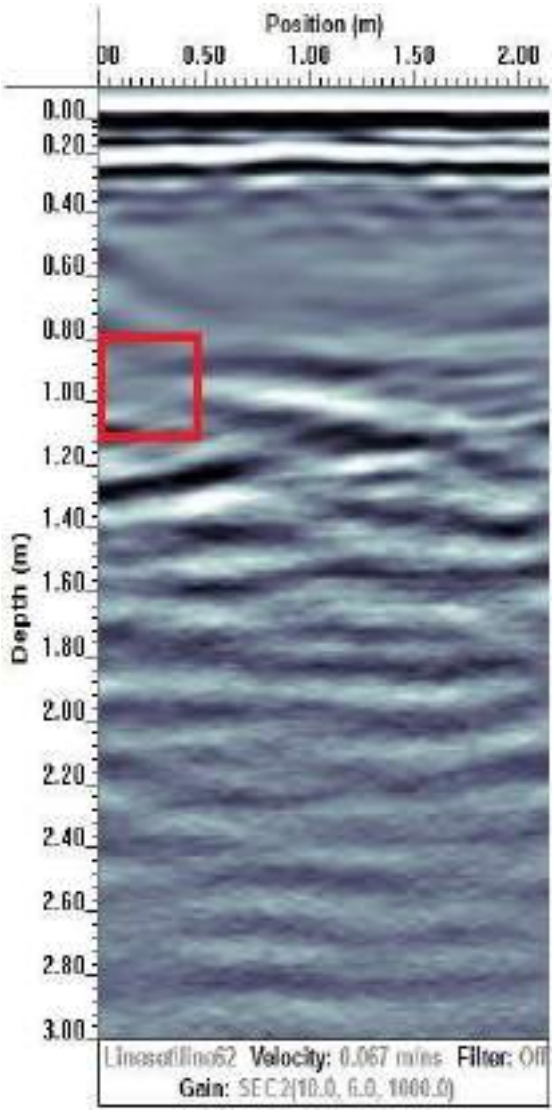


Figure 5.7.9 Line 62

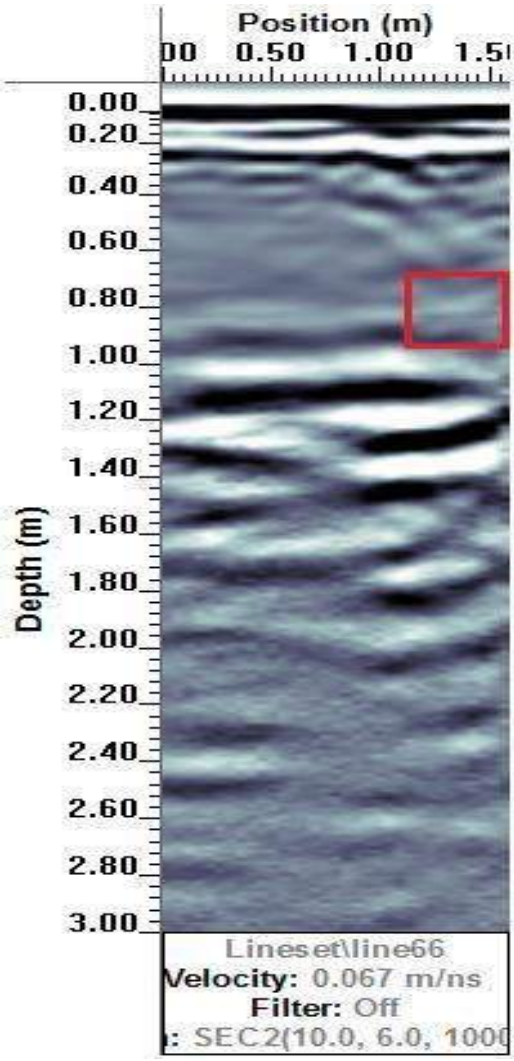


Figure 5.7.10: Line 66

6. NON-DESTRUCTIVE TESTING OBSERVATION

1) The Rebound Hammer Test Results are as follows:
    - The average compressive strength of stilt level column is 42.87 N/mm^2.

2) The ultrasonic pulse velocity test results:
    - The mean velocity of column of stilt level is 2.90 km/sec which indicates that the **quality of concrete is poor.**

3) Core test results indicates :
    - The average compressive strength extracted core from footing is 21.85 MPa.

4) The rebar mapping of the structural elements indicates that:

Stilt floor

- The vertical main bar diameter of column (C1) is 12 mm with stirrups of 8mm and cover is 45mm.
- The vertical main bar diameter of column (C2) is 12 mm with stirrups of 8mm and cover is 55mm.

Ground floor

- The vertical main bar diameter of column (D1) is 12 mm with stirrups of 8mm and cover is 50mm.
- The vertical main bar diameter of column (E1) is 12 mm with stirrups of 8mm and cover is 55mm.
- The vertical main bar diameter of column (D2) is 12 mm with stirrups of 8mm and cover is 45mm.

5) The safe bearing pressure of footing are:
   - For the 3m depth of the foundation of Bore Hole (BH1) the safe bearing pressure is 80 kN/m^2.
   - For the 3m depth of the foundation of Bore Hole (BH2) the safe bearing pressure is 60 kN/m^2.

6) The GPR survey indicates that the depth of footing is 1.10m and the size of footing is 1.0m to 1.30m.

7. PHOTOS TAKEN WHILE TESTING:

1) **Rebound Hammer Test:**

Figure 7.1: Execution of rebound hammer test to determine the approximate compressive strength of the column

2) Ultrasonic Pulse Velocity Test:

Figure 7.2: The ultrasonic pulse velocity test shows that the distance between the transducer and receiver divided by time gives velocity of the wave of propagation in concrete.

3) Core Test

Figure 7.3: Execution of core test for determination of compressive strength of the footing

4) Rebar Scanning:

Figure 7.4: Execution of rebar scanning for detection of reinforcement and concrete cover in the structural elements

5) Digging for checking Soil Bearing Capacity:

Figure 7.5: Drilling for taking out samples for checking safe bearing capacity of soil

6) Analysis of foundation:

Figure 7.6: Exposing reinforcement for foundation analysis

7) GPR survey:

Figure 7.7: GPR survey for determining the depth and size of footing

8. REFERENCE:

1. IS 516 part-5/ sec-1:2018 for Non-Destructive Testing of Concrete – Ultrasonic Pulse Velocity Test- Guidelines, Bureau of Indian Standards, New Delhi.
2. IS 516 part-5/ sec-2:2021 for Non-Destructive Testing of Concrete – Half Cell Potentials of Uncoated Reinforcing Steel in Concrete - Guidelines, Bureau of Indian Standards, New Delhi.
3. IS 516 part-5/ sec-3:2021 for Non-Destructive Testing of Concrete – Carbonation Depth Test- Guidelines, Bureau of Indian Standards, New Delhi.
4. IS 14959 (Part 2):2001 for Determination of Water Soluble and Acid Soluble Chlorides in Mortar and Concrete Test -Guidelines, Bureau of Indian Standards, New Delhi.
5. IS 456-2000 for Plain and Reinforced Concrete - Code of Practice -Guidelines, Bureau of Indian Standards, New Delhi.
6. IS 1199-1059 for Methods of Sampling and Analysis of Concrete -Guidelines, Bureau of Indian Standards, New Delhi.
7. IS 516-1959 for Methods of Test for Strength of Concrete -Guidelines, Bureau of Indian Standards, New Delhi.

A REPORT ON
STRUCTURAL AUDIT
OF JIDNYASA
BUILDING (G+3), PUNE, MAHARASHTRA
411 038.

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16/10/2023

By

COEP TECHNOLOGICAL UNIVERSITY
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(A Unitary Public University of Government of Maharashtra)

Title: Structural Audit of Jidnyasa Building (G+3) of NCCS at Kothrud, Pune, Maharashatra 411 038
Client: Technical officer NCCS, Pune
Your Ref: NCCS/Civil-124/09-23/WO/705/524 **Date:** 26/09/2023
Our Ref: COEP TECH/AMD/BGB/2023/B-1290/2714 **Date:** 14/10/2023

1.0 Introduction:

A proposal of conducting the structural audit/load test of Jidnyasa Building (G+3) of NCCS at Kothrud, Pune, Maharashtra 411 038 was under consideration of NCCS Pune. They requested COEP Technological University, Pune to carry out the site inspection and structural audit of (G+3) building. Accordingly, the team visited the site on date 29th & 30th Sept. 2023, and 1st Oct. 2023, the following details are presented with reference to load test.

2.0 Scope of the Work:

i) To apply uniformly distributed load on first floor slab (1.25 times the live load as per cl. 17.6.2 of IS: 456:2000) and measure the deflection of slab at center of the span. The design live load is 4.5 kN/m^2.

ii) Analysis of results and comment on stability of the structure based on load test and recommendations for strengthening if so required.

16/10/23

3.0 Description of the Structure:

The existing structure has following information which is based on observations on site.

- Purpose of the structure: Office Building
- Type of Structure: RCC Framed Structure
- No. of floors : G + 3 floors
- Year of building construction: 1990 (as reported).
- Age of the structure: 33 Years.
- Status of structure: No occupancy, the structural drawings are not available for review.
- Area of slab to be loaded = 46.62 sq. m. [3.7 m x 6.3 m x 2]. It is one-way slab. (Two Spans)

4.0 Superimposed load on Slab

- Design Live Load = 4.5 kN/m^2 [as per IS : 875- II]
- Floor finish load already exists.
- Total load on slab to be applied is 25% in excess of design load as per cl. 17.6.2 of IS: 456-2000. = 1.25 x 4.50 = 5.625 kN/m^2.
- Hence the total load on slab is 5.625 x 46.62 = 262.2375 kN = 26223.75 kg. sand (26225 kg)
- No of sand bags required= 26225/35 = 750 nos. [Wt. of sand bag 35 kg / bag]

5.0 Application of load on slab:

- The total superimposed load (450x1.25)=563 kg/sq.m was applied on slab in 17 increments. Each increment of loading, approximately 33.11 kg/sq.m [1543 kg] was maintained for ten minutes duration and the corresponding deflection at the center of two slabs and at center of beam was recorded. For this purpose three dial gauges (L.C. is 0.01mm) were installed.

16/10/2023

5.1 Set up of loading:

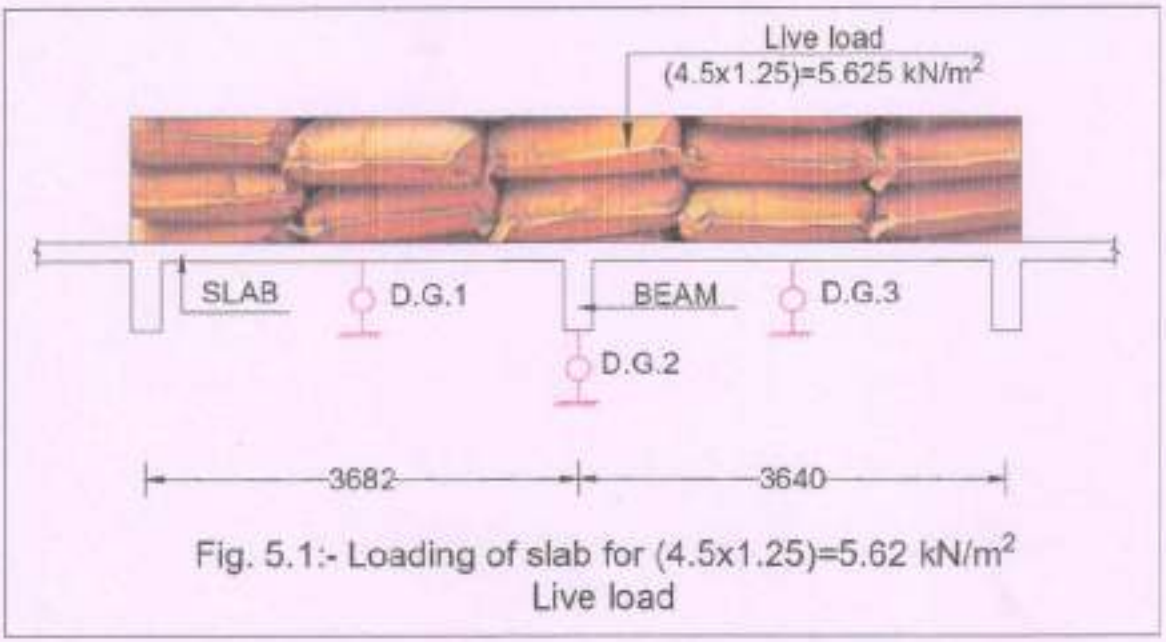

Fig. 5.1:- Loading of slab for (4.5x1.25)=5.62 kN/m² Live load

6.0 Methodology of Load Test:

- Two dial gauges (BAKER J08A) were installed below the slab at the center of slab and, one dial gauge was installed at mid span of the beam. The least count of these gauges was 0.01mm and total measuring capacity was 25 mm. After installing these gauges below the slab and beam, it was confirmed that the needle of dial gauge is touching the bottom surface of slab and beam. The slab was loaded gradually in increments of loading and the corresponding deflection readings were noted. After applying the total load, the loading status was kept loaded for 24 hours. After 24 hours, before unloading the imposed load, the final deflection occurred was also noted. While unloading the each stage of load, the corresponding deflection recovery was noted. The procedure was repeated till the complete unloading of the imposed load and the corresponding readings were noted.

16/10/23

7.0 Test Results:

The observations of load and deflection were noted for each increment of loading and are given in the table no. 1.

Loading was stated at 2 pm on 29/09/2023, loading was done upto 13755 kg. Then again loading was started at 10 am on 30/09/2023 and completed at 5:30 pm. unloading was started 5:30 pm on 01/10/2023.

16/10/23

Table no 1: Load and deflection for slab and beam.

Sr. No.	Super imposed Load [Kg]	Loading			Unloading		
		Deflection at center of slab in mm		Deflection at center of beam in mm	Deflection at center of slab in mm		Deflection at center of beam in mm
		D1	D3	D2	D1	D3	D2
0	0	0	0	**0**	0.07	0.06	**0.05**
1	2100	0.09	0.11	0.04	0.11	0.13	0.13
2	4200	0.09	0.15	0.06	0.16	0.18	0.18
3	6300	0.21	0.25	0.13	0.21	0.24	0.24
4	8400	0.26	0.32	0.19	0.27	0.30	0.31
5	10500	0.31	0.36	0.30	0.33	0.35	0.39
6	12600	0.35	0.39	0.35	0.35	0.37	0.39
7	13755 (2.95 kN/m²)	0.36	0.41	0.36	0.37	0.38	0.40
8	15015	0.39	0.41	0.36	0.41	0.39	0.40
9	16275	0.42	0.47	0.37	0.46	0.42	0.43
10	17535	0.46	0.53	0.45	0.50	0.46	0.47
11	18795	0.55	0.58	0.47	0.56	0.51	0.52
12	20055	0.55	0.61	0.52	0.61	0.56	0.57
13	21315	0.68	0.63	0.54	0.66	0.61	0.62
14	22575	0.73	0.68	0.62	0.74	0.67	0.68
15	23835	0.78	0.72	0.68	0.79	0.72	0.74
16	25095	0.85	0.78	0.77	0.87	0.79	0.80
17	26250 (5.63 kN/m²)	0.85	0.78	0.78	**0.91**	**0.82**	**0.83**

After 24 hrs of loading

16/10/23

Beam Recovery (D2)

Deflection of beam = 0.83 mm (After loading)

Deflection of beam = 0.83-0.05 = 0.78 mm (Unloading Case)

Percentage Recovery of Beam = $100 - \left[\frac{0.83-0.78}{0.83} \; x\,100\right]$ = 93.976 %

Slab Recovery (D1)

Deflection of slab = 0.91 mm (After loading)

Deflection of slab = 0.91-0.07 = 0.84 mm (Unloading Case)

Percentage Recovery of slab = $100 - \left[\frac{0.91-0.84}{0.91} \; x\,100\right]$ = 92.307 %

Slab Recovery (D3)

Deflection of slab = 0.82 mm (After loading)

Deflection of slab = 0.82-0.06 = 0.76 mm (Unloading Case)

Percentage Recovery of slab = $100 - \left[\frac{0.82-0.76}{0.82} \; x\,100\right]$ = 92.683 %

8.0 Acceptance Criteria:

- IS:456:2000, cl.17.6.3.: The deflection due to imposed load only shall be recorded. If within 24 hrs of removal of the imposed load, the structure does not recover at least 75% of the deflection under superimposed load, the test may be repeated after a lapse of 72 h. If the recovery is less than 80%, the structure shall be deemed to be unacceptable.

- IS:456:2000, cl.17.6.3.1: If the maximum deflection in mm, shown during the 24 hrs under the load is less than $40L^2/D$, where L is the effective span in m, and D, the overall depth of the slab in mm, it is not necessary for the recovery to be measured and the recovery provisions of cl. 17.6.3 shall not apply.

16/10/23

9.0 Observation during Load Test:

- The slab and beam were inspected prior to load test to record the initial stage. It was found that, there was no initial cracking at all locations and, also no cracks are seen at different stages of the loading. After 24 hrs of loading (4.5 x 1.25) is 5.625 kN/m^2, there was no visible cracking at any locations of beams and slab.

10.0 Comments on load test results:

[1] According to IS:456:2000, the recommended value of percentage recovery of deflection is 75%. It is observed that recovery of deflection under imposed load for slab and beam is found within the acceptable limit.

[2] It was noted that there was no cracking in slab and beam after the application of full imposed load. Hence, the slab and beam are found safe under the full application of imposed load.

(4.5x1.25 =5.625 kN/m^2)

[3]The maximum deflection under 24 hrs is 0.91 mm which is less than (40L^2/D) 3.611 mm. It is acceptable.

