TENDER DOCUMENT

INDEX

NOTICE FOR INVITING TENDER (SUPERSEDED)

To

M/s_____
_____
_____

Dear Sir,

Sub : TENDER FOR PROPOSED CONSTRUCTION OF (PH-II) AT NIT ROURKELA (ORISSA)

Sealed item rate tenders are invited in the prescribed form from prequalified contractors for execution of civil, sanitary, plumbing, internal electrification, external electrification and external services and development works for the proposed **CONSTRUCTION OF BUILDING (PH-II) AT NIT ROURKELA (ORISSA)** as per following details.

a)	NAME OF THE WORK	:	
b)	ESTIMATED COST OF THE WORK	:	
c)	EARNEST MONEY DEPOSIT	:	01 % of the estimated cost by crossed Demand Draft at Rourkela drawn in favour **of National Institute of Technology.**
d)	PERIOD OF COMPLETION	:	24 Calendar Months
e)	VALIDITY OF TENDER	:	120 Days
f)	DATE OF ISSUE OF TENDER	:	From……..upto…….during office hours
g)	PRE-BID MEETING WITH CONTRACTOR	:	……..at 10.30 A.M.
h)	LAST DATE OF SUBMISSION	:	……...Upto 3 P.M.
i)	DATE & TIME OF OPENING OF THE TENDER	:	……...at 3.30 P.M.

1) The clarification, if any, regarding this tender should be got clarified from the Consultant. A prebid conference shall be arranged on …….. in the office of Director, National Institute of Technology, Rourkela -769008(Orissa) to discuss the relevant points/clarification if any. "So that tenderers are well acquainted" with the details of the End.

2) Tender documents including all Bill of Quantities can be had from the office of REGISTRAR, NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA -769008(ORISSA). On Payment of Rs. 5000/- (non-refundable) in favour of NATIONAL, INSTITUTE OF TECHNOLOGY, Payable at Rourkela and should be submitted in original, duly stamped, and sealed in the same office.

3) The submission of bids by the Tenderer and opening of the same by REGISTRAR, NATIONAL INSTITUTE OF TECHNOLOGY, ROURKELA -769008(ORISSA) will be done as per procedure enumerated below:

Envelope No. 1. To contain Earnest Money in form of Demand Draft/Pay Order favouring Nationalized Bank payable at Rourkela.

TENDER FORM

NATIONAL INSTITUTE OF TCHNOLOGY
ROURKELA – 769008 (ORISSA)

To be returned by _____hours on _____. And to be opened at _____ hours on _____

To,

Registrar,
National Institute of Technology ,
Rourkela – 769008(Orissa)

TENDER FOR : PROPOSED CONSTRUCTION OF MECHANICAL SCIENCES BUILDING (PH-II) AT NIT ROURKELA (ORISSA)

Sir,

1. We have read and examined the following documents as received by us :

    a) Notice Inviting Tender
    b) Instructions to Tenderers
    c) Conditions of Contract.
    d) Supplementary Conditions.
    e) Specifications
    f) Drawings
    g) Schedule of Quantities.

2. We are well aware and are familiar with CPWD Schedule of Rates and their specifications, BIS publication and National Building code which shall apply to this contract to supplement any missing details in this contract in order of preference.

   Further to the above, we have visited and examined the site of the proposed works and have acquired the requisite information relating thereto as affecting the tender invited by you.

3. We agree that any other terms or conditions of contract or any general reservation which may be printed on any correspondence emanating from us in connection with this tender or with any contract resulting from this tender shall not be applicable to this tender or to the contract.

4. We have obeyed the rules about confidentiality of tenders and will continue to do so as long as they apply.

5. We are enclosing along with our tender an earnest money being Rs. (1% of the estimated cost) in the form of Crossed Demand Draft on Nationalised Rourkela Bank. We hereby agree that this sum shall be forfeited by DIRECTOR, NATIONAL INSTITUTE OF TECHNOLOGY , ROURKELA -769008(ORISSA) in the event of our tender being accepted and if we fail to execute the contract when called upon to do so. We note that Earnest Money Remittance in form other than Crossed Demand Draft on Rourkela Bank shall not be accepted.

6. Subject to and in accordance with paragraphs 3 & 4 above and the terms and conditions contained or referred to in the documents listed in paragraph 1, we agree and offer to execute all the Works referred to in the said documents upon the terms and conditions contained or referred to therein and to carry out such deviations as may be ordered to be valued as per the conditions of contract.

7. We undertake to complete and deliver the whole of the works within a period as specified in the contract and further confirm that the time allowed for completion is adequate. Time allowed for completion of entire job or part job assigned shall be reckoned from the tenth day of the date of letter of intent. We shall be under the obligation to pay the sum as stated in the contract for every day that the works shall remain incomplete, damages as compensation subject to the conditions of contract relating to extension of time.

8. We hereby also agree that unless & until a formal agreement is prepared & executed in accordance with the Articles of agreement, this tender together with your acceptance thereof, shall constitute a binding contract between us.

9. The person/persons whose tender may be accepted (hereinafter called the tenderer) shall pay initial deposit of 2% (including Earnest Money) by way of Demand Draft in favour of NATIONAL INSTITUTE OF TECHNOLOGY, payable at Rourkela. This amount shall be released after virtual completion of work. We further agree for a deduction of 8% from the running bill as retention money.

10. Validity of the tender shall be 120 days from the date of opening of tender or it may be beyond 120 days if mutually accepted.

11. The Owner is at liberty to accept or reject any tender, without assigning any reasons whatsoever.

12. Work may be split up in the first instance. But it may be split up in more parts or parts combined if so desired by the Owner without assigning any reasons whatsoever.

13. Adherence to the pert chart shall be ensured by the contractor as the project is to be executed in a very strict time frame.

14. In the event of our selection of award of work we agree to submit a PERT/BAR Chart based on the drawings along with the tender documents before the issue of work order. And this will form a part of the agreement.

Signed in the capacity of duly authorised to sign tenders for and on behalf of

Address ……. Telephone No……..

…… Telex No.

…… Fax No.

……..

Date :

INSTRUCTIONS WITH REGARD TO SUBMISSION OF TENDERS

NOTE: Tenderers are requested to note that non-compliance of the following instructions is liable to render their tenders unacceptable.

1) Address at which the tender is to be submitted : REGISTRAR, NATIONAL INSTITUTE OF TECHNOLOGY , ROURKELA – 769008(ORISSA)

2) a. Prebid conference date _____
   b. Last date for receipt of tender _____
   c. Date of opening of tender _____

3) The different Schedules should be filled as follows:
   (a) The "Rate" Column wherever applicable to be legibly filled in ink in both figures and words.
   (b) The "Amount" Column also to be legibly filled in ink in both figures and words.
   (c) All corrections to be initialed.
   (d) No over writing is allowed.
   (e) The figure of percentage of rate shall be legibly filled in ink in both figure and words.

4) Bank Guarantee or cheques shall not be accepted for the Earnest Money Deposit. "The Earnest Money Deposit should be in strict compliance of requirement as specified in the tender documents.

5) The tender shall be signed and dated at all places provided therein. Also all pages, drawings and corrections/alterations shall be initialed. The tender submitted on behalf of a firm shall be signed by all the partners of the firm or by a partner who has the necessary authority on behalf of the firm to enter into the proposed contract.

6) **CONDITIONAL OFFER:** Any tenderer who proposes alterations to any of the conditions/specifications laid down in the tender documents or proposes any new conditions, whatsoever shall be summarily rejected.

7) **PROCEDURE FOR SUBMISSION AND OPENING OF TENDERS :**

   a) Tenders must be submitted on the tender documents issued by the Accepting Officer. Intimation of tender quoted by a letter, telegram or telex will not be accepted.

   b) Tenderers are expected not to propose any alterations to any of the conditions laid down in the tender. Stipulated conditions embodied in the tender shall be binding on the tenderers.

   c) In view of the postal and other delays the tenders should be posted sufficiently in advance of the last date and time fixed for receipt of tenders or be sent by a special messenger. Tender received late shall be rejected.

   d) The procedure for submission and opening of tenders has been set out in details in tender documents.

8) Drawings must be returned along with the tender documents duly stamped and signed. These Drawings are for reference only.

VALIDITY OF TENDERS

9) Tenderers should note that their tenders should remain open for consideration for a minimum period of 120 days from the last date fixed for the receipt of tenders. The validity period may, however be extended by mutual agreement. The tenderer shall not be allowed to cancel or withdraw the tender during the initial validity period of 120 days.

10) For Sewerage, Electrical, Water supply and Surface drainage works, Tenderers must possess respective licenses from the respective authorities valid in Rourkela for doing such works.

SUPPLEMENTARY CONDITION

INDEMNITY BOND

On the acceptance of his tender, the contractor will be required to execute an Indemnity Bond with-in 10 days of issue of work order in favor of the Owners against third party claims, civil or criminal complaints, site mishaps and other accidents or disputes, against any damages, loss or expenses due to or resulting from any negligence or breach of duty on the part of the contractor, his subcontractors or his employees and agents etc., as per the appropriate Indemnity Bond attached.

It will also be covered by labour laws of the Govt. of Orissa.

Any other conditions suggested by the Institute may be added subsequently.

INDEMNITY BOND

(On Non-Judicial Stamp Paper of Rs. 10/-)

KNOW all men by these presents that I/We _____ do hereby execute Indemnity Bond in favour of The Director, National Institute of Technology,Rourkela -769008(Orissa). On this _____ day of _____

WHEREAS The Director, National Institute of Technology,Rourkela -769008(Orissa., have appointed _____ as the Contractors for their Proposed in National Institute of Technology, Rourkela _____

THIS DEED WITNESS AS FOLLOWS :

I/We _____hereby do Indemnify and save harmless The Director, National Institute of Technology,Rourkela -769008(Orissa).

Any third party claims, civil or criminal complaints/liabilities, site mishaps and other accidents or disputes and/or damages occurring or arising out of any mishaps at the site due to faulty work, negligence, faulty construction and/or for violating any law, rules and regulations in force, for the time being while executing/executed works by me/us.

Any damages, loss or expenses due to or resulting from any negligence or breach of duty on the part of me/us or my sub contractor's if any, servants or agents.

Any claim by an employee of mine/ours or of sub contractors if any, under the Workmen's Compensation Act and Owners Liability Act, 1939 or any other law, rules and regulations in force for the time being and any Acts replacing and/or amending the same or any of the same as may be in force at the time and under any law in respect of injuries to persons or property arising out of and in the course of the execution of the contract work and/or arising out of and in the course of employment of any workman/employee.

Any act or omission of mine/ours of sub-contractor's if any, our/their servants or agents which may involve any loss, damage, liability, civil or criminal action.

IN WITNESS WHEREOF THE _____ has set his/their hand on this day of _____.

SIGNED AND DELIVERED BY THE NAME AND ADDRESS

AFORESAID _____ (Contractor)

IN THE PRESENCE OF WITNESSES:

1.

2.

ARTICLES OF AGREEMENT

ARTICLES OF AGREEMENT made the ……..….. date of …….. …….. between …… having its offices at Rourkela (hereinafter called "the owner" of the One Part and …… …… …… (hereinafter called "The Contractor" of the other Part.)

Where the Employer is desirous of …….... and has caused drawings and specification describing the works to be done to be prepared by Arch-En Design, it's Architect.

And whereas the said Drawings numbered ……..... to …….. Inclusive, the specifications and the schedule of Quantities with rates have been signed by or on behalf of the parties hereto.

And whereas the Contractor has agreed to execute upon and subject to the conditions set forth herein and to the conditions set forth herein in the Special conditions and in the Schedule of quantities and conditions of Contract (all of which are collectively hereinafter referred to as "the said Drawings and/or described in the said specifications and included in the Schedule of quantities at the respective rates therein set forth amounting to the sum as therein arrived at or such other sum as shall become payable there under (hereinafter referred to as "the said contract Amount").

NOW IT IS HEREBY AGREED AS FOLLOWS:

In consideration of the said contract amount to be paid at the items and in the manner set forth in the said conditions, the contractor shall upon and subject to the said conditions executed complete the work shown upon the said Drawings and described in the said specifications and the priced schedule of quantities.

The Employer shall pay to the contractor the said contract amount, or such other sum as shall become payable, at the times and in the manner specified in the said conditions.

The term "the Architects" in the said conditions shall mean the said Arch-En Design, or in the event of their ceasing to be the Architects for the purpose of this contract for whatever reason, such other person or persons as shall be nominated for that purpose by the Employer, not being a person to whom the contractor shall object for reasons considered to be sufficient by the Employer, **Provided Always** that no person or persons subsequently appointed to be Architects under this contract shall be entitled to disregard or overrule any previous decisions or approval or direction given or expressed in writing by the outgoing Architects for the time being.

The said conditions and Appendix thereto shall be read and construed as forming part of this Agreement, and the parties hereto shall respectively abide by, submit themselves to the said conditions and perform the Agreements on their part respectively in the said conditions contained.

The plans, agreements and documents mentioned here in should form the basis of this Contract.

This Contract is neither a fixed lump-sum contract nor a piece work contract but a contract to carry out the work in respect of the building complex, to be paid for according to actual measured quantities at the rates contained in the Schedule of Quantities and Rates or as provided in the said Conditions.

The contractor shall afford every reasonable facility for the carrying out of all works relating to civil works, installation of telephone, electrical installations, fittings, and other ancillary works in the manner laid down in the said conditions, and shall make good any damages done to walls, floors, etc. after the completion of his work.

The employer reserves to itself the right of altering the drawings and nature of the work by adding to or omitting any items of work or having portions of the same carried out without prejudice to this contract.

Time shall be considered as the essence of this contract and the contractor hereby agrees to commence the work soon after the site is handed over to him or from 14th day after the date of issue of formal works order as provided for in the said conditions whichever is later and to complete the entire work within twenty four calendar months, subject to nevertheless to the provisions for extension of time.

All payments by the Employer under this contract will be made only at Rourkela.

All disputes arising out of or in any way connected with this agreement shall be deemed to have arisen at Rourkela and only the courts in Rourkela shall have jurisdiction to determine the same.

1. That the several parts of this contract have been read by the contractor and fully understood by the contractor.

IN WITNESS WHEREOF THE EMPLOYER and the contractor have set their respective hands to these presents and two duplicates hereof the day and year first hereinabove written.

SIGNATURE CLAUSE

SIGNED AND DELIVERED by the

_____by name
(Employer)

Hand of Shri_____

_____
(Name and Designation) (Signature of Employer)

In the presence of:

Shri / Smt. _____

Address _____ (Signature of witness)
_____
_____
_____
(Witness)

SIGNED AND DELIEVERED by the

_____ (Signature of Contractors)
(Contractors)

In the presence of:
Shri/Smt._____ (Signature of witness)

Address _____
_____
_____
_____
(Witness)

GENERAL INSTRUCTIONS TO CONTRACTORS AND SPECIAL CONDITIONS

1) Sealed Tenders should be addressed to The Registrar, National Institute of Technology, and Rourkela 769008(Orissa).

2) No Tender will be received after the due date under any circumstances whatsoever.

3) The contractors are not expected to include any conditions contrary to tender provisions. However, if it is necessary to include certain conditions, the same should be submitted in a separate sealed cover. To facilitate the processing of offers, two separate sealed covers, and one containing, priced tender and second containing Earnest Money Deposit should be submitted. The covers should be suitably subscribed indicating the contents.

4) **(a)** The envelope one shall contain earnest money deposit, terms and conditions, if any, imposed by the contractor for the subject tender shall be opened first in the Office of The Registrar, National Institute of Technology,Rourkela -769008(Orissa) in the presence of the Architects and the authorized representative of the tenderers.

   (b) The covers received as indicated in 4 (a) above, shall be opened first the second cover containing the priced Tender on item-rate basis will be opened after finding the tenders eligible for the same.

   (c) Priced Tenders shall remain open to acceptance by the Owners for a period of four months, from the date of opening of the second cover containing the Tender, which period may be extended by mutual agreement and the Tenderer shall not cancel or withdraw the Tender during this period.

   (d) The tenderer must use only the Forms issued by the Registrar, National Institute of Technology, and Rourkela 769008(Orissa) to fill in the rates.

5) **(a)** The Tender Form must be filled in English and all entries must be made by the hand and written in ink, If any of the documents is missing, or unsigned, the Tender may be considered invalid by the owners in its discretion.

   (b) Each of the Tender documents should be signed by the person or persons submitting the Tender in token of his/ their having acquainted himself/themselves within the General condition of Contract, specifications, special conditions, etc., as laid down. Any Tender with any of the documents not so signed will be rejected.

   (c) The Tender submitted on behalf of a Firm shall be signed by all partners of the Firm or by a partner who has the necessary authority on behalf of the Firm to enter into the proposed contract. Otherwise the Owners may reject the Tender.

6) The owners do not bind themselves to accept the lowest or any tender and reserve to themselves the right to accept or reject any or all the Tenders, either in whole or in part, without assigning any reasons for doing so.

7) Intending Tenderers shall pay as Earnest Money deposit shall be Rs. 1% of the total estimated cost by Bank Draft drawn in favour of National Institute of Technology, payable at Rourkela. A Tender which is not accompanied by such an Earnest Money will not be considered. The Earnest Money will be returned to the Tenderer if his tender is not accepted, but without any interest.

8) The successful Tenderer shall within fifteen days of the receipt of the advice of acceptance of the Tender by Registered A.D.Post, deposit as further security, a sum balance of Rs.2% of contract amount after deducting Earnest money deposit paid by him when he submits his Tender shall be held by Registrar, National Institute of Technology, Rourkela -769008(Orissa), as initial security for the execution of the due fulfillment of the contract.

9) On receipt of intimation from the Owner of the acceptance of his/their Tender, the successful Tenderer shall be bound to implement the Contract and within Twenty days thereof, the successful Tenderer shall sign an Agreement in accordance with the successful Tenderer shall sign up Agreement in accordance with the draft Agreement and the schedule of conditions, but the written acceptance by Director, National Institute of Technology,Rourkela -769008(Orissa) of a Tender will constitute a binding Contract between Director, National Institute of Technology,Rourkela -769008(Orissa) and the person so tendering, whether such formal agreement is or is not subsequently executed.

10) 50% of retention money and total of initial security deposit will be returned after virtual completion of the work. Balance 50% of retention money shall be released to the contractor after satisfactory completion of defect liability period (this amount will be kept in fixed Deposit with the Institute after the work is virtually completed and the same will be returned along with interest after satisfactory completion of defect liability period).

11) The total security deposit shall comprise of EMD+ Initial Security Deposit + Retention Money.

    The amount of initial security deposit shall be 2% of the accepted value of the tender including the EMD. The amount of initial security deposit shall be paid within 14 days of intimation of the acceptance of this tender.

In addition to the initial Security Deposit, 8% of the running bill amount will be deducted as retention money till total security deposit amount is achieved.

12) The contractor shall not assign the contract. He shall not subject any portion of the contract except with the written consent of the Employer subcontracting to Electrical Partner having a valid electrical license. In case of breach of these conditions, the Employer may cause the Architect to serve a notice in writing on the contractor rescinding the contractor whereupon the Security Deposit shall stand forfeited to the Employer, without prejudice to his other remedies against the contractor.

13) The contractor shall carry out all the work strictly in accordance with Drawings, details and instructions of the Architect, Consultant and the Employer. If in the opinion of the Architect, consultant or the Employer, changes have to be made in the design and with the prior approval in writing of the Employer, they desire the contractor to carry out the same, the contractors shall carry out the same without any extra charge. The Architect's/ The Director, National Institute of Technology, Rourkela -769008(Orissa) decision in such cases shall be final and shall not be open to arbitration.

14) A Schedule of probable quantities in respect of each work and specifications accompany these special conditions. The Schedule of probable quantities is liable to alteration by omission, deductions or additions at the discretion of the Architect/ The Director, National Institute of Technology, Rourkela -769008(Orissa).

15) The Tenderer must obtain for himself on his own responsibility and at his own expenses all the information which may be necessary for the purpose of making a Tender and for entering into a contract and must examine the drawings and must inspect the site of the work and acquaint himself with all local conditions, means of access to the work, nature of the work and all matters pertaining thereto.

16) The rates quoted in the Tender shall be inclusive of all charges for clearing of site before commencement as well as after completion, water, electrical consumption, meters, double-scaffolding, centering, boxing, staging, planking, timbering and pumping out water, including bailing, fencing, , hoarding, plant and equipment, storage sheds, watching and lighting by night as well as day, including Sundays and Holidays, temporary plumbing and electric supply, protection of the public and safety of adjacent roads, streets, cellars, vaults, open pavements, walls, houses, buildings and all other erections, matters or things and the contractor shall take down and remove any or all such centering, scaffolding, staging, planking, timbering, strutting, shoring, etc. as occasion shall require or when ordered so to do, and fully reinstate and make good all matters and things disturbed during the execution of the work and to the satisfaction of the Architect. No claim in respect of Sales Tax on work contract, Excise Duty, Octroi or other Tax, Duty or Levy whether existing or future shall be entertained by the Employer.

17) Time allowed for carrying out the work as mentioned in the Memorandum shall be strictly observed by the contractor and its shall be reckoned from the 10 days after written order to commence the work is issued or the date of handing over the site to the contractor whichever is later. The work shall throughout the stipulated period of the contract be preceded with all due diligence and if the contractor fails to complete the work within the specified period, he shall be liable to pay compensation as defined conditions of contract: "The Conditions Herein before Referred To". The Tenderer shall before commencement of the work, prepare a detailed work programme which shall be approved by the Architect and the Employer.

18) The contractor shall not be entitled to any compensation for any loss suffered by him on account of delays in commencing or executing the work, whatever the case of delays may be, including delays arising out of modifications to the work entrusted to him or in any sub-contract connected therewith or delays in awarding contracts for other trades if the project or in commencement or completion of such works or in procuring government controlled or other building materials or in obtaining water and power connections for construction purposes or for the other reasons whatsoever and the Employer shall not be liable for any claim in respect thereof. The Employer does not accept liability for any sum besides the Tender amount, subject to such variations as are provided for herein.

19) The successful Tenderer is bound to carry out any items of work necessary for the completion of the job even though such items are not included in the quantities and rates. Schedule of instructions in respect of such additional items and their quantities will be issued in writing by the Architect with the prior consent in writing of the Employer.

20) The successful Tenderer must co-operate with the other contractors appointed by the Employer so that the work shall proceed smoothly with the least possible delay and to the satisfaction of the Architects.

21) The contractor must bear in mind that all the work shall be carried out strictly in accordance with the specifications made by the Architects and also in compliance of the requirements of the Authorities concerned and no deviation on any account will be permitted.

22) Water Supply

a. Raw water for works and drinking water shall be supplied free of cost by the employer to the contractor at suitable points Within 300 meters of each section of the work. The contractor cannot claim compensation for any failure in water supply caused due to any reason whatsoever.
b. The contractor shall be responsible to store water in sufficient quantities to meet his requirements in well built storage tanks With covered top to prevent entry of foreign material, dust, smoke etc.

c. Potable water for domestic use for contractor's colonies shall be supplied free of cost by the employer at central tank in the labour camps provided that these camps of the contractors are located in the areas developed by the employer for the purpose.
d. The contractor is responsible to ensure that there in no wastage of water raw or domestic. He will also be responsible for Maintaining the tank, pipe lines etc. in proper condition.

Electric Power for Construction Purposes

a. The employer will install and operate a power station of adequate capacity to supply and demand for the construction equipment and for lighting 5 K.W. 440/3-phase AC Supply will be made available to the contractor in bulk of the distribution centres within 100 meters of lead mentioned in works areas free of charges. The contractor will have to make his own arrangements to lay and maintain the necessary distribution lines and wiring for the works at his cost. Within 14 days of acceptance of contract by letter, the contractor should give his firm demand of power at various points. In tendering, an approximate indication of this should be given.
. .c. Contractor may, subject to the approval of the Engineer, his labour camps in areas other than those laid out by the employer. In that event the contractor shall make his own arrangement for water and electricity.
d. The contractor shall ensure that the electrical equipment deployed by him will be such that the aggregate power factor not falls below 0.5 at the owner's terminal points.
e. The installation of fixed construction machinery and the points for tapping of electric supply connection from pipe lines of different kinds, and location of temporary building including labour camps and storages for materials, should be approved in advance by the engineer.
f. The source of power to be made available for the contractor would be within 100 meters from the site of work..
g. The contractor will supply and install switch, fuse units of suitable rated and capacity separately for power and lighting on a frame preferably of steel and provide rain water protection on the switches. The installation will be made as relevant I.S. Rules and site location to be made in consultation with engineer- in-charge of the site.
h. The contractor will get his installation inspected by the Asst. Electrical Inspector, Govt. of Orissa Deputy Director, Central Electricity authority Ministry of Power, Government of India and obtain a certificate for energisation of the installation.
i. The contractor will supply and install all distribution cables, wires and switches etc. of rated capacity for the work starting from the source of power at his own cost. He will employ Electricians possessing Electrical contract License (copy to be submitted) for carrying out the installation as well as the maintenance works.
j. The contractor will provide proper facilities to the Engineer-in-charge concerned or his authorised representative for inspecting his temporary electrical installation as and when required. He will immediately attend to the defects so pointed out during this inspection including replacement of faulty cables, switches etc.
k. The contractor shall not effect any changes in the temporary installation unless permission is obtained from concerned engineer (Elect.) or his authorised representative.