16/10/2023

11.0 Review comment on NCCS (G+3) Building:

It is noted that the proposed live/imposed load of 4.5 KN/m² on floors of building can be applied safely based on load test results.

Further, the building as a whole structure is analyzed for subjected/ proposed imposed loads as checked for compliance of prevailing IS code provision. To meet the compliance, the following recommendations are made to serve the building for next 25 years.

1. The strengthening of beams & columns should be carried out as per provisions made in IS: 1893-2016 and allied codes.
2. The strengthening of slab is not required.
3. The need of strengthening of footing is required; it should be worked out after detailed analysis.
4. The detailed strengthening /improvement in design with drawing for beam, column and footing are needed, as per IS code provision, shall be certified prior to execution of the work.

16/10/23

B.G. Birajdar
Professor, COEP

Remark: Responsibility of COEP TU Pune is limited to technical advice only. Moreover, COEP TU will not represent for the appraisal of the findings of the reports to any statutory body / Judicial / Committee / Competent authority as the case may be.

SITE PHOTOGRAPHS

Photo 1(a): Dial gauges at center of slab and beam.

Photo 1(b): Dial gauge below the beam.

16/10/23

Photo 2: View of loading [4.5x1.25=5.31 kN/m^2] on RC slab of Jidnyasa Building, NCCS, Pune.

16/10/2023

A REPORT ON
STRUCTURAL AUDIT
OF JIDNYASA
BUILDING (G+3), PUNE, MAHARASHTRA
411 038.

By

COEP TECHNOLOGICAL UNIVERSITY
(COEP TECH)
SHIVAJINAGAR, PUNE- 411005
(A Unitary Public University of Government of Maharashtra)

Title: Structural Audit of Jidnyasa Building (G+3) of NCCS at Kothrud, Pune, Maharashtra 411 038
Client: Technical officer NCCS, Pune
Your Ref: NCCS/Civil-124/09-23/WO/705/524 **Date:** 26/09/2023
Our Ref: COEP TECH/AMD/BGB/2023/B-1290/2714 **Date:** 14/10/2023

1.0 Introduction:

A proposal of conducting the structural audit/load test of Jidnyasa Building (G+3) of NCCS at Kothrud, Pune, Maharashtra 411 038 was under consideration of NCCS Pune. They requested COEP Technological University, Pune to carry out the site inspection and structural audit of (G+3) building. Accordingly, the team visited the site on date 29th & 30th Sept. 2023, and 1st Oct. 2023, the following details are presented with reference to load test.

2.0 Scope of the Work:

i) To apply uniformly distributed load on first floor slab (1.25 times the live load as per cl. 17.6.2 of IS: 456:2000) and measure the deflection of slab at center of the span. The design live load is 4.5 kN/m^2.

ii) Analysis of results and comment on stability of the structure based on load test and recommendations for strengthening if so required.

16/10/23

3.0 Description of the Structure:

The existing structure has following information which is based on observations on site.

- Purpose of the structure: Office Building
- Type of Structure: RCC Framed Structure
- No. of floors : G + 3 floors
- Year of building construction: 1990 (as reported).
- Age of the structure: 33 Years.
- Status of structure: No occupancy, the structural drawings are not available for review.
- Area of slab to be loaded = 46.62 sq. m. [3.7 m x 6.3 m x 2]. It is one-way slab. (Two Spans)

4.0 Superimposed load on Slab

- Design Live Load = 4.5 kN/m^2 [as per IS : 875- II]
- Floor finish load already exists.
- Total load on slab to be applied is 25% in excess of design load as per cl. 17.6.2 of IS: 456-2000. = 1.25 x 4.50 = 5.625 kN/m^2.
- Hence the total load on slab is 5.625 x 46.62 = 262.2375 kN = 26223.75 kg. sand (26225 kg)
- No of sand bags required= 26225/35 = 750 nos. [Wt. of sand bag 35 kg / bag]

5.0 Application of load on slab:

- The total superimposed load (450x1.25)=563 kg/sq.m was applied on slab in 17 increments. Each increment of loading, approximately 33.11 kg/sq.m [1543 kg] was maintained for ten minutes duration and the corresponding deflection at the center of two slabs and at center of beam was recorded. For this purpose three dial gauges (L.C. is 0.01mm) were installed.

16/10/2023

5.1 Set up of loading:

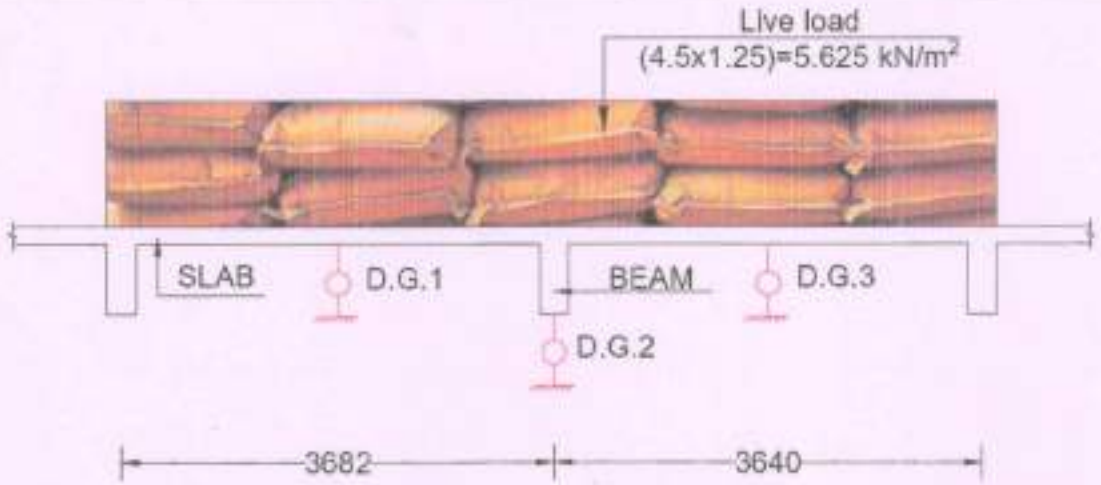

Fig. 5.1:- Loading of slab for (4.5x1.25)=5.62 kN/m² Live load

6.0 Methodology of Load Test:

- Two dial gauges (BAKER J08A) were installed below the slab at the center of slab and, one dial gauge was installed at mid span of the beam. The least count of these gauges was 0.01mm and total measuring capacity was 25 mm. After installing these gauges below the slab and beam, it was confirmed that the needle of dial gauge is touching the bottom surface of slab and beam. The slab was loaded gradually in increments of loading and the corresponding deflection readings were noted. After applying the total load, the loading status was kept loaded for 24 hours. After 24 hours, before unloading the imposed load, the final deflection occurred was also noted. While unloading the each stage of load, the corresponding deflection recovery was noted. The procedure was repeated till the complete unloading of the imposed load and the corresponding readings were noted.

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7.0 Test Results:

The observations of load and deflection were noted for each increment of loading and are given in the table no. 1.

Loading was stated at 2 pm on 29/09/2023, loading was done upto 13755 kg. Then again loading was started at 10 am on 30/09/2023 and completed at 5:30 pm. unloading was started 5:30 pm on 01/10/2023.

16/10/23

Table no 1: Load and deflection for slab and beam.

Sr. No.	Super imposed Load [Kg]	Loading			Unloading		
		Deflection at center of slab in mm		Deflection at center of beam in mm	Deflection at center of slab in mm		Deflection at center of beam in mm
		D1	D3	D2	D1	D3	D2
0	0	0	0	**0**	0.07	0.06	**0.05**
1	2100	0.09	0.11	0.04	0.11	0.13	0.13
2	4200	0.09	0.15	0.06	0.16	0.18	0.18
3	6300	0.21	0.25	0.13	0.21	0.24	0.24
4	8400	0.26	0.32	0.19	0.27	0.30	0.31
5	10500	0.31	0.36	0.30	0.33	0.35	0.39
6	12600	0.35	0.39	0.35	0.35	0.37	0.39
7	13755 (2.95 kN/m²)	0.36	0.41	0.36	0.37	0.38	0.40
8	15015	0.39	0.41	0.36	0.41	0.39	0.40
9	16275	0.42	0.47	0.37	0.46	0.42	0.43
10	17535	0.46	0.53	0.45	0.50	0.46	0.47
11	18795	0.55	0.58	0.47	0.56	0.51	0.52
12	20055	0.55	0.61	0.52	0.61	0.56	0.57
13	21315	0.68	0.63	0.54	0.66	0.61	0.62
14	22575	0.73	0.68	0.62	0.74	0.67	0.68
15	23835	0.78	0.72	0.68	0.79	0.72	0.74
16	25095	0.85	0.78	0.77	0.87	0.79	0.80
17	26250 (5.63 kN/m²)	0.85	0.78	0.78	**0.91**	**0.82**	**0.83**

After 24 hrs of loading

16/10/23

Beam Recovery (D2)

Deflection of beam = 0.83 mm (After loading)

Deflection of beam = 0.83-0.05 = 0.78 mm (Unloading Case)

Percentage Recovery of Beam = $100 - \left[\frac{0.83-0.78}{0.83} \times 100\right] = 93.976$ %

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SITE PHOTOGRAPHS

Photo 1(a): Dial gauges at center of slab and beam.

Photo 1(b): Dial gauge below the beam.

16/10/23

Photo 2: View of loading [4.5x1.25=5.31 kN/m^2] on RC slab of Jidnyasa Building, NCCS, Pune.

16/10/2023

PART - 1 - CIVIL WORKS - LIST OF APPROVED MAKES

SL. No.	PRODUCT CATEGORIES		APPROVED BRAND
1	ADHESIVES FOR CARPENTARY WORKS		
	RUBBER BASED / GLUE / EPOXY BASED ADHESIVES	:	PIDILITE FEVICOL / JIVANJOR / REHAU
2	ANCHORS & FASTENERS		
	MECHANICAL / CHEMICAL ANCHORS	:	PENTAGON / ACE / HILTI
	SCREWS		PENTAGON / ACE
3	CEILING / PARTITION		
	GYPSUM CEILING SYSTEMS	:	WESTERN / USG / DIAMOND
	GYPSUM PARTITION SYSTEMS	:	WESTERN / USG / DIAMOND
	FIRE RETARDANT PARTITION SYSTEMS	:	WESTERN / USG / DIAMOND
	GRID CEILING SYSTEM	:	OWA / USG BORAL / KNAUF
	AXIOM TRIM	:	PROJECT INTERIOR / TECHNO / METAL MATRIX
	METAL PLAIN CEILING	:	PROJECT INTERIOR / TECHNO / METAL MATRIX
	METAL PERFORATED CEILING	:	PROJECT INTERIOR / TECHNO / METAL MATRIX
	SLIDING FOLDING OPAQUE PARTITION SYSTEMS	:	MALROX / ZILIO / ECOTONE
	SLIDING FOLDING GLASS PARTITION SYSTEM	:	HAFELE / ENOX / ZILIO / GEZE
	ACOUSTIC BAFFLE / SCREEN	:	NOIZ / CONTINUM / TECHNO / TRANQUIL
4	BUILDING MATERIAL		
	GYPSUM PLASTER	:	WESTERN / CHIRAG / DAIMOND
	CONSTRUCTION BLOCKS	:	AEROCON / MAGIC / BILLTECH
	ORDINARY PORTLAND CEMENT	:	AMBUJA / ACC / ULTRTECH
	WHITE CEMENT	:	JK WHITE / BIRLA
	WATER PROOFING	:	PIDILITE / ROFF / SIKA
	METAL FRAMES	:	IGI / USG / AHLADA
	CONCEALED WALL ANGLE GUARDS	:	WESTERN / USG / DIAMOND
	STRUCTURAL STEEL	:	SAIL / APPOLO / JINDAL
	REINFORCEMENT STEEL	:	SAIL / APPOLO / JINDAL
5	CEILING/PARTITION ACCESSORIES & COMPONENTS		
	JOINTING COMPOUND FOR GYPSUM PARTITIONS	:	WESTERN / USG / DAIMOND
	PAPER TAPES FOR GYPSUM PARTITIONS	:	WESTERN / USG / DAIMOND
	DRY WALL TOP COAT FOR GYPSUM PARTITIONS	:	WESTERN / USG / DAIMOND
	G.I. FRAMES & ACCESSORIES FOR MODULAR/FALSE CEILINGS	:	WESTERN / USG / DAIMOND
	INSULATION	:	ROCKWOOL / LOYOD / SUNROK
	ALUMINIUM	:	SNALCO / GALCO / NARMADA
6	FLOORINGS		
	ENTRANCE MAT	:	3M / URONICS / DORA

	VITRIFIED TILE	:	SILVER CERMMICS (ICE BERG) / KAJARIA / NITCO
	MARBLE	:	AS PER CLIENT /CONSULTANT
	GRANITE	:	AS PER CLIENT /CONSULTANT
	VINYL FLOORS	:	RESPONSIVE / WONDER FLOOR / LOCAL INDIAN
	ANTISTATIC VINYL FLOORS / ESD FLOORING	:	RESPONSIVE / CIR_Q_TECH / LOCAL INDIAN
	SELF LEVELING	:	FINESSE / COLOUR PLUS / ARDEX
	EPOXY FILLER	:	LATICRETE EPOXY BASE
	INTEGRAL WATER-PROOFING COMPOUND	:	PIDILITE / ROFF / SIKA
7	WALL FINISHINGS		
	CERAMIC TILE	:	SILVER CERMMICS (ICE BERG) / KAJARIA / NITCO
	DECORATIVE WALL TILES	:	SILVER CERMMICS (ICE BERG) / KAJARIA / NITCO
8	FILMS		
	VINYL FILMS	:	RESPONSE / WONDER FLOOR / LOCAL INDIAN
	FROSTED FILMS	:	ASHIYANA / 3M / LG
9	BLINDS & DRAPERY		
	ROLLER BLINDS	:	ASHIYANA / ARTLINE / FERRARI
10	HARDWARE		
	DOOR HINGES	:	HAFELE / OZONE / ENOX
	DOOR CLOSERS	:	HAFELE / OZONE / ENOX
	FLOOR SPRINGS	:	HAFELE / OZONE / ENOX
	DOOR LOCKS	:	HAFELE / OZONE / ENOX
	PULL HANDLES	:	HAFELE / OZONE / ENOX
	STORAGE HINGES	:	EBCO / ASEEM / HAFELE
	TELESCOPIC DRAWER CHANNELS	:	EBCO / ASEEM / HAFELE
	KITCHEN DRAWER BASKETS	:	EBCO / ASEEM / HAFELE
11	BOARDS		
	MOISTURE RESISTANT GYPSUM BOARD	:	USG BORAL
	PLAIN GYPSUM BOARD	:	USG BORAL
	FIRE RETARDANT GYPSUM BOARD	:	USG BORAL
	CEMENT BOARDS	:	EVEREST / VISHAKA
	CALCIUM SILICATE BOARD	:	RAMCO- HILUX
	PRE- LAMINATED PARTICLE BOARD	:	ASIAN / MERINO / HERITASE
	PLAIN PARTICLE BOARD	:	ASIAN / MERINO / HERITASE
	MARINE PLY WOOD	:	ARCHID / SOMANY / KITPLY
	COMMERCIAL BLOCK BOARD	:	ARCHID / SOMANY / KITPLY
	FLUSH DOORS	:	ARCHID / SOMANY / KITPLY
	COMMERCIAL PLY	:	ARCHID / SOMANY / KITPLY
	LAMINATES	:	AMULYA / CENTURY / MERINO
	MEDIUM DENSITY FIBRE BOARDS	:	ACTION TESA / VEER / MERINO
	MIRROR	:	SAINT GOBAIN / MODYGUARD

	CORIAN	:	SOLYX / LG / DUPONT
12	PAINTING & POLISH WORKS		
	EMULSION PAINTS	:	ASIAN PAINT / NEROLAC / BERGER
	PLASTIC PAINTS	:	ASIAN PAINT / NEROLAC / BERGER
	ENAMEL PAINT	:	ASIAN PAINT / NEROLAC / BERGER
	TEXTURE PAINT	:	ASIAN PAINT / NEROLAC / BERGER
	WALL PUTTY	:	SAKARNI / JK / BIRLA
	ACRYLIC PAINTS	:	ASIAN PAINT / NEROLAC / BERGER
13	MISCELLANEOUS		
	TRAP DOOR	:	M2M / KNAUF / INDIAN MAKE
	SILICON	:	PEDILITE / AROLITE / ASTAL
	FIRE BARRIER	:	3M / HILTI
	SLOTTED ANGEL RACK	:	STEELEDGE / JP TRADING / STEELMADE
	COMPACTORS SYSTEM	:	STEELEDGE / JP TRADING / STEELMADE
14	SKIRTING AND TRIMS		
	ALUMINIUM SKIRTING	:	ARTLINE / KUBIK / BOTTOMLINE
	ALUMINIUM EXPOSED WALL ANGLE GUARDS	:	ARTLINE / KUBIK / BOTTOMLINE
	ALUMINIUM PROFILES , STAIR EDGINGS, WALL TRIMS	:	ARTLINE / KUBIK / BOTTOMLINE
	ALUMINIUM TRANSITION PROFILES	:	ARTLINE / KUBIK / BOTTOMLINE
	ALUMINIUM WALL GUARDS	:	ARTLINE / KUBIK / BOTTOMLINE
	ALUMINIUM DUSTER HOLDER	:	ARTLINE / KUBIK / BOTTOMLINE
15	PLUMBING & SANITATION		
	UPVC PIPES	:	ASHIRVAD / SUPREME / ASTRA/PRINCE
	SANITARY WARES	:	ICE BERG / HINDWARE / JAQUAR
	CP FITTINGS & FIXTURES	:	ICE BERG / HINDWARE / JAQUAR
	SINK	:	NIRALI / FRANKI / MITHALI
	TOILET CUBICAL	:	TLINE / S CUBE
16	FIRE RATE GLASS PARTITION AND DOORS		
	GLASS FIRE RATED PARTITION	:	IGI / MPP / AHLADA
	GLASS FIRE RATED DOOR	:	IGI
	METAL FIRE DOOR	:	IGI
17	MODULAR GLASS PARTITION AND DOORS		
	MODULAR GLASS PARTITION & DOORS	:	OTTIC / ARTLINE / REDPLUS (KUBIK)
18	ANTI CORROSIVE CHEMICAL	:	R &M/ FOSROC/ SICA
	GROUTING		R &M/ FOSROC/ SICA
	EPOXY RESIN		R &M/ FOSROC/ SICA
	CFRP SHEETS		R &M/ FOSROC/ SICA
	CFRP LAMINATES		R &M/ FOSROC/ SICA
	CARBON FIBRE ANCHOR		R &M/ FOSROC/ SICA
	ANCHOR BOLTS		HILTI / FISCHER

PART - 2 - ELECTRICAL LT WORKS - LIST OF APPROVED MAKES

1.	CURRENT TRANSFORMER	:	KALPA / KAPPA / VOLTAMPS / PROK DEVICE
2.	DIGITAL PANEL METERS	:	ELMEASURE / CONZERV / TRINITY / MECO / CIRCUITOR
3.	ACB/ MOULDED CASE CIRCUIT BREAKERS (MCCBS)	:	ABB / LEGRAND / SCHNEIDER/ SIEMENS/ L&T
4.	MINIATURE CIRCUIT BREAKERS (MCBS), MPCB, EARTH- LEAKAGE CIRCUIT BREAKERS, RCBO, SPD	:	ABB / LEGRAND / SCHNEIDER / HAGER/ SIEMENS
5.	MCB DISTRIBUTION BOARDS	:	ABB / LEGRAND / SCHNEIDER / HAGER/ SIEMENS
6.	FABRICATED DISTRIBUTION BOARDS BUILDER & ELECTRICAL PANEL BUILDERS	:	SHRI SIDDHALINGESHWARA POWER GEARS / IMPERIAL ELECTRO CONTROLS PVT LTD. / HERTZ ENTERPRISES ELECTRICALS/ NANDINI POWER CONTROL
7.	CAPACITORS	:	NEPTUNE / EPCOS
8.	SELECTOR SWITCHES/PANEL ROTARY SWITCHES	:	ABB / SCHNEIDER / L&T / VAISHNO / SALZER / TEKNIC / KAYCEE
9.	POWER CONTACTORS	:	ABB / LEGRAND / SCHNEIDER/ SIEMENS
10.	BI-METALLIC OVERLOAD RELAYS	:	ABB / LEGRAND / SCHNEIDER/ SIEMENS
11.	EARTH-LEAKAGE RELAYS	:	PROK DEVICES / VOLTAMP / L&T / ABB/ SIEMENS
12.	AUXILIARY RELAY	:	ABB / SCHNEIDER / L&T / SIEMENS
13.	VFD	:	YASKAWA- HV 600
14.	INDICATING LAMPS / ILLUMINATED PUSH BUTTON	:	ABB / SCHNEIDER / VAISHNO / TEKNIC
15.	LT 1.1 KV POWER CABLES	:	POLYCAB / KEI / / FINOLEX/ GEMSCAB
16.	LT 1.1 KV PVC INSULATED / FR / FRLS FLEXIBLE CABLES	:	POLYCAB / KEI /FINOLEX/ GEMSCAB/ POWER FLEX
17.	PVC INSULATED / FR / FRLS COPPER WIRES	:	POLYCAB / KEI / / FINOLEX/ LAPP / POWER FLEX / HAVELLS / GEMSCAB
18.	CABLE LUGS (COPPER)	:	MULTI / BRACO/ CONNECTWELL/ DOWELLS
19.	CABLE GLANDS (BRASS)	:	SMI / HMI / BRACO / DOWELLS
20.	PVC / MS CONDUITS AND ACCESSORIES	:	VIP / UNIVERSAL / AKG / BHARATH
21.	LIGHT SWITCHES / POWER SOCKETS	:	NORTHWEST / LEGRAND / MK / HAVELLS
22.	INDUSTRIAL PLUG & SOCKET	:	LEGRAND / NEPTUNE BALLS / CLIPSAL / BCH
23.	LED LIGHT FIXTURES	:	PMEA / LIGHTING TECHNOLOGIES
24.	LED CHIPS	:	CREE / NCHIA/BRIDGELUX
25.	PVC RACEWAY	:	SCHNEIDER / LEGRAND / MK
26.	CABLE TRAYS / METAL RACEWAY	:	PROFAB / PUSHPAK
27.	ON/OFF, EMERGENCY PUSH BUTTON	:	HENSEL / SCHNEIDER / L&T
28.	FIRE SAFETY EQUIPMENTS	:	ALERT / MINIMAX / SAFEX
29.	LIGHTNING ARRESTOR	:	ABB/ INDELEC/AXIS- TRISHA ENGINEERING SOLUTIONS
30.	UPS	:	NUMERIC/ FUJI ELECTRIC/ SOCOMAC
31.	ISOLATION TRANSFORMER	:	SERVO INC / KRYKARD / DATSON

PART 3 - HVAC WORKS - LIST OF APPROVED MAKES

1.	DOUBLE SKIN AHU	:	CITIZEN / LUFTEK / EDGETECH / AIRMASKINE/ ZECO / VTS /CARYAIRE / SYSTEMAIR/ FLAKTWOOD /STULZ / DRI / BLUE BOX
2.	CENTRIFUGAL FANS FOR AHU	:	NICOTRA / KRUGER
3.	MOTORS	:	CROMPTON / SEIMENS / BHARATH BIJLEE / ABB
4.	PROPELLER FANS	:	CARYAIRE / SYSTEMAIR / AIRE MASKIN
5.	FINE FILTERS	:	AAF / MECHMARK / CAMFILL
6.	PRE FILTERS	:	AAF / MECHMARK / CAMFILL
7.	HEPA FILTERS	:	AAF / MECHMARK / CAMFILL
8.	TERMINAL HEPA FILTERS	:	AAF / MECHMARK / CAMFILL AAF / MECHMARK / CAMFILL/ Freudenberg
9.	SUPPLY AIR / RETURN AIR DIFFUSER & GRILLES (ADP)	:	SYSTEMAIR / COSMOS / VEDA
10.	VIBRATION ISOLATOR	:	DUNLOP / GERB / RESISTOFLEX / BASE
11.	GALVANIZED SHEET STEEL	:	JINDAL / TATA / SAIL
12.	DUCT FABRICATION	:	COOL FREEZE / VEDA / VANES / DEV DUCT / ZECO / REDICAL DUCT / ASAWA /ROLASTAR
13.	DUCT INSULATION	:	ARMACELL / SUPREME ARMACELL / SUPREME/ K FLEX
14.	FIRE DAMPER	:	SYSTEMAIR / COSMOS / VEDA
15.	GI VOLUME CONTROL DAMPER	:	SYSTEMAIR / COSMOS / VEDA
16.	INSULATED FLEXIBLE DUCT	:	SYSTEMAIR / UP TWIGA
17.	MAGNEHELIC GAUGE	:	DWYER / OMICRON
18.	DX HI WALL UNIT	:	LG / BLUESTAR / SAMSUNG / HITACHI CARRIER/ MISTUBHISI/ LLYOD
19.	MILD STEEL	:	JINDAL / TATA/SAIL
20.	ROCK WOOL	:	ROXUL ROCKWOOL / SAINT GOBAIN

PART 4 - VRF WORKS - LIST OF APPROVED MAKES

1.	VRF OUT DOOR UNITS	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
2.	VRF CASSETTE UNITS	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
3.	VRF HI WALL UNIT	:	SAMSUNG / LG / DAIKIN/ CARRIER/TOSHIBA
4.	COPPER PIPING	:	MANDEV / MAXFLOW
5.	COPPER PIPING INSULATION	:	ARMACELL / SUPREME
6.	EXPANSION KIT	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
7.	CONTROL KIT	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
8.	CORDED REMOTE	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
9.	MODE CONTROL UNIT	:	SAMSUNG / LG / DAIKIN/ CARRIER/ TOSHIBA
10.	POWER & CONTROL CABLES	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
11.	MCCB	:	ABB / LEGRAND / SEIMENS / SCHNEIDER / L&T

12.	MILD STEEL	:	JINDAL / TATA/SAIL

PART 5 - SCRUBBER WORKS - LIST OF APPROVED MAKES

1.	DRY SCRUBBER	:	AERO / PURAFILL / SEAT
2.	EXHAUST BLOWER	:	UNIVERSAL AIR CONTROL SYSTEM / LIFE LINE / ENVIGUARD / GDS STERLING GAS
3.	PP FRP DUCTING	:	UNIVERSAL AIR CONTROL SYSTEM / LIFE LINE / ENVIGUARD / GDS STERLING GAS
4.	PVC BRAIDED FLEXIBLE HOSE	:	GIBBON / SAVERA / FLEXAFLEX
5.	PP SHEETS FOR EXHAUST DUCTING	:	MANDHANA / DUGAR / KHANNA / SIMONA
6.	RESIN	:	MECHEMCO / KAYSYNTH / ORSYN / SIMONA/ CREST COMPOSITE
7.	PP DAMPERS	:	UNIVERSAL AIR CONTROL SYSTEM / LIFE LINE / ENVIGUARD / GDS STERLING GAS
8.	CAV DAMPER	:	ALDES / TROX / AIR FLOW
9.	MILD STEEL	:	JINDAL / TATA/SAIL

PART - 6 - EMS AND BMS - LIST OF APPROVED MAKES

1.	CLIENT WORK STATION	:	DELL / LENOVO / HP
2.	SOFTWARE: WEB BASED GRAPHICAL INTERFACE SOFTWARE	:	DELL / LENOVO/HONEYWELL-TREND / SCHNEIDER / SIEMENS
3.	DDC CONTROLLER	:	HONEYWELL-TREND / SCHNEIDER / SIEMENS
4.	DDC PANEL	:	HONEYWELL-TREND / SCHNEIDER
5.	DUCT TYPE TEMPERATURE SENSOR	:	HONEYWELL / OMICRON / GLOBAL ELECTRONICS / SCHNEIDER
6.	DUCT TYPE RH TRANSMITTER	:	HONEYWELL / OMICRON / GLOBAL ELECTRONICS / SCHNEIDER
7.	DUCT TYPE TEMPERATURE & RH COMBO TRANSMITTER	:	HONEYWELL / OMICRON / GLOBAL ELECTRONICS / SCHNEIDER
8.	AMBIENT TEMPERATURE SENSOR	:	HONEYWELL / OMICRON / GLOBAL ELECTRONICS / SCHNEIDERTEKNIC / KAYCEE
9.	DUCT TYPE STATIC PRESSURE TRANSMITTER	:	HONEYWELL / OMICRON / GLOBAL ELECTRONICS / SCHNEIDER
10.	ACTUATORS FOR ON/OFF DAMPE	:	BELIMO / HONEYWELL
11.	ACTUATORS FOR MOTORISED DAMPER	:	BELIMO / HONEYWELL
12.	CABLES	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
13.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND
14.	CABLE TRAY	:	PUSHPAK / PROFAB/PROFAB / NIEDAX
15.	MS ANGLE	:	JINDAL/ TATA/ SAIL
16.	2-ROW BRIGHT LED DISPLAY UNIT	:	RADIX / GLOBAL ELECTRONICS/ SAUTER / ENVIRO
17.	1-ROW BRIGHT LED DISPLAY	:	RADIX / GLOBAL ELECTRONICS/ SAUTER / ENVIRO
18.	FIELD DEVICES (FOR LOCAL DISPLAY UNIT)	:	RADIX / GLOBAL ELECTRONICS/ SAUTER / ENVIRO

PART - 7 – ELV WORKS(FAS) - LIST OF APPROVED MAKES

1.	FIRE ALARM PANEL	:	HONEYWELL-NOTIFIER / EDWARD'S / SCHNEIDER/AGNI
2.	DETECTOR	:	HONEYWELL-NOTIFIER / EDWARD'S / SCHNEIDER

3.	DEVICES	:	HONEYWELL-NOTIFIER / EDWARD'S / SCHNEIDER
4.	MANUAL PULL STATIONS / MANUAL CALL POINTS	:	HONEYWELL-NOTIFIER / EDWARD'S / SCHNEIDER
5.	HOOTER	:	HONEYWELL-NOTIFIER / EDWARD'S / SCHNEIDER
6.	FIRE ALARM ARMOURED CABLE	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
7.	FRLS PVC CONDUIT	:	VIP / UNIVERSAL

PART - 7 – ELV WORKS(ACS) - LIST OF APPROVED MAKES

1.	8 READER DOOR CONTROLLER	:	AVON / SPECTRA / HID / STYRAX
2.	PROXIMITY CARD READER	:	STYRAX / AVON / SPECTRA / ELTECH
3.	ELECTRO MAGNETIC LOCKS	:	BEL / ELTECH
4.	HEAVY DUTY MAGNETIC CONTACTS (DOOR POSTION SENSOR)	:	BEL / ELTECH
5.	RESETTABLE EMERGENCY DOOR RELEASE PUSH BUTTON	:	AVON / SPECTRA / ELTECH / STYRAX
6.	EXIT PUSHBUTTON	:	AVON / SPECTRA / ELTECH / STYRAX
7.	CABLE TRAY	:	PUSHPAK / PROFAB
8.	MS ANGLE	:	JINDAL / TATA / SAIL
9.	CABLES	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
10.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND

PART - 7 – ELV WORKS(DIS) - LIST OF APPROVED MAKES

1.	DOOR INTERLOCK SYSTEM	:	AVON / SPECTRA / HID / STYRAX
2.	ELECTRO MAGNETIC LOCKS	:	BEL / ELTECH
3.	HEAVY DUTY MAGNETIC CONTACTS (DOOR POSTION SENSOR)	:	BEL / ELTECH
4.	NO TOUCH EGRESS SWITCH	:	AVON / SPECTRA / ELTECH / STYRAX
5.	RESETTABLE EMERGENCY DOOR RELEASE PUSH BUTTON	:	AVON / SPECTRA / ELTECH / STYRAX
6.	CABLES	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
7.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND

PART - 7 – ELV WORKS(CCTV) - LIST OF APPROVED MAKES

1.	WORK STATION	:	DELL / HP / LENOVO
2.	VIDEO MANAGMENT SOFTWARE	:	HIKVISION / DAHUA/ BOSH/ MATRIX
3.	NETWORK VIDEO RECORDER (NVR)	:	HIKVISION / DAHUA/ BOSH/ MATRIX
4.	NO TOUCH EGRESS SWITCH	:	AVON / SPECTRA / ELTECH / STYRAX
5.	6U CLOSED RACK(FOR NVR PLACEMENT)	:	NETRACK / PRESIDENTAL(APW)
6.	CAMERA	:	HIKVISION/ DAHUA/ SAMSUNG/ HANWHA/ / BOSH/ MATRIX
7.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND

PART - 7 – ELV WORKS(GDS) - LIST OF APPROVED MAKES

1.	ELECTRO CHEMICAL BASED OXYGEN DEPLETION GAS DETECTOR	:	AMBETRONICS / UNIPHOS
2.	CONTROLLER	:	NEPTUNE CONTROLS-BANGALORE

3.	HOOTER MINIMUM OF 80DB	:	HONEYWELL / EDWARD'S / SCHNEIDER
4.	PRESSURE TRANSMITTER SUITABLE GAS LINE	:	OMICRON/ HONEYWELL / EDWARD'S / SCHNEIDER
5.	CABLES	:	POLYCAB / KEI / / FINOLEX/ RAVICAB
6.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND

PART - 8 – NETWORKING SYSTEM WORKS - LIST OF APPROVED MAKES

21.	DATA PORTS	:	DLINK/MOLEX
22.	COPPER CABLING SYSTEM (CONNECTIVITY COMPONENTS FROM USER END TO HUB RACK)	:	DLINK/MOLEX
23.	FIBER CABLING SYSTEM (FROM ISP RACK TO SERVER RACK)	:	COMMSCOPE/PANDUIT/NEXANS
24.	RACKS & CABLE MANAGERS	:	NETRACK/PRESIDENTAL(APW)
25.	CABLE RACEWAYS / CABLE TRAYS	:	PROFAB / PUSHPAK
26.	MS ANGLE	:	JINDAL / SAIL /TATA
27.	PVC CONDUIT	:	VIP / UNIVERSAL/DIAMOND
28.	ACTIVE PARTS POE SWITCH	:	D LINK, SMART MANAGED SWITCH / NET GEAR
29.	Fire Wall	:	D LINK, SMART MANAGED SWITCH / NET GEAR
30.	SFP Module Multi mode	:	D LINK, SMART MANAGED SWITCH / NET GEAR
31.	ACTIVE PART SERVER	:	DELL / HP / LENOVO