23) The Contractor shall strictly comply with provision of safety code annexed hereto.

24) The contractors shall fulfill the requirements of the Employees State Insurance Act, 1948 applicable to all States, towards their employees and keep all the required record regarding the same for inspection by the Authorities concerned at any time. The contractor shall indemnify Registrar, National Institute of Technology, Rourkela-769008 (Orissa), against any claim or legal action arising out of the said Act due to the failure of non-compliance of the provisions of the said Act and the penalty or any other amount levied by the authorities, shall be recoverable from the payments due to the contractors.

25) The Contractor shall comply with the provision of the Apprentices Act, 1961, and the Rules and Orders issued there under from time to time. Failure to do so will be in a breach of the contract and the Architects and the Owners may in their discretion cancel the contract. The contractor shall also be liable for any pecuniary or other liabilities arising on account of any violation by him of the provisions of the Act.

26) The Security Deposit of the successful Tender will be forfeited if he fails to comply with any of the conditions of the contract.

27) The contractor shall be responsible for the observance of all Central Rules and Regulation framed by the Central Government under the Contract Labour (Regulation and Abolition) Act, 1970 and Indian Electricity Rules & Regulations and safety of the persons and Electrical installations. The Owners shall be entitled to deduct all damages, which it might suffer on account of non-observance of these rules by the Contractor, from the amount payable to the Contractor.

Mobilization Advance

Mobilization Advance can be given against bank guarantee.at an interest 12% Mobilization Advance upto 10% of contracted value payable in two equal installments. The first installment shall be paid after Mobilization has started and next installments shall be paid after satisfactory utilization of earlier advance (s).
The recovery of the Mobilization.

Advance against materials brought at Site:

Secured Advance on Materials

Contractor may be allowed Secured advance on security for materials brought to site for execution on contracted item of work upto the extent of 75% of the value of the materials assessed to by the Engineer-in-charge provided that the materials of the imperishable nature and that of the formal agreement drawn up with the contractor under which employer secures a lien on the materials and is safeguarded against losses due to the contractor postponing execution of the work or to the storage or misuse the materials and against the expenses entitled for their proper watch and safe custody. Recoveries of advances so made would not be possessed until the whole of the work entrusted to the contract is completed. They should be adjusted from his bills for work done as the materials are used with the necessary deductions being made. The secured advance may be given against the following materials brought to the site and stored properly.

75% of the total cost of materials purchased and brought at site.

Advance against the materials at Site will be paid only after verifying the quantity of materials received at the Site of work.

The Contractors will have to submit the bills for the materials purchased, in triplicate, to verify the cost of the materials purchased and brought at Site.

No advances against perishable materials purchased and brought at Site will be made.

The Contractors will have to keep the materials at Site under their safe custody and at their risk and cost.

The Owner is not responsible for damages and losses of such materials brought a Site.

28) Contractors are not allowed to remove materials brought at Site against which advances have been paid.

29) The Contractor is to provide at all times during the progress of the works and the maintenance period proper means of access, with ladders, gangways, etc., and the necessary attendance to move and adopt as directed for the inspection or measurement of the works by the Architects or their representatives.

30) Materials shall be of approved quality and the best of their kind available and shall generally conform to I.S. Specifications. The Contractor shall order all the materials required for the execution of work as early as necessary and ensure that such materials are on site well ahead or requirement for use in the work. The work involved calls for approved standard of workmanship combined with speed and to the entire satisfaction of the Architects.

31) The Contractors shall after completion of the work clear the Site of all debris and left over materials at his own expenses to the entire satisfaction of the Architects and Municipal or other public authorities.

32) The proposed work under this tender during its progress and after completion can be examined/inspected by the Chief Tech. Examiner/Tech. Examiner of CVC or any other Vigilance Authority appointed by the department. Any correction/ redoing of the work/deduction in the payment suggested by such Authority will be binding on the contractor.

33) The rates for vitiated/deviated/ or non schedule items to be worked out on the rates quoted in the tender for the similar items. Wherever it is not possible to base the rates for vitiated/deviated/non schedule extra items on the tender quoted rates then the rate analysis is to be submitted by the contractors as under and get the same approved before execution of the work by the command Architect.

Actual cost of materials	…….. Rs.
Add for Labour charges	…….. Rs.
Add for Taxes, Transportation, If any.	…….. Rs.
Add for Wastage of Materials (Upper Limit 5% wherever applicable).	…….. Rs.
Add for water and electricity Charges if any Required, upper limit 2% of basic cost of materials.	……...Rs.
Add for 15% towards contractor's overheads and profit.	…..……Rs.
	Rs.……
Final rate arrived.	Rs…….

34) Contractors are requested to note that no extra item or deviated item of work to be executed without taking prior permission, the institute shall not be responsible for the payment of such works executed. Contractors will have to submit all the particulars including purchase bills/price list for the materials along with the rate analysis for verification of item rates.

35) The rates quoted in the tender should be inclusive of contract Sales Tax, Turn over Tax. It is contractor's responsibility to pay the taxes to the Authorities concerned and produce documentary evidence of the taxes paid, to the Owners on demand.

36) If it is observed the existing compound wall, gates railings are damaged then the contractors will have to make good the same at their own cost.

37) If contractors fail to pay the taxes/royalties to the Authorities concerned, the Owners reserve their rights to recover the said amount from the amount payable to the contractor and pay the same to the Authorities concerned.

38) Work is to be executed & measurements are to be paid as per the detail specification & description of item given in the Standard Specification Book except for the items which are specifically mentioned in the tender for which the details of item and mode of measurements to be followed as indicated separately in the conditions of contractors, Part–I.

39) For Sanitary plumbing work and storm water drain, wherever it is indicated C.P.W.D. details for these items to be followed as per the description/ specification given in the Book published by Central Public Works Department.

40) Employer's decision in this regard shall be final and binding.

41) After awarding the work, contractor shall get registered with the office of the Labour commissioner and inform Employer accordingly.
Contractors shall follow all rules and regulations stipulated by the Labour Commissioner strictly.

42) Contractors shall quote consistent rates for the items of similar nature or analogous in specifications for the sections in schedule of quantities. If it is observed that the rates quoted for similar nature of items or analogous in specification under different sections, are inconsistent, then the Employer reserves his right to consider the lowest of rates for all such items and work out the final amount for payment, unless the competent authority finds that there is justifications for such inconsistent rates.
I/We hereby declare that I/We have read and understood the above instructions for the guidance of Tenders.

Witnesses : Signature of Tenders.

Date : Address :

THE CONDITIONS HEREINBEFORE REFFERED TO

1. In construction these conditions, the specification schedule of quantities and contract agreement, the following words shall have the meanings herein assigned to them expect where the subject or context otherwise requires.

   (a) **"Employer"** shall mean "Director, National Institute of Technology, Rourkela -769008(Orissa).

   (b) **"Contractors"** shall mean…….and shall include his (their) legal representative assigns or successors.

   (c) **"Site"** shall mean "Work Place located at Rourkela include any building and erections any building and erections thereon and any other land (inclusively), as aforesaid, allotted by the employer for the contractor's use.

   (d) **"This Contract"** shall mean Articles of Agreement, the special conditions, the conditions, the appendix, the schedule of quantities and specifications, attached hereto and duly signed.

   (e) **"Notice in writing"** or written notice shall mean a notice in written, typed or printed characters sent (unless delivered personally or otherwise proved to have been received), by registered post to the last known private or business address or registered office of the addressee and shall be deemed to have been received when in the ordinary course of post, it would have been delivered.

   (f) **"Act of Insolvency"** shall mean any Act of Insolvency as defined by the Presidency Towns Insolvency Act, or the Provincial Insolvency Act or any amending such original.

   (g) **"Net Prices"** If in arriving at the contract amount, the contractor shall have added to or deducted from the total of the items in the Tender any sum either as a percentage or otherwise, then the net price of any item in the Tender shall be the sum arrived at by adding to or deducting from the actual figure appearing in the Tender as the price of that item a similar percentage or proportion of the sum so added or deducted of the sum so added or deducted by the contractor the amount of any Prime Cost items and provisional sums of money shall be deducted from the total amount of the Tender. The expression "net rates" or "net prices" when used with reference to the contract or accounts shall be held to mean rates or prices so arrived at.

   Words importing persons include firms and corporations. Words importing the singular only also include the plural and vice versa where the context requires.

2. The Contractor shall carry out and complete the said work in every respect in accordance with this contract and of with the directions of and to the satisfaction of Architect/Employer. The Architect may in his absolute written instructions, details directions and to as Architect/Employer. The Architect may in his absolute discretion and in consultation with the employer (with prior approval from the Director) and from time to time issue further drawings and/or written instruction, details directions and explanations which are hereafter collectively referred to as "Architect's/Employer's Instruction".

   In regard to :-
   (a) The variations or modifications of the design, quality or quantity of works or the additions or omission or substitution of any work.
   (b) Any discrepancy in the drawings or between the schedule of quantities and/or drawings and or drawings and or specification.
   (c) The removal from the site of any materials brought thereon by the contractor and the substitution of any other materials therefore.
   (d) The removal and/or re-execution of any works executed by the contractor.
   (e) The dismissal from the works of any person employed thereupon.
   (f) The opening up for inspections of any work covered up.
   (g) The amending and making good of any defects under clauses 19 hereon.

   The contractor shall forthwith comply with and duly execute and work comprised in such Architect's/Employer instructions, provided always that the verbal directions, and explanations given to the contractor or his representative upon the works by the Architect/Employer shall, if involving a variation, be confirmed in writing by the contractor within seven days, and if not dissented from in writing within a further seven days by the architect, such shall be deemed to be Architect's/Employer instructions within the scope of the Contract.
3. The work shall be carried out strictly in accordance with particular specifications and drawings. The drawings, specifications BOQ etc. shall be taken complementary and also supplementary to each other and shall form part this contract. Any work or material shown on drawings and not specifically included in BOQ/specification or vice versa shall be executed and deemed to be included in the scope of work .

4. Incase there are no specifications for items shown on the drawings or where items are not exhaustively described, the general specifications of CPWD shall be followed for which nothing extra shall be paid. In case, no details are available even in CPWD specifications, then decision of Institute is final & binding on the contractor.

5. The scope of work for buildings under this contract includes for full & final and entire completion of all works including all internal and external services in all respects described in particular specification as shown on drawings forming part of the contract.

6. Although all the details of construction have been by an large covered in these documents, any item or details of construction not specifically covered but obviously implied and essential to consider Civil Works and all internal and external services complete and functional, shall be deemed to have been covered in the contract. The cost of external development works pertaining to a particular contract shall also be carried out on a final lump sum price based on the rates quoted for each item. The tenderer may however, consider a minimum level of specifications conforming to IS code or National Building Code to cover any missing details.

7. Variations to be approved by the Employer/Architect.

Notwithstanding anything herein contained, the Architect or his representative shall not, without prior concurrence in writing of the Employer, issue any instructions, verbal or in writing, the Architect can get the work done upto an amount of Rs. 25.,000/- (Rupees Twenty Five Thousand) and all instruction issued to the contractor should forth width brought to notice of the Employer. The contractor shall submit through the Architect, a statement of variations giving quantity any rates duly scrutiny and final acceptance by the Employer shall form a supplementary tender the Employer shall not be liable for payment of such variations until these statements are sanctioned by him.

Drawings and Schedule of quantities and agreement.

8. The contract shall be executed in triplicate, the cost incurred to the same shall be reimbursed by the contractors to the Architect and the Architects, the Employer and the contractor shall be entitled to one executed copy each for his use. The Contractor on the signing hereof shall be furnished by the Architects, the Employer and the contractor shall be entitled to one executed copy each for his use. The contractor on the signing hereof shall be furnished by the Architects free the specifications and one copy of all further Drawings issued during the progress of the works. Any further copies of such drawings required by the contractor shall be paid by him. The contractor shall keep one copy of all drawings on the works and the Architects/Employers or their representatives shall at all reasonable times have access to the same. Before the issue of the final certificate to the contractor, he shall forthwith return to the Architect all Drawings and Specifications.

9. The contractor shall provide everything necessary for the proper execution of the works according to the intent and meaning of the Drawings, Schedule of quantities and Specification taken together whether the same may or may not be particularly shown or described therein provided that the same can be reasonably be inferred there from, and if the contractor finds any discrepancies therein, he shall immediately and in writings, refer the same to the Employer /Architect whose decision shall be final and binding. The contractor shall provide himself for ground and fresh water for carrying out of the works at his own cost. The Employer shall on account be responsible for the expenses incurred by the contractor for hired ground or fresh water obtained from elsewhere.

The rates quoted against individual items will be inclusive of everything necessary to complete the said items work within the contemplation of the contract, and beyond the unit price no extra payment will be allowed for incidental or contingent work, labour and /or materials inclusive of all taxes and duties whatsoever except for specific items, if any, stipulated in the tender documents.

The contractor shall supply, fix and maintain at his own cost, for the execution of any work, all tools, tackles, machineries and equipments and all the necessary centering, scaffolding, staging, planking, timbering, strutting, shoring, pumping, fencing, boarding, watching and lighting by night as well as by day required not only for the proper execution and protection of the said work but also for the protection of the public and safety of any adjacent roads, streets, walls, houses, buildings, all other erections, matters and things and the contractor shall take down and remove any or all such centering, scaffolding, plumbing, timbering, strutting, shoring etc., as occasion shall be required or when ordered so to do, and shall fully reinstate and make good all matters and things disturbed during the execution or when ordered so to do, and shall fully reinstate and make good all matters and things disturbed during the execution of works to the satisfaction of the Employer / Architects.

The Contractor shall also provide such temporary load on the site as may be necessary for the proper performance of the contract, and for his own convenience but not otherwise. Upon completion, such roads shall be broken up and leveled where so required by the drawings unless the Employer shall otherwise direct.

The contractor shall at all times give access to workers employed by the Employer or any men employed on the buildings and to provide such parties with proper sufficient and if required, special scaffolding, hoists and ladders and provide them with water and lighting and leave or make any holes, grooves etc., in any work, where directed by the employer as any be required to enable such workman to lay or fix pipes, electrical wiring, special fittings etc. The quoted rates of the tenderers shall accordingly include all these above-mentioned contingent works.

Authorities notices and patents.

10. The contractor shall confirm to the provisions of any Act of the legislature relating to the works, and to regulations and bye-laws of any authority, and of any water electric supply and other companies and /or authorities with and whose the systems the structures is proposed to be connected, and shall, before making any variations from the drawing or specifications that may be necessitated by so confirming, give to the Architect written notice, specifying the variations proposed to be made and the reason for making it and apply for instructions thereon. In case the contractor shall not within ten days receive such instructions he shall proceed with the work confirming to the provisions, regulations, or bye-laws in questions, and variations so necessitated shall be dealt with under clause 13 hereof.

    The contractor shall bring to the attention of the Architect all notices required by the said Acts, regulations or bye-law to be given to any authority and pay to such authority, or to any public office, all fees that may be properly chargeable in respect of the said work, and lodge the receipt with the Architect.

Setting out of work.

11. The contractor shall set out the works and shall be responsible for the true and perfect setting out of the same and for the correctness of the positions, dimensions, and the alignment of all the parts thereof. If at any time any error in this respect shall appear during the progress of the work or within the period of one year from the completion of the works, the contractor shall, if required at his own expenses rectify such error to the satisfaction of the Architect / Employer.

12. All the works specified and provided for in the specifications or which may be required to be done in order to perform and complete any part thereof shall be executed in the best and most workman like manner with materials of the best and approved quality of the respective kinds in accordance with the particulars contained in and implied by the specifications and represented by the drawings or according to such other additional particulars and instructions as may from time to time be given by the Employer / Architects during the execution of the work, and to his entire satisfaction.

    If required by the Employer / Architect the contractor shall have to carry out test on materials and workmanship in approved materials testing laboratories or as prescribed by the Employer/ Architects at own cost to proved the materials etc., under test confirm to the relevant I.S. Standard or as specified in the specifications. The necessary charges for preparation of mould (in case of concrete cube) transporting testing etc. shall have to borne by the contractors. No extra payment on this account should in any case be entertained.

    All the materials (except where otherwise described) store and equipment required for the full performance of the work under the contract must be provided through normal channels and must include charges for import duties, sales tax, octroi and other charges and must be the best of their kind available and the contractors/must be entirely responsible for the proper and efficient carrying out the work. The work must be done in the best workman like manner. Samples of all materials to be used must be submitted to the Employer / Architect when so directed by the Engineer/Architect and written approval from Employer / Architect must be obtained prior to placement of order.

    During the inclement weather the contractor shall suspend concreting and plastering for such time as the Employer / Architect may direct and shall protect from injury all work when in course of execution. Any damage (during construction) to any part of the work for reasons due to rain, storm, or neglect of contractor shall be rectified by the contractor in an approved manner at no extra cost.

    Should the work be suspended by reason of rain, strike, lock-outs or any other new work and supply all temporary / doors, protection to windows, and any other requisite protection to windows, and other requisite protection for the execution of the work whether by himself or special for the execution of the work whether by himself or special tradesmen or sub-contractor at his own expenses.

Contractor superintend & representative on the works.

13. The contractor shall give all the necessary personal superintendence during the execution of the works, and as long thereafter as the Employer/Architect may consider necessary until the expiration of the defects liability period stated in the Appendix hereto. The contractor shall also during the whole time the works are in progress employ a competent representative who shall be in constantly attendance at work while the men are at work. Any directions, explanations, instructions, or notices given by the Employer/Architect to such representative shall be held to be given to the contractor.

    For day to day site supervision contractor has to provide 10 years experienced qualified Graduate Civil Engineer at site as representative of the contractor and shall be available through out the day during work is under progress. For non-compliance an amount of Rs.25,000/- pm shall be deducted from the contractor for the period of work carried out without the supervision of such Engineer. However, deduction of payment shall not exonerate contractor for his responsibility for executing quality work.

Dismissal of workmen.

14. The contractor shall at the request of the Employer/Architect immediately dismiss from the works, any person employed thereon by him who may in the opinion of the Employer/Architect incompetent or misconduct himself and such person shall not be again Employer/Architect to such representative shall be held to be given to the contractor.

Access to work.

15. The Employer, the Architect and their responsible representative shall at all reasonable times have free access to the works and/ or to the workshops, factories or other places where materials are being prepared or constructed for the work and also to any place where the materials are lying from which they are being obtained the contractor shall give every facility to the Employer, the Architect and their representative necessary for inspection and examination and test of the materials and the workmanship. No. persons not authorised by the Employer or the Architect except the representatives of Public Authorities shall be allowed on the works at any time.

Asst. Engineer/Site/Engineer/Construction Manager

16. The term Site Engineer/Construction Manager shall mean the person appointed and paid by the Employer and acting under the orders of the Employer / Architect to inspect the works in the absence of the Employer / Architect to inspect the works in the absence of the Architect, the contractor shall afford the Assistant Engineer/Site Engineer/Construction Manager every facility and assistance for inspecting the works and materials and checking and measuring time and materials item and materials. Neither Assistant Engineer/Site Engineer/Construction Manager nor any representatives or the Architect shall have power to set out works or to revoke, alter, enlarge or relax any requirements of the contract, or to sanction any day work, additions, alterations, deviation or omission, or any extra work whatever except in so for as such authority may be specially conferred by a written order of the Architect with the prior concurrence in writing of the Employer.

Technical staff should be specified and penalty should be imposed for non availability of technical staff.

The Assistant Engineer/Site Engineer/Construction Manager or any representative of the Architect, or the Employer shall have power to give notice to the contractor or to his representative, of non-approval of any work or materials and such work shall be suspended or the use of such materials shall be discontinued until the decision of the Architect is obtained. The work will be from time to time be examined by the Architect, the Employer's Engineer or the Architects representative, but such examination shall not in any way exonerate the contractor from the obligations to remedy any defects which may be found to exist at any stage of the works or after the same is complete. Subject to the limitations of this clause, the contractor shall take instructions only from the Architect / Employer.

17. The whole of the works include in the contract shall be executed by the contractor and the contractor shall not directly or indirectly transfer, assign, or under-let the contract or any part share there of or any interest therein without the prior written consent of the Employer and no undertaking shall relive the contractor of the full and entire responsibility of the contract or from active superintendence of works during their progress.

18. No alterations, omissions or variations shall vitiate this contract, but in case the Architect thinks proper at any time during, the progress of the works to make any alterations in, or additions to or omissions from, the work or any alteration in the kind or quality of materials to be use therein and shall give notice thereof in writing under his hand to the contractor, the contractor shall alter, add to, or omit from, as the case may be, in accordance with such notice, but the contractor shall not do any work extra to or make any alterations or additions to or omissions from the works or any deviations from any of the provisions of the contract, stipulation specifications or contract drawings without the previous consent in writing of the Architect and the values of such extras, alternations, additions or omissions shall in all cases be determine by the Architect with the prior approval in writing of the Employer in accordance with the provision of the contract and the same shall be added to, or deducted from the contract amount, as the case may be accordingly.

19. The Schedule of quantities, unless otherwise stated shall be deemed to have been prepared in accordance with the standard method of quantity measurement.

Any error in description or in quantity or in omission of items from the Schedule of quantities shall not vitiate this contract but shall rectified and the value thereof, as ascertained under clauses 17 hereof, shall be added to or deducted, from the contract amount (as the case may be), provided that no rectification of errors, if any, shall be allowed in the contractor's Schedule of rates.

20. The contractor shall be deemed to have satisfied himself before tendering as to the correctness and sufficiency of this tender for the works and the prices stated in the Schedule or quantities and or the schedule of rates and prices which rates and prices shall cover all his obligations under the contract, and all matters and things necessary for the proper completion of works.

21. The Architect may from time to time intimate to the contractor and the Employer that he requires works to be measured, and the contractor shall forth with attend or send a qualified agent to assist the Architect's or the representative or the Assistant

Engineer/Site Engineer/Construction Manager in taking such measurements and calculations and to furnish all the particulars or to give all assistance required by any of them.

Should the contractor not attend or neglect or omit to send such agent them the measurement taken by the Architect or a person approved by him shall be final and binding on the contractors. Such measurements detailed in the specifications.

The contractor or his representative also supply without charge the requisite number of persons with means and materials necessary for the purpose of measurements or examinations at any time and from time to time of the work or counting weighting of the materials of the materials etc.

All authorized extra works, omissions and all variations made without the Architect's knowledge, if subsequently sanctioned by him in writing (with the prior approval in writing of the Employer) shall be included in such measurement.

Site Engineer/Construction Manager will take measurement of the work jointly with the contractor and enter the same in measurement books. Based on these measurements the contractor will raise the bill as per the prescribed format. Architect to verify the bill/measurement and issue certificate stating that the work completed is as per the specifications and the measurement claimed for the works, are actually executed at site. This certificate shall be issued within 15 days after bill submission by the Contractor. Institute/Registrar upon receipt of the bill alongwith certificate of project architect shall release 75% bill amount within 10 days and balance 25% within 30 days. Please refer Annexure – A & B.