PART 9 – CLEAN ROOM PANEL WORKS - LIST OF APPROVED MAKES

1.	CLEAN ROOM PANEL	:	NICOMAC / I CLEAN /GMP/EPAC/ Lloyd
2.	CLEAN ROOM FALSE CEILING	:	NICOMAC / I CLEAN /GMP/EPAC/ Lloyd
3.	CLEAN ROOM DOORS	:	NICOMAC / I CLEAN /GMP/EPAC/ Lloyd
4.	VIEW PANEL	:	NICOMAC / I CLEAN /GMP/EPAC/ Lloyd
5.	RETURN AIR RISER	:	NICOMAC / I CLEAN /GMP/EPAC/ Lloyd
6.	AIR FILTERS	:	AAF / FREUDENBERG / CAMFIL
7.	PASS BOX	:	NICOMAC / I CLEAN /GMP
8.	ANCHOR, FASTENER	:	HILTI / FISHER
9.	SILICON SEALANT	:	MC COY / DOW CORNING
10.	TOUGHENED GLASS	:	SAINT GOBAIN
11.	FIRE RATED GLASS	:	SAINT GOBAIN
12.	UV LIGHT	:	PHILIPS
13.	CFL LIGHTS	:	PHILIPS / WIPRO/HAVELLS
14.	DOOR CLOSURE	:	DORMA

PART 10 – LAB FURNITURE WORKS - LIST OF APPROVED MAKES

1.	LAB FURNITURE	:	SML / NEPTUNE / DYNA/EQUIV. BRAND APPROVED BY NCCS
2.	PASS BOXES	:	SML / NEPTUNE / DYNA/EQUIV. BRAND APPROVED BY NCCS
3.	SS CROSS OVER BENCHES	:	SML / NEPTUNE / DYNA/EQUIV. BRAND APPROVED BY NCCS

4.	STORAGE CABINETS	:	SML / NEPTUNE / DYNA/EQUIV. BRAND APPROVED BY NCCS

PART 11 – COLD ROOM WORKS - LIST OF APPROVED MAKES

1.	COLD ROOM VENDORS	:	CARRIER / BLUESTAR / RINAC
2.	COMPRESSOR & CONDENSER		FRASCOLD / DANFOSS / BITZER
3.	INDOOR EVAPORATOR:	:	GEA / THERMO FIN / GUNTNER / ALFA LAVAL / BLUE STAR
4.	INSULATION	:	ARMACELL / SUPREME
5.	TEMPERATURE INDICATORS	:	SUBZERO / ELLIWELL / DANFOSS / CARREL
6.	DATA LOGGER	:	EURO THERM / YUKOGOWA
7.	LIGHT FITTINGS	:	PHILIPS / HAVELLS / CG
8.	PANEL & COVINGS	:	LLYODS / METECNO / RINAC
9.	COLD ROOM DOOR	:	METAFLEX / ISOFLEX / RINAC

PART - 12 – UTILITY PIPING WORKS - LIST OF APPROVED MAKES

1.	CPVC PIPES, VALVES, AND FITTINGS	:	ASTRAL/ASHIRVAD
2.	HDPE	:	PRIME/MANAGALAM/GODAVARI
3.	SS 316 TUBING	:	SANDVIK /RATNAMANI /MAXIM
4.	SS316 WELD/COMPRESSION FITTINGS (END CAP, BEND, TEE & FEMALE/MALE CONNECTOR)	:	EX-LOK/SG-LOK/DK-LOK/SE-LOK
5.	SS316 BALL VALVE	:	EX-LOK/SG-LOK/DK-LOK/SE-LOK
6.	SS316 NEEDLE VALVE	:	EX-LOK/SG-LOK/DK-LOK/SE-LOK
7.	SS316 CHECK VALVE	:	EX-LOK/SG-LOK/DK-LOK/SE-LOK
8.	SS316 SEMI AUTOMATIC CHANGE OVER PANEL	:	EX-LOK/PSG-LOK/ROTAREX/ GCE
9.	SS316 LINE PRESSURE REGULATOR	:	EX-LOK/PSG-LOK/ROTAREX/ SE-LOK
10.	SS316 FLEXIBLE HOSE	:	EX-LOK/SG-LOK/ SE-LOK/ SE-LOK
11.	SS316 FILTER	:	EX-LOK/SG-LOK/ SE-LOK/ SE-LOK
12.	SS316 FLASH BACK ARRESTOR	:	ESSAB/CELSUN
13.	SS304 PIPES	:	PRAKASH/HINDUSTAN INOX
14.	SS304 SS PIPE FITTINGS	:	EX-LOK/SG-LOK/ SE-LOK
15.	PRESSURE GAUGES /VACUUM GAUGES / TEMP GAUGES	:	H.GURU / BAUMER
16.	SS304 BALL VALVES	:	INTERVALVE/ L & T/
17.	SS304 NRV	:	INTER VALVE/ L & T
18.	GASKET MATERIAL	:	KLINGER / CHAMPION
19.	AIR PRESSURE REGULATOR	:	DOMNICK HUNTER/JANATIC
20.	COMPRESSED AIR FILTER	:	DOMNICK HUNTER/JANATIC
21.	AUTO MOISTURE TRAP	:	DOMNICK HUNTER/JANATIC
22.	FASTNERS	:	TVS / UNBRAKO
23.	ANCHOR FASTNERS	:	HILTI/FISCHER
24.	STRUCTURAL STEEL	:	SAIL / JINDAL / TATA
25.	PP CLAMP WITH RAIL NUT	:	STAUFF/UNSTUT/EX-LOK/SG-LOK/DK-LOK/SE-LOK/VAISHNAVI

26.	PAINTS	:	ASIAN / NEROLAC / BERGER
27.	WELDING RODS	:	ESAB/MANGALAM
28.	WELDING MACHINES (NO TRANSFORMER M/C)	:	3 PH DC RECTIFIER
29.	DRILLING MACHINES / GRINDING MACHINES	:	HILTI/BOSCH/HITACHI
30.	Y-STRAINER	:	HAWA/SHENCO VALVE
31.	COMPRESSOR	:	CHICOGO PNEMATIC/PARKER/ATLAS COPCO
32.	INSULATION	:	ARMSTRONG/GRUNDFOS/XYLEM
33.	LIQUID NITROGEN PIPES AND FLEXIBLE PIPES	:	MEGOLECK/SG-LOK/EX-LOK/ SHELL-N-TUBE
34.	MANUAL GLOBE VALVE	:	BESTOBELL/CRYOCOMP
35.	DRAIN VALVE	:	BESTOBELL/CRYOCOMP
36.	THERMAL RELIEF VALVE	:	BESTOBELL/CRYOCOMP
37.	PRESSURE REGULATOR	:	CASH VALVE

PART - 13 – FIRE PROTECTION SYSTEM -APPROVED MAKE LIST

1	ELECTRICAL DRIVEN CENTRIFUGAL FIRE PUMP	:	KIRLOSKAR/ ARMSTRONG/ GRUNDFOS/ JHONSON/ WILLO
2	MCC PANEL COMPONENTS	:	ABB/L & T(ONLY FOR ELECTRICAL DRIVEN STANDBY PUMP AND JOCKEY PUMP)
3	OS & Y GATE VALVE(IS APPROVED)	:	BDK/KIRLOSKAR/HD FIRE/RAPIDROP
4	NRV	:	TYCO/ADVANCE/AUDCO/BDK
5	BUTTERFLY VALVE(NON FM APPROVED)	:	ADVANCE/ADUCO/L& T/BDK
6	BALL VALVE(GUN METAL/BRASS/BRONZE)	:	KITZ/ZOLOTO/LEADER
7	GI PIPES	:	JINDAL/TATA
8	HYDRANT VALVES	:	WINCO/NEWAGE
9	HYDRANT BRANCH PIPE	:	WINCO/NEWAGE
10	HYDRANT FIRE HOSE	:	WINCO/NEWAGE
11	HYDRANT HOSE REEL	:	WINCO/NEWAGE
12	WATER FOAM MONITOR	:	HD FIRE/TYCO-ANSUL
13	FOAM CONCENTRATE	:	KV FIRE/ANSUL
14	PRESSURE GUAGE	:	H.GURU/WAREE/BAUMER
15	PRESSURE SWITCH	:	DANFOS/INDFOS
20	WATER FLOW SWITCH	:	POTTER/SYSTEM SENSOR
21	ALARM CONTROL VALVE	:	TYCO/ HD FIRE/VIKING
28	STRAINER	:	PROCEDYNE/ARMSTRONG
29	PAINTINGS	:	ASIAN/BURGER
30	WRAPPING & COATING	:	IWL/PYPKOTE
31	DELUGE VALVE	:	HD FIRE/TYCO
32	FIRE EXTINGUISHER	:	CEASEFIRE/USHA ARMOUR/SAFEX
33	MOULDED CASE CIRCUIT BREAKERS (MCCBS)	:	ABB / SIEMENS / SCHNEIDER / LEGRAND
34	MINIATURE CIRCUIT BREAKERS (MCBS), EARTH-LEAKAGE CIRCUIT BREAKERS	:	ABB / SIEMENS / SCHNEIDER / LEGRAND
35	CURRENT TRANSFORMER	:	KALPA / KAPPA / VOLTAMPS / PROK DEVICE
36	POTENTIAL TRANSFORMER	:	KALPA / KAPPA / VOLTAMPS / PROK DEVICE

37	ANALOG / DIGITAL PANEL METERS	:	ELMEASURE / CONZERV / TRINITY / RISHABH / MECO / CIRCUITOR
38	MULTI-FUNCTION METER (MFM)	:	SCHNEIDER MAKE MODEL NO: 6400NG OR EQUIVALENT MAKE
39	SELECTOR SWITCHES/PANEL ROTARY SWITCHES	:	ABB / SCHNEIDER / VAISHNO / SALZER / TEKNIC / KAYCEE
40	POWER CONTACTORS	:	ABB / SIEMENS / SCHNEIDER / LEGRAND
41	BI-METALLIC OVERLOAD RELAYS	:	ABB / SIEMENS / SCHNEIDER / LEGRAND
42	EARTH-LEAKAGE RELAYS	:	ABB / SIEMENS / SCHNEIDER / LEGRAND
43	INDICATING LAMPS / ILLUMINATED PUSH BUTTON	:	ABB / SCHNEIDER / VAISHNO / TEKNIC
44	LT 1.1 KV POWER CABLES	:	POLYCAB / KEI / / FINOLEX/ GEMSCAB
45	LT 1.1 KV PVC INSULATED / FR / FRLS FLEXIBLE CABLES	:	POLYCAB / KEI / / FINOLEX/ GEMSCAB / POWER FLEX
46	PVC INSULATED / FR / FRLS COPPER WIRES	:	GEMSCAB / POLYCAB / KEI / / FINOLEX/ POWER FLEX
47	CABLE LUGS (COPPER)	:	MULTI / BRACO/ CONNECTWELL/ DOWELLS
48	CABLE GLANDS (BRASS)	:	SMI / HMI / BRACO / DOWELLS
49	CABLE TRAYS	:	PUSHPAK / OBO / PROFAB
50	ON/OFF, EMERGENCY PUSH BUTTON	:	HENSEL / SCHNEIDER
51	FIRE SAFETY EQUIPMENTS	:	MINIMAX / SAFEX /CEASEFIRE
52	PRESSURE RELIEF VALVE	:	RAPIDROP/TYCO
53	PASSIVE FIREPROTECTION/ FIRE STOP	:	HILTI/3M

PLEASE NOTE:

a) WHILE ESTIMATING RATES W.R.T MAKES ENSURE THAT THE PRICES FOR ALTERNATIVES ARE CORRECTLY CONSIDERED.
b) NCCS & CONSULTANT (MJA) RESERVE THE RIGHT TO INSIST ON ANY PARTICULAR MAKE IN THE ALTERNATIVES MENTIONED IN ABOVE LIST. IT IS DEEMED THAT RATES QUOTED ARE FOR ANY OF THE ALTERNATIVES MENTIONED FOR EACH ITEM.
c) ANY OTHER MAKES NOT MENTIONED IN THE ACCEPTED MAKE MAY BE CONSIDERED WITH PRIOR TECHNICAL DISCUSSION.
d) PROPER MATERIAL SUBMITTAL SHOULD BE MADE FOR ALL ITEMS & APPROVALS SOUGHT BEFORE ORDERING THE MATERIALS.