Duties of Site Engineer/ Construction Manager

i. To make a thorough study of contract documents, Architectural/Structural drawings and other details so as to bring out ambiguities/discrepancies between them and to obtain clarification from the Competent Authority well in time to avoid delays.
ii. To render a certificate to the Competent Authority to the effect that he has studied the contract documents, drawings and specifications.
iii. To approve the center-line layout of building pegged out on site by the contractor and the benches for ground floor and other levels.
iv. To take charge of objects of value and antiquity found on site or in excavations, immediately, after their discovery, to hold them in safe custody and to hand them over to the Competent Authority of the institute for further action.
v. To approve the foundation strata when the appropriate depth of excavation is reached in consultation with the architects.
vi. To ensure that the quality of materials and workmanship as laid down in the contract is maintained and the accuracy of dimension shown on drawings is attained in the construction.
vii. To watch the validity of the building permission issued by the Local Authority and to ensure that the revalidation, if necessary, is obtained well in time.
viii. To arrange periodical reconciliation of cement and steel account and ensure that proper recoveries are effected from contractor's running account bills.
ix. To maintain the undernoted records at the site of work, in addition to normal routine requirements of an office:
    a. Daily Progress Record
    b. Work Site Order Book.
    c. Instruction by the institute authorities.
    d. Cement Statement (Receipt/Consumption/Balance).
    e. Steel Register/any other costly Material Register.
    f. Contract Pour Reports including Slump Test Record including electrical items.
    g. Concrete Cube Test Register.
    h. Test Registers of other materials/fittings, fixtures, equipments as stipulated in the tender.
    i. Register of Drawings and Working Details.
    j. Log Book of Defects.
    k. The Site Engineer/Construction Manager should maintain in a Hindrance Register giving details of commencement and removal of each hindrance.
    l. Dismantled Materials Account Register.
    m. Supply and consumption register of scarce/costly materials like bitumen, lead, laminates, special paints etc.
    n. Record of cement used/ received: Day to day record of cement used/received shall be entered in the register) and signed by the Site Engineer/Construction Manager of the institute/Architect as well as contractors representative at site.
    o. Record of reinforcement bars received at site: Necessary entry for reinforcement bars of each category shall be made in the register for steel and signed by the Site Engineer/Construction manager of the institute/Architect and the contractor daily.
x. To study the quality of approved coarse and fine aggregate and get the design of the concrete mix in accordance with modern practice. The Site Engineer/Construction Manager shall ensure that the mix design for RCC work shall be carried out by the Architect/Structural Consultant, if applicable.
xi. To record measurements of completed work jointly with the Contractor and to process them in running account bills.
xii. To receive running account bills from the contractor and to forward them after checking, to the Competent Authority with his comments and recommendations and accompanied by all supporting documents.
xiii. To submit to the Competent Authority the Progress Report fortnightly.
xiv. To watch that the concerned contract does not lapse for want of extension of time. Therefore, to keep it alive and in operation from point of consideration that "Time is the essence of contract".

xv. To ensure that progress on every contract is in accordance with the appropriate stage of its Time and Progress Chart.
xvi. To prevent contractor from proceeding with any work on which the contractor has got intentions of raising claims of extra/deviated items, until the Competent Authority approves the work to continue.
xvii. To receive the Final Bill from the contractor, to check it, and forward it with his comments and recommendations to the Competent Authority with all the supporting documents duly attached.
xviii. To submit the final summary of costs for the project to the Competent Authority.
xix. To submit the Competent Authority authentic information on and the undernoted records pertaining to the completed work in order to enable the Competent Authority to finalise them in the due course:

a) Record i.e. as completed drawings.
b) Record of Standard Measurements for periodical services.
c) Inventory of fittings and fixtures.

To hand over to the Competent Authority a "first draft" of "A Note of Comprehensive Information to the User" containing detailed instructions on how to use and maintain the completed building to the best advantage of the institute.

Procedure for measurement and billing of work in progress:

1. Measurement:

Measurements shall be recorded as per IS 1200 mode measurement and in metric system. Measurement shall be recorded in jointly in measurement sheets to be supplied by the contractor. Such measurement shall be recorded by the Engineer-in-charge or Institute authorities and not by contractor. Recorded Measurement Sheets shall be kept in the custody of the Registrar's official procedure for bill would be as under.

Site engineer/Construction Manager from the institute or appointed by the Project Architects shall act as from clients side who will record all measurement and prepare bills. After finalisation of all quantities and amount, contractors would be furnished details for preparing bills on his letter pad. Such bills along with measurement sheets in soft as well as hard copy will be submitted to Project Architects office for issuing payment certificate. This exercise has to be done at site on regular basis right from the submission of Ist R/A Bill. Based on this payment certificate Registrar will honour the bill by releasing 75% of the payment within 15 days after issuing of payment certificate by Project Architects. Balance 25% payment shall be released after thorough checking of the bills by the institute within 30 days.

The minimum value of the bill shall be Rs.50.00 lakhs (Rupees Fifty Lakhs only per month).

2. Running Account Payments to be regarded as Advances:

All running account payments shall be regarded as payments by way of part payment/running against the final payment only and not as payments for work actually done and completed and accepted and shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be removed and taken away and reconstructed or re erected or be considered as an admission of the due performance of the contract, or any part thereof, in this respect, or the accruing of any claim, nor shall it conclude, determine or effect in any way the powers of the owner under these conditions or any of them as to the powers of the owner under these conditions or any of them as to the final settlement and adjustment of the accounts or otherwise, or in any other way vary/affect the contract. The final bill shall be submitted by the contractor within two months of the date fixed for completion of the work, other wise the Architect/Engineer-in-charge's certificate of the measurement and of the total amount payable for the work accordingly shall be final and binding on all parties.

From each running bill 8% value of the work certified shall be as retention amount. 50% of the retention amount will be released to the contractor on issuing completion certificate and the balance 50% fourteen days after the end of defects liability period.

3. Completion Certificate
Application for completion certificate:

The Architect/Engineer-In-Charge shall normally issue to the contractor the completion certificate within one month after receiving, an application thereof from the contractor and after verifying from the completion documents and satisfying himself that the work has been completed in accordance with and as set out in the construction and erection drawing and contract documents.

The contractor, after obtaining the completion certificate, is eligible to present the final bill for the work executed by him under the terms of contract.

Completion Certificate

Within one month of the completion of the work in all respects, the Contractor shall be furnished with a certificate by the Architect/Engineer-In-Charge of such completion but no certificate shall be given nor shall the work be deemed to have been completed until all scaffolding, surplus materials and rubbish is cleared of the site completely. The work will not be

considered as complete and taken over by the employer, until all the temporary works, labour and staff colonies etc., constructed, are removed and the works site cleared to the satisfaction of the Architect/Engineer-In-Charge.

If the Contractor shall fail to comply with the requirements of this clause on or before the date fixed for the completion of the work, the Architect/Engineer-In-Charge may at the expenses of the contractor remove such scaffolding, surplus materials and rubbish and dispose off the same as he thinks fit and clean up the site and the contractor shall for the with pay the employer for all expenses so incurred and shall have no claim in respect of any such scaffolding or surplus materials as aforesaid except of any sum actually realized by the sale thereof.

CERTIFICATE

It is certified that various items of works claimed in the …… RA Bill by Contractor …….. have been completed in accordance with and fully confirming to the standard and/or prescribed specifications. As net amount of Rs…… (Rupees ……) is recommended to be paid to the contractor making the total upto date payment of Rs……..……..
(Rs. ……..……)

Quality and rates verified. The material supplied and work done confirm with the tender specifications.

SITE ENGINEER

ANNEXURE – A

ON LETTER HEAD OF CONTRACTOR

……. Running Bill No. …….

Tender Amount		Rs. ……
Value of work done		Rs. ……
Less rebate	(-)	Rs. ……
Net Value of work done		Rs. ……
Extra variation items after settlement @100%		Rs. ……
Extra variation items without settlement @75%		Rs. ……
Total		
Add : Cost of material on site @ 75%		Rs. ……
Total payable		Rs. ……

Deductions

1.	Retention money	Rs. ……	
2.	Recovery of advance if any	Rs. ……	
3.	Income-tax	Rs. ……	
4.	Total bill paid till last bill	Rs. ……	
	Total deductions	Rs. ……	Rs. ……
	Net payable		Rs. ……
	Amount certified for payment		Rs. ……

Note : This page shall be signed and stamped by the Site Engineer, Contractor and Project Architect.

ANNEXURE – B

ACCOUNT OF SECURED ADVANCE IF ADMISSIBLE ON MATERIALS HELD AT SITE BY THE CONTRACTOR

Sno.	Name	Quantity	Unit	Amount	Remarks
1	2	3	4	5	6
Face value of Materials at site					
Secured Advance …… % of above value.					

Date …….

……..
Signature of Site Engineer
Preparing the bill.

Date …….

Signature of Owner's representative

Date …….

Signature of the Contractor

PROFORMA OF RUNNING BILL

I	Name of the Contractor / Agency	:	
II	Name of the Work	:	
III	Sr.No. of the Bill	:	
IV	Sr.No. of the Previous Bill	:	
V	Reference to Agreement No.	:	
VI	Date of written order to commence	:	
VII	Date of Completion as per Agreement	:	
VIII	Date of Measurements	:	
XI	Present status of work	:	

SL No.	Items of Description	Unit	Rate	As per Qty.	Tender Amount Rs.	UPTO Qty.	R.A. Bills Amount Rs.	

Note :

1. If part rate is allowed for any item, it should be indicate with reasons for the allowing such a rate.

2. If adhoc payment is made, it should be mentioned specially.

3. Consumption of Cement/Steel statement material consumption statement to be submitted with each R.A. Bills.

4. Electrical R/A Bills to be supported with a certificate from the electrical supervisor for the electrical portion of work for safety and charging of the installations.

22. The contractor may, when authorized, and shall, when directed in written by the Architects with the approval of the Employer, add to, omit from, or vary the works shown upon the drawings, or included in the schedule of quantities, but contractor shall make no addition, omission or variation without such authorisation or direction. A verbal authority or direction by the Architect shall, if confirmed by them in written within seven days, be deemed to have been given in writing.

(a) (i) The net rates or prices in the original tender shall determine the valuations of the extra tender shall determine the valuation of the extra work where such extra work is of similar character and executed under similar conditions as the work priced therein.

(ii) Rates for all items, wherever possible, should be derived out of the rates given in the priced Schedule of quantities.

(b) The net prices of the original tender shall determine the value of the items omitted, provided if omissions vary the conditions under which only remaining items of works are carried out, the prices for the same shall be valued.

(c) Where the extra works are not of similar character and /or executed under similar conditions as aforesaid or where the omissions vary the conditions under which any remaining items of works are carried out or if the amount of the whole of the contract works or to any part thereof shall be such that in the opinion of the Architect the net rate or price contained in the priced schedule of quantities or tender or for any item of the works involves loss or expense beyond that reasonably contemplated by the contractor or is by reason unreasonable or inapplicable, the Architect shall fix such other rate or price as in the circumstances he shall feel reasonable and proper, with the prior approval in writing of the employer.

(d) Where extra work cannot be properly measured or valued the contractor shall be allowed days work prices as the priced schedule of quantities or, if not so stated, then in accordance with the local day work rates and wages for the district; provided that in either case vouchers specifying the daily time (and if required by the Architect, the workman's name) and materials employed to be delivered for verification to the Architect, or his representative at to the Architect or his representative at or before the end of the week following that in which the work has been executed.

The measurement and valuation in respect of the contract shall be complete within the "period of final measurements" stated in the tender document.

Unfixed materials when taken into account to be the property of the Employer.

23. Where in any certificate (of which the contractor has received payment), the Architect has included the value of any unfixed materials intended for and /or placed on adjacent to the works, such materials shall become the property of the Employer and they shall not be removed except for use upon the works, without the written authority of the Architect/Employer. The contractor shall be liable for any loss of or damages to such materials.

Removal of improper works.

24. The Architect/Employer shall, during the progress of the works, have power to order in writing from time the removal from the work within such reasonable time or times as may be specified in order, of any materials which in the opinion of the Architect/Employer are not in accordance with the specifications or the instructions, the substitution of proper materials, the removal and proper re-execution of any work executed with materials or workmanship not in accordance with the drawings and specification instruction and the contractor shall forthwith carry out such order at his own cost. In case of default on the part of the contractor to carry such order, the Employer shall have the power to employ and pay other persons to carry out the same and all expenses consequent thereon, or incidental thereto, shall be deducted by the Employer from any money due or that may become due, to the contractor.
No certificate, which may have been issued by the Architect, shall relieve the contractor from his liability in respect of unsound work of bad materials.

Defects after completion.

25. The contractor shall make good at his own cost and to the satisfactions of the employer all defects, shrinkage, settlements or other faults, which may appear within 12 months after completion of the work. In default the Employer may employ and pay other persons to amend and make good such damages, losses and expenses consequent thereon or incidental there to shall be made good and borne by the contractor and such damages, loss and expenses shall be recoverable from him by the Employer or may be deducted by the employer, in lieu of such amending and making good by the contractor, deduct from any cost of amending such work and in the event of the amount retained being insufficient, recover that from the contractor from the amount retained under General Instructions and special conditions together with any expenses the Employer may have incurred in connection therewith.

Certificate of virtual completion & defects liability period.

26. The work shall not be considered as completed until the architect has certified in writing that they have been virtually completed. The defects Liability Period shall commence from the date indicated in the virtual completion certificate issued by the Architect.

Nominated Sub-Contractors

27. All specialist, Merchants, Tradesmen and others executing any work of supplying and fixing any goods for which prime cost prices or provisional sums are included in the Schedule of Quantities and/or Specifications who may be nominated or selected by the Architect/Owner and hereby declared to be Sub-Contractors employed by the Contractors and are herein referred to as nominated Sub-Contractors.

No nominated Sub-Contractor shall be employed on or in connection with the works against whom the Contractor shall make reasonable objection or (save where the Architect and Contractor shall otherwise agree) who will not enter into a Contract providing:-

27.1 That the nominated Sub-Contractor shall indemnify the Contractor against the same obligations in respect of the Sub-Contract as the Contractor is under in respect of this contract.

27.2 That the nominated Sub-Contractor shall indemnify the Contractor against claims in respect of any negligence by the Sub-Contractor, his servants or agents or any misuse by him or them or any scaffolding or other plant, the property of the Contractor or under any workmen's Compensation Act in force.

28. The contractor is not authorized to submit or assign the job or part there of on back to back transfer basis. In case of breach of these conditions, the Employer may serve a notice in writing on the contractor rescinding the contractor whereupon the

Security Deposit shall stand forfeited to the employer, without prejudice to his other remedies against the contractor. Central Govt./ State Govt. organization will not be allowed to sublet the work on back to back basis.

Other persons engaged by the Employer

29. The employer reserves the right to execute any part of the work included in this contract by other agency or persons and contractor shall allow all reasonable facilities and use of his scaffolding for the execution of such work. The main contractor shall extend all co-operations in this regard.

Insurance in respect of damage to persons and property.

30. The contractor shall be responsible for all injury to persons, animals or things, and for all structural and decorative damage to property which may arise from the operation or neglect of himself or of any nominated sub-contractor or any employee of either, whether such damage injury arises from carelessness, accident or any other cause whatever in any way connected in the carrying out of this contract. This clause shall be held to include inter alias, any damage to buildings, whether immediately adjacent or otherwise, and any damage to the roads, streets, foot-paths, bridge or ways as well as all damage caused to the building or ways as well as damage caused to the buildings and works indemnify the Employer and hold it harmless in respect of all and any expense arising from such injury or damage to persons or property as aforesaid and also in respect of any claim made in respect of injury and damage under any Act of any Legislature or otherwise and also in respect of any award of compensation or damage consequent upon such claims.

The contractor shall reinstate all damage of every sort mentioned in this clause, so as to deliver up the whole of the contract works complete and respect in every respect and so as to make good or otherwise satisfy all claims for damage to the property of third parties.

The contractor shall indemnify the Employer against all claims which may be made against the Employer by any member of the Public or third party in respect of any thing which may arise in respect of the works or in consequence thereof and shall at his own expense arrange to effect and maintain, until the virtual completion of the contract, with an approved office, a Policy of Insurance in the name of the Employer and the contractor against such risks and deposit such policies with the Employer from time to time during the currency of this contract. The contractor will also similarly indemnify the Employer of all claims which may be made upon the Employer whether under the workmen's composition Act or play other statute in force during the currency of this contract or at common law in respect of any employee of the contractor or any sub-contractor and shall at his own expense effect and maintain, until the virtual completion of the contract, with an approved office, a Policy of Insurance in the joint name of the Employer and the Contractor against such risks and deposit such policy or policies with the Employer from time to time during the currency of the contract.

The contractor shall be responsible for any liability which may be excluded from the Insurance Policies above referred to and also for all other damages to any person animal or property arising out of incidental or defective carry in out of this contract. He shall also indemnify the Employer in respect of any cost, charges or expenses arising out of claims or proceeding and also in respect of any award of composition and damages arising therefrom.

The Employer shall be entitled to deduct the amount of any damage, compensation, cost, charges and expenses arising from or accruing from, or in respect of, any such claims or damage from any or all sums due or to become due to the contractor without prejudice to the Employer's other rights in respect thereof.

Fire Insurance

31. (a) The Contractor shall, within fourteen days from the date of commencement of works, insure the works at his cost and keep them insured until the virtual completion if the works, against loss or damage by fire with an office to be approved by the Architect in the joint name of the Employer and the Contractor (the name of the former being placed first in the policy), for the contract amount only. The Contractor shall deposit the policy and receipts for the premises with the owner within thirty days from the commencement of the works, unless otherwise instructed by commencement of the works, unless otherwise instructed be the Architect. In default of the Contractor insuring as provided above, the Employer or the Architect on his behalf, may so insure the works and may deduct the premium paid from any money due or may become due to the Contractor without prejudice to the other rights of the Employer in respect of such default. In case it becomes necessary to suspend the works, the Contractor shall as soon as the claim under the policy is settled, or work reinstated by the Insurance office should they elect to do so, proceed with all due diligence with the completion of the works in the same manner as though the incident had not occurred and in all respects under the same conditions of the Contract. The contractor in case of rebuilding or reinstatement after fire, shall be entitled to such extension of time for completion as the Architect deemed fit.

(b) The amount so due as aforesaid shall be the total value of the works duly executed and of the contract and of the contract materials and goods delivered upon the site for use in works and including the date of the date not more than seven days prior to the date of the said Certificate less the amount to be retained by the Employer (as hereinafter provided) and less any installments previously pain under this clause. Provided the such Certificate shall only include the value of the materials and goods as and from time to time as they are reasonably, properly and not prematurely brought upon the site and then only if properly stored and/or protected against weather.

The Contractors will have to take out following Insurance Policies:

1) All Risks Insurance Policy to cover-
   Earthquake- Fire & Shock
   Landslide/Rockslide/Subsidence.
   Flood/Inundations.
   Storm/Tempest/Hurricanes/Typhoon /Cyclone Collapse.
   Theft/Burglary.
   Damage to material brought at Site and to be subsequently used in the work.

2) Third party Insurance Policy
   a. For accidental loss or damage caused to the property of other persons.
   b. For fatal or non-fatal injury to any person other than insured own employees or work men of employees of the owner of the works any other construction work thereon, or member of the Insured's family or of any of the aforesaid; directly consequent upon of solely due to the construction of any property described in the Schedule.
   c. Limit of indemnity in respect of any one of the accidents or series of accidents arising out of one event, the amount is Rs.3,00,000.00

3) Workmen's Compensation Insurance.

32. The Contractor shall be allowed admittance to the Site on the "Date of Commencement" stated in the Appendix hereto, or such later date as may be specified by the Architect and he shall there up on and forthwith begin the works and shall regularly proceed with and complete the same (except the painting or other decorative works the Architect may desire to delay) on or before the "Date of Commencement" stated in the Appendix subject nevertheless to the provision for extension of time hereinafter contained.

33. If the Contractor fails to complete the works by the date stated in the Appendix or within any extended time of under the clause 28 hereof and the Architect certifies in writing that in his opinion, the same ought reasonably to have been completed, the Contractor shall pay the Employer the sum named in the Appendix as "Liquidated Damages" for the period during which the said works shall so remain incomplete and the employer may deduct such damages from any moneys due to the Contractor.

34. If in the opinion of the Architect the work be delayed
(a) by force majored or **(b)** by reason of any exceptionally inclement weather or **(c)** by reason of proceedings taken or threatened by or dispute with adjoining or neighboring owners or public authorities arising otherwise then through the Contractors own default or **(d)** by the works and delay or the other Contractors or tradesmen engaged or nominated by the Employer or the Architect and not referred to in the Schedule of Quantities and/or specification or **(e)** by reasons of the Architect's instructions **(f)** by reason of civil common, local combination of workmen or strike or lock-out affecting any of the building trades or **(g)** in consequence of the Contractor not having received in due time necessary instructions from the Architect for which he shall specifically applied in writing or **(h)** from other cause which the Employer may consider as beyond the control of the Contractor or **(i)** In the event, the value of work exceed the value of the Priced Schedule of Quantities owing to variation, the architect may with the previous approval in writing of the Employer make a fair and reasonable extension of time for the completion of the Contract works; in case of such strike or lockout, the Contractor shall as soon as may be, give written notice thereof to the Architect, but the Contractor shall nevertheless constantly use his endeavor to prevent delay and shall nevertheless constantly use his endeavor to required to the satisfaction of the Architect/Employer to proceed with the work.

35. If the Contractor after receipt of written notice from the Architects requiring compliance within ten days fails to comply with such further drawings and/or Architect's instructions, the employer may employ and pay other persons to execute any such work whatsoever it may be necessary to give effect thereto, and all costs incurred in connection therewith shall be recoverable form the Contractor by the Employer on the Certificate of the Architect as a debt or may be deducted by him from any moneys due to the Contractor.

36. If the Contractor being a individual or a Firm, commits any "act of insolvency" or shall be adjudged an Insolvent or being an Incorporate company, shall have an order for supervision of the court and the official Assignee or the Liquidator in such acts of insolvency and winding up, as the case may be, shall be unable within seven days after notice to him requiring him to do so, to show the reasonable satisfaction of the Architect that he is able to carry out and fulfill the Contract and to give security therefore, of so required by the Architect.

Or if the Contractor (whether an individual, Firm or Incorporated Company) shall suffer execution or other process of court attaching property to be issued to the Contractor.

Or shall suffer any payment under this Contract to be attached by or on behalf of any of the creditors of the Contractors.

Or shall assign or sublet this Contract without the consent in writing of the Employers first obtained.

Or shall charge or encumber this Contract or any payment due or which may become due to the Contractor hereunder.

Or if in the opinion of the Employer that the hereunder.

a. Has abandoned the Contract, or
b. Has failed to commence the works, or has without any lawful excuse under these conditions suspended the progress of the works for fourteen days after receiving form the Architect notice to proceed, or
c. Has failed to proceed with the works with such due diligence and failed to make such due progress as would enable the works to be completed within the time agreed upon, or
d. Has failed to remove materials from the Site or to pull down and replace work for seven days after receiving form the architect written notice that the said materials or work were condemned and rejected by the Architect under these conditions or,
e. Has neglected or failed persistently to observe and perform all or any of the acts, matters or things by this Contract to be observed and performed by the contractor to observe or perform the same.

Then and in any of the said cases the Employer may, notwithstanding any previous waiver, after giving seven days notice in writing to the Contractor, determined the Contract but without there by affecting the powers of the Architect/Employer or obligations or liabilities of the Contractor has not been so determined, and as if the work subsequently executed had been executed by or on behalf pf the Contractor, And further, the Employer by his agent or servants may enter upon and take possession of the work and all plant, tools, scaffoldings, shed, machinery, steam and other power utensils and materials lying upon the premises or on the adjoining land or roads and use the same as his own property or may employ the same by means of his own servants and workmen in carrying on and completing the works or by the employing any other contractor or person to completing or finishing or using the materials and plant for the work. When the work shall be completed or as soon as thereafter as convenient the Architect shall give a notice to the Contractor to remove his surplus materials and plant, and should the Contractor fail to do so within the period of fourteen days after receipt thereof by him, the Employer may sell the same by public auction, and give credit to the Contractor for the net amount realized. The Employer shall have been put to in procuring the works to be completed and the amount, if any, owing to the Contractor and the amount, which shall thereupon be paid by the employer to the Contractor or by the Contractor to the Employer.

37. The Contractor shall be paid by the Employer from time to time by installments under Interim certificates to be issued by the Architects to the Contractor on account of the works executed when in the opinion of the Architect, work for Interim Certificates (or less at the reasonable discretion of the Architect) has been executed in Accordance with this contract, subject, however, to a retention of the percentage of such value named in the appendix hereto as "retention percentage for Interim Certificate", until the total amount retained shall reach the named in the Appendix as "Total Retention Money", after which time the installments shall be upto the full value of the work subsequently so executed and fixed in the building. The Architect may in his discretion include the Interim Certificate, such amount, as he may consider proper on accounts of material delivered upon the site by the contractor for use in the works. And when the works have been virtually completed and the Architect shall have certified in writing that they have been complete, the contractor shall be paid by the Employer in accordance with the certificate to be issued by the Architect the sum of money named in the Appendix "Installment after virtual completion" being a part of the said Total Retention Money. And the contractor shall be entitled to the payment of the Final Balance in accordance with the Final Certificate to be unused in writing by the Architect at the expiration of the period referred to as "The Defects Liability Period" in the appendix hereto from the date of virtual completion, or as soon after the expiration of such period as the works shall be finally completed and all defects made good according to the true intent and all defects made good according to the true intent and meaning and hereof whichever shall last happen, provided always that the issue of the Architect of any certificate during the progress of the works or at or after the completion shall not relieve the contractor from his liability nor relieve the Contractor from his liability in case of fraud, dishonesty or fraudulent concealment relating to the works or materials or to any matter dealt with in the certificate, and I case of all the defects and insufficiencies in the works or materials which a reasonable examination would not have disclosed. No certificate of the Architect shall of itself be conclusive evidence that any works or materials to which it relates are in accordance with the contract, neither will the contractors have a claim for any amounts which the Architects might have certified in any interim bill and paid by the employer and which might subsequently be discovered as not payable and in this respect the Employers decision shall be final and binding.