HVAC ROOM DATA SHEET

CLIENT: M/s. NATIONAL CENTRE FOR CELL SCIENCE

PROJECT: ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

LEAD CONSULTANT: M/s. SHRIYATA LIFETECH PVT LTD.,

TECHNICAL CONSULTANTS : MJA PHARMATECH PRIVATE LIMITED

DOCUMENT NO :-
MJ 437 - HVAC RDS - 7110

DATE:- 07.07.2023
REVISION:- R0

			DESIGN DATA																								VALIDATION DATA															
UNIT TAG NO.	ROOM NUMBER	ROOM DESCRIPTION	ROOM LENGTH (MTS)	ROOM WIDTH (MTS)	FLOOR AREA (SQ.MT)	CEILING HEIGHT (MTS)	VOLUME (CU.MTS)	OCCUPANCY IN NOS	LIGHTING LOAD (W/SQ.FT.)	CONNECTED EQUIPMENT LOAD (KW)	HEAT DISSIPATION (%)	EQUIPMENT HEAT FOR CALCULATION (KW)	LAF LOAD (KW)	TOTAL KW LOAD CONSIDERED FOR CALCULATION	GRADE	DESIGN TEMP. (°C)	DESIGN RH (%)	TYPE OF SYSTEM	HEPA FILTER (PLENUM HEPA / TERMINAL HEPA)	ROOM PRESSURE (Pa)	ROOM PRESSURE (Pa)	MINIMUM AIR CHANGES PER HOUR	AIR CHANGES PER HOUR CONSIDERED	MINIMUM FRESH AIR CHANGE (ACPH)	RESULTANT ACPH	INF/EXF (CFM WITH IN SYSTEM)	INF/EXF (CFM OUT OF SYSTEM)	MACHINE EXHAUST (CFM)	REHEAT (KW)	COMPANSEATION HEATING (KW)	SELECTED HEATER CAPACITY (KW)	COOLING LOAD (TR)	SELECTED COOLING CAPACITY (TR)**	AIR QTY AS PER ACPH (CFM)	DEHUMIDIFIED AIR QTY (CFM)	SELECTED SUPPLY AIR QTY (CFM)	RETURN AIR / EXHAUST AIR QTY (CFM)	FRESH AIR QTY (CFM)	AHU SELECD AIR QTY (CFM)	BLOWER CAPACITY (CFM)	SELECTED AHU CAPACITY (CFM)	INDICATED MOTOR CAPACITY (KW)	BLOWER CAPACITY (CFM) WITH 15% SAFETY	INDICATED MOTOR CAPACITY (KW)	SELECTED MOTOR CAPACITY (KW)	REMARKS
BASEMENT FLOOR																																											
VRF CASSETTE UNIT																																											
	BS-001	RECEPTION	3.60	2.45	8.81	2.50	22.02	2	1.0	0.3	1.00	0.3	0.0	0.3	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	13	0	0	0				0.51		78	169	169	169								
B-CU-1					**8.81**		**22.02**	**2**		**0.3**		**0.3**	**0.0**	**0.3**												**0**	**0**	**0**				**0.51**	**0.80**	**78**	**169**	**169**	**169**			**169**	**200**			**0.10**	**0.10**	**0.8 TR x 1 No. VRF CASSETTE UNIT**
	BS-002	PASSAGE	8.84	1.20	10.61	2.50	26.52	1	1.0	0.0	1.00	0.0	0.0	0.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	8	0	0	0				0.35		94	125	125	125								
B-CU-2					**10.61**		**26.52**	**1**		**0.0**		**0.0**	**0.0**	**0.0**												**0**	**0**	**0**				**0.35**	**0.80**	**94**	**125**	**125**	**125**			**125**	**200**			**0.10**	**0.20**	**0.8 TR x 1 No. VRF CASSETTE UNIT**
	BS-003	MATERIAL OUT	6.10	1.50	9.15	2.50	22.87	1	1.0	0.0	1.00	0.0	0.0	0.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	23	0	0	0				0.80		81	316	316	316								
B-CU-3					**9.15**		**22.87**	**1**		**0.0**		**0.0**	**0.0**	**0.0**												**0**	**0**	**0**				**0.80**	**1.60**	**81**	**316**	**316**	**316**			**316**	**400**			**0.10**	**0.20**	**0.8 TR x 2 Nos. VRF CASSETTE UNIT**
	BS-004	MATERIAL IN	6.10	2.34	14.27	2.50	35.67	1	1.0	0.0	1.00	0.0	0.0	0.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	6	0	0	0				0.41		126	116	126	126								
B-CU-4					**14.27**		**35.67**	**1**		**0.0**		**0.0**	**0.0**	**0.0**												**0**	**0**	**0**				**0.41**	**1.60**	**126**	**116**	**126**	**126**			**126**	**200**			**0.10**	**0.20**	**0.8 TR x 2 Nos. VRF CASSETTE UNIT**
	BS-005	WAREHOUSE	6.10	4.60	28.05	2.50	70.13	4	1.0	1.0	1.00	1.0	0.0	1.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	11	0	0	0				1.34		247	472	472	472								
B-CU-5					**28.05**		**70.13**	**4**		**1.0**		**1.0**	**0.0**	**1.0**												**0**	**0**	**0**				**1.34**	**2.00**	**247**	**472**	**472**	**472**			**472**	**500**			**0.10**	**0.20**	**1.0 TR x 2 Nos. VRF CASSETTE UNIT**
	BS-006	OFFICE AREA	7.40	3.00	22.19	2.50	55.47	8	1.0	2.0	1.00	2.0	0.0	2.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	20	0	0	0				2.01		196	658	658	658								
B-CU-6					**22.19**		**55.47**	**8**		**2.0**		**2.0**	**0.0**	**2.0**												**0**	**0**	**0**				**2.01**	**2.40**	**196**	**658**	**658**	**658**			**658**	**700**			**0.10**	**0.20**	**1.2 TR x 2 Nos. VRF CASSETTE UNIT**
	BS-008	SAMPLE ARCHIVAL	3.50	4.05	14.15	2.50	35.39	1	1.0	3.2	0.50	1.6	0.0	1.6	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	19	0	0	0				1.00		125	397	397	397								
B-CU-7					**14.15**		**35.39**	**1**		**3.2**		**1.6**	**0.0**	**1.6**												**0**	**0**	**0**				**1.00**	**1.20**	**125**	**397**	**397**	**397**			**397**	**400**			**0.10**	**0.10**	**1.2 TR x 1 No. VRF CASSETTE UNIT**
VRF HI WALL UNIT																																											
	BS-009	IT HUB ROOM	3.50	2.69	9.39	2.50	23.49	1	1.0	3.0	1.00	3.0	0.0	3.0	COMFORT AC	NMT25	NC	REC	NA	0	Ambient	6	6	0.6	42	0	0	0				1.36		83	576	576	576								
B-HWU-1					**9.39**		**23.49**	**1**		**3.0**		**3.0**	**0.0**	**3.0**												**0**	**0**	**0**				**1.36**	**2.00**	**83**	**576**	**576**	**576**			**576**	**600**			**0.10**	**0.20**	**2 TR x 1 No. VRF HI WALL UNIT**
VRF OUTDOOR UNIT																																											
B-VRF-ODU-1																															**12.40**	**16**									**12.00**	**12.00**	**16 HP x 1 NO VRF OUT DOOR (COOLING ONLY) UNIT FOR BASEMENT FLOOR**
GROUND FLOOR																																											
AIR HANDLING UNIT																																											
	GF-001	CHANGE ROOM - 1	2.32	2.00	4.64	2.50	11.60	0	1.0	0.0	1.00	0.0	0.0	0.0	CNC	NMT25	NC	REC	NA	5	5	10	20	1.0	20	0	-56	0	NA	NA		0.23		136	88	136	192	9							
	GF-002	CELL BANK REPOSITORY	7.12	3.60	25.63	2.50	64.08	4	1.0	12.0	0.30	3.6	0.0	3.6	CNC	NMT25	NC	REC	NA	5	5	10	10	1.0	30	0	0	0	NA	NA		2.82		377	1140	1140	1140	50							
	GF-003	CELL FREEZING AREA 2 ISOLATION	3.04	3.60	10.94	2.50	27.36	1	1.0	11.0	0.30	3.3	0.0	3.3	CNC	NMT25	NC	REC	NA	5	5	10	10	1.0	51	0	0	0	NA	NA		1.90		161	815	815	815	21							
GF-AHU-1A					**41.22**		**103.04**	**5**		**23.0**		**6.9**	**0.0**	**6.9**												**0**	**-56**	**0**				**4.95**	**8.00**	**674**	**2043**	**2091**	**2147**	**80**	**136**	**2227**	**2300**	**2.16**	**2530**	**2.37**	**2.20**	**SUPPLY AIR BLOWER**
GF-AHU-1B																																					**2147**	**2200**	**1.03**	**2420**	**1.14**	**1.10**	**RETURN / EXHAUST AIR BLOWER**
	GF-004	CHANGE ROOM - 2	2.50	2.06	5.15	2.50	12.87	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	25	-245	139	0	1.42	0.31		1.05		189	97	189	295	139							
	GF-005	MEDIA PREPARATION AREA	2.46	6.14	15.10	2.50	37.76	2	1.0	0.9	1.00	0.9	1.5	2.4	GRADE 'D'	NMT25	NMT60	REC	T	30	30	25	25	2.5	31	106	0	0	2.12	4.01		1.82		555	691	691	585	56							
	GF-006	CHANGE ROOM - 3	2.40	1.80	4.32	2.50	10.79	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	35	35	45	45	4.5	45	26	0	0	1.81	0.20		0.36		286	76	286	260	29							
	GF-007	CORRIDOR	9.27	1.80	16.69	2.50	41.72	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	45	45	45	45	4.5	45	7	-286	0	7.21	0.52		1.14		1104	261	1104	1383	110							
	GF-009	AUTOCLAVE ROOM	3.29	5.87	19.30	2.50	48.25	2	1.0	16.9	0.50	8.5	0.0	8.5	GRADE 'C'	NMT25	NMT60	REC	T	35	35	45	45	4.5	66	-118	0	0	2.96	11.15		4.74		1277	1880	1880	1998	128							
	GF-008	COOL ZONE & MEDIA STORAGE	1.89	3.35	6.31	2.50	15.79	1	1.0	0.5	1.00	0.5	1.5	2.0	GRADE 'C'	NMT25	NMT60	REC	T	55	55	45	45	4.5	46	106	0	0	0.41	2.48		1.16		418	426	426	320	42							
	GF-012	INCUBATOR ROOM	2.10	3.60	7.56	2.50	18.90	1	1.0	5.7	0.70	4.0	0.0	4.0	GRADE 'C'	NMT25	NMT60	REC	T	55	55	45	45	4.5	72	118	0	0	0.53	4.73		2.01		500	796	796	678	50							
	GF-013	WASHING AREA	6.14	2.67	16.40	2.50	40.99	2	1.0	6.1	0.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NC	OT	T	35	35	45	45	45.0	45	0	-118	0	8.10	3.35		8.44		1085	869	1085	0	1085							ONCE THROUGH EXHAUST CONSIDERED
	GF-	DECONTAMINATION	2.70	1.92	5.19	2.50	12.98	0	1.0	1.2	0.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NC	OT	T	35	35	45	45	45.0	45	0	0	0	2.57	0.54		2.58		344	240	344	0	344							
	GF-016	WASTE OUT	1.80	1.27	2.29	2.50	5.73	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NC	OT	T	30	30	45	45	45.0	45	0	0	0	1.15	0.32		1.21		152	144	152	0	152							
GF-AHU-2					**98.31**		**245.77**	**10**		**31.3**		**13.8**	**3.0**	**16.8**												**0**	**-265**	**0**	**28.29**	**27.61**	**29.00**	**24.51**	**26.00**	**5910**	**5480**	**6953**	**5519**	**2133**	**699**	**7652**	**7700**	**10.00**	**8470**	**11.00**	**11.00**	
GF-EAU-1																																					**1699**			**1699**	**1700**	**0.80**	**1870**	**0.88**	**1.10**	**ONCE THROUGH EXHAUST UNIT CONNECTED TO GF-AHU-2**
	GF-010	CHANGE ROOM	2.20	1.75	3.85	2.50	9.63	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'B'	NMT25	NMT60	REC	T	60	60	60	60	6.0	60	-106	130	0	2.11	0.24		1.12		340	147	340	316	130							
	GF-010A	EXIT AIRLOCK	1.27	1.57	2.00	2.50	5.00	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'B'	NMT25	NMT60	REC	T	60	60	60	60	6.0	60	-106	130	0	1.14	0.12		0.98		176	91	176	152	130							
	GF-011	STERILITY TESTING	4.57	3.14	14.35	2.50	35.87	2	1.0	16.0	0.40	6.4	0.0	6.4	GRADE 'B'	NMT25	NMT60	REC	T	70	70	60	60	6.0	79	212	0	470	4.43	9.86		5.98		1266	1661	1661	979	470							470 CFM x 1 No. 5' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
GF-AHU-3					**20.20**		**50.50**	**3**		**16.0**		**6.4**	**0.0**	**6.4**												**0**	**260**	**470**	**7.68**	**10.22**	**11.00**	**8.08**	**9.00**	**1782**	**1899**	**2177**	**1447**	**730**	**0**	**2177**	**2200**	**3.10**	**2420**	**3.41**	**3.70**	
	GF-014	CELL CULTURE 1	3.60	2.60	9.36	2.50	23.39	2	1.0	15.5	0.40	6.2	0.0	6.2	GRADE 'C'	NMT25	NMT60	REC	T	60	60	45	45	4.5	99	0	144	360	1.35	8.07		5.86		619	1358	1358	854	504							360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
GF-AHU-4					**9.36**		**23.39**	**2**		**15.5**		**6.2**	**0.0**	**6.2**												**0**	**144**	**360**	**1.35**	**8.07**	**9.00**	**5.86**	**7.00**	**619**	**1358**	**1358**	**854**	**504**	**0**	**1358**	**1400**	**1.97**	**1540**	**2.17**	**2.20**	
	GF-015	CELL CULTURE 2	3.60	2.60	9.36	2.50	23.39	2	1.0	15.5	0.40	6.2	0.0	6.2	GRADE 'C'	NMT25	NMT60	REC	T	60	60	45	45	4.5	109	0	144	360	2.12	8.96		6.04		619	1500	1500	996	504							360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
GF-AHU-5					**9.36**		**23.39**	**2**		**15.5**		**6.2**	**0.0**	**6.2**												**0**	**144**	**360**	**2.12**	**8.96**	**9.00**	**6.04**	**8.00**	**619**	**1500**	**1500**	**996**	**504**	**0**	**1500**	**1500**	**2.02**	**1650**	**2.23**	**2.20**	
VRF OUTDOOR UNIT																																											
GF-VRF ODU-1																													**16.50**	**58.00**		**58.00**	**73**								**19.00**	**57.00**	**24 HP x 3 Nos. VRF HEAT RECOVERY OUT DOOR UNIT CONNECTED TO GROUND FLOOR AHU**
FIRST FLOOR																																											
AIR HANDLING UNIT																																											
	FF-001	PASSAGE	2.55	1.20	3.05	2.50	7.64	1	1.0	0.0	1.00	0.0	0.0	0.0	CNC	NMT25	NMT60	REC	NA	5	5	10	10	1.0	24	-260	75	0	1.05	0.48		0.70		45	108	108	293	75							
	FF-003	MALE CHANGE	2.85	2.50	7.13	2.50	17.81	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	25	236	0	0	1.09	0.69		0.47		262	149	262	26	26							
	FF-002	FEMALE CHANGE	2.55	2.10	5.35	2.50	13.37	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	40	2.5	40	236	0	0	2.26	0.41		0.36		315	111	315	79	20							
	FF-009	PASSAGE	2.69	1.87	5.03	2.50	12.58	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	10	10	25	25	2.5	25	-448	0	0	1.17	0.21		0.28		185	69	185	633	19							
	FF-010	AIRLOCK	1.70	1.50	2.55	2.50	6.37	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	25	106	-106	0	0.64	0.06		0.10		94	26	94	94	9							
	FF-004	UNISEX CHANGE ROOM	2.69	1.50	4.04	2.50	10.09	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	25	25	45	45	4.5	45	0	0	0	1.62	0.64		0.45		267	135	267	267	27							
	FF-005	AIRLOCK	2.00	1.50	3.00	2.50	7.50	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	40	40	45	45	4.5	45	24	0	0	1.16	0.49		0.31		199	102	199	175	20							
	FF-006	PASSAGE	7.19	1.50	10.79	2.50	26.96	1	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	50	50	45	45	4.5	45	106	288	0	3.82	2.13		2.33		714	422	714	320	288							
FF-AHU-1					**40.93**		**102.33**	**6**		**0.0**		**0.0**	**0.0**	**0.0**												**0**	**257**	**0**	**12.81**	**5.11**	**13.00**	**5.00**	**8.00**	**2080**	**1122**	**2144**	**1887**	**483**	**226**	**2370**	**2400**	**3.38**	**2640**	**3.72**	**3.70**	
	FF-011	INNER CORRIDOR	12.60	1.99	25.02	2.50	62.56	2	1.0	1.5	1.00	1.5	0.0	1.5	GRADE 'D'	NMT25	NMT60	REC	T	30	30	25	30	2.5	30	122	641	0	5.84	2.96		5.15		1104	610	1104	341	641							
	FF-012	MICROBIOLOGY LAB WITH INCUBATOR	3.10	4.52	13.98	2.50	34.95	2	1.0	5.7	0.70	4.0	0.0	4.0	GRADE 'D'	NMT25	NMT60	REC	T	30	30	25	25	2.5	55	-113	0	360	2.71	6.72		4.29		514	1131	1131	884	360							360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
	FF-012A	AIRLOCK	1.50	1.80	2.70	2.50	6.75	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	40	40	25	25	2.5	63	226	0	0	1.72	1.17		0.60		99	252	252	26	10							360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
	FF-018	QC LAB - 3	4.00	3.33	13.33	2.50	33.33	2	1.0	5.2	0.30	1.6	0.0	1.6	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	30	-118	0	0	2.34	3.34		1.54		490	579	579	697	49							
	FF-	DARK ROOM	1.70	1.70	2.89	2.50	7.22	0	1.0	0.7	0.60	0.4	0.0	0.4	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	44	0	0	0	1.02	1.06		0.45		106	187	187	187	11							
	FF-017	QC LAB - 2	4.00	3.21	12.84	2.50	32.10	2	1.0	6.8	0.30	2.0	0.0	2.0	GRADE 'D'	NMT25	NMT60	REC	T	20	20	25	25	2.5	36	0	0	0	2.61	4.01		1.77		472	687	687	687	47							

UNIT TAG NO.	ROOM NUMBER	ROOM DESCRIPTION	ROOM LENGTH (MTS)	ROOM WIDTH (MTS)	FLOOR AREA (SQ.MT)	CEILING HEIGHT (MTS)	VOLUME (CU.MTS)	OCCUPANCY IN NOS	LIGHTING LOAD (W/SQ.FT.)	CONNECTED EQUIPMENT LOAD (KW)	HEAT DISSIPATION (%)	EQUIPMENT HEAT FOR CALCULATION (KW)	LAF LOAD (KW)	TOTAL KW LOAD CONSIDERED FOR CALCULATION	GRADE	DESIGN TEMP.-(°C)	DESIGN RH (%)	TYPE OF SYSTEM	HEPA FILTER (PLENUM HEPA / TERMINAL HEPA)	ROOM PRESSURE (Pa)	ROOM PRESSURE (Pa)	MINIMUM AIR CHANGES PER HOUR	AIR CHANGES PER HOUR CONSIDERED	MINIMUM FRESH AIR CHANGE (ACPH)	RESULTANT ACPH	INF/ EXF(CFM WITH IN SYSTEM)	INF/EXF (CFM OUT OF SYSTEM)	MACHINE EXHAUST (CFM)	REHEAT (KW)	COMPANSSATION HEATING (KW)	SELECTED HEATER CAPACITY (KW)	COOLING LOAD (TR)	SELECTED COOLING CAPACITY (TR)**	AIR QTY AS PER ACPH (CFM)	DEHUMIDIFIED AIR QTY (CFM)	SELECTED SUPPLY AIR QTY (CFM)	RETURN AIR / EXHAUST AIR QTY (CFM)	FRESH AIR QTY (CFM)	AHU BLEED AIR QTY (CFM)	BLOWER CAPACITY (CFM)	SELECTED AHU CAPACITY (CFM)	INDICATED MOTOR CAPACITY (KW)	BLOWER CAPACITY (CFM) WITH 10% SAFETY	INDICATED MOTOR CAPACITY (KW)	SELECTED MOTOR CAPACITY (KW)	REMARKS
	FF-016	QC LAB - 1	4.00	3.00	12.00	2.50	30.00	2	1.0	8.3	0.30	2.5	0.0	2.5	GRADE 'D'	NMT25	NMT60	REC	T	10	10	25	25	2.5	54	-118	0	360	4.32	5.66		3.83		441	960	960	718	360				8.02	6270	8.83	9.30	360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
	FF-019	WASTE OUT	2.04	1.50	3.06	2.50	7.65	0	1.0	0.0	0.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NC	OT	T	20	20	25	25	25.0	25	0	48	0	0.94	0.31		0.85		112	79	112	0	112								ONCE THROUGH EXHAUST CONSIDERED CONNECTED TO FF-EAU-1
	FF-015	WASH + CLEANING + DECONTAMINATION	3.60	4.00	14.40	2.50	36.00	2	1.0	13.1	0.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NC	OT	T	20	20	25	25	25.0	25	0	-118	0	3.49	2.57		4.27		529	483	529	0	529								
FF-AHU-2					**100.22**		**250.55**	**12**		**41.3**		**12.0**	**0.0**	**12.0**												**-1**	**571**	**720**	**24.99**	**27.80**	**28.00**	**22.75**	**25.00**	**3868**	**4968**	**5541**	**3540**	**2120**	**119**	**5660**	**5700**	**8.02**	**6270**	**8.83**	**9.30**	
FF-EAU-1																																								**711**	**800**	**0.38**	**880**	**0.41**	**0.55**	**ONCE THROUGH EXHAUST UNIT CONNECTED TO FF-AHU-2**
	FF-014	AIRLOCK	1.80	1.50	2.70	2.50	6.75	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	10	10	25	25	2.5	25	-130	-150	0	0.68	0.07		0.11		99	28	99	379	10								
	FF-013	AIRLOCK	2.00	1.50	3.00	2.50	7.50	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	25	25	45	45	4.5	45	24	0	0	1.33	0.08		0.19		199	44	199	175	20								
	FF-007	CELL CULTURE WITH INCUBATOR	3.90	3.23	12.60	2.50	31.51	2	1.0	11.9	0.70	8.3	0.0	8.3	GRADE 'C'	NMT25	NMT60	REC	T	35	35	45	45	4.5	91	106	-144	360	1.03	9.86		4.91		834	1679	1679	1357	216								360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED BIOSAFETY CABINET SHALL HAVE INBUILT EXHAUST NO SEPARATE EXHAUST BLOWER CONSIDERED IN HVAC
FF-AHU-3					**18.30**		**45.76**	**2**		**11.9**		**8.3**	**0.0**	**8.3**												**0**	**-294**	**360**	**3.04**	**10.01**	**11.00**	**5.21**	**7.00**	**1132**	**1751**	**1977**	**1911**	**246**	**180**	**2157**	**2200**	**3.10**	**2420**	**3.41**	**3.70**	
	FF-021	AIRLOCK	1.80	1.50	2.69	2.50	6.74	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'D'	NMT25	NMT60	REC	T	10	10	25	25	2.5	25	-130	-150	0	0.68	0.07		0.11		99	28	99	379	10								
	FF-020	AIRLOCK	2.00	1.50	2.99	2.50	7.49	0	1.0	0.0	1.00	0.0	0.0	0.0	GRADE 'C'	NMT25	NMT60	REC	T	25	25	45	45	4.5	45	24	0	0	1.32	0.08		0.19		198	44	198	174	20								
	FF-008	VIROLOGY LAB WITH INCUBATOR	3.90	2.86	11.15	2.50	27.89	2	1.0	10.5	0.70	7.4	0.0	7.4	GRADE 'C'	NMT25	NMT60	REC	T	35	35	45	45	4.5	90	106	-144	360	0.92	8.74		4.46		738	1469	1469	1147	216								360 CFM x 1 No. 4' BIOSAFETY CABINET EXHAUST CONSIDERED A SEPARATE EXHAUST BLOWER WITH DRY SCRUBBER IS CONSIDERED IN HVAC
FF-AHU-4					**16.84**		**42.11**	**2**		**10.5**		**7.4**	**0.0**	**7.4**												**0**	**-294**	**360**	**2.93**	**8.89**	**9.00**	**4.76**	**6.00**	**1035**	**1541**	**1766**	**1700**	**246**	**180**	**1946**	**2000**	**2.60**	**2200**	**2.86**	**3.70**	
VRF OUTDOOR UNIT																																														
FF-VRF ODU-1																														**17.35**	**61.00**		**46.00**	**58**								**25.00**	**50.00**	**28 HP x 2 Nos. VRF HEAT RECOVERY OUT DOOR UNIT CONNECTED TO FIRST FLOOR AHU**
SECOND FLOOR																																														
DX HI WALL UNIT																																													
	FF	BMS ROOM	3.44	1.98	6.82	2.50	17.05	2	1.0	1.0	1.00	1.0	0.0	1.0	COMFORT AC	NMT25	NC	REC	NA	5	5	6	6	0.6	33	0	0	0				0.81		60	329	329	329									
SF-DX HWU-1					**6.82**		**17.05**	**2**		**1.0**		**1.0**	**0.0**	**1.0**												**0**	**0**	**0**				**0.81**	**1.00**	**60**	**329**	**329**	**329**			**329**	**400**			**1.30**	**1.30**	**1 TR x 1 No. DX HI WALL UNIT**
	FF	UPS ROOM	3.44	2.33	8.00	2.50	20.00	1	1.0	3.0	1.00	3.0	0.0	3.0	COMFORT AC	NMT25	NC	REC	NA	5	5	6	6	0.6	52	0	0	0				1.40		71	611	611	611									
SF-DX HWU-2					**8.00**		**20.00**	**1**		**3.0**		**3.0**	**0.0**	**3.0**												**0**	**0**	**0**				**1.40**	**2.00**	**71**	**611**	**611**	**611**			**611**	**700**			**2.60**	**2.60**	**2 TR x 1 No. DX HI WALL UNIT**
	FF	BATTERY ROOM	3.44	1.68	5.76	2.50	14.41	1	1.0	2.0	1.00	2.0	0.0	2.0	COMFORT AC	NMT25	NC	REC	NA	5	5	6	6	0.6	63	0	0	0				1.21		51	533	533	533									
SF-DX HWU-3					**5.76**		**14.41**	**1**		**2.0**		**2.0**	**0.0**	**2.0**												**0**	**0**	**0**				**1.21**	**2.00**	**51**	**533**	**533**	**533**			**533**	**600**			**2.60**	**2.60**	**2 TR x 1 No. DX HI WALL UNIT**
EXHAUST AIR PROPELLER FAN																																													
	GF-018	ELECTRICAL ROOM	7.10	6.02	42.74	4.00	170.97								VENTILATION & EXHAUST	NC	NC					20				0	0	0						2011		2011	2011									
SF-PF EA-1																																									**2011**			**2011**	**2100**	**0.49**	**2310**	**0.54**	**0.55**	**PROPELLER EXHAUST UNIT**
DRY SCRUBBER																																													
SCB-1																																									**360**			**360**	**400**	**0.56**	**440**	**0.62**	**0.75**	**DRY SCRUBBER FOR EXHAUST FROM BIO SAFETY CABINET OF VIROLOGY LAB**
	LEGEND :	**NC : NOT CONTROLLED**																																												**172.65**	
		NMT : NOT MORE THAN																																												
		NA : NOT APPLICABLE																																												
		AHU : AIR HANDLING UNIT																																												
		PF : PROPEELER FAN																																												
		EA : EXHAUST AIR																																												
		OT : ONCE THROUGH																																												
		REC : RECIRCULATION																																												