The Architect shall have power to withhold any Certificate if the works or any parts thereof are not being carried out to his satisfaction.

The Architect may by any certificate make any correction in any previous certificate, which shall have been issued by him.

No certificate of payment shall be issued by architect if the contractor fails to insure the works and keep them insured till the issue of Virtual completion certificate.

All the interim payments shall be regarded as payments by way of advance against the final payment only and not as payments for work actually done and completed and shall not preclude the requiring of bad, unsound and imperfect or unskilled work to be removed and taken away and reconstructed or re-erected or be considered as an admission of the due performance of the contract, or any part thereof in any respect or the accruing of any claim nor shall it conclude determine

or affect in any way the power of the final settlement and adjustment of the accounts or otherwise or in any other way vary or affect the contract.

Settlement of Disputes by Arbitration

38. All dispute or difference of any kind whatsoever which shall at any time arise between the parties hereto touching or concerning the works or the execution or maintenance thereof of this contract or the construction, remaining operation or effect thereof of this contract or the construction, remaining operation or effect thereof or to the rights or liabilities of the parties or arising out of or in relation thereto whether during or after determination, foreclosure or breach of this contract (other than those in respect of which the decision of any person is by the contract expressed to be final and binding) shall after written notice by either party to the contract to the other of them and to the appointing authority. Hereinafter mentioned be referred for adjudication to a sole arbitrator to be appointed as hereinafter provided.

For the purpose of appointing the sole Arbitrator refereed to above, the Appointing Authority will send within thirty days of receipt by him of the written notice aforesaid to the contractor, a panel of three names of persons who shall be presently unconnected with the organization for which the work is executed.

The contractor shall on receipt by him of the names as aforesaid, selected any one of the persons named to be appointed as a sole Arbitrator and communicate his name to his name to the appointing authority within thirty days of receipt by of the names. The appointing authority shall thereupon without any delay appoint the said person as he sole Arbitrator, if the contractor fails to communicate such selection as provided above within the period specified, the appointing authority shall make the selection and appoint the selected person as the sole Arbitrator.

If the appointing authority fails to send the contractor the panel of three name s as aforesaid within the period specified, the contractor shall send the appointing authority a panel of three names of persons who shall be unconnected with either party. The appointing authority shall on receipt by him of the names as aforesaid select any one of the persons named and appoint him as a sole Arbitrator. If the appointing authority fails to select the person and appoint him as the sole Arbitrator within 30 days or receipt by him of the panel and inform the contractor accordingly, the contractor shall be entitled to appoint one of the person from the panel as sole Arbitrator and communicate his name to the appointing authority.

If the Arbitrator so appointed is unable or unwilling to act or resign is appointing or vacate his office due to any reason whatsoever another sole Arbitrator shall be appointed as aforesaid.

The work under the contract shall, however continue during the Arbitration proceeding and no payment due or payable to the contractor shall be withheld on account of such proceedings.

The Arbitrator shall be deemed to have entered on the reference on the date he issued notice to both the parties fixing the date of the first hearing.

The Arbitrator may from time to time, with consent of the parties, enlarge the time for making and publishing the Award.

The Arbitrator shall give a separate award in respect of each dispute in accordance with the terms of the contract and give a reasoned award. The venue of arbitration in his sole discretion.

It is also a term of the contract that if contractor's do/does not make any demand for arbitration in respect of any claims/Architects that the bill after due verification is passed for payment of a lesser amount, or otherwise, the contractor's right under this agreement to refer to arbitration shall be deemed to have been forfeited and Clients/Architects shall be relieved and discharged of their liability under this agreement in respect of such claim(s). Further, it is agreed that for the purpose of this clause, such notice is deemed to have been received by the contractor(s) within 2 days of posting of the letter by Clients/Architects or when delivered by hand immediately after receipt thereof by the contractor's, whichever is earlier. Further a letter signed by the officials of Clients/Architects that the letter was so posted to the Contractor's shall be conclusive.

The Fees, if any, of the Arbitrator shall, if required to be paid before the award is made and published, be paid half and half by each of the parties. The costs of the reference and of the award including the fees, if any, of the arbitrator who may direct to and by whom and in what manner, such costs or any part thereof shall be paid and may fix or settle the amount of costs to be paid.

The award of the Arbitrator shall be final and binding on both the parties.

Subject to aforesaid, the provisions of the Arbitration Act, 1940, or any statutory modification or re-enchantment there of and the rules mad ether under, and for the time being in force, shall apply to the arbitration proceeding under this clause.

Right of technical scrutiny of final bill.

39. The Employer shall have right to cause a technical examination of the works and the final bill of the works and the final bill of the contractor including all supporting vouchers, abstracts, etc., to be made at the time of payment of the final bill. If as a result of this examination or otherwise any sum is found to have been overpaid or over certified, if shall be lawful for the Employer to recover the sum.

The subject wok will be scrutinised by the Chief Technical Examiner's Office, a technical wing of Central Vigilance Commission and other Vigilance and Audit Authorities of the institute Decision of this Authority shall be binding on the contractor. Any discrepancy noted defected shall be rectified by the contractor free of cost or appropriate amount will be recovered from the contractor's payment.

Employer entitled to recover compensation paid to work men.

40. If, for any reason, the Employer is obliged, by the virtue of the provisions of the workmen's compensation Act, 1923, or any statutory modification or re-enactment thereof to pay compensation to a workman employed by the contractor in execution of the works, the Employer shall be entitled to recover from the contractor the amount of compensation so paid, and without produce to the rights of the employer under said Act. The employed shall be at liberty to receive such amount or any part thereof by deduction it from the security deposit or from any sum due to the contractor and upon his giving to the Employer full security to the satisfaction of the Employer for all costs for which the Employer might become liable in consequence of contesting such claim.

Abandonment of works.

41. If at any time after the acceptance of the Tender, the Employer shall for any reasons whatsoever not require the whole or any part of the works to be carried out, the Architect shall give notice in writing to the contractor who shall have no claim to any payment of compensation or otherwise whatsoever on account of any profit or advantage which be might have derived from the execution of the whole works.

Return of surplus materials.

42. Notwithstanding anything to the contrary contained in any or all the clauses of this contract, where any material for the execution of the contract is procured with the assistance of the Employer by purchase made under orders or permits or licenses issued by the Government, the contractor shall hold the said materials economically and solely for the purpose of the contract and not dispose them without the prior written permission of the Employer and return it to the Employer, if required by the Employer, at the price to be determined by the Architect having due regard to the condition of the materials, the price to be determined not to exceed the purchase price thereof inclusive of Sales Tax, Octroi Duty and other such levies paid by the contractor in respect thereof. In event of the breach of the aforesaid condition, the contractor shall, in addition to being liable to action for contravention of the terms of license or permit and /or criminal breach of trust, be liable to Employer for all such moneys, advantage or profits resulting or which in the usual course would have results to him by reason of such breach.

Right of Employer to terminate contract in event death of contractor if individual.

43. Without prejudice to any of the rights or remedies under this contract, if the contractor, being an individual dies, the Employer shall have the option of terminating the contract without incurring any liability for such termination.

The acceptance of tender will rest with the Employer. The Employer, however does not bind himself to accept the lowest, and reserves to himself the authority to reject any or all the tenders received without assigning any reason whatsoever. The whole work may be split up between two or more contractors or accepted in part and not in full if considered expedient by the Employer and the tenderer will have no claim for revision of rates or other conditions if his tender is accepted in parts.

Tenders in which any of the particulars and prescribed information are missing or are incomplete in any respect and or the prescribed condition are not fulfilled are liable to be rejected.

Canvassing in connection with tenderer is strictly prohibited and the tenders submitted by the Tenderers is strictly prohibited and the tenders submitted by the Tenders who resort to canvassing ill be liable to rejection.

Tenderers containing uncalled for remarks or any additional conditions are liable to be rejected.

Marginal Notes.

44. The marginal notes and in the catch lines hereto and in the annexes are meant only for convenience of reference and shall not in any way be taken into account in the interpretation of these presents and the annexure hereto.

Escalation

45. The rate quoted shall be firm throughout the tenure of the contract (including extension of time, if any, granted) and will not be subject to any fluctuation due to increase in cost of materials, labour, sales tax, octroi, etc., unless specifically provided in these documents variation clause enclosed in the tender

In anywhere there is discrepancy with CVC guidelines current and future, The CVC guideline and Govt./NIT regulation will have precedence

Price variation adjustment (PVA) clause

If the prices of materials and/or wages of labour required for execution of the work increase/or decrease, the price variation adjustment (PVA) shall be worked out as per provisions detailed below and the amount of the contract shall accordingly be varied, subject to the other condition that compensation for escalation in prices shall be available only for the work periods for which the contract is validly extended under the provision of relevant clause of the contract.

In partial modification of (any) provisions made elsewhere in this Manual (contract) regarding rate quoted in a tender being not subject to any variations, price adjustment to the value of work payable to the contractor at tendered rates shall be made towards variation in the prices of materials and labour supplied by the contractor in the manner specified hereinunder:

If, after the written order to commence the work and during the operative period of this contract including any authorized extensions of the original stipulated completion period –

a) There be any variation in the consumer price index – general index – for industrial workers (Base 1982 = 100) (source data published from time to time in Indian Labour Journal by the Labour Bureau, Government of India.)

b) There be any variation in the All India Wholesale Price Index for all commodities (Base 1981-1982 = 100) (as published from time to time in the RBI Bulletin based on the data issued by the office of the Economic Adviser to the Government of India).

Price Variation Adjustment (PVA) towards (1) labour component and (2) material component for all materials other than steel shall be calculated in accordance with the formulae (A) and (B) respectively, given below, subject to stipulations hereinafter mentioned.

Formula (A) for labour

$$\mathbf{VL} = [\ 0.87\ P \times \frac{K_1}{100} - S\ ] \times \frac{C_1 - C_0}{C_0}$$

Formula (B) for materials –

$$\mathbf{VM} = [\ 0.87\ P \times \frac{K_2}{100} - C - S\ ] \times \frac{I_1 - I_0}{I_0}$$, where

VL = Amount of Price Variation Adjustment – increase or decrease in rupee due to Labour Component. Formula (A) for labour.

VM = Amount of Price Variation Adjustment – increase or decrease in rupees on account of materials component.

P =Cost of Work done during the period under consideration (bill period) as per Gross amount of bill excluding, cost of extra or substituted items, rates of which are fixed on prevalent market rates and advances on materials and/or adjustments thereof; if any.

C = Cost of material if any, like cement, steel etc. which are either arranged or supplied at actual or fixed rates and consumed in the work done during the period under consideration.

S = Cost of services like power or water supply, hire charges of machinery etc., which are supplied at fixed rates by the chart to the contractor.

Note – This is generally nil in case of department work.

$\mathbf{K_1}$ = Percentage of labour component as calculated, as indicated in Note (1) below.

$\mathbf{K_2}$ = Percentage of materials component as indicated in Note (2) below.

$\mathbf{C_0}$ = Consumer Price Index – General Index Number for industrial workers (Base 2007= 100) referred to at (a) above, ruling on the last date for receipt of tenders, and as applicable to the center, nearest to the place of work, for which the index is published.

C_1 = Average of above mentioned consumer price index number during the period under consideration (bill period).

I_0 = All India Wholesale Price Index Number for all commodities referred to at (b) above, rulings on the last date for receipt of tenders and as applicable to the center, nearest, to the place of work for which the index is published.

I_1 = Average of above mentioned monthly All India Wholesale Price Index Numbers during the period under consideration (bill period).

Note (1) : K_1 shall be taken as under :-

2a. Component of work : Civil work including ancillary works and external and R.C.C./tanks, septic tank etc., if any, for sanitary and plumbing work.	30%
2b. Sanitary and plumbing works including fittings and fixtures (internal work only)	20%
2c. Electrical installations work including fittings and fixtures (external and internal works)	20%

Note (2) : K_2 shall be taken as under :-

a. Civil work including ancillary works as detailed under Note (1) (a) above	70%
b. Sanitary and plumbing works including fittings and fixtures as detailed under Note (1) above	80%
c. Electrical installation work including fittings and fixtures as detailed under Note (1)(c) above	80%

Stipulations:

PVA clause is operative either way i.e. the variations in above referred price indicates are on the plus side, PVA shall be payable to the contractor and if they are on the negative side PVA shall be recoverable form the contractor, for the respective bill period of occurrence of fluctuations.

The rates quoted by the contractor shall be treated as firm for the value of work required to be done in the first 24 months of the contract period from the date of written order to commence work, and no PVA is admissible on the same on any grounds whatsoever. The value of work required to be done during the first 24 months of the contract period shall be taken as 80% of the value of work to be done on pro-rate basis in 24 months as compared to the total stipulated completion period. No PVA is admissible on the value of work required to be done in the first 24 months as worked out above, even if this work is actually done in a period longer than 24 months due to genuine reasons which are beyond his control, such period of delay will be deducted from 24 months, and the value of work to be done will be 80% of the prorata value of work to be done in such reduced period on prorata basis.

a. For works where the original stipulated period of completion is not more than 24 months no PVA whatsoever is permissible under this clause. However, if the period of completion is delayed beyond 24 months on account of genuine reasons which are beyond the control of the contractor, PVA will be admissible on the value of work done only in excess of value of work required to be done on a prorata basis in the first 24 months minus the period of such genuine delay.

For purpose of admissibility of PVA all the cumulative period of extensions granted for reasons which are solely attributable to the contractor is excluded from the total extended period of the contract and PVA shall not be admissible on the value of work done during such period of extensions, which are granted for keeping the contract, but only due to reason for which the contractor was solely responsible. Periods of extensions granted on account of genuine reasons which are not attributable to the contactor and which are beyond his control will, however, be included in the period for which PVA is admissible.

Not with standing anything to the contrary mentioned in any other clause/clauses of the contract, extensions of the contract period shall be granted by the Architect only with prior approval of the Director, NIT,Rourkela. Extensions granted by the Architect without Director's prior approval shall not bind the institute of payment of PVA for work done in the concerned period of extension.

a) Where the total cost of work done beyond the value of work required to be done in the first 24 months does not exceed Rs. 50 lakhs the total amount of PVA worked out the basis of provisions of foregoing stipulations will be limited to an upper ceiling of 10% of such value of work done in excess of value of work required to be done in the first 24 months, minus the cost of cement and steel and any other materials and services issued/arranged by the institute at fixed price i.e. P – (C + S) (terms being as per definitions given under formulae A and B above).

b) Where the total value of work done beyond then value of work required to be done in the first 24 months exceeds Rs. 50 lakhs the PVA on the first Rs. 50 lakhs will be calculated as provided for in the foregoing para and for the balance value of work done for which PVA will not have the upper ceiling of 10% but it ill be worked out at a lower rate i.e., at 90% of the amount worked out as per the formula A and B referred to earlier.

In working out the amount of PVA as per all the foregoing stipulations, value of such extra items or such portions of extra items the rates of which are derived from the prevailing market rates of materials and labour will not be included in the value of work done. Value of only such extra items or from tendered rates will be included in the value of work on which PVA is calculated.

For claiming the payment for PVA the contractor shall keep such books of accounts and other documents, vouchers, receipts etc., as may be required by the institute/Architect, for verification of the increased claims for reductions, to be made as the case may be and he shall also allow inspection of books, documents by the Site Engineer/Construction Manager and/or other duly authorized representative of the institute/Architects and furnish such information as may be require or called for to enable verification of the claim within a week of such request.

The contractor is required to submit to the institute, through the Architect, his claims for PVA separately for each running bill for the individual bill period for the works paid to him by the institute. He will also be required to submit detailed calculations in support of the claims.

No claim will be entertained from the contractor for interest or any other grounds for non-payment or for any delay in payment of PVA due to late publication or non-availability of the necessary price indices or due to delay in preparation of the running of final bills.

The increase/or decrease in statutory measures such as taxes, levies etc. will be considered while working out the adjustments, in accordance with Formula (B).

In all cases of disputes under this clause the decision of the Competent Authority who shall give a reasonable hearing to the contractor in person (not through Agents/Advocates) shall be final and binding.

Office accommodation for Site Engineer/Construction Manager

47 The contractor shall provide, erect, and maintain at his cost a separate simple watertight office accommodation for the Site engineer/Construction Manager to facilitate day to day functioning of site supervision and construction management of the project. This accommodation shall be well lighted and ventilated and provided with windows, door with lock, also having toilet, pantry drinking water cooler etc. The site engineer's office shall be minimum of 300 Sq.Ft. and the contractor shall provide desk, chairs, drawers, for keeping drawing setup board having proper lock and a tack board for displaying drawings. In addition to above contractor shall provide a conference hall of minimum 250 sq.ft area equipped with centre table and number of required chairs to hold meetings at site. Contractor shall also install and maintain at his own expenses telephone and fax machine at the site for his own use and for the use of Architect besides providing Architect's office (for their site engineer) well equipped with a P4 onwards computer loaded with Auto Cad, MS Office, Prima ware and other software's and A3 size coloured printer for efficient co-ordination at site & [Labour welfare Taxes/Tax

Service Tax- The Service Tax Shall be payable extra as per relevant Govt. rules on production of receipt.]

APPENDIX HEREIN BEFORE REFERRED TO

Clause			
1	Defect Liability Period		Twelve months.
2	Period of Final Measurement		Three months.
3	Date of Commencement		14th days from the date of issue of works order, or the date site is handed over whichever is later.
4	Completion period		24 months for the entire construction.
5	Liquidated damages		Shall be 0.5% of contact amount per week of delay subject to maximum of 5.0 % of the contract amount.
6	Value of works for Interim Certificates		Rs.50,00,000.00 minimum (Rs. Fifty Lacs) excluding secured advance against materials.
7	Retention Percentage per bill		8%
8	Total retention money		-
9	Installment after virtual completion		50% of total retention money, Earnest money, & security deposit.
10	Period for honoring certificate of payment,		Interim certificate upto 75% of amount certified by the Architect within 15 days and balance 25% amount within 30 days from the date of certificate issued by the Architect. Final Certificate – Three months.

……. ……

Employer **Contractor**

SAFETY CODE

1. Scaffolds

Suitable scaffolds shall be provided for workmen for all works that cannot safely be done form the ground, or from solid construction except in the case of short duration work which can be done safely from ladders. When a ladder is used, it shall be of rigid construction made either of good quality wood or steel. The steps shall have a minimum width of 450 mm and a maximum rise of 300 mm. Suitable hand holds of good quality wood or steel shall be provided and the ladder shall be given an inclination not steeper than ¼ to (¼ horizontal and 1 vertical).

Scaffolding or staging more than 4 m. above the ground floor, swung or suspended from an overhead support or erected with with stationary support shall have a guard rail property bolted, braced or otherwise secured, at least 1 m. above the floor or platform of such scaffolding or staging and extending along the entire length of the outside and ends there of with only such openings as may be necessary for the delivery of materials. Such scaffolding or staging shall be so fastened as to prevent it from swaying from the building or structure.

Working platforms, gangways and stairways shall be so constructed that they do not sag unduly or unequally and if the height of the platform, gangway or stairway is more than 4 m. above ground level or floor level, they shall be closely boarded and shall have adequate width and be suitably fenced as described in (ii) above.

Every opening in the floor of a building or in a working platform shall be provided with suitable means to prevent the fall of persons or materials by providing suitable fencing or railing whose minimum height shall be 1 m.

Wherever there are open excavations in ground, they shall be fenced off by suitable railing and danger signals installed at night so as to prevent persons slipping into the excavations.

Safe means of access shall be provided to all working places. Every ladder shall be securely fixed. No portable single ladder shall be over 9 m. in length while the width between side rails in rung ladder shall in no case, be less than 290 mm. for ladder up to and including 3 m. in length. for longer ladders this width shall be increased at least 20 mm. for each additional meter of length.

A sketch of the ladders and scaffolds proposed to be used shall be prepared and approval of the Engineer obtained prior to construction.
(A - FIRST AID BOX -First Aid Box has to be provided by the contractor at site.)

2. Other Safety Measure

All personnel of the contractor working within the plant site shall be provided with safety helmets. All welders shall wear welding goggles while doing welding work and all metal workers shall be provided with safety gloves. Persons employed on metal cutting and grinding shall wear safety glasses.
Adequate precautions shall be taken to prevent danger from electrical equipment. No materials on any of the sites of work shall be so stacked or placed as to cause danger or inconvenience to any person or the public.

3. Excavation & Trenching

All trenches, 1.25 m. or more in depth shall at all times be supplied with at least one ladder for each 30 m. in length or fraction thereof. The ladder shall be extended from bottoms of the trench to at least 1 m. above the surface of the ground. Sides of trenches which are 1.5 m. or more in depth shall be stepped back to give suitable slops or securely held by timer bracing so as to avoid the danger of sides of collapsing. The excavated materials shall not be placed within 1.5 m. of the edges of the trench or half of the depth of the trench whichever is more. Cutting shall be done from top to bottom. Under no circumstances undermining or undercutting shall be done.

The contractor shall take all measure on the site of the work to protect the public from accidents and shall be bound to bear the expenses of defence of every suit, action or other proceedings at law that may be brought by any persons for injury sustained owing to neglect of the above precautions and to pay any such persons or which may with the consent of the contractor, be paid to compromise any claim by any such person.

4. Demolition

Before any demolition work is commenced and also during the process of the work:

All roads and open areas adjacent to the work site shall either be closed or suitably protected.

No electric cable or apparatus which is liable to be a source of danger over a cable or apparatus used by the operator shall remain electricity charged.

All practical steps shall be taken to prevent danger to persons employed from the risk of fire or explosion or flooding. No floor, roof or other part of the building shall be so overloaded with debris or materials as to render it unsafe.

5. Personal Safety Equipments

All necessary personal safety equipment as considered adequate by the Engineer should be kept available for the use of the person employed on the site and maintained in a condition suitable for immediate use, the contractor should take adequate steps to ensure proper use of equipment by those concerned.

Workers employed on mixing asphaltic materials, cement and lime mortars shall be provided with protective footwear and protective goggles.

Those engaged in white washing and mixing or stacking of cement bags or any material which is injurious to the eyes shall be provided with protective goggles.

Those engaged in welding works shall be provided with welder's protective eyesight lids.

Stone breakers shall be provided with protective goggles and protective clothing and seated at sufficiently safe intervals.

When workers are employed in sewers and manholes, which are in use, the contractor shall ensure that the manhole covers are opened and are ventilated at least for an hour before the workers are allowed to get into manholes and the manholes so opened shall be cordoned off with suitable railing and provided with warning signals or boards to prevent accident to the public.

The contractor shall not employ men below the age of 18 years and women on the work of painting with products containing lead or any toxic material in any form. Wherever men above the age 18 are employed on the work of such painting the following precautions should be taken:

No paint containing lead or lead products shall be used except in the form of paste or ready made paint. Paints like vinyl and epoxies having toxic fumes should be applied after following all precautions laid down by manufactures.

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

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

When the work done near any public place where there is risk of drawings all necessary equipments should be provided and kept ready for use and all necessary steps taken for prompt rescue of any person in danger and adequate provision should be made for prompt first aid treatment of all injuries likely to be sustained during the course of the work.

Electrical Safety :

All switches/equipments to be properly connected & earthed and to be checked by electrical supervisor and certified for safe use. A record to be kept all such equipments to be use e.g. welding machine, hoist etc.

6. Hoisting Machines

Use of hoisting machines and tackle including their attachments anchorage and supports shall confirm to the following standards or conditions:

These shall be of good mechanical constructions sound material and adequate strength and free from patent defect and shall be kept in good repair and in good working order.

Every rope used in hoisting or lowering materials or as means of suspension shall be of durable quality and adequate strength and free from patent defects.

Every crane driver or hoisting appliance operator shall be properly qualified and no person under the age of 21 years shall be in charge of any hoisting including any scaffolding winch or give signals to operator.

In case of every hoisting machine and of every chain ring hook, shackle shovel and pulley block used in hoisting or as means of suspension the safe working load shall be ascertained by adequate means. Every hoisting machine and all gear referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load and the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear referred to above in this paragraph shall be loaded beyond the safe working load except for the purpose of testing.

In case of departmental machines, the safe working load shall be notified by the Engineer. As regards contractor's machines, the contactor shall notify the safe working load of the machine to the Engineer to the Engineer Whenever he brings any machinery to site of work and get verified by the Engineer concerned.

Motors, gearing, transmission, electrical wiring and other dangerous parts of hoisting appliances should be provided with efficient safeguards. Hoisting appliances should be provided with such means as will reduce to the minimum of the risk of any part of a suspended load becoming accidentally displace. When workers are employed on electrical installations which are already energized, insulating mats, wearing apparel, such as gloves, sleeves and boots as may be necessary, should be provided. The workers should not wear any rings, watches and carry keys or other materials which are good conductors of electricity.

All scaffolds, ladders and other safety devices mentioned or described herein shall be maintained in safe condition and no scaffold, ladder or equipment shall be altered or removed while it is in use.

Adequate washing facilities should be provided at or near places of work.

These safety provisions should be brought to the notice of all concerned by display on a notice board at a prominent place at work spot. The person responsible for compliance of the safety code shall be named therein by the contractor.

To ensure effective enforcement of the rules and regulations relating to safety precautions the arrangements made by the contractor shall be open to inspection by the Labour Officer, Engineer of the institute or their representatives.

Display of danger board sign near switch is to be ensured by the contractor.

The contractor shall be responsible for all damages, losses etc due to fire or otherwise if i.e. is due to his negligence on proper operation and maintenance of his part of installations.

ADDITIONAL CONDITIONS

The scope of work covers execution and completion of the foundations and super structure of the proposed Construction of Buildings National Institute of Technology at Rourkela -769008(Orissa) in accordance with drawings and specifications prepared by and under direction and to the satisfaction of the Employer/Director, National Institute of Technology at Rourkela - 769008(Orissa) and the Architect.

Contract : The form of contact shall be according to the printed form "Conditions of contract". The following clauses shall be considered as and extension and not in limitation of the obligation of the contractor.

Drawing : Two copies of all drawings, the schedule of quantities and specification shall be furnished by the Architect to the contractor for his own use until the completion of the contract, and shall be accessible at all reasonable time to the Architects or their representatives.

All important drawings are to be mounted on boards and placed in racks and indexed.

Dimensions : Figured dimensions are in all cases to be accepted in preference to scale sizes. Large-scale details take precedence over small-scale drawings. In case of discrepancy the contractor is to ask for clarification before proceeding with the work.

1. **Contractor to inspect Site :** The contractor shall visit and examine the construction site and satisfy himself as to the nature of the existing roads or other means of communications, the character of the soil and the excavation , the extent of magnitude of the work and facilities for obtaining material and shall obtain generally his own information on all matters affecting the execution of the work. No extra change made in consequence of any misunderstanding or incorrect information on any of these points or on grounds of insufficient description will be allowed. All expenses incurred by the contractor by the contractor in connection with obtaining information for submitting this including his visits to the site or efforts in compiling the tender shall be borne by the Tenderer and no claim for reimbursement thereof shall be entertained.

2. **Access to Site :** The contractor is to include in his rates for forming access to the Site with all temporary roads gangways required for the works.

3. **Setting out :** The contractor shall set out the building in accordance with the plans. All grid/centre lines shall be pegged out to satisfaction of the Architects. The contractor shall be responsible for the correctness of the lining out and any inaccuracies are to be rectified at his own expenses. He will be responsible for taking ground levels of the Site before setting out and recording them without any extra charge.

   The contractor shall construct and maintain proper benches at the intersection of all main walls, columns, etc., in order that the lines and levels may be accurately checked at all times.

4. **Treasure Trove :** Should any treasure, fossils, minerals, or works of art of antiquarial interest be found during excavation or while carrying out the works, the contractor shall give immediate notice to the Architects of any such discovery and shall make over such finds to the Employer.

5. **Access for Inspection :** The contractor is to provide at all items during the progress of the works and the maintenance period proper means of access, with ladders, gangways, etc., and the necessary attendance to move and adopt as directed for the inspection of measurement of the work by the Architects or their representatives.

6. **Attendance upon all Traders :** The general contractor shall be required to attend on all the Tradesman or Sub-contractor/ contractors appointed by the Employer for Water-Supply & Sanitary, Electrical installation, Air-conditioning, Security Equipment, Hardware, Telephone and other special contactors. The rates quoted shall be inclusive of attendance and also allow the contractors and retain until such times the relevant Sub-contract works are completed.

7. **Gate-Keeper and Watchmen :** The contractor from the times of being placed in possession of the Site must make arrangements for watching lighting and protecting the work, all materials, workmen and the public by day and night on all days including Sundays and holidays at his own cost.

8. **Sheds for materials :** The contractor shall provide for all necessary sheds of adequate dimensions for shortage and protection of materials like cement, lime, timber, and such other materials including tools and equipments which are likely to deteriorate by the action of sun, wind, rain or other natural causes due to exposure in the open..

   All such sheds shall be cleared away and the whole area left in good order on completion of the contract to the satisfaction of the Architects.

   All materials which are stored on the site such as bricks, aggregate, etc. shall be stacked in such a manner as to facilitate rapid and easy checking of quantum of such materials.

9. **Cost of transporting :** The contractor shall allow in his cost for all transporting, unloading stacking and storing or supplies of goods and materials for this work on the site and in the places approved form time by the Architects. The contractor shall allow in his price for transport of all materials controlled or otherwise to the site.

10. **W.C and Sanitary accommodation and office Assessors and accommodation:** The Contractor shall provide at his own cost and expense adequate closet and sanitary accommodation complying in every respect to the rules and regulations in force of the local authorities and other public bodies, for his workmen of nominated sub-contractors and other contractors working in the building, the assistant engineer and other employer's agent connected with this building project and maintain the same in good working order.

    The Contractor shall also provide at his own expense adequate office and shall maintain the same in a satisfactory condition and shall provide light, fan and attendant, etc… for the same and shall remove them after completion of works. He shall arrange to supply at his own expense, office furniture with drawing assessors for the official use of the assistance engineer and at all times maintain in good working order a dumpy level and a Theodolite at Site, to enable the Assistant Engineer to check the lines and levels of work.

11. **Materials, Workmanship & Samples :** Materials shall be of approved quality and the best of their kind available and shall generally conform to I.S. Specifications, The Contractor shall order all the materials required for the execution of work as early as necessary and ensure that such materials are on site well ahead of requirement for use in the work. The work-involved calls for high standard of workmanship combined with speed and to the entire satisfaction of the Architects.

12. **Rates for Non-Tender Items :** Rates of items not included in Schedule of Quantities shall be settled by the Architects as mentioned in the variation clause of the Contract Conditions.

13. **Rate to include:** The rates quoted shall be for all heights and depths and for finished work. To ascertain from contractors for other trades.

    The contractor shall ascertain from other contractors as directed by the Architects all particulars relating to their work with regard to the order of its execution and the position in which cases, holes and similar items will be required, before the work is taken in hand as no claims for extras will be allowed for cutting away work already executed in consequence of any neglect by the contractors to ascertain these particulars beforehand.

    Before ordering materials, the contractors shall get the samples approved from the Architects well in time.

14. **Testing of work and material:** The contractors will have to carryout testing of the material at regular interval to proof quality, soundness and efficiency of the material. Expenditure required to works testing and transportations shall be borne to be contractor. All Electrical materials are to be purchased from the approved list of manufacturers or from the authorized stockist/agent of the manufacturer and a proof of such purchases made are to be submitted and a record to be kept for authenticity and quality assurance.

All the test should be as under:

LIST OF MANDATORY TESTS

MATERIALS	TEST	TEST PROCEDURE	MINIMUM QUANTITY	FREQUENCY
1	2	3	4	5
Lime	Chemical and Physical Properties of lime	IS-6932	15 Mt.	10 mt or part thereof
Sand	a) Silt Content	Field	40 Cu.M.	40 Cu.M. or part thereof 50 Cu.M.
	b) Bulking	Field	40 Cu.M.	40 Cu.M. or part thereof 50 Cu.M.
	c) Particle size distribution	Field	80 Cu.M.	Every Cu.M. required in R.C.C. Work
Stone Aggregate	Particle size distribution		135 Cu.M.	Every 135 Cu.M. or part thereof for R.C.C. work. For rest of work as desired.
Cement	Setting time strength soundness	IS-269 and other applicable I.S.		Every batch of Consignment and as directed wherever there is a change of source.
Cement Concrete or R.C.C.	1. Slump			Once a day or as desired.
	2. Cube strength		20 Cu.M. in slab beams & connected columns	Every 20 Cu.M. of a days concrete.

			5 Cu.m. in column.	
Bricks	1. Water absorption & Efflorescence		Designation-35	One test for each source of manfacture.
	2. Compressive strength		Designation-35	1, 00,000 or part thereof. Two test for 1st lot of 1,00,000 & One test later for every 2,00,000 & part thereof.
Timber	Moisture		1 Cu.M.	Every three Cu.M. & part thereof.
Aluminum doors or Windows fitting	Thickness of anodic coating	IS-5523	Rs.5000.00	Rs. 10000 or part thereof.
Mortice Locks	Testing of springs		50 os.	100 or part thereof.
Steel	a) Tensile strength	IS-1529	Every Consignment	Every 20 Tonne or part thereof.
	b) Bend strength		-----do------	-----do------
Marble/Mosaic/ Terrazo Tiles	1) Transverse strength	IS-1237	10000 tiles	10000 tiles or part thereof
	2) Water absorption	-----do------	-----do------	-----do------
	3) Abrasion test	-----do------	-----do------	-----do------
White glazed tiles	1) Water absorption	IS_777	10000 tiles	10000 tiles or part thereof
	2) Cracking		-----do------	-----do------
	3) Impact		-----do------	-----do------
Flush door	1) End Immersion		IS-2202	Destructive tests nos No. of shutters
	2) Knife			No. of shutters
	3) Adhesion		22-65	1
			66-100	2
			101-180	2
			181-300	3
			301-500	4
			501-above	5

- Cost of testing and transport will be borne by contractors.
- Any other materials will be tested by contractors at his own cost as per the instruction of contractors at his own cost as per the instruction of Consultants and institute from time to time.
- Frequency stated above is minimum and the Contractor may have to test materials with any frequency or as instructed by Employer/Architects without any cost.

If after any such test the work or portion of works is found in the opinion of the Architect to be defective or unsound, the contractor shall pull down and re-do the same at his own cost. Defective materials shall immediately be removed from the site.

15. Mechanical Plant : Besides the provisions made in clause no.4 of the conditions of contract, the contractor will be required to provide and maintain in working order the following power-driven equipments during the constructions work :-

1. A batch mix plant for Design mix concrete as per specifications shall be provided by the contractor.
2. Devices to lift up materials to the highest level of the building of the capacity in R.C.C. beams, columns and partition wall and surface type vibrators shall be maintained on the site of work.
3. Pumps for bailing out water.
4. Any other machinery ordered by the Architects.

16. Foremen and Tradesmen : All tradesmen shall be experienced men properly equipped with suitable tools for carrying out the work of carpentry and joinery and other specialist trades in a first class manner and where the Architects deemed necessary , the contractor shall provide any such tools, special or ordinary which are considered necessary for carrying out the work in a proper manner.

All such tradesmen shall work under an experienced and properly trained foremen, who shall be capable of reading and understanding all drawings, pertaining to this work**.** Electrical tradesmen should possess electrical license and a supervisor nominated should possess supervisory license. The contractor shall also comply with other conditions set out in Clause 9 of the conditions of the contract.

17. Work Program/Weekly progress report : The contractor shall prepare and submit to Architects for approval, a bar chart showing the program of construction of various items in detail, fitted within the period stipulated for completion, within 15 days of the communication of the acceptance of the tender. The contractor shall also furnish necessary particulars to the assistance engineer for compiling weekly progress reports in the form furnished by the Architects.

18. **Clearing of Site:** The contractor shall after completion of the work clear the site of all the debris and left over materials at his own expense to the entire satisfaction of the Architects and Municipal or other public authorities.

19. The Contractor shall at his own expense supply to the Architects with triplicates copies of large photographs not less than 25 cm. x 20 cm. (10" x 8") of the works taken from two approved portions of each buildings, at intervals of not more than one month during the progress of the work, or at every important stage of construction.

    Preparation of building for occupation and use on completion:

20. The whole of the work shall be thoroughly inspected by the contractor and all deficiencies and defects put right. On completion of such inspection, the contractor shall inform the Architects in writing, that he has finished the work and it is ready for the Architects inspection.

    On completion, the contractor shall clean all windows and doors and all glass panes, including cleaning of all floors, staircases and every part of the buildings including oiling of all hardware. He should also get fans etc. cleaned and ensure all light/fan and socket outlet are in working condition. He will leave the entire building neat and clean and ready for immediate occupation and to the satisfaction of the Architects.

21. **Contractor to provide etc :** The contractor shall provide a notice board on proper supports 2 m. x 1.5m (6' x 4'-6") in a position approved by the Architects. He shall allow for painting and lettering stating name of work, name of Architects, Structural consultants, general contractor and Sub-contractor. All letters except that of the name of the work shall be in letters not exceeding 5 cm. in height and all to the approval of the Architects.

22. **Vouchers :** The contractor shall furnish the Architects with vouchers on request , to prove that the materials are as specified and to indicate the rates at which the materials are purchased in orders to work out the rate analysis of the non-tender and tendered items which he may be called upon to carry thereafter. All Electrical materials are to be purchased from the approved list of manufacturers or from the authorized stockist/agent of the manufacturer and a proof of such purchases made are to be submitted and a record to be kept for authenticity and quality assurance.

23. **Protection :** The contractor shall properly cover up and protect all work through the duration of work until completion, particularly masonry, risers, moldings, steps, terrace or special floor finishes, staircases and balustrades, doors and glass, paint work and all finishing.

Materials Specification other than indicated in the standard specification Book.

M.D.F. Blocks & Boards:

M.D.F. Blocks & Boards should be of good quality and as specification under the items.

M.D.F. Boards should have I.S.I. Mark.

M.D.F. Blocks & Boards are to be stacked and used as directed by the manufacture.

While fixing hinges and fittings etc. screws should be fixed with plastic sleeve as directed by the manufacturer.

All joinery to be made as directed by the manufacturer.

Finishing to be made as directed under the item.

If it is felt necessary contractors will have to take test for the M.D.F. boards and blocks at their own cost and submit the report to the Architect's office in triplicate.

If it is required and advised by the Architect, contractor will have to give one more finishing coat of enamel paint over M.D.F. Materials without any extra charge.

Aluminium Extrusion Sections:

All Aluminium sections, fittings used in the work for door, windows should be powder coated aluminum (minimum thickness of powder coating 50 microns).

All Aluminium sections to be used in the work should confirm to the specifications given under the items.

All Aluminium works to be carried out in a workman like manner.

Aluminium extrusion sections used for windows shall be of approved manufacturer and shall conform to IS standards. These shall be fabricated as per the detail drawings, aluminum fabrication works shall give anodized film of 50 micron powder coated finished.

Contractor shall take care to stack fabricated frames and materials on Site under cover.

They shall be handled with care and stacked on edge on level bears and supports evenly.

Before erection the frames coming in contract with concrete or masonry plaster shall be coated with a coat of Zinc Chromate.

The rates quoted for these items shall include supplying and fixing all fittings and fixtures required for proper and safe operation.

Granite : Granite stone slabs are to be used should be of approved any colour and shade and of required thickness. Should be properly cut with electric machine and all exposed edges to be polished.

It should be of required lengths widths. No un-necessary joints to be provided. Wherever it is required it should of full length and width as shown on drawing or as directed.

Granite stone joints in the sink are to the sealed with approved chemical either epoxy base or resin base adhesive. All exposed edges of Granite stone slabs are to be polished.

G.I. Pipes Concealed : All G.I. Pipes canceled should be covered with impregnated bit mastic Hessian cloth properly overlapped and fixed in position with nails, hooks or clamps etc.

All concealed pipe work to be tested before they are covered with finishing material, if any leakages are observed then it is contractors responsibility to remove leakages and make good the surface at their own cost. Contractor will have to obtain certificate from the Site Engineer for checking the concealed pipes and testing the same.

Cast Iron Anti-symphonies Pipes: Cast Iron Anti-symphonies Pipes shall cost without ISI Mark of approved make. Rate quoted for this item shall include charges for making holes and making good the same.

Cast Iron Soil Water, Waste Water Pipes, Nahani Traps : All joints to be provided lead caulked joints as per the specification given in the Standard specification book.

Waterproofing Treatment : The Contractor shall carry out waterproofing treatment of terraces, toilets and water retaining structures reputed firms having specialization in the line and approved by the Architect/Employer. The contractor shall also furnish full details of such treatment to the Architect and provide all information regarding effectiveness of the treatment when called upon to do so. All such treatment shall have to be guaranteed in the form of proforma given in tender for a period of Ten Years. Any defects/leakages noticed during the guarantee period shall have to be rectified free of cost by the contractor including reinstating the surface to its original condition and finish.

DRAFT

(TO BE SUBMITTED ON STAMPED PAPER OF APPRORIATE VALUE)

WATERPROOFING WORK
FREE MAINTENANCE GUARANTEE

FORM OF AGREEMENT

After completion of the work and before …… .day of the month …….. if at the any time or times the roofs, moris, toilets, water tanks and any other portion thus treated by M/s.……..…… (hereinafter called "the contractor") starts leaking or in any way give way to the influence of water including forming wet patches, dampness etc., due to the inadequacy of the work carried out or due to any other reason whatsoever relating to the specification, workmanship, etc. including the responsibility for any surface treatment and plumbing etc., works carried out by other agencies, the contractor should, without any extra cost, to the Employer or to the occupants, carry out necessary remedial measure to such extent and so often as may be necessary to free the said premises from leakage etc. The question of whether there is any leakage or the treatment has given way to water or moisture after the completion of the treatment aforesaid and before ……. shall be decided by the Employer and the decision of the Employer in this regard shall be final and binding on the contractors. The contractors shall reinstate the surface to its original condition after carrying out the rectification work, if necessary, by bringing new materials at no extra cost to the Employer.

…….	……
Signature of Employer	Signature of Contractors
Place :	Place :
Date :	Date :

NOTE : Guarantee to be submitted by both the contractors, Main Civil contractors and the Waterproof Specialist Agency).

PROFORMA FOR EXTENSION OF THE PERIOD

1.	Name of Contractor			:	
2.	Name of the work as given in the Agreement			:	
3.	Agreement No.			:	
4.	Estimated tender amount			:	
5.	Date of Commencement of work as per Agreement			:	
6.	Period allowed for completion of work as per Agreement.			:	
7.	Date of Completion stipulated in Agreement.			:	
8.	Period for which extension of time has been give previously			:	
a)	Ist extension vide Architect's /Institute letter			:	
	No.	Dated	Month	Days	
b)	2nd extension vide Architect's /Institute letter			:	
	No.	Dated			
c)	3rd extension vide Architect's / Institute letter			:	
	No.	Dated			
d)	4th extension vide Architect's / Institute letter			:	
	No.	Dated			
	Total extension previously given			:	
9.	Reason's for which extensions have been previously given (Copies of the previous applications should be attached)			:	
10.	Period for which extension is applied for			:	
11.	Hindrances on account of which extension is applied for with dates on which hindrances occurred and the period for which these are likely to last.			:	
a)	Serial No.				

b)	Nature of Hindrance		
c)	Date of occurrence		
d)	Period for which it is likely to last.		
e)	Period for which extension required for this particular hindrance		
f)	Over lapping period if any, with reference to item (e) above		
g)	Net extension applied for		
h)	Remarks, if any		
12.	Extension of time required for extra work	:	
13.	Details of extra work and the amount involved	:	
a)	Total value of extra work		
b)	Proportionate period of extension of time on estimated amount put to tender.		
14.	Total extension of time required for 11 & 12	:	

Submitted to the Architect/Institute …….

Date: Signature of Contractor

PROFORMA OF REGISTRATION
PROFORMA SIEVE ANALYSIS OF FINE AGGREGATE

S.No.	Date of Test	Materials to be Tested	Wt. of materials to be Tested	Sieve as per I.S. Designation	Wt. of Sand retained	% Retain to each sieve successively
1	2	3	4	5	6	7

S.No.	Cumulative % Retained	P.M.	Signature of Site Engineer	Signature of Contractor	Signature of Architect's Representative
1	2	3	4	5	6

S.No.	Sample No.	No. of Cubes taken	Specific Marketing of Cubes	Proportion of Mixture	Description of work carried cut	Signature of Site Engineer taken sample
1	2	3	4	5	6	7

S.No.	Date of Test	Volume of dust sand in cylinder	Volume of inundated sand in cylinder	Percentage of bulk age	Signature of the Site Engineer	Signature of the Contractor	Signature of the Architect Representative
1	2	3	4	5	6	7	8

a

PROFORMA OF PAINT/CEMENT/LEAD/CICO

PARTICULARS OF RECEIPTS						
S.No.	Date of Receipt	Qty. Read	Progressive	Date of Issue	Qty of Issued	Items of work for when Issued
1	2	3	4	5	6	7

PARTICULARS OF ISSUE				Signature of the Site Engineer	Signature of the Contractor	Signature of the Architect's Representative
S.No.	Net Qty for the	Processing Total	Daily balance at hand			
8	9	10	11	12	13	14

PROFORMA FOR SLUMP TEST

Sr.No.	Date of test	Type of work for which slump	Specified When Vibrators are used	Slump When Vibrators are not used	Slump When Vibrators are used.	Obtained When Vibrators are not used.
1	2	3	4	5	6	7

Signature of the Site Engineer	Signature of the Contractor	Signature the Architects Representatives
8	9	10

PROFORMA FOR SILT TEST

Sr.No.	Date of test	Height of sand in Cylinder inundated & starred	Height of silt	Max. percentage of silt as specified	Pecenatge of Silt obtained	
1	2	3	4	5	6	7
Signature of the Site Engineer		Signature of the Contractor		Signature the Architects Representatives		
8		9		10		

PROFORMA OF SIEVE ANALYSIS OF COURSE AGGREGATE

Sr.No.	Date of test	Weight of materials to be tested	Nominal size of Aggregate	I.S. Sieve designation	Standard and % passing for graded Aggregate of nominal size	Test Result	Percentage obtained passing
1	2	3	4	5	6	7	8
Signature of the Site Engineer			Signature of the Contractor		Signature the Architects Representatives		
8			9		10		

PARTICULAR SPECIFICATIONS
PART - I

1. General: The work shall be carried out strictly in accordance with particular specifications and drawings. The drawings, specifications BOQ etc. shall be taken complementary and also supplementary to each other and shall form part this contract. Any work or material shown on drawings and not specifically included in BOQ/specification or vice versa shall be executed and deemed to be included in the scope of work for lump sum rate.

2. Incase there are no specifications for items shown on the drawings or where items are not exhaustively described, the general specifications of CPWD shall be followed for which nothing extra shall be paid. In case, no details are available even in CPWD specification, then decision of owner is final & binding on the contractor.

3. Scope of works : The scope of work for buildings under this contract includes for full & final and entire completion of all works including all internal and external services in all respects described in particular specification Part-I and as shown on drawings forming part of the contract.

4. Although all the details of construction have been by an large covered in these documents, any item or details of construction not specifically covered but obviously implied and essential to consider Civil works and all internal and external services complete and functional, shall be deemed to have been covered in the lump sum quoted. The cost of external development works pertaining to a particular contract shall also be carried out on a final lump sum price based on the rates quoted for each item. The tenderer may however, consider a minimum level of specifications conforming to IS code or National Building Code to cover any missing details.

5. Sample of Materials: The Contractor shall produce samples of all materials and shall obtain approval of these in writing from Architect/ Project Engineer before he places bulk order for the materials for incorporation in the works. The samples must be produced at least six week before they are to be incorporated in sample dwelling units. Materials to be incorporated in the work shall conform to latest relevant ISI. The items should be ISI marked where manufactured.

6. Slopes : Adequate slope shall be provided in areas where there is likelihood of ingress of water such as toilets, balconies, verandah, kitchens, terraces, top of chajjas, window sill, plinth protections etc. though these may not be expressly shown in drawings.