CLIENT: M/s. NATIONAL CENTRE FOR CELL SCIENCE	TECHNICAL CONSULTANTS : MJA PHARMATECH PRIVATE LIMITED	LEAD CONSULTANT: M/s. SHRIYATA LIFETECH PVT LTD.,

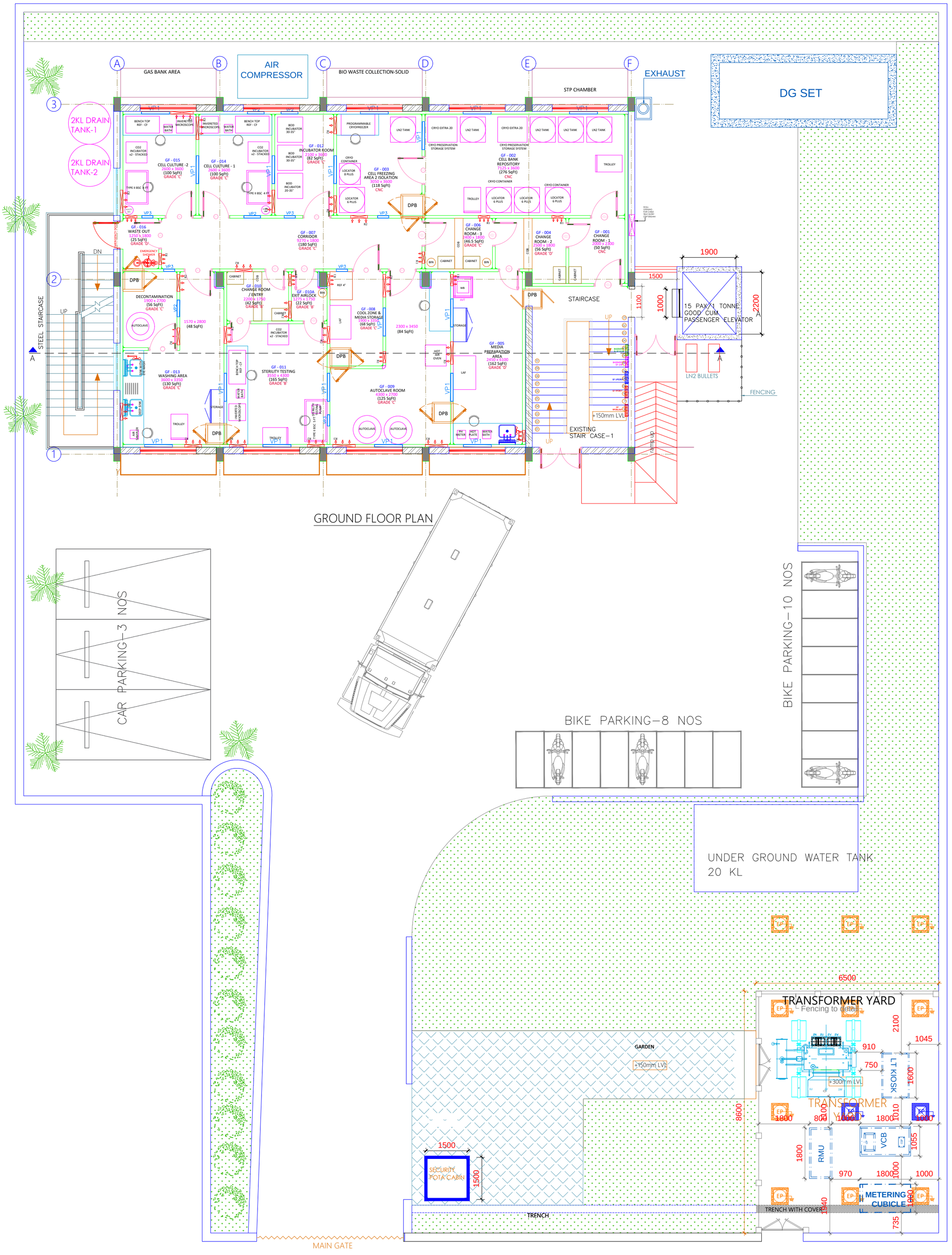
PROJECT : ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE	DATE:- 07.07.2023
HVAC EQUIPMENT SCHEDULE SHEET	REVISION:- R0

UNIT NO.	SUPPLY AIR (CFM)	RETURN / EXHAUST AIR (CFM)	FRESH AIR(CFM)	BLEED OFF (CFM)	DEHUMIDIFIED (CFM)	SELECTED FAN (CFM)	SELECTED COOLING CAPACITY (TR)	SELECTED HEATING CAPACITY (KW)	SELECTED MOTOR (KW)	REMARKS	CLASS
BASEMENT FLOOR											
VRF CASSETTE UNIT											
B-CU-1	169	169	0	0	200	200	0.80	0.00	0.10	**0.8 TR x 1 No. VRF CASSETTE UNIT**	
B-CU-2	125	125	0	0	200	200	0.80	0.00	0.20	**0.8 TR x 1 No. VRF CASSETTE UNIT**	
B-CU-3	316	316	0	0	400	400	1.60	0.00	0.20	**0.8 TR x 2 Nos. VRF CASSETTE UNIT**	
B-CU-4	126	126	0	0	200	200	1.60	0.00	0.20	**0.8 TR x 2 Nos. VRF CASSETTE UNIT**	
B-CU-5	472	472	0	0	500	500	2.00	0.00	0.20	**1.0 TR x 2 Nos. VRF CASSETTE UNIT**	
B-CU-6	658	658	0	0	700	700	2.40	0.00	0.20	**1.2 TR x 2 Nos. VRF CASSETTE UNIT**	
B-CU-7	397	397	0	0	400	400	1.20	0.00	0.10	**1.2 TR x 1 No. VRF CASSETTE UNIT**	
VRF HI WALL UNIT											
B-HWU-1	576	576	0	0	600	600	2.00	0.00	0.20	**2 TR x 1 No. VRF HI WALL UNIT**	
GROUND FLOOR											
AIR HANDLING UNIT											
GF-AHU-1A	2091	2147	80	136	2300	2300	8.00	0.00	2.20	**SUPPLY AIR BLOWER**	CNC
GF-AHU-1B	0	0	0	0	2200	2200	0.00	0.00	1.10	**RETURN / EXHAUST AIR BLOWER**	CNC
GF-AHU-2	6953	5519	2133	699	7700	7700	26.00	29.00	11.00		GRADE 'C'
GF-AHU-3	2177	1447	730	0	2200	2200	9.00	11.00	3.70		GRADE 'B'
GF-AHU-4	1358	854	504	0	1400	1400	7.00	9.00	2.20		GRADE 'C'
GF-AHU-5	1500	996	504	0	1500	1500	8.00	9.00	2.20		GRADE 'C'
ONCE THROUGH EXHAUST UNIT											
GF-EAU-1	0	1699	0	0	1700	1700	0.00	0.00	1.10	**ONCE THROUGH EXHAUST UNIT CONNECTED TO GF-AHU-2**	
FIRST FLOOR											
AIR HANDLING UNIT											
FF-AHU-1	2144	1887	483	226	2400	2400	8.00	13.00	3.70		GRADE 'C'
FF-AHU-2	5541	3540	2120	119	5700	5700	25.00	28.00	9.30		GRADE 'D'
FF-AHU-3	1977	1911	246	180	2200	2200	7.00	11.00	3.70		GRADE 'C'
FF-AHU-4	1766	1700	246	180	2000	2000	6.00	9.00	3.70		GRADE 'C'
ONCE THROUGH EXHAUST UNIT											
FF-EAU-1	0	0	0	0	800	800	0.00	0.00	0.55	**ONCE THROUGH EXHAUST UNIT CONNECTED TO FF-AHU-2**	
SECOND FLOOR											
DX HI WALL UNIT											
SF-DX HWU-1	329	329	0	0	400	400	1.00	0.00	1.30	**1 TR x 1 No. DX HI WALL UNIT**	
SF-DX HWU-2	611	611	0	0	700	700	2.00	0.00	2.60	**2 TR x 1 No. DX HI WALL UNIT**	
SF-DX HWU-3	533	533	0	0	600	600	2.00	0.00	2.60	**2 TR x 1 No. DX HI WALL UNIT**	
EXHAUST AIR PROPELLER FAN											
SF-PF EA-1	0	2011	0	0	2100	2100	0.00	0.00	0.55	**PROPELLER EXHAUST UNIT**	
VRF OUTDOOR UNIT											
B-VRF-ODU-1	0	0	0	0	0	0	0.00	0	12.00	**16 HP x 1 NO VRF OUT DOOR (COOLING ONLY) UNIT FOR BASEMENT FLOOR**	
GF-VRF ODU-1	0	0	0	0	0	0	0.00	0	57.00	**24 HP x 3 Nos. VRF HEAT RECOVERY OUT DOOR UNIT CONNECTED TO GROUND FLOOR AHU**	
FF-VRF ODU-1	0	0	0	0	0	0	0.00	0	50.00	**28 HP x 2 Nos. VRF HEAT RECOVERY OUT DOOR UNIT CONNECTED TO FIRST FLOOR AHU**	
DRY SCRUBBER											
SCB-1	0	360	0	0	400	400	0.00	0.00	0.75	**DRY SCRUBBER FOR EXHAUST FROM BIO SAFETY CABINET OF VIROLOGY LAB**	

PART- B
TENDER DRAWINGS

REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	PRANAV
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM



MASTER PLAN

TECHNICAL CONSULTANTS:

MJA PharmaTech Pvt Ltd
PROJECT ENGINEERING CONSULTANTS

MJA PHARMATECH PVT. LTD.,
#45, 1st Floor, 5th Cross, 8th Main Road,
Vasanthanagar, Bangalore - 560 052.
Tel: +91-80-2220 4636/222 84583 /41131518

LEAD CONSULTANT:

SHRIYATA LIFETECH PRIVATE LIMITED
YOU ENVISION, WE REALIZE

M/s. SHRIYATA LIFETECH PVT LTD.,
B-1702, BRIGADE GATEWAY, 26/1, DR. RAJKUMAR ROAD,
MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

MASTER PLAN

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
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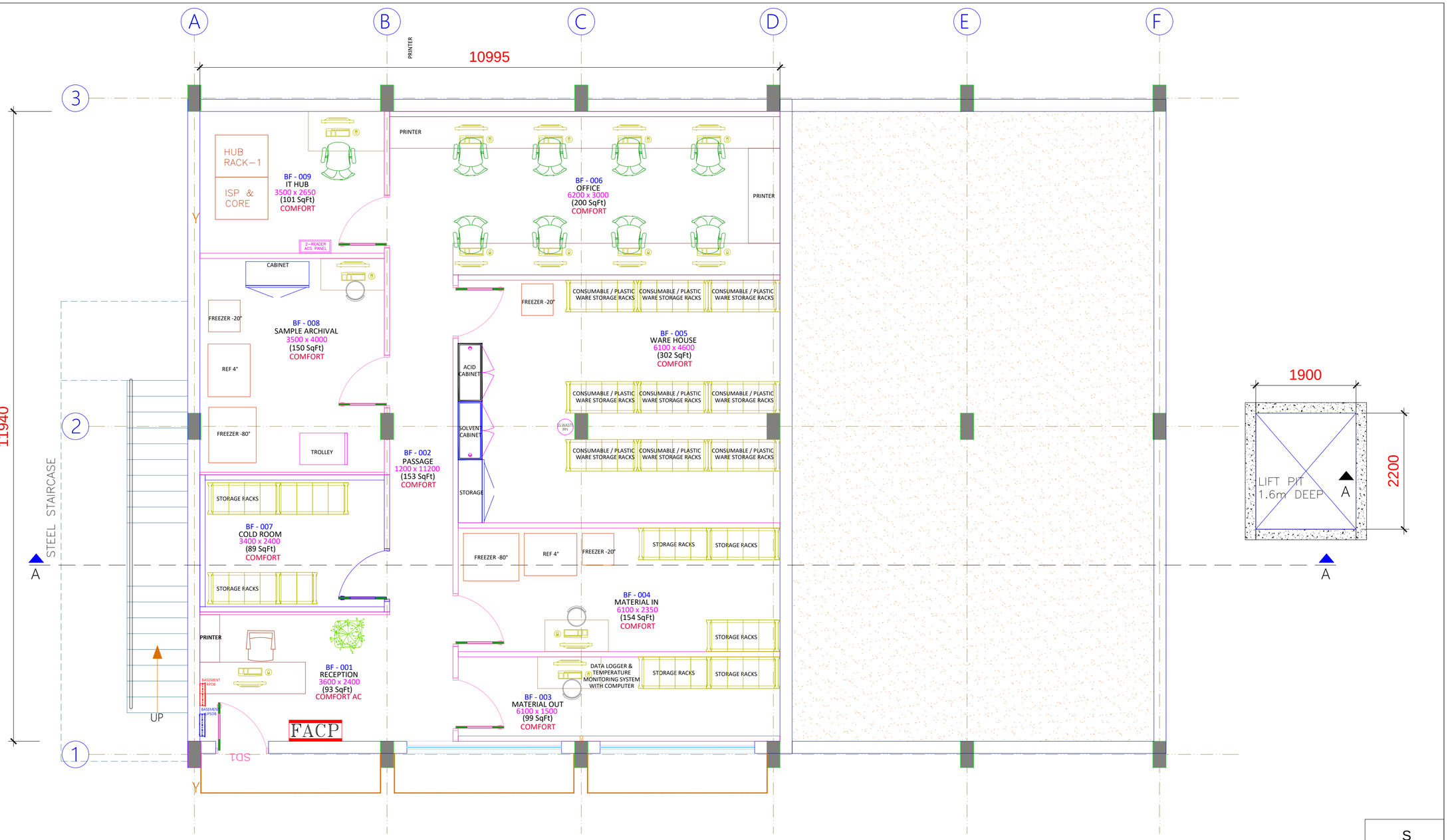