7. Curing: Exposed surfaces of all cement works viz. cement concrete, brick work, flooring, plastering, pointing and the like shall be cured by keeping the surface adequately and continuously wet as directed by Architect and Project Engineer for at least seven days where ordinary Portland cement has been used. Approved curing compound may be used in lieu of moist curing with the permission of Architect and Project Engineer. Such compound shall be applied to all exposed surface of cement works as soon as possible after the initial setting of cement. This shall be without extra cost.

SECTION – I
EXCAVATION EARTH WORK & ANTITERMITE TREATMENT

1. General : The work to be done under this section comprises of supply of all labour, plant materials and other performance of all work necessary for excavation with necessary close timbering, strutting, shoring & bailing/pumping out water including disposing of all surplus excavated material from the side as directed by Architect/Project Engineer.

2. Site Clearance: Before the start of work, the area of the plot shall be cleared of all shrubs, vegetation, grass, bush wood, shrubs etc. The building shall be laid out to ensure that the layout plan of other building fits at site. After completion of the work, the entire area of the plot of this building shall be cleared from all debris, unwanted materials and level/slope of ground as required at site upto peripheral roads. The debris and unwanted material shall be disposed off away from from owner's plots as directed without extra cost to owner.

3. Site Levels: After site clearance and before commencement of excavation or filling, the contractor shall take levels at 3.0mtr. Intervals in either directions or at lesser intervals as considered necessary at site for the proposed plot marked for this building. A record of these levels shall be signed jointly by Contractor and Project Engineer and Architect. These records shall be, kept by the Project Engineer.

4. Setting out of works : The contractor shall set out the works and shall provide and fix all setting out apparatus required and solely be responsible for the true and perfect setting out the same and for the correctness of the position, levels, dimensions and alignment of all building as per the drawings. The contractor shall take in writing the approval of the Architect and Project Engineer for setting out and levels before starting the works. These approvals shall be recorded in the stage passing register and signed by the Architect and contractor and countersigned by the Project Engineer.

5. Surface Excavation: The surface area to be occupied by the building shall be cleared of all debris, shrubs and plants, trees etc. of any height, grass and thereafter excavated, including 3.0mtr.all round the building including ramps if any. All roots and organic material shall be cleared from the filling area inside the building.

6. Excavation in Trenches:

(a) Earth work in excavation in any type of soil as existing at site for foundations of columns and walls shall be carried out as indicated on drawings.

(b) The finished floor level of ground floor building shall be fixed at site by the Architect and Project Engineer The work shall be executed at site as per levels shown on drawings/approved by the Architect/Project Engineer

(c) Immediately after the execution of the foundation work and before covering the same the record of the following levels as actually executed at site separately for building shall be recorded in the measurement book and jointly signed and dated by the Architect, contractor and Project Engineer.

(i) Existing ground level
(ii) Level of bottom of lean concrete, under footings of columns and walls.
(iii) Finished floor level of stilt area and ground floor for the building.

(d) If trenches or foundations are excavated beyond the specified dimensions due to bad workmanship of contractor, the extra excavation shall be filled with lean concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40 mm nominal size) without any extra cost to Employer. All material cost also for such jobs shall be borne by the Contractor.

7. Excavation over Areas: Excavation over areas shall be carried out to the required depths and profiles. Suitable arrangements shall be made by the contractor. The sides of the trench shall be kept vertical upto a depth of 2 mtr. from the bottom. For a greater depth, the excavation profiles shall be widened by allowing steps of 50 cm on either side after every 2 mtr. from the bottom. Alternately the excavation can be done so as to give slopes of 1:4. Where the soil is soft, loose or slushy, the width of steps shall be suitably increased or side sloped or the soil shored up as directed by Architect/Employer. It shall be the responsibility of the contractor to take complete instructions in writing from Architect/Employer regarding the stepping, sloping or shoring to be done for excavation deeper than 2 mtr.

8. Slips: The contractor shall take all necessary precautions to prevent slips in excavation and shall at his own expense make good any damage or defect and remove top soil dumps and any surplus material caused by slips.

9. Plinth Filling:

a. Earth obtained from excavation (or approved earth brought form outside for which no extra payment shall be made) shall be filled in layers not more than 20cm. in depth at a time, spread, leveled, watered and well consolidated around foundations, under floors and other locations. The earth used for filling shall be free from all grass, roots debris etc. In case extra earth filling is required for under floors, verandah and court yards/open to sky area within the perimeter of the Academic/other building the contractor will do so at their own cost. The quoted rate shall be deemed to include the earth filling required under floors for the locations indicated herein before.

b. Testing of filling layers: After the compaction of each layer, samples shall be taken from the compacted layer and tested for dry density as per IS practice. The next layer of filling shall not be permitted to be deposited until the Architect/Project Engineer is satisfied that the previous layer has achieved required compaction. The contractor shall inform the Architect/Project Engineer in writing for inspection after filling and compaction of each layer. If any particular layer fails to meet the required compaction, it shall be re-compacted as directed by the Architect/Project Engineer and fresh samples shall be taken to ascertain the compaction density. Such re-compaction shall continue till the desired compaction is achieved.

10. Sand Filling: Sand shall be free from dust and organic and foreign matters and corresponding to approved grading meeting the approval of the Architect/Project Engineer. Fine sand filling under floors of stilt and ground floor building shall be provided with specified thickness as shown on drawing. This shall be dry River fine sand watered and consolidated including dressing and leveling.

11. Disposal of Surplus Soil/Material: Surplus soil/earth if any shall be disposed off with-in the site of owner as directed by the Architect/Project Engineer. The same shall be spread out evenly. All excavated material not so used shall only be disposed of in areas approved by the Architect/Project Engineer, at no extra cost.

12. Dressing around Building: After construction and before handing over any building, the area around as defined in clause 5 above shall be finally dressed without extra cost to the Employer.

13. Anti-Termite Treatment:

(a) This shall be provided to bottom of trenches sides, including treating the back fill, under floors and other locations as specified in IS-6313 Part II for pre construction soil treatment with any of the following:-

Chemical	**Concentration by weight Percent**

(i) Chlorpyriphos emulsifiable concentrates to IS 8944-1978 1.00

(ii) Heptachlor emulsifiable concentrates conforming to IS 6436 – 1978 0.50

(iii) Chlordane emulsifiable concentrates conforming to IS 2682 - 1966 1.00

(b) The work of antitermite treatment shall be got executed by a specialist firm which must be member of IPCA and approved by the Architect/Project Engineer and shall be carried out as per IS 6313 Part II of 1981 for preconstruction soil treatment. The firm shall render a five year guarantee to the employer through the contractor who will be the principal guarantor. The period of five year shall be reckoned from the date of virtual completion of the contract.

(c) Such guarantee shall be directly given by the specialist agency to the employer in all form approved by the employer. In the event of reinfestation at any time during guarantee period, the specialist agency shall undertake to the employer through the contractor i.e. the principal guarantor to carry out such treatment as may be necessary to render the structure free form termite infestation including breaking and reinstalling any other work that may necessary for the treatment at no extra cost.

SECTION II
CONCRETE (PLAIN & REINFORCED)

1. General : This section covers the requirements for furnishing of cement concrete including materials proportioning, batching, mixing, testing, placing, compacting, finishing, jointing, curing and all other work as required for cast-in-place/precast cement concrete.

2. Submittals:

Materials Reports: Prior to start of delivery of materials required for cement concrete the following shall be submitted by the contractor to the Architect/Project Engineer for approval.

i. Recommended suppliers and/or sources of all ingredients for making concrete including cement, fine and coarse aggregates, water and additives.

ii. Quality Inspection Plan to ensure continuing quality control of ingredients by periodic sampling, testing and reporting to the Architect/Project Engineer on the quality of materials being supplied.

Plant & Equipment*:* The contractor shall submit the following to the Architect/Project Engineer well in advance.-

The proposed Programme, methods and details of plant and equipment to be used for batching and mixing of concrete.

Reports for Inspection and Testing: During concreting operations, the contractor shall conduct inspection and testing as described above and all reports thereon shall be submitted in summary form to the Architect/Project Engineer.

Schedules: The contractor shall prepare working schedule for dates and frequency of placing of concrete for each item of work and submit the same to the Architect/Project Engineer when requested.

3. Materials: Before bringing to the site, all materials for cement concrete shall be approved by the Architect/Project Engineer. All approved samples shall be deposited in the office of the Architect/Project Engineer. The Architect/Project Engineer shall have the option to have any of the materials tested to find whether they are in accordance with specifications at the contractor's expenses.

a. Cement*:* shall be ordinary Portland cement grade as per IS 8112 – 1989 specified and shall be stored in a dry waterproof godown.

b. Fine Aggregate*:* For all concrete work, it shall be coarse sand/coarse stone dust conforming to the grading given below :- (Zone I or II only applicable to concrete). Silt content not to exceed 4% by weight. The grading of fine aggregate shall be within the limits given in the following table and shall be described as fine aggregate grading Zone I and II:-

IS Sieve Designation	Percentage Passing for	
	Grading Zone I	Grading Zone II
10mm	100	100
4.75mm	90-100	90-100
2.36mm	60-95	75-100
1.18mm	30-70	55-90
600micron	15-34	35-59

300micron	5-20	8-30
150micron	0-10	0-10

c. Coarse aggregate: For concrete it shall be crushed stone graded coarse aggregate. Grading shall be within the limits as given in the following table:-

d. Coarse aggregate of all grades shall be from the crushers of approved source).

IS Sieve Designation Nominal size	Percentage 40mm	Passing 20mm	for graded 16mm	Aggregate of 12.5mm
80mm	100	-	-	-
63mm	-	100	-	-
40mm	95-100	100	-	-
20mm	30-70	95-100	100	100
12.5mm	-	-	-	90-100
10mm	10-35	25-55	30-70	40-85
4.75mm	0-5	0-10	0-10	0-10
2.36mm	-	-	-	-

e. Broken Brick aggregate: Broken brick aggregate shall be prepared from well burnt bricks. These shall be free from under burnt particles and adherent coating of soil or silt.

Note: If directed by Architect/Project Engineer, the aggregate (fine as well as coarse) shall be washed at contractor's expense.

f. Water: Used in concrete, brick work, plasters shall be clean fresh and non saline according to relevant IS. Water samples should be got tested by contractor before use if required by Architect/ Project Engineer. In case, water is obtained from digging bore well at site all required permission shall be obtained from local authority & all charges to be paid to authority as & when demanded. In case, water available at site is not fit for construction purposes, contractor will make his own arrangement for supply of water as per relevant IS at no extra cost to employer.

g. Admixture & Additives: Chemically admixtures are not to be used until permitted by the Architect/Project Engineer. In case their use is permitted, the type amount and method of use of any admixture proposed by the contractor shall be submitted to the Architect/Project Engineer.

4. Mixing: All cement concrete (plain or reinforced) shall be mixed in mechanical mixers only. No hand mixing will be allowed.

5. Consolidation : Concrete for all reinforced concrete works in column footings, columns, beams, slabs and the like shall be deposited and well consolidated by vibrating, using portable mechanical vibrators. The rest of the concrete such as chajjas and shelving etc.shall be deposited and well consolidated by pouring and tamping. Care shall be taken to ensure that concrete is not over vibrated so as to cause segregation.

Form Work

6. General: The steel/ply wood form work shall be designed and constructed to the shapes, lines and dimensions shown on the drawings. All forms shall be sufficiently water tight to prevent leakage of mortar. Forms shall be so constructed as to be removable in sections. One side of the column forms shall

be left open and the open side filled in board by board successively as the concrete is placed and compacted except when vibrators are used. Maximum height of column for which concrete can be placed at a time shall not be more than 1.5 mtr.

7. Props must be of steel. Pre moulded cement cubes blocks of desired thickness will be placed between formwork and reinforcement to achieve uniform cover of concrete.

8. Cleaning and Treatment of Forms: All rubbish, particularly chippings, shavings and saw dust, shall be removed from the interior of the forms (steel/ply) before the concrete is placed. The form work in contact with the concrete shall be cleaned and thoroughly wetted or treated with an approved composition to prevent adhesion between form work and concrete. Care shall be taken that such approved composition is kept out of contact with the reinforcement.

9. Verticality of frame structure: All the outer columns of the frame will be checked for plumb by plumb-bob as well as by the theodolite as the work proceeds to upper floors. Internal columns will be checked by taking measurements from outer row of columns for their exact position.

10. Stripping time: Forms shall not be struck until the concrete has attained a strength at least twice the stress to which the concrete may be subjected at the time of removal of form work. The strength referred to shall be that of concrete using the same cement and aggregates with the same proportions and cured under conditions of temperature and moisture similar to those existing on the work. Where so required form work shall be left longer in normal circumstances and where ordinary Portland cement is used, forms may generally be removed after the expiry of the following periods:-

(a)Walls, Columns and Vertical faces of all structural members 2 days
(b) Removal of props under slabs :(i) Spanning upto 4.5 mtr. 7 days
(ii) Spanning over 4.5 mtr. 14 days
(c) Removal of props under beams :-(i) Spanning upto 6.0 mtr. 14 days
(ii) Spanning over 6.0 mtr. 21 days
(d) In case of cold weather these periods may be increased at the discretion of the Architect/Project Engineer. For other cements (like pozzolana etc.) Stripping time recommended for ordinary Portland cement may be suitably modified. The number of props left under, their size and disposition shall be such as to be able to safely carry full dead load of the slab beam or arch, as the case may be together with any live load likely to occur during placing of concrete, curing or further construction.

11. Removal of Form Work: Form work shall be removed in such a manner as would not cause any shock or vibration that would damage the concrete. Before removal of soffits and props, concrete surface shall be exposed to ascertain that the concrete has sufficiently hardened.

12. Where the shape of element is such that form work has re-entrant angles, the form work shall be removed as soon as possible after the concrete has set, to avoid shrinkage cracking occurring due to the restraint imposed.

13. Finish concreting work:

(a) All concrete while being poured against form work shall be worked with vibrators rods & trowels as required so that good quality concrete is obtained.
(b) All exposed surface of RCC lintels, beams, columns etc. shall be plastered to match with adjoining plastered face of walls after suitably hacking the concrete surface.
(c) All soffits of RCC slabs, loft slab, cupboard slab, shelves and working platform in kitchen etc. and other exposed surfaces of RCC work not continuous to brick work shall be

plastered (6mm thick) with cement mortar 1:3 (1 cement:3 fine sand) to give an even and smooth surface.

(d) The top of loft slabs and shelves shall be smooth finished while the concrete is green with a floating coat of neat cement to give a smooth and even surface. The exposed front face shall be finished in cement plaster 1:3(1 cement:3 coarse sand) to bring it in line and level and finished in neat cement. Such thin slabs shall be carefully cast so that they can be finished within 12mm of their specified thickness. Additional thickness of plaster which makes these elements look unnecessarily heavy will not be allowed.

(e) Chicken wire mesh 24 gauge and 20mm mesh will be provided all along RCC surface adjoining brick work giving 150mm lapping on either side using stainless steel nails etc for fixing mesh while plastering.

(f) The rate shall be deemed to include for small and incidental labour such as chamfer, splays, rounded or curved angles, grooves, rebate and drip moulds/courses.

14. Sampling and testing of concrete: Samples from fresh concrete shall be taken as per IS-1199-1959(method of sampling of concrete) and cubes shall be made, cured and tested at 28 days in accordance with IS 516- 1959 (method of test for strength of concrete). For testing cement concrete the contractor shall arrange for all the tools/moulds for making necessary cubes and shall bear all the charges for making the cubes, curing and testing through an approved laboratory. Further the contractor shall make available laboratory equipment at site. A temporary room of adequate size having these facilities, shall also be constructed by the contractor at his expense. After completion of work the contractor shall remove the equipment, dismantle the room and clear the site:-

15. Compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test for a quicker idea of the quality of concrete. In all cases the 28 days, compressive strength alone shall be the criteria for acceptance or rejection of the concrete.

16. Test Specimen: Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for such purposes as to determine the strength of concrete at 7 days or to check the testing error.

17. Test strength of samples: The test strength of the sample shall be the average of the strength of three specimens. The individual variation shall not be more than + - 15 percent of the average.

18. Cement boiling test: Accelerated compressive test as per IS-9013/78 shall be carried out to determine the quality of cement received at site in each consignment. This shall be done as per details below. The test result shall be recorded, signed and kept in a register with the Architect /Project Engineer.

I) Prepare 9 cubes with cement concrete mix proposed to be used for the job. Keep the same water cement ratio that will be actually used. Slump could be a good indication.

II) After the cubes are cast,3 moulds containing the cubes to be tested by accelerated curing method must be covered on the top with a machine plate. The plate should be of the same size as cube mould plates.

III) After 24 hours of casting, the three cubes shall be boiled with the top plates on, in the field. These could be boiled in a drum with at least 75mm water standing over the cube moulds. The boiling must be uniform and constant for exactly 3.1/2 hours. Thereafter, the cubes must be taken out of the boiling water, remolded and cooled for 1 hour and tested., Exact timings are extremely important and must be followed. The anticipated 28 days compressive strength can be calculated from the regression equation given below:-

$$Y = 8.2+1.609A$$

Where Y = the predicted 28 days cube result in N/mm^2

A = accelerated cube result in N/mm^2

IV) Contractor shall arrange all tools, moulds and cubes etc. and bear all expenses for carrying out the cement boiling test as per above.

19. Mix of cement concrete/reinforced cement concrete required to be used in various locations /situations shall be as shown on drawing. Wherever not mentioned shall be as under:-

(a) Cement concrete in floors (self finished) and concrete as under layer for terrazzo floor cast in situ shall be PCC 1:2:4(1 cement:2 coarse aggregate:4 graded stone aggregate 12.5 nominal size).

(b) Cement concrete for RCC work in raft, columns footings, beams/ Roof/ floor slabs, landing, fins, lintels, chajjas, shelves, staircases, balconies, Loft slabs and in any other situation shall be of design mix cement concrete M-20 grade as per IS 456-2000 including Admixtures in recommended proportions (as per IS 9103) to accelerate, related setting of concrete, improve workability without impairing strength and durability as per direction of Architect /Project Engineer).

(c) Cement concrete for piles, pile cap, columns, walls overhead water tank shall be of mix cement concrete 1:1.5:3 (1 cement : 1.5 coarse sand : 3 stone aggregate, 20mm nominal size).

(d) Cement concrete in PCC filling for pressed steel frames, hold fast blocks and rain water pipes etc. shall be 1:3:6 (1 of cement:3 of coarse sand:6 stone aggregate 12mm nominal size).

(e) The mix 1:1.5:3 shall conform to M 20 (Design Mix) as per IS 456-2000 for the purpose of testing and acceptance based on 28 days strength.

(f) Lean cement concrete below raft columns/walls footings and in sub flooring of ground floor shall be of mix 1:4:8 (1 cement: 4coarse sand: 8 stone aggregate 40mm nominal size).

20. Construction Joints: Construction joints shall be made only where shown in the drawings. Vertical constructed joints shall be formed against a stop board and horizontal construction joints shall be level.

21. Contraction Joints: Contraction joints required will be as shown on the drawings. Contraction joints shall not be hacked, wetted or mortared before concrete is placed against them.

22. Expansion Joints: Expansion joints shall be provided where shown on the drawings. They shall be constructed with an initial gap between the adjoining parts of the works of the width specified in the drawings. The contractor shall ensure that no debris is allowed to enter expansion joints. Expansion joints shall be provided with joints filler, a joint sealing compound and in water proof concrete a water bed.

23. Open Joint Fillers: Where shown on the drawings, open joints in the structure shall be filled with one of the following of expansion joint filler:

(a) In internal areas a material conforming to IS: 1838 containing bitumen emulsion fibers of cork granules bound together with natural resin.

(b) In external areas a material comprising closed cell rubber or containing cork granules bound together with natural resin.

24. The Joints filler shall be easily and uniformly compressible to its original thickness, tamable, easily cut of sawn, robust, durable, resistant to decay due to termite or weathering, unaffected by water and free of any constituent work) will be into or stain the concrete. The joints filler shall be of same thickness of the joint width, it shall extend through the full thickness of the concrete unless otherwise specified and shall be sufficiently rigid during handling and placing to permit the formation of straight joints.

25. Joint Sealing Compounds: Joints sealing compounds shall seal joints in concrete against the passage of water prevent the ingress of grit or other foreign material and protect the joint filler. The compound shall have good extensibility and adhesion to concrete surfaces and shall be resistant to flow and weathering.

Poly sulfide joints where specified on the drawings shall be sealed with poly sulfide liquid polymer, stored, mixed, handled applied and cured strictly in accordance with the manufacturer's written instructions. Such joints shall be formed to the correct dimensions, thoroughly cleaned and treated with recommended primer strictly in accordance with the manufacturer's written instructions prior to sealing. The contractor shall use only competent personnel experienced in the application of poly sulfide for such work.

26. P.V.C. Water Bars/Water stop: Where water bars are shown on the drawings, the joints shall incorporate an approved PVC external type, water bar complete with all necessary moulded or prefabricated intersection pieces assembled in accordance with the drawings with bends and butt joints in running lengths made by heat welding in an electrically heated jig. Joining and fixing of water bars shall be carried out strictly in accordance with manufacturer's written instruction.

27. Inserts: The contractor shall fix all necessary inserts such as steel plates, pipe sleeves, bolts etc. and make holes, pockets, dowels etc., in the form work to enable efficient fixing of supports in the form work to enable efficient fixing of supports, brackets, ceilings, precast members etc. as indicated on the drawings, called for in the schedule of quantities or as required by the Architect/Project Engineer. In-situ concrete inserts shall be as per IS: 1946 and of a type approved by the Architect/ Project Engineer.

28. Bearing Plaster : This shall consist of cement plaster 1:3 (1 cement:3 fine sand) 20mm thick finished with a coat of neat cement laid on top of walls as bearing for RCC lintels, beams and slabs, when dry, a thick coat of lime wash shall be given before starting, shuttering. The shuttering shall be started after minimum one day of bearing plaster so that it is set.

29. All RCC Beams resting on masonry work shall be provided with PCC Bed Block cast in PCC 1:2:4 TypeB1.Bed Blocks shall be twice the width of beam in length covering the entire thickness of the wall and of depth 150mm unless otherwise shown on drawings.

30. No Treatment shall be provided under bearing of RCC Bands.

31. Concrete filling for sunken and lowered portions of slab: This shall be cement concrete 1:5:10 (1 cement:5 coarse sand:10 brick ballast 40mm nominal size) in the entire sunken portions irrespective of what is shown on the drawings. Over this sub base, flooring as per specifications shall be provided.

32. Damp Proof Course:

(a) This shall consist of 40mm thick PCC 1:2:4 (1 cement: 2 coarse sand:4 graded stone aggregate :12.5mm nominal size)with water proof compound confirming to IS-2645) as per manufacturer's specifications) .

(b) DPC as specified above shall be provided 40mm thick at level with finish floor to the full width of walls (Ground floor only)

(c) No DPC shall be provided over dwarf walls but floors shall be carried over to the width over the dwarf wall finished 10mm projecting over from the wall.

(d) The dried up surface of DPC shall be cleared with brushes and finally with a piece of cloth soaked in kerosene oil and then applied with hot bitumen using 1.7 kg per sqm. Of DPC area.

(e) Vertical Damp proof course shall be provided at ground floor on common walls between floors at different levels and shall consist of 20mm thick plaster of mix 1:4 (1 cement:4 coarse sand) with

water proofing compound at the rate as unused in as in (d) above before filling earth /sand is carried out.

33. Plinth Protection : PCC 1:3:6 (1 cement:3 coarse sand:6 graded stone aggregate 20mm nominal size) 50mm thick of width as shown on drawing shall be provided and laid in alternate bays in slope over 75mm hard core of rammed dry brick aggregates of 40mm nominal size. Over well rammed and consolidated earth base with brick edging all around the building except in portions covered by steps, ramps and platforms. A joint of 10mm shall be left through depth of concrete all along with junction between wall and plinth protection at all turnings and across at every 2.5m. These joints shall be filled with a mixture of blown grade bitumen 85/25 and sand. The surface shall be screed finished. Brick edging shall be laid on header with cement mortar 1:4 (1Cement: 4 Coarse sand) as per detail as shown on drawing.

SECTION III - BRICK WORK

MATERIAL

1. Sand for Masonry Mortars: Unless otherwise indicated, sand for masonry mortars shall consist of natural sand (generally termed as coarse sand) crushed stone sand or crushed sand or a combination of any of these conforming to IS 2116-1965 specifications for sand for masonry mortars. Sand shall be hard, durable, clean and free from adherent coatings and impurities such as iron particles, alkali, salts, coal, mica, shale or similar laminated or other materials exceeding the specified limit. Grading of sand shall be as under:-

IS Sieve	**Percentage passing by weight**	
	Unreinforced masonry	Reinforced masonry
4.75 mm	100	100
2.36 mm	90-100	90-100
1.18 mm	70-100	70-100
600 micron	40-100	40-100
300 micron	5-70	5-70
150 micron	0-75	0-10

2. The maximum quantities of clay, fine silt and fine dust in sand shall not be more than 4 percent by weight; Organic impurities shall be below that obtained by comparison the standard solution on specified in 6-2-2 of IS-2386 (Part II 1983).The coarse/fine sand shall be from river.

3. Common Burnt clay building brick: Common burnt clay building bricks (herein-after termed as bricks shall conform to the requirements laid down in IS-1077-1976 for common burnt clay building bricks. Bricks shall be class designation 75, sub Class 'A' as per parameters given in the IS regarding edges, dimensions etc. The overall dimensions shall however be as per local practice of moulds. Water absorption after immersion in cold water for 24 hours shall not exceed 20% and grading for efflorescence shall be less than moderate. Bricks shall be free from cracks, flaws and nodules of free lime. Dimension shall be all within tolerance. Under/over burnt bricks and warped bricks shall be totally rejected.

4. Test check on random samples from each lot of bricks brought at site shall be carried out for compressive strength and water absorption test. Results of these tests duly signed and dated by Contractor; Architect and Project Engineer shall be recorded in a separate register, which shall be kept with the Project Engineer.

WORKMANSHIP - MASONRY MORTARS

5. Preparation of Cement Mortars: Mortar shall be of mix as indicated. The mixing specified is by volume. Mixing shall be done in a mechanical mixer only. The mortar shall be mixed for at least three minutes after adding 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.

6. Bond: All brick works shall be built in English bond. Unless otherwise indicated. Half brick walls shall be built in stretcher bond. Header bond shall be used for walls curve on plan for better alignment, header bond shall also be used in foundation, and stretchers may be used when the thickness of wall renders use of header impracticable. Where the thickness of footings is uniform or a number of courses, the top course of the footings shall be of headers. Brick courses at DPC level and at all slab levels below the bearings of slab shall be as bricks on edges.

7. Half or cut brick shall not be used except where it is necessary to complete the bond.

8. Overlap in stretcher bond is usually half brick and is obtained by commencing each alternate course with a half brick. The Overlap in header bond which is equally half the width of the brick is obtained by introducing a three quarter brick in each alternate course at quoins. In general, the cross joints in any course of brick work shall not be nearer than a quarter of brick length from those in the course below or above it.

9. Curing: The bricks shall be adequately wet before use and brickwork shall be constantly kept wet for at least seven days.

10. Half Brick Walls: The bricks shall be laid in stretcher bond in cement and sand mortar 1:4 (1cement:4coarse sand) or as indicated. The reinforcement shall be 2 Nos. MS round bars or as indicated. The diameter of bars shall be 6mm. The first layer of reinforcement shall be used at second course and then at every third course of brick work. The bars shall be properly anchored (min. 150mm) at their ends where the portions and or where these walls join with other walls / columns. The steel reinforcement shall be completely embedded in mortar. Overlap in reinforcement if any, shall not be less than 30cm. The cover i.e. the mortar interposed between the reinforcement bars and brick shall not be less than 6mm. The mortar covering in the direction of joints shall be not less than 15mm.

11. Brick work in foundation upto plinth: Brickwork in foundation shall be with brick of class designation 75 upto plinth levels in cement mortar 1:6(1 cement: 6 coarse sand).

12. Brick work in Super structure: Brickwork in superstructure including parapets etc. shall be bricks of class designation 75 /fly ash in cement mortar 1:6 (1 cement: 6 coarse sand).

13. Brick work in steps of staircase: Brick work in steps of staircase if shown in drawings shall be in bricks of class designation 75 and in cement mortar 1:4 (1 cement: 4coarse sand).

14. Parapets and Railings: Parapets and railing shall be provided to balconies, Terraces, roof tops and stair landing etc. of upper floors as per details shown on drawings.

15. 70mm Thick Brick Work: 70mm thick brick work shall be provided with bricks of class designation 75 in cement mortar 1:3 (1 Cement: 3 coarse sand) wherever shown in the drawings.

16. Crumple joints shall be provided all as per details shown on drawings.

17. All Brick masonry panel walls other than half brick wall shall be bonded with the adjoining RCC Columns with M.S Flat Iron ties of size 40x3mm and 55cm long at every fourth course starting from floor level.

SECTION - IV
PRESSED/COLD ROLLED FORMED STEEL

Pressed/Cold Rolled Formed steel frames for doors, windows& Ventilators including combined door cum window frames

1. Frames shall be conforming to IS-4351 and shall be manufactured from mild steel sheet of 1.25mm thickness conforming to IS 513-1973 (second revision). The overall size and types of doorframes (four/double/single rebated) shall be made in the following profiles as shown on drawings:

a)	105x60mm	- Single rebated
b)	120x60mm	- Double rebated
c)	120x60mm	- Mullion four rebate

2. Each doorframe shall consist of hinge jamb, lock jamb and head mullions where shown on drawings. The whole shall be welded. Two base tie of MS angle 25x25x3 mm shall be welded to the feet of frame in order to form a rigid unit. The tie shall not be removed after fixing the frame in position. This shall get embedded in the floor concrete. There shall be three MS holdfasts 30cm long out of MS Flat 40x3 mm with one end split into fish tail for each jamb. One end of the hold fast shall be bent and welded to frame and the other end (split fish end) shall be embedded in wall in cement concrete block 1:3:6 mix of size 230x230x150 .MS flat 35mm x 6mm shall be welded on inner face of the frame at the position of the lock plate. Four number 100mm long heavy duty MS Butt hinges shall be provided for each door shutter leaf & three numbers MS ball type hinges for each window shutters. These shall be welded to the pressed steel frame. For fixing the hinges a slit shall be cut at the corner edge of the rebate and the hinge shall be welded to the back side of the jamb of the frame as per sample. Necessary provision/slots shall be made for fixing locks, tower bolts, sliding bolts, peg stay etc. The work shall conform to the sample available for inspection. Suitable sizes of flat 6mm in thickness and mortar guards are to be welded at the rear of frame where slots, holes etc. are to be provided.

3. Vertical members of door frames shall be 40mm more than the specified height and shall be embedded in floor at all floor levels. All members of the frame shall be sand papered to remove all scale and rust. A coat of red oxide zinc chromate primer shall be applied as primer coat all round as per manufacture's specifications. Thereafter, the frame shall be filled with cement concrete 1:3:6(1 cement: 3 coarse sand:6 stone aggregate 12mm down gauge). The concrete shall be compacted very carefully to ensure that no area is left loose, and cured for at least 5 days. The cement concrete shall not have a slump more than 1 cm.

4. In case of doors cum window the size of profile of the complete frame shall be as para 1 above other details for door portion shall be as per para 2&3 above and for window portion other detail shall be as per para 7 below.

5. Each window frame shall consist of jambs (sides), heads (tops) sill (bottom) and mullions (central members etc.) The whole shall be welded as described in para 2 and 3 above.

6. There shall be two MS hold fasts 20cm long out of MS flat 40mmx3mm with one end split into fish tail to each jamb upto1650mm length and three holdfasts for jamb above 1650mm in length. One end of the hold fast shall be bent and welded to the frame and other embedded in wall in cement concrete block 1:3:6 of size 230 x230x 150mm. Before erection, the frame shall be sand papered and provided a coat of primer and filled with concrete (1:3:6) as in the case of door frames. 100mm long MS flats 35mm x 6mm shall be welded on inner face of the frame at the position of the hinges. Two number 75mm long heavy duty Butt hinges shall be provided to each leaf of window shutter at a distance of 150mm from top and

bottom welded to the pressed steel frame. Necessary provision/slots shall be made for fixing tower bolts, etc.

7. Frames shall be fixed in position true to line and levels. Necessary opening shall be left in the walls to receive frames. During construction of masonry lay dry bricks in mud mortar in position that they can be removed subsequently for providing cast in situ concrete blocks for holdfasts.

8. Whenever frames are required to be fixed adjacent to RCC columns the frame shall be fixed with MS size of straps and Anchor (dash) fastener in lieu of holdfasts. The strap shall be concealed in plaster after covering with chicken wire mesh 150mm wide.

9. Overall dimensions of the doors/windows and ventilator frames shown in the drawing shall be maintained.

10. The contractor shall submit the fabrication (shop) drawings from the manufacturers for the approval of Project Engineer/ Architect before starting the fabrication. On getting approval of the shop drawing the contractor shall produce the sample piece of each profile with required fittings for final approval of Project Engineer and Architect before mass production by the manufacturer.

GLAZING FOR WINDOW & DOOR FAN LIGHT

11. All window and Door fan light where fixed glass is to be provided to the pressed steel frames, M.S. beading 12x12mm (made out of 1.25mm thick. M.S. sheet) shall be provided with the pressed steel frames. The beading shall be fixed to the frames with machine screws (steel). Thickness and quality of glass shall be 4mm thick

SECTION V- JOINERY

1. General : The type of shutters for doors, windows, ventilators etc. viz. paneled glazed wire gauzed and flush shall be as indicated and detailed in the drawing.

2. Flush Door shutters: Door shutters shall be 35 mm thick flush door shutters/solid core type non decorative factory made confirming to IS- 2202 and ISI marked with block board core (confirming to the requirements as per IS-1659 1969)with external Hollock wood lippings and both faces commercial ply veneered. Adhesive used shall be phenyl formaldehyde synthetic resin conforming to BWP types specified in IS-848-1974.

3. Contractor shall obtain the approval for the name of the manufacturer of the flush door shutters from the Project Engineer/Architect before placing the supply order. While asking for the approval, copy of the "Bureau of Indian Standard" letter under which manufacturer has been authorized to mark the product with ISI marking should be attached. Project Engineer and Architect before giving the approval shall ensure that the validity date of license has not expired.

4. Testing of Flush Door Shutters: On receipt of the shutters at site the Project Engineer or the Architect shall be entitled to get the samples of door shutters tested in any approved laboratory. From each lot of approximately 500 shutters, one shutter shall be selected at random by the Project Engineer/Architect. The cost of replacement of the door shutters selected as samples, their transportation to the laboratory and cost of testing by the laboratory shall be borne by the contractor.

5. Wire gauge shutters: Provisioning and fixing of factory fabricated 35mm thick wire gauge shutters to all open able windows is in the scope of work of this contract. Wire cloth shall be securely housed in rebates by giving a right angled bend and fixing by means of suitable staples at intervals of 75mm. Over this wooden machined bead of specified size shall be fixed with nails, or screws, where indicated to cover the rebate fully. The space between the beading and the rebate shall be filled with putty to give it a neat finish. Exposed edges of the beads shall be rounded. Wire cloth for wire gauge shutters made of wood/steel window shall be of galvanized mild steel of average width of aperture 1.4mm with wire of dia 0.63mm

6. Door and factory fabricated windows glazed and wire ganged shutters shall be provided as per details shown on the drawings.

7. The bottom of door shutters shall be 5mm above the finished floor level.

8. The glass panes shall be free from flaws, specks or bubbles and shall have square corners and straight edges. The glass panes shall be so cut that it fits slightly loose in the frames. The glass pane shall be fixed to the shutter with first glass hardwood beading of size as indicated properly screwed to the shutter with steel nails and necessary adhesive as per details as shown on drawings.

9. Glazing to windows/doors shutters shall be as follows of quality as approved by Project Engineer and Architect.

(a) Fan light of Doors shutters : 4 mm thick float glass/wt not less than 10kg/sq.m

(b) Windows (open able & fixed) except for toilets. : 4 mm thick float glass/wt not less than 10kg/sq.m

(c) Windows open able and fixed of toilets : 4 mm thick frosted glass/wt not less than 10kg/sq.m

NOTE:- On all toilet door shutters, aluminum sheet 18 gauge bent to U shape shall be provided at the bottom of the flush shutters. This sheet shall be upto 100cm height on the interface of the shutters and upto width of door on bottom of the shutters. This shall be fixed with 12mm steel Nails.

SECTION VI - BUILDERS HARDWARE

1. Mongery shall be provided to all doors, windows and ventilator shutters with necessary matching screws of suitable size.

2. Fittings and fixtures to all doors window and ventilators etc.shall be Aluminum anodized Matt finish ISI marked of approved make. These shall be ISI marked where manufacturer contractor shall obtain the approved of the name of the manufacturer and brand of fittings from page of Engineer/Architect before placing the supply order. While asking for the
Approved copy of bureau of Indian Standard letter under which the manufacturer has been issued the license and authorized to make the items of builder hardware with ISI marking should be attached and one sample of each fillings of the particular brand duly ISI marked shall be given by contractor.

3. Butt hinges for doors shall be ISI marked cold rolled mild steel heavy quality of size as specified with mild steel pin and shall be oxidized finish. These shall be welded to pressed steel frames as specified.

4. Aluminum Handles for door shutters shall be 125 mm D-Type ISI marked anodized anodic coating not less than grade AC 10 as per IS:1868 with necessary screws.

5. Link chain and sliding channel shall be sturdy of CP brass and shall be provided to main entrance door of all buildings as specified.

6. Aluminum sliding door bolt ISI marked anodized /anodic coating not less than grade AC 10 as per IS:1968 with nuts and screws of size 250x16mm.

7. One sample piece of each fitting shall be produced for approval of Project Engineer /Architect. The bulk supply order shall be placed by the contractor only after approval is accorded by Project Engineer/Architect. Aluminum Tower Bolts ISI marked anodized (anodic coating not less than grade AC 10 as per IS: 1868) with necessary
Screws and of size 200x10mm.

8. Aluminum hanging floor door stopper ISI marked (anodized coating not less than grade 10 as per IS 1868 with Necessary screws).

9. Aluminium casement stays ISI marked anodized/anodic coating not less than grade AC-10 as per IS: 1868) with necessary screws for windows shutters

10. Curtains rods /Venetian blinds:

i. Steel Head Channel:-Steel Head Channel shall be roll formed 25 mm high × 27 mm wide “U” shaped 0.50 mm, galvanized steel strip with inside edges flanged. It shall be pretreated and powder coated of colour as approved by GE. The Head channel shall be provided with snap in plastic end caps. The head channel shall house drum, cradle assembly, tilter and cord lock.

ii. Slats: Slats shall be made of virgin Aluminum/ Magnesium alloy of width 25 mm. The painted slats shall have Thickness of 0.19 mm. Slats shall be roll formed with an elliptical crown to ensure overlapping for perfect light control. The alloy is meant to give high strength and minimum elongation.

iii. Tilter: Tilter shall consist of an enclosed gear mechanism operated with a wand for opening and closing of Slats. Synthetic worm and gear shall be housed in clear plastic casing.

iv. Drum & Cradle: Drum and cradle shall be made of molded high strength plastic. The drum shall have two Holes to anchor barbs of both ladder ends. The drum and cradle assembly shall provide bearing support for tilt rod to avoid weight of the blinds being transferred to the tilter to prevent additional resistance. v. Tilt Rod: Tilt Rod shall be ‘D’ shaped galvanized steel Rod with an average cross section of 4 mm to achieve minimal tensional deflection.

vi. Wand: Wand shall be transparent Acrylic wand with hexagonal cross section of 8 mm across flat edges. It Shall be attached with tilter with help of hook. It shall hang vertically by its own weight and will swivel easily from any convenient position.

vii. Lift Cord: Lift Cord shall be made of braided high strength polyester cord of diameter 1.50 mm. It shall be Flexible, having minimum elongation, stretch and maximum abrasion resistance.

viii. Ladder: Ladder shall be made of braided polyester yarn. It shall have two thicknesses 0.70 mm. The bottom Channel shall be pretreated and powder coated in colours as approved be GE and shall have plastic end caps. The curvature of the bottom rail shall match the curvature of the slat.

ix. Installation Bracket: Installation Bracket shall be made of steel sheet of thickness 1.2 mm and shall be designed
to facilitate quick installation and removal of blinds.

Schedule of Builder's Hardware

11. Schedule of Hardware/fittings to door, window and ventilator shutters shall be as per drawing.
NOTE:

(A) - It shall insure that all builder’s hardware are from one manufacturers only for the entire work, However, if due to any reason contractor progress to provide part quantity from other manufacturer, then he may be permitted but he will have to obtain specific approval of project Engineer/Architect for this change in brand. This will be subject to that all items and fixtures in any particular blocks shall be always of one manufacturer only. In no circumstances items of two manufacturers shall be used in all of the particular blocks.

(B) - Project Engineer before giving the approval of the name of the manufacturer and brand shall ensure that the validity date of license for making the fittings as ISI marked has not expired, wherever applicable.

SECTION VII

STEEL AND IRON WORK

INCLUDING STEEL DOOR & ROLLING SHUTTERS

(OTHER THAN PRESSED/COLD ROLLED FORMED STEEL DOORS AND WINDOWS FRAMES)

1. Steel and ironwork shall be executed as indicated in drawing and as per standard practice. 2. Quality of steel shall conform to the following specifications:

(a)	Mild steel (Misc.)	IS 432-1966 Part I
(b)	MS reinforcement bars	IS 432 Part II 1962
(c)	Structural steel works	IS 226-1962
(d)	TMT Steel Bars	IS-1786/1979

3. Reinforcement:

(a)	Reinforcement bars 6mm dia shall be MS bars.	
(b)		All reinforcement bars 8mm and above shall be Thermo-mechanically treated bars.
(c)		Laps and crossing shall be tied with mild steel binding wire of size not less than 0.9mm dia.
(d)		The contractor shall be responsible for accurate fixing and placing of reinforcement shown in drawing and shall not place the concrete until the reinforcement has been checked, passed and recorded by the Architect and Project Engineer.
(e)	Reinforcement shall be bent and fixed as per IS-2502-1963.	
(f)		Laps in reinforcement for columns, beams and slabs etc. will be as stipulated in IS.

4. Holdfasts: Holdfasts shall be made out of MS flats of size as specified with split fish tail ends coated with anti trust paint/tar. Holdfast shall be welded to door/windows frame as specified.

5. Steel Door frame and shutters: Size of door and locations shown on drawing and shall comprising of frame and shutter fabricated and welded out of MS angle, plate & sheet and 10mm square tie bar. The door shall be painted with two or more coats of synthetic enamel paint of approved quality & shade over one coat of steel primer. Each MS gate shall have hold fast - 6 Nos, Butt hinges 125mm - 3 Nos, MS handles 100mm - 2 Nos and MS sliding bolts 300 x 16 mm - 2 Nos (1 inside and 1 outside). Hold fasts shall be embedded in PCC block (1:3:6) of size 23 x 23 x 15cm.

6.Steel Window/Ventilators:

§ Glazed/Gauged shall be ISI marked of standard rolled steel sections shall conform to IS-1038 and shall be of Factory made.

§ Wire Gauge shutters will be galvanized M.S wire gauge of average width of aperture 1.4mm wire of dia 0.63mm.Wire gauge shall be fixed with M.S Bead 12x12mm (made out of 1.25mm thick M.S sheet) with steel screws.

7. Grills: MS grills factory manufactured out of flat iron, MS square bars etc. and of pattern as shown on drawing shall be provided to all windows open able/fixed and fanlight of doors. All Grills shall be factory fabricated and screwed to the pressed steel frames in the factory where the pressed steel frames are manufactured and shall be brought to site screwed.

8. Railing to staircases, landings, passages, balconies & parapets:

(a) Railing to staircase, landing etc. shall be fabricated with M.S Flats and square MS bars etc. with vertical Supports & top handrail made of ERW Tube 40mm nominal dia (medium grade) welded at joints fixed into floor/steps as shown in drawing.

(b)

Top handrail made of M.S. pipe drawing. Verandah/Balcony Railing shall be fabricated with MS flat, M.S. tubes MS bars with vertical supports &

(Medium grade) welded at joints fixed into floor/steps as shown in

(c) The fixing details and dimensions for 7 (a), 7(b) above shall be as shown in drawings. All welded joints Shall be grounded properly before painting. The finished railing shall be true to plumb, line and levels as called for. The mild steel balusters and other exposed mild steel members shall be painted with approved shade and brand synthetic enamel paint.

9. Exhaust Fan opening: In kitchen, toilets, WC, bath etc. Provision for fixing of exhaust fan shall be made by Fixing 19mm thick BWP grade commercial board with a circular whole 300mm dia in window as shown on drawings. This opening shall be covered by bird guard fabricated out of galvanized iron sheet 18 gauges as shown on drawing.

10. Welding: This shall be done by electric process with precautions for health and safety. The places to be welded

be cut angularity so that the welding material does not protrude and the members to be welded join properly. The welds shall be ground clean to give a one piece appearance. The welds shall run around the contact surfaces of two meeting sections. Throat thickness not less than 4mm.

11. Anodized Aluminum doors/windows/ventilators/Fixed Glazing etc.

Providing and fixing anodized aluminum work for doors, windows, ventilators and partitions with extruded built up standard tubular and other sections of approved make conforming to IS: 733 and IS : 1285, anodized transparent or dyed to required shade according to IS : 1868. (Minimum anodic coating of grade AC 15), fixed with raw plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions, at top, bottom and sides with required PVC/neoprene felt etc. Aluminum sections shall be smooth, rust free, straight, mitered and jointed mechanically wherever required including cleat angle, Aluminum snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing and paneling to be paid for separately.) Glazing for Aluminum Door /windows/ventilators will be 5.5mm thick float glass wt not less than 13.75kg/sq.m

SECTION VIII
ROOF COVERING, WATER PROOFING & RAIN WATER PIPES

1. Exposed roof at terrace floor level: Roof slabs shall be cleaned thoroughly and following treatment/covering shall be provided:

(a) Clean the RCC slab surfaces using wire brush to remove all loose material if any. Chisel out any mortar Sticking to the surface and then rendering rough/ uneven surface with cement mortar 1:4 (1 cement:4 coarse sand).It is recommended that during slab casting concrete RMW, should be used to reduce permeability of concrete.
(b)

Concrete. (c)
pores. Extensive cleaning of RCC surface using wire brush to remove all the loose material if any. It is recommended that during slab casting Faircrete RMW, should be used to reduce permeability of the

Concrete of Water guard A, two par pre packed polymer modified cementations water proof coating, excellent waterproofing, forms a monolithic bond with the surface by penetrating in to the microscopic

(d) Providing sloping plaster in two layers using aggregates in 1st layer to form slope and then finishing plaster
Admixed with Faircrete RMW, integral waterproofing compound in dosage of 150ml per 50 kg cement. (e) Providing two coats of Waterguard I, high performance insulation cum waterproof coating. Pre packed
Two component of 10kg powder + 5 ltr liquid specially designed polymer, processed cement with fillers. It ensures perfect water tightness with insulating properties to cool down the inner temperature by 5-8 Celsius. Available in attractive white colour.

2. Goal: Providing Gola 75x75 in cement concrete 1:2:4 (1 cement: 2 coarse sand:4 stone aggregate 10mm and down gauge) at the junction of RCC slab and wall and junction of tiles and parapet/wall including finishing exposed surfaces
With cement mortar 1:4 (1 cement: 4 fine sand) as per drawing. Goal shall be done before the plaster of parapet.

3. Khurras: Making khurras 450 x 450mm with average minimum thickness of 50mm cement concrete 1:2:4 (1 cement:2 coarse sand:4 stone aggregate 10mm nominal size)finished with 12mm cement plaster 1:3 (1 cement : 3coarse sand) mixed with water proofing compound) and coat of neat cement including rounding of edges and making and finishing the outlets complete as per standard design.

4. Chajjas: Slab shall be cleaned thoroughly and following treatment/covering shall be provided:
a) Apply treatment as per para 1.(a) above.

b) Finishing with 12mm plaster in cement mortar 1:4(1 cement: 4 coarse sand) mixed with water proofing Compounds per manufacturer's specifications OR @ 5% of amount by weight. This shall be applied after treatment as 7 (a) above

5. Sunken/Lowered slabs: Water proofing treatment shall be provided to all sunken/lowered portion of slabs. This shall consist of the following:

§ Extensive cleaning of the surface and removal of any loose substrates if any with wire brush. § Providing & Applying coating of Waterguard A, two part pre packed brush applied polymer modified cementitious waterproof coating. It forms a monolithic bond with the surface hence providing excellent waterproofing.

§ Providing and Applying screening with Water guard WM(F), single pack fiber reinforced trowel applied cementitious waterproof screed which resists hydrostatic pressure with a thickness of 10mm approx.
§ Sloping plaster admixed with Faircrete RMW, integral waterproof compound cum plasticizer which reduces Permeability throughout the depth of concrete & mortar towards sprout.

NOTE: All CI/GI pipes and fittings passing through the wall of the sunken portion shall be laid/fixed before the treatment as specified in Para 8 above is carried out.