BASEMENT FLOOR PLAN

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REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	KM
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM

TECHNICAL CONSULTANTS:

MJA PHARMATECH PVT. LTD.,
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LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
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MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

BASEMENT LAYOUT DRAWING

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
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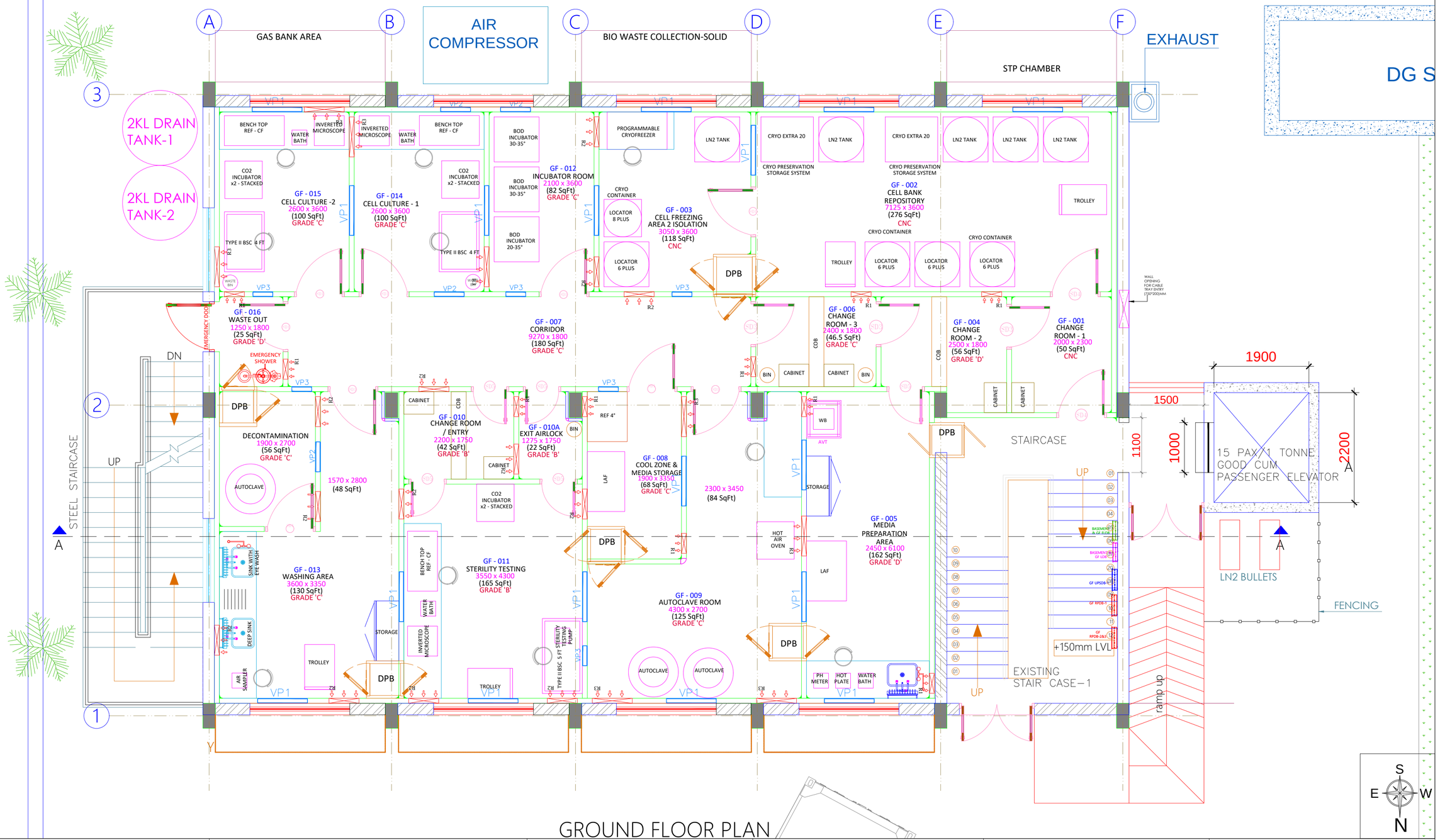

GROUND FLOOR PLAN

REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	PRANAV
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM

TECHNICAL CONSULTANTS:

MJA PHARMATECH PVT. LTD.,
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LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
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MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

GROUND FLOOR LAYOUT DRAWING

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
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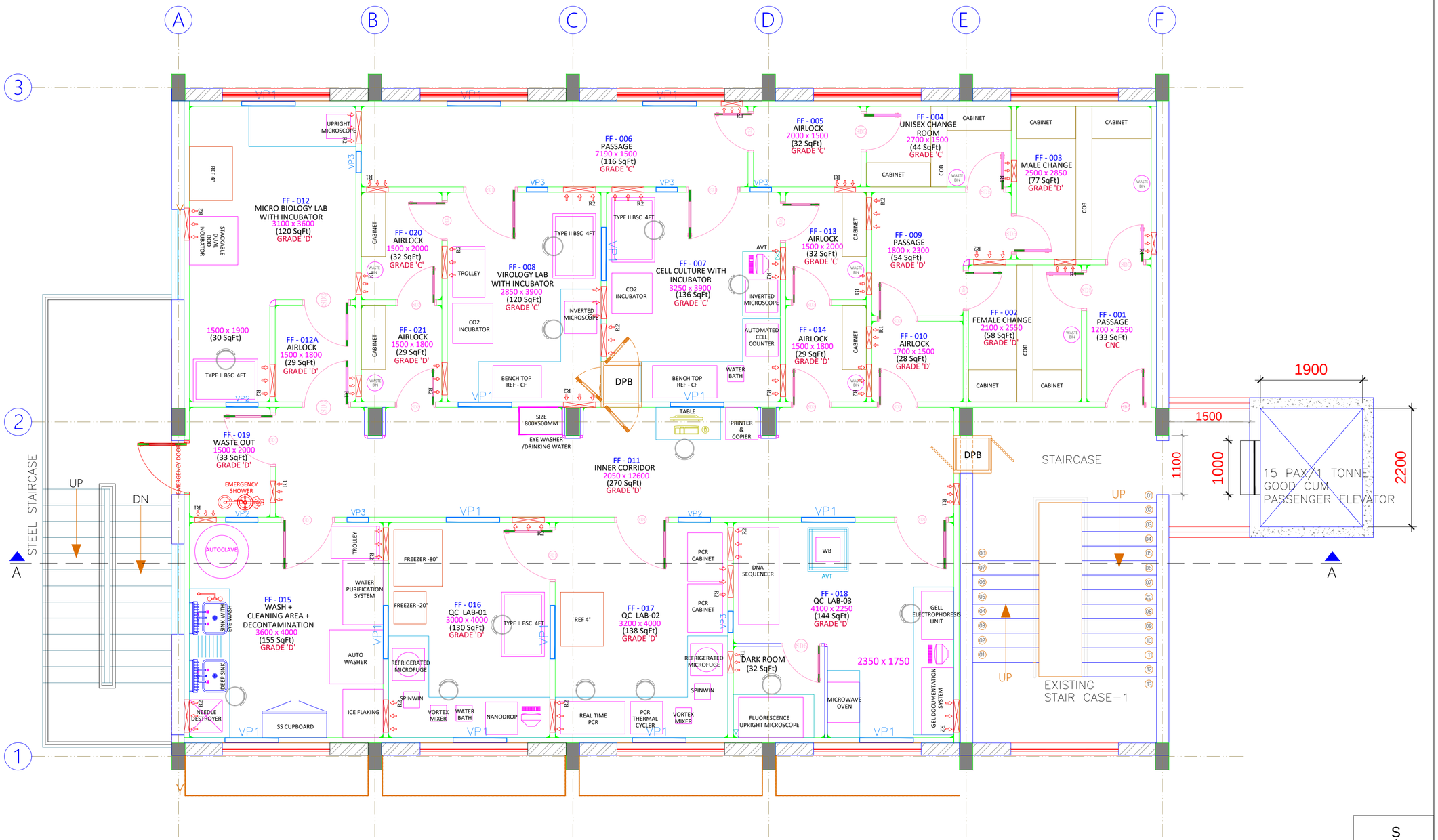
DRAWING NO.	MJ 437 - GFL - 2001	



FIRST FLOOR PLAN

REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	PRANAV
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM

TECHNICAL CONSULTANTS:

MJA PHARMATECH PVT. LTD.,
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LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
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MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University
Campus, PUNE.

PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

FIRST FLOOR LAYOUT DRAWING

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
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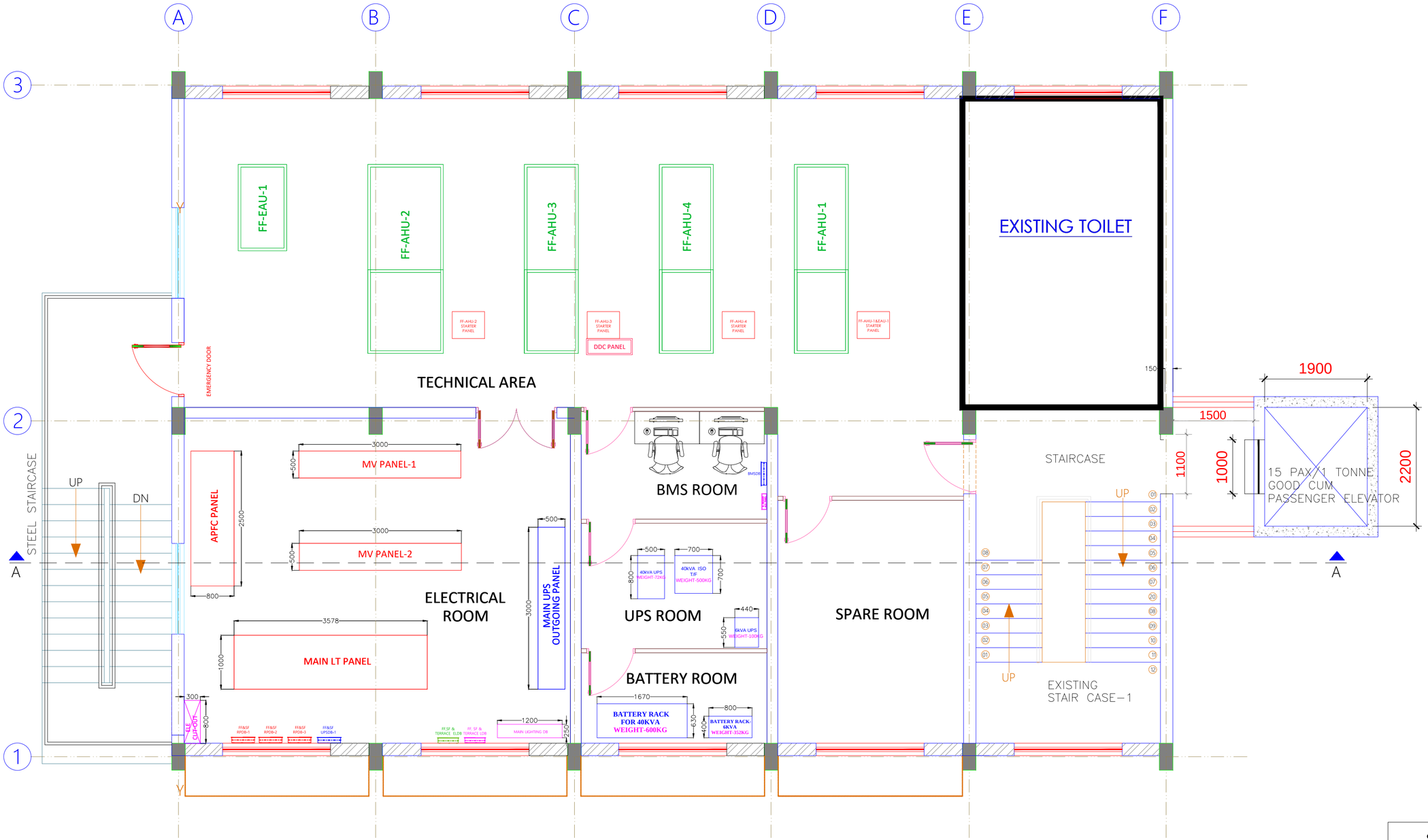

SECOND FLOOR PLAN

REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	PRANAV
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM

TECHNICAL CONSULTANTS:

MJA PharmaTech Pvt Ltd
PROJECT ENGINEERING CONSULTANTS

MJA PHARMATECH PVT. LTD.,
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LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
B-1702, BRIGADE GATEWAY, 26/1, DR. RAJKUMAR ROAD,
MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

SECOND FLOOR LAYOUT DRAWING

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
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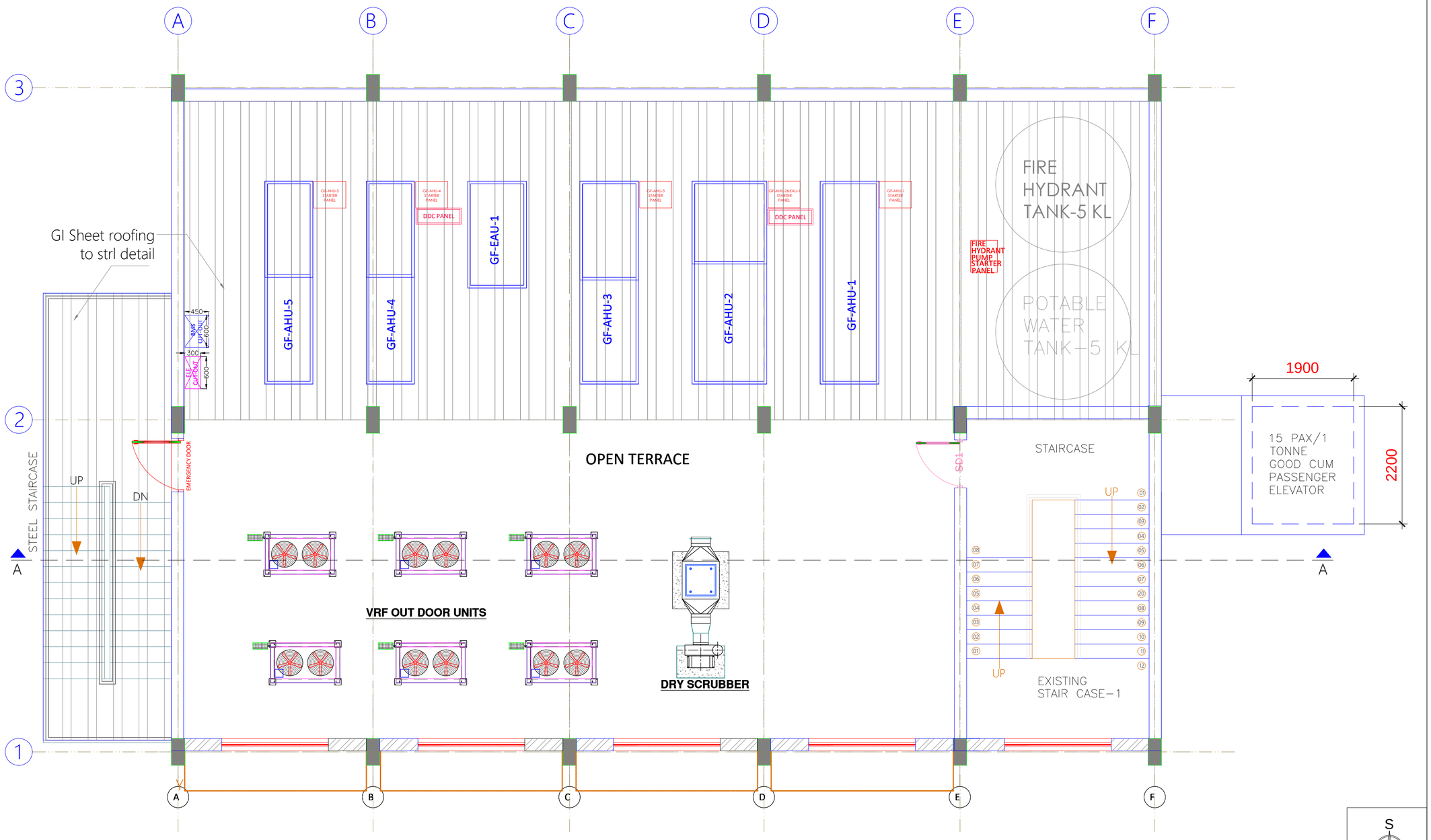
DRAWING NO.	MJ 437 - SFL - 2003	



TERRACE FLOOR PLAN

REVISIONS :

NO	DESCRIPTION	DATE	BY
R0-A	INITIAL ISSUE	02.12.2022	KM
R0-B	UPDATED INTERNAL LAYOUT	19.12.2022	PRANAV
R0-C	UPDATED INTERNAL LAYOUT	03.02.2023	PRANAV
R0-D	UPDATED AS PER CLIENT REQUIREMENT	21.03.2023	KM
R0-E	UPDATED AS PER CLIENT REQUIREMENT	24.04.2023	KM
R0-F	UPDATED AS PER CLIENT REQUIREMENT	29.06.2023	KM
R0-G	LIFT UPDATED AS PER CLIENT REQUIREMENT	25.10.2023	KM

TECHNICAL CONSULTANTS:

MJA PHARMATECH PVT. LTD.,
#45, 1st Floor, 5th Cross, 8th Main Road,
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Tel: +91-80-2220 4636/222 84583 /41131518

LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
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MALLESWARAM WEST, BANGALORE.

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

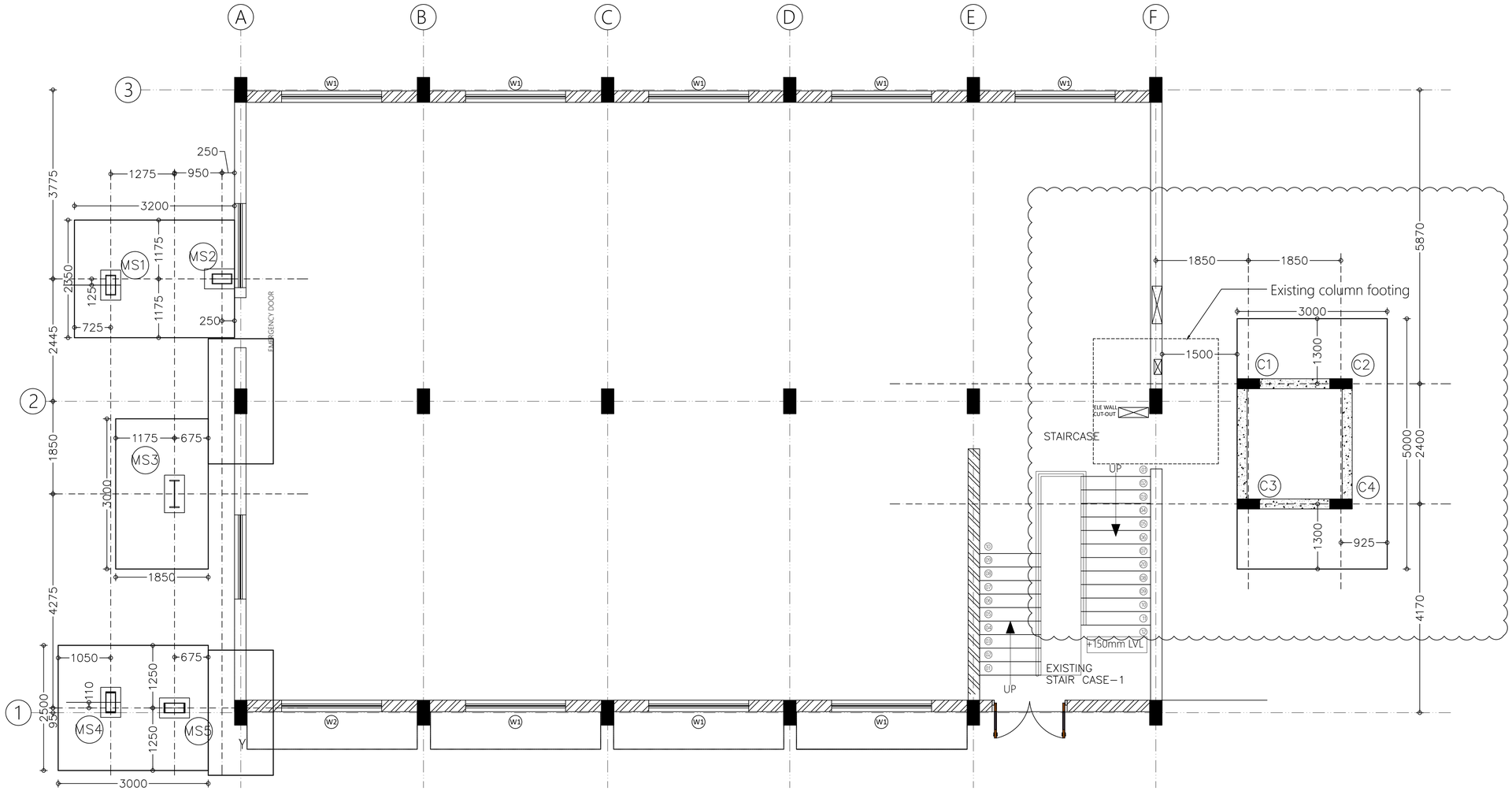
PROJECT :

ESTABLISHMENT OF c-GMP COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

TERRACE FLOOR LAYOUT DRAWING

DATE	25.10.2023	
DRAWN	KM	
CHECKED	ARS	REVISION
APPROVED	VS / DBS	R0-G
SCALE	1:50	PAGE - A2
DRAWING NO.	MJ 437 - TFL - 2004	



M.S.STAIRCASE & LIFT FOUNDATION LAYOUT PLAN

M.S.COLUMN SCHEDULE

SL.NO.	NOMENCLATURE	DESCRIPTION FOR BASEMENT & GROUND FLOOR
1	MS1,MS2.	2NOS. ISMC 400
2	MS3	ISMB 600
3	MS4.	10MM M.S.PLATE ON EITHER SIDE 2NOS. ISMC 400
4	MS5.	12MM M.S.PLATE ON EITHER SIDE 2NOS. ISMC 400

REV	DATE	DESCRIPTION
R1	19-10-2023	LIFT LOCATION REVISED AS PER LATEST ARCHITECTURAL DRAWING.

NOTES: –

1. READ THIS DRAWING ALONG WITH RELEVANT ARCHITECTURAL DRAWING.
2. FOR GENERAL NOTES REFER FOUNDATION DRAWING.
3. CONCRETE MIX GRADE – M25 C.C(UNLESS SPECIFIED).
4. STEEL GRADE Fe 500.
5. MINIMUM WELD THICNKESS 6MM.
6. STRUCTURAL STEEL SHALL CONFIRM TO LATEST IS:2062-2006.

PROJECT

COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

CLIENT

M/s.NATIONAL CENTRE FOR CELL SCIENCE SAVITRIBAI PHULE PUNE UNIVERSITY CAMPUS, PUNE.

TITLE	M.S.STAIRCASE & LIFT FOUNDATION DETAILS.		
REV	R1	DRG.NO.SA/NC/S-01	
DATE	13-10-2023		
DRAWN	N.S.S.	CHECKED	

TECHNICAL CONSULTANTS :

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Tel: +91-80-2220 4636/222 84583 /41131518

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Tel : 080 – 41225820

STRUCTURAL ENGINEER

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ARUNACHALA CONSULTANTS
NO.3753, 7TH CROSS, 'B' BLOCK,
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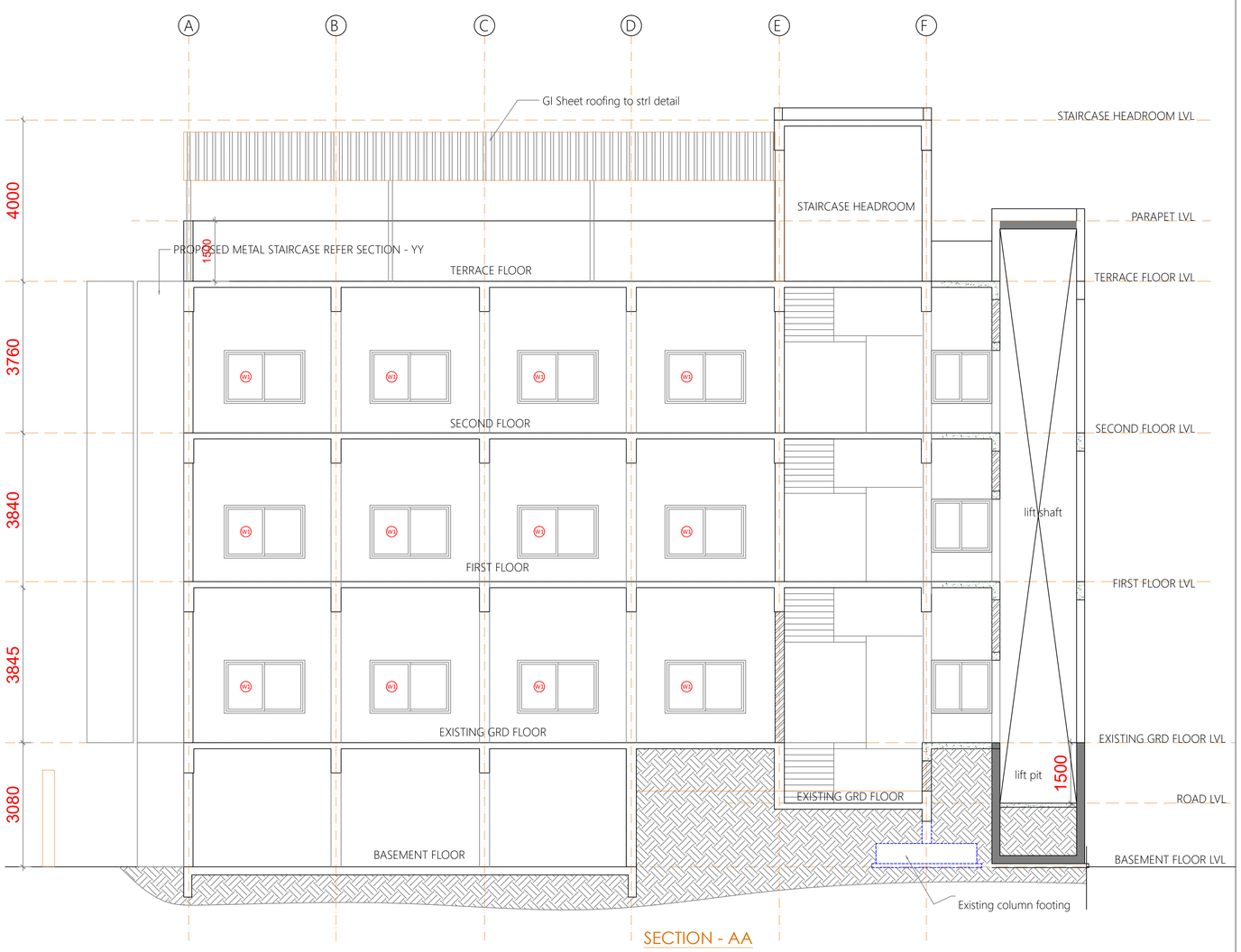
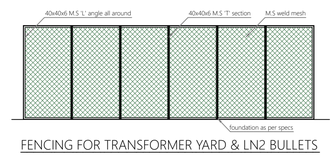
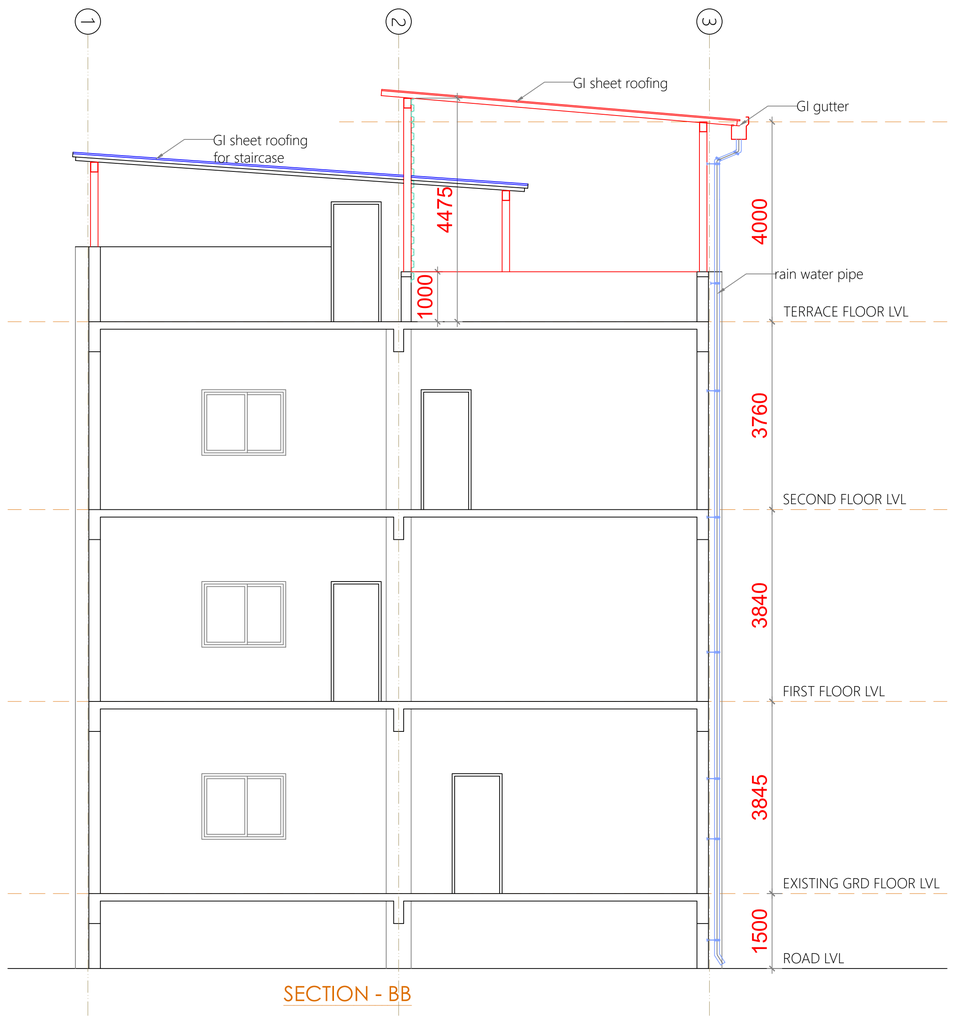
archalastr1@gmail.com Ph.No.23326540



SECTION - AA

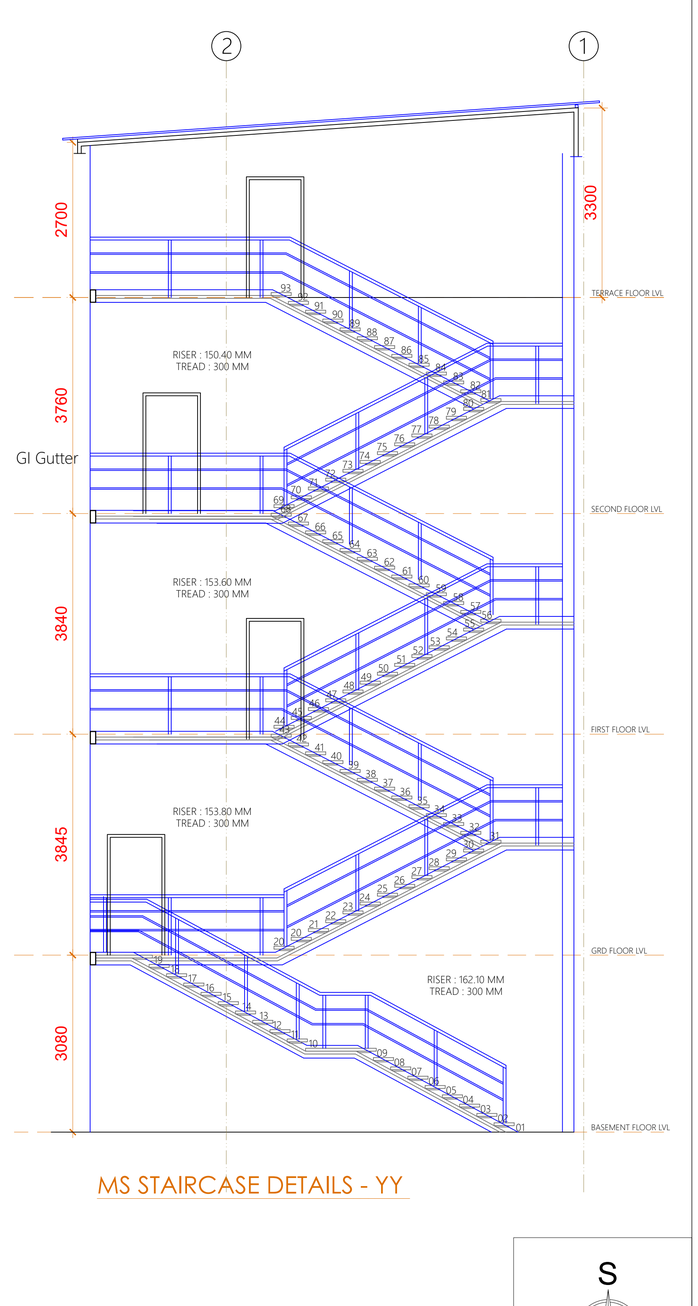


FENCING FOR TRANSFORMER YARD & LN2 BULLETS



SECTION - BB

FRONT ELEVATION



MS STAIRCASE DETAILS - YY

S
E W
N

DESIGN & PROJECT MANAGEMENT CONSULTANTS:

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#98,Royal Luxuria,Flat no.101, Robertson Road
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LEAD CONSULTANT:

M/s. SHRIYATA LIFETECH PVT LTD.,
B-1702, BRIGADE GATEWAY, 26/1, DR. RAJKUMAR ROAD,
MALLESWARAM WEST, BANGALORE .

CLIENT:

M/s. NATIONAL CENTRE FOR CELL SCIENCE
Savitribai Phule Pune University Campus, PUNE.

PROJECT :

COMPLIANT MAMMALIAN CELL LINE REPOSITORY AT NCCS, PUNE

DRAWING TITLE:

SECTION AA,BBm FRONT ELEVATION, MS STAIRCASE & FENCING DETAILS

DATE	01.08.2023	
DRAWN	RP	
CHECKED	RP	REVISION
APPROVED	SB	R0
SCALE	1:50	PAGE - A2
DRAWING NO.	AD 108	