6. Water proofing treatment to raft/floor, walls and roofs of overhead water storage tanks & pump room etc. shall be as per
Drawing & BOQ.

8. Rain Water pipes:

a) The rain water pipes and fittings shall be provided sand cast iron. All pipes and fittings shall conform to IS 1729 - 1979 and ISI marked. These shall have uniform wall thickness for the entire length, free from surface and other defects. The pipes shall be coated externally and internally with coating material Tar or any other suitable materials. The coating material should set quickly with good adherence and should not scale off.

b) Cast iron rain water pipes and accessories shall be provided as shown on the drawings. The joints in cast iron rain water pipes shall be with cement mortar 1:3. The CI pipe will start from 150mm above plinth protection with bend and a tee junction shall be provided at all terraces levels to collect water from khurras and vertical pipe shall be extended upto 150mm above top of parapet wall. At top cast iron COWL shall also be provided.

c) Cast iron chamber and grating at the top and outlet of every rain water pipe shall be provided and shall fit In snugly on the socket end of the pipe. The perforations in the gratings shall be atleast 60% of the total area of gratings.

d) e) f) round.

At all joints. Provide angled end pieces CI shoes. Where the rain water pipes are to be provided concealed within masonry the pipes shall be embedded in the walls with PCC 1:3:6 (1 Cement:3 coarse sand:6 stone aggregate 20 mm down gauge) encasing all Rain water pipes running down along the walls/columns shall be firmly fixed with MS holder bat clamps

SECTION - IX

FLOOR FINISHING, SKIRTING & DADO

1. General :

a) This section shall cover all flooring and wall tiling work as shown in the drawing. No work under this section shall be started until specifically allowed by the Architect/Project Engineer and until all other major works such as plastering, embedding of conduits and pipes, channels, windows fixing etc. have been completed. Samples of adequate size representing the nature of variation including quality, size, and texture after polishing of the tiles to be used in the flooring work fully shall be prepared for all work and got approved by the Architect/Project Engineer before proceeding. The approved samples shall be retained up to the end.

b) Floor shall be laid to level and or to slope as shown on drawings and as required and directed by Project Engineer /Architect. Floor shall be carried through all the doors and other openings and over dwarf walls. Exposed edge of floors shall be finished in the same manner as for top surfaces. Skirting shall match with the floor finish.

2. Sub Flooring :

For Ground floor Area: Sub floors (base concrete under floor finish)100mm thick lean concrete in 1:4:8 (1cement:4 coarse sand & 4 stone aggregate 40mm nominal size) for all locations except sunken portion.

For Upper Floors:

a. Sunken/lower portion of slabs: Sub base shall be in lean concrete in 1:5:10 (1 cement :5 coarse sand and 10 brick ballast 40mm nominal size).

b. Other floors: Where ever required/directed lean concrete 1:5:10 (1 cement: 5coarse sand: 10 stone aggregate 40mm nominal size) of required thickness laid over RCC slab.

c. Floors under cupboards/book shelves/kitchen counters etc.in 1:5:10 lean concrete (1 cement: 5 coarse sand & 10 stone aggregate 40mm nominal size).

3. Plain cement concrete flooring (IPS Floors): Cement concrete 1:2:4 (1 cement: 2 coarse sand:4 graded stone aggregate flooring of specified thickness. The top surface shall be finished with floating coat of neat cement using steel float while the concrete is green or broom finished as specified.

4. **"Hardcrete " cement concrete flooring**": - 62 mm thick cement concrete flooring with "Hardcrete" concrete hardener topping under layer 50 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20mm nominal size) and top layer 12mm thick Hardcrete cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 stone aggregate 6mm nominal size) by volume with which Hardcrete hardening compound of Snowcem India Ltd. or equivalent is mixed @ 2 litre Hardcrete per 50kg of cement including cement slurry, but excluding the cost of nosing of steps etc. complete.

5. Skirting: To match PCC floors 18mm thick plaster in cement mortar of mix 1:3 (1 cement: 3 coarse sand) finished with a floating of neat cement shall be applied to skirting. The skirting shall be 100 high and it shall be flush with the plastered surfaces of walls and columns and separated with a horizontal groove of 10mmx10mm

6. Terrazzo Cast in situ flooring:

(a) Terrazzo cast in situ shall consist of 9mm thick (top layer) over 31mm (Avg.) thick PCC (under layer) with 4mm thick 38mm wide PVC strips and shall be provided conforming to the specifications given hereafter.

(b) 2mm thick and 40mm wide Aluminium dividing strips shall be placed in position to form bays. Generally these shall be at 750mm centers for internal floors. Extra strips shall be provided on both sides of door sills. The strips shall be kept in position with cement concrete fillets 1 cement: 1 coarse sand: 2 stone aggregate 6mm gauge and as few fillets as possible shall be used. The top of the strips shall be so kept that it will flush with floor finish it should neither project above the floor finish nor be depressed.

(c) Base concrete shall be cleaned, moistened and brushed with cement slurry at 2.5kg/sq.mts A layer of 31 mm thick PCC 1:2:4 (1cement: 2 coarse sand: 4 stone aggregate 12.5mm nominal size) as specified shall then be laid between the strips. This layer shall be thoroughly worked and leveled with screening board to leave slightly rough surface.

(d) Terrazzo cast in situ topping 9mm thick shall be of following description and mix proportions. This topping layer shall be laid between 24-28 hours after laying the under layers:-

i. A mixture of 50% ordinary grey cement and 50% white cement with approved white marble dust/powder mixed in proportion of 3 parts of cement and 1 part of marble dust/powder by volume.

ii. Marble Chips: Size of marble chips shall be 4mm to 7mm and of size 1 B for skirting and dados.

iii. Proportion of chips shall be as per approval of Project Engineer and Architect. For finalizing proportion, a sample of 18" x 18" floor pattern with different suggested proportions will be first done by the contractor & the final floor will be laid after proportion approved by Architect & Project Engineer.

iv. Mix one part by volume of mixture vides (d) (i) above with 1.25 parts by volume of (d) III above.

(a) The terrazzo mixture shall be thoroughly mixed dry. First apply cement slurry to under layer, make the terrazzo mix wet to make a stiff mixture and lay in position over PCC under layer (in bays between the Aluminium strips). The terrazzo layer shall be tamped to bring maximum amount of marble chips to the surface. After allowing for air curing for 24 hours the surface shall be cured well for 3 to 4 days. The surface of terrazzo shall then be cut with machine at least four times with different course and fine graded carborundum stone as per details given below:-

(i) The first grinding should be done with No.60 grit stone after 3-4 days. During grinding, keep the floor wet all the time.

(ii) Clean the floor with water. The floor should then be grouted with neat cement to fill up all holes and imperfections.

(iii) Air dries the grouted floor for day and then cure for 3-4 days for hardening.

(iv) The second grinding should be done after 7 days of lying with grit No.80 and repeat grouting as above.

(v) Third grinding is done after 14-15 days of lying with carborandum stone of grit blocks No.120.

(vi) The final grinding and polishing should be done with carborandum stone of grit block No.320

After final grinding is over, scrub the floor thoroughly with soft soap solution made in water to clean the floor, when the surface is adequately dry slightly moisture with oxalic acid powder at the rate of 5 gm per square metre of floor surface and finally polished with wax polish of approved brand (mansion) to the entire satisfaction of Architect/Project Engineer.

(vii) After the floor is polished fully saw dust shall be spread over the floor for protection after which no moisture will be allowed to avoid stains on the floor.

(f) The mixing shall be done in tubs and the whole operation shall be carried out in absolutely clean conditions so that there is no staining due to dirt and other materials.

(g) The terrazzo flooring of treads of steps and landings of staircase where shown on drawing shall be projected 10mm in front and sides to form nosing and shall be finished as directed by Project Engineer and Architect.

7. Terrazzo cast in situ in skirting, risers to treads and landings of staircases and where indicated:

a. 6mm thick terrazzo in skirting matching the terrazzo flooring shall be provided of the same composition as specified above as in the case of terrazzo floors except that the size of chips shall be 3mm to 4mm and base shall be 12-15mm thick with cement mortar 1:3 (1 cement: 3 coarse sand). The colour and mix of marble chips to match main floor. Aluminium strips shall be provided in line with strips in the floor in vertical direction only. The skirting shall be 150mm high. The height of riser shall be as shown on drawings.

b. The terrazzo mix shall be applied firmly and finished to the required thickness.

c. Cutting and polishing shall be done by hand machine till a smooth polished surface is obtained. After final grinding is over scrubbing, polishing and finishing to be done as per para 5 (e) (vii) above.

NOTE: Before starting the terrazzo work, the contractor shall submit the terrazzo finish samples for Project Engineer/Architect's approval.

8. Glazed Ceramic Tile Flooring : Ceramic Tiles 7mm thick of size shown on drawings or of size 300x300x7mm thick where not shown on drawings of 1st Quality conforming to IS-13755 of Nitco, Orient, Kajaria or equivalent make of colours as approved by Architect/Project Engineer laid over 20mm thick cement mortar 1:4 (1cement:4 coarse sand) including pointing the joints with white cement and matching pigment etc. complete.

Glazed Ceramic Tiles Dado:

(a) The tiles shall be of first quality and shall generally conform to IS: 13755 of Nitco, Orient, Kajaria or equivalent make of colours as approved by Architect/Project Engineer.These shall be flat, and ture to shape and free from cracks, crazing, spots, chipped edges and corners. The glazing shall be of uniform shade and shall be provided in Dado of kitchen and toilets. The tiles shall be set over screed/ plaster 12 mm thick with cement mortar 1:3 (1 cement :3 coarse sand) to all surface, set and jointed with neat white cement slurry. The joints shall be neat and fine. Tiles face shall be kept flush with the skirting below.

(b) Size of glazed tiles both for toilets, Baths, WC and kitchen shall be as shown on drawings.

(c) The colour of the tiles shall be of pattern as approved by Architect & Project Engineer.

(d) Height of glazed tiles dado above skirting in toilets and in kitchen, above kitchen platform shall be as shown on the drawings.

9.Finish of Lining in front of lifts : 20mm thick white marble Raj Nagar plain or as approved by the Architect/Project Engineer shall be laid over 20mm thick cement mortar 1:3(1cement:3 coarse sand) including pointing with white cement. Gun metal cramps 25x6mm, 30cms long as per design shall be fixed in CM 1:2(1cement: 2 coarse sand) including making necessary changes.

10. Finish of working plate forms in kitchens: Finish of the working platform in kitchen/laboratories etc shall be with 20mm thick marble (Udaipur Green) stone slabs machine cut and mirror polished laid over RCC slab with 20mm cement mortar 1:4 (1cement:4 coarse sand). Marble slabs shall not be in more than two pieces for each side straight length of working plate form or as decided by Architect/Project Engineer. Marble shall be jointed with white cement slurry mixed with pigment including grinding smooth and granite polishing complete.

11. **Polished Kota stone flooring**: The Kota stone slabs shall be machine cut and machine polished and of selected quality, hard, sound, dense and homogeneous texture, free from cracks decay watering and flaws. They shall be machine cut to the requisite thickness. The edges shall truly vertical. The colour of the slabs will be approved by the Architect/Project Engineer, before starting of work. The slabs shall have the top (exposed) face polished before being brought to site. The slabs shall conform to the size conform to the size required. The thickness of the slabs shall be 25mm.

(i) **Dressing: Every** slab shall be cut to the required size and shape and fine chisel dressed in the edges to the full depth. The edges shall be table rubbed with coarse sand or machine rubbed before paving. All angles and edges shall be true and square and the surface shall be true and plane.

(ii) **Preparation of surface and laying**: The sub grade concrete or RCC slab on which the kota stone slabs are to be laid shall be cleaned, wetted and mopped. The bedding shall be with cement mortar of an average thickness of 20mm and mix 1:4(1 cement: 4 coarse sand), over this bedding, neat grey cement slurry of honey lie consistency shall be spread. The edges shall be pasted with cement slurry @ 4.4 kgs of cement per sqm mixed with pigment to match the shade of the slabs. The joints shall be kept as thin as possible.

(iii) **Polishing and finishing**: The floor shall then be kept wet for a minimum period of seven days. The surface thereafter shall be grounded with machine fitted with grit block No.60, then No.120 and finally with No.320. Between every two successive grindings the surface shall be washed, cleaned and covered with a thin coat of grey cement in order to fill any pin hole that appear. After the final polish oxalic acid shall be dusted over the surface at the rate of 33 gm per square metre sprinkled with water and rubbed hard with mamdah block (pad 7% woolen rags) the following day the floor shall be wiped with a moist rag and dried with a soft cloth and finished clean.

12. Polished Kota Stone in Risers of Steps, Skirting and Dado: The Kota stone slabs for skirting shall be as specified in clause 10 above and of thickness 25mm. The height of skirting shall be 150mm and for risers to steps it shall be up to full height. The height of dados shall be as shown on drawings.

(i) **Preparation of surface and laying**: The surface shall be chipped off the projections/productions if any cleaned and wetted 12mm thick plaster of cement mortar 1:3 (1cement:3coarse sand) shall be applied and allowed to harden. The plaster shall be roughened with wire brushes or by scratching diagonal lines 2mm deep at approximately 7.5 cms centre both ways. The back and edges of the stone slabs shall be buttered with a coat of grey cement slurry and set in the bedding mortar.

(ii) **Cutting, Polishing and finishing**: Cutting, grinding and polishing of skirting shall be done in the same manner as of flooring but by hand.

Marble flooring: 20mm thick marble (Rajnagar Pune White marble) having black streds stone slabs laid over sub floor with 20mm thick base cement mortar 1:3 (1 cement : 3 coarse sand) Marble shall be jointed with white cement slurry including grinding smooth & granite polishing complete.

Marble Skirting: The marble stone slabs for skirting shall be as specified and of thickness 20mm. The height shall be laid over 12mm thick cement mortar plaster 1:3 (1cement:3 coarse sand), jointed with white cement slurry mixed with pigment including grinding smooth and granite polishing.

13. **PRECAST TERRAZO TILE FLOOR -** Where shown /indicated in drawings/schedule of finishes shall be laid as under:
It shall be 22mm thick with graded marble chips of size upto 12mm of ordinary cement without any pigment jointed with cement slurry mixed with pigment to match the shade of tile including rubbing and polishing complete laid on 20mm thick be of CM 1:4 (1cement: 4 coarse sand).

14. PRECAST TERRAZO TILE SKIRTING: It shall be 22mm thick with graded marble chips of sizes upto 12mm laid over 12mm thick CM 1:3 (1cement: 3 coarse sand) 150mm high jointed with neat cement slurry mixed with pigment to match the shade of tile including rubbing and polishing.

15. RED SAND STONE FLOORING: Wherever sand stone flooring has been shown in drawings and schedule of finishes it shall be as under:

40mm thick rubbed sand stone flooring over 20mm thick average base with joints 3mm thick, side buttered with Cm1:2(1cement:2coarse sand) admixed with pigment to match the shade of the stone pointed with same mortar with base with cement mortar 1;5(1cement:5 coarse sand).

16. **NON - SKID CERAMIC TILES:** Where indicated in Schedule of finishes shall be laid as under:

(i) It shall be 6 mm to 8 mm thick of size 300x300mm, conforming to IS 13755 hydraulically pressed, high temperature fires (around 1200^{o}C) in single operation having breaking strength 350 to 400 Kg per Sqm. & weighing 17 Kg per Sq.M of approved make and shall be laid & jointed in white cement paste pigmented to tile shade over 20 mm thick cement & sand screed (1:4) over sub base.

(ii) **NON-SKID CERAMIC TILES SKIRTING:** where shown/indicated in the drawing / schedule of finishes shall be provided 100mm height over 10mm thick cement mortar (1:3 (1Cement: 3 coarse sand) and Jointed with white cement paste pigmented to the tile shade.

17. **VITRIFIED TILE FLOOR :** Vitrified Tile Flooring (mirror polish) of size of 600x600 and 10mm thick of make granitite and carbonate of shade and pattern as directed by the Architect/Project Engineer shall be laid over 20mm thick screed in CM 1:4 (1cement: 4 coarse sand) over sub base / subfloor. The tiles shall be jointed with neat cement slurry and pointed with white cement, with pigment to match the colour /shade of tile.

18. VITRIFIED TILE SKIRTING/DADO: Vitrified tile 10mm thick of size as shown on drawings or as approved by Architect/Project Engineer shall be laid over 10mm thick screed in Cm 1:4 (1cement: 4 coarse sand).The tiles shall be jointed with neat cement slurry and pointed with white cement with pigment to match the colour /shade of tile.

19. CHEQUERED TERRAZO TILE FLOORING

a) Tiles shall generally conform to IS:1237 the tile shall be supplied with initial grinding and grouting of wearing layer. The size of tile shall be 250 x 250 x 22mm thick or as shown in the

drawings or as required by the Architect/Project Engineer. The tile shall be manufactured in a factory under presser process subjected to hydraulic pressure of not less than 140 kg per square cm. The finished thickness of the upper layer shall not be less than 6mm for size of marble chips varying from the smallest upto 20mm.

b) **PRECAST CEMENT CONCRETE TILES**:- The cement concrete tiles shall be of nominal size of 30x30 Cum with equal sides. The overall thickness of tiles shall not be less then 22mm. The tiles shall confirm to the method of manufacture, the mix of backing and wearing layers.

Where full tile cannot be fixed, tile shall be cut (Sawn) from full time to the required size and their edges rubbed smooth to ensure straight and true joint to be approved by the Project Engineer/Architect before installing at site.

c) **LAYING:** Base concrete or RCC slab on which the tiles are to be laid shall be cleaned wetted and mopped. The bedding for the tiles shall be 20mm thick cement mortar 1:4 (1cement: 4 coarse sand). Over the bedding neat grey cement slurry shall be spread @ 4.4 Kg of cement per square meter.

d) **CURING, POLISHING & FINISHING**

i) The day after the tiles are laid all joints shall be cleaned of the grey cement grout with a wire brush or trowel to a depth of 5mm and all dust and loose mortar removed and cleaned. Joints shall than be grouted with grey or white cement mix with or without pigment to match the shape of the topping of the wearing layer of the tiles. The same cement slurry shall be applied to the entire surface of the tiles.

ii) The grinding, curing, polishing & finishing shall be done as specified above for terrazzo floorin

SECTION X - WALL FINISHES

1. General :

Scope: This section shall cover internal and external plastering/rendering works as shown in the drawings.

Mortar: The mortar of specified mix shall be used.

Scaffolding: Double Stage steel scaffolding shall be provided for plastering work as per standard practice and as directed by Architect/Project Engineer. This shall be independent of the walls.

Preparation of Surfaces: Joints of brickwork wall shall be raked-out properly. Dust and loose mortar shall be brushed out. Efflorescence if any shall be removed by brushing and scraping, shuttering imperfections of all concrete shall be roughened by hacking with chisel and all resulting dust and loose particles cleansed and the surface shall be thoroughly hacked or bush hammered to the satisfaction of Architect/Project Engineer. The surface shall be thoroughly washed with water, cleaned and kept wet before plastering is commenced.

Approval of Architect/Project Engineer to be taken: No plastering work shall be started before all conduits, pipes fittings and fixtures clamps, hooks etc. are embedded, grouted and cured and all defects removed to the satisfaction of Architect/Project Engineer. Special approval shall be taken from Architect/Project Engineer before starting each plastering work. No cutting of finished plaster shall be allowed. No portion shall be left out initially to be patched up later on.

Mixing: The ingredients shall be mixed in specified proportions by volume. The mixing shall be done in a mechanical mixer. The cement and sand shall first be mixed thoroughly dry in the mixer. Water shall then be added gradually and wet mixing continued for at least a minute until mortar attains the consistency of a stiff paste and uniform colour. Mortar shall be used within 30 minutes of addition of water. Mortar which has partially set shall not be used and removed from the site immediately.

2. Internal Surfaces: Plastering shall be started after the completion of ceiling plaster from top and gradually worked down towards floor. It shall not, at any place be thinner than as specified. To ensure even thickness and a true surface plaster of about 15cm x 15 cm shall be first applied horizontally and vertically at not more than 2m interval over the entire surface to serve as gauges. The mortar shall then be applied to the wall/surface between the gauges and finished even. All corner junctions and rounding shall be truly vertical or horizontal and finished carefully. In suspending work at the end of the day plaster shall be cut clean to line, where recommencing the plastering, edge of old work shall be crapped, cleaned and wetted with cement putty before restarting plastering

Cement plastering internally on all internal surfaces including soffits of RCC slabs, chajjas, lintels, around shelves, inner side of parapets and around of parabolas etc. shall be as shown on drawing. Wherever not shown it shall be as under:-

(a) 15mm thick plaster in cement mortar 1:6 (1 cement:6 parts 75%: 2 fine sand & 25% coarse sand) over brick and concrete surfaces. Dubbing out wherever required (i.e. bringing up the undulation on the rough face of brick work in level with proudest points) shall also be executed in the same mix along with rendering coat.

(b) 6 thick plaster in cement mortar 1:3 (1 cement: 3 fine sand) on soffits of RCC slabs, chajjas, lintels and kitchen platforms and alround of shelves and para golas.

(c) 10mm x 6mm grooves shall be provided in ceiling plaster at junction of wall and ceiling/beam and junction of RCC Column & Wall.

(d) 15mm thick plaster in cement mortar 1:4 (1cement: 4 fine sand & coarse sand) to be done on the inside face of the cupboards.

(e) 15mm thick plaster in cement mortar 1:4 (1 Cement: 4coarse sand) to be done on the internal surfaces of parapet walls including dubbing wherever required.

(f) Before plastering it should be ensured that brick masonary joints are raked out (atleast on even surfaces) to a depth of 12mm and all concrete surfaces are rough enough for proper adhesion of plaster. If not they shall be made rough by hacking or bush hammering at intervals of 2". Efflorescence if any and dust/dirt shall be removed. The surfaces shall be wetted adequately before plastering.

(g) G.I. Chicken wire mesh of 24 guage and 20mm mesh shall be fixed all along RCC Surface adjoining brick work given 150mm lapping on either side of the junction in double fold or as called for using nails etc and cement slurry before plastering. Ensuring equal thickness of plaster on both sides of the mesh.

(h) Sand used in plaster shall be within the grading zones as stipulated in the IS and silt contents shall not exceed 4% by weight. Brick surface shall be raked out at the end of day brick work to afford key to plaster. Plaster surface shall be hard and even without patchy appearance. If they flake or show scratch marks if rubbed by a pointed nail the plaster shall be rejected, dislodged and redone.

3. Drip course: Drip course shall be provided to all projections as per details shown in drawings.

4. External Surfaces:

i. Pavit Tiles: Vitrified tiles 200x200x10mm thick PAVIT(EXOTIC) Series x1.26.1WP laid over 10mm thick CM 1:4 (1cement: 4 coarse sand). The tiles shall be jointed with neat white cement slurry and pointed with white cement slurry with pigment to match the colour/shade of the tiles. Note: Pavit Tiles shall be laid on external periphery of the walls from GL & up to window sill on all building.

ii. Italia Glass Mosaic Tiles : Italia Glass Mosaic Tiles –Random Mix (Excluding premium and texture series) on walls 16mm thick screed in cement mortar 1:4(1cement: 4 coarse sand).The tiles shall be jointed with neat cement slurry and pointed with white cement slurry with pigment to match the colour/shade of the tiles. Glass Mosaic tiles shall be laid from sill level to terrace parapet level on external periphery of the building

SECTION XI

WHITE WASH, DISTEMPER & PAINTING

1. White wash shall be provided to all ceiling and internal surfaces of lofts, Walls of store rooms & toilets blocks.

2. Oil Bound distemper of approved shade shall be provided to all internal surfaces of walls & ceiling except store room,
Toilet block, seminar, walk-in- incubator, meeting room, HOD, Conference room & Audio Visual Room & also as directed
by Architect/Project Engineer.

3. Plaster Emulsion Paint shall be provided to all Internal Surfaces of Walls and Ceiling in seminar, walk-in-incubator,
Meeting room, HOD, Conference & Audio Visual Room & also as directed by Architect/Project Engineer.

4. Before application of white wash and distemper the surfaces shall be prepared to a clean and even surface.

5. White wash (lime wash) shall be carried out in three coats.

6. White wash shall be prepared from lime slacked on site, mixed and stirred with sufficient water to make a thin cream. This shall be allowed to stand for 24 hours and shall be screened through clean cloth. Four kg.of gum dissolved in hot water shall be added to each to cubic meter of the cream(115gm/cft). Blue shall be added to give required whiteness. The approximate quantity of water to be added in making cream shall be five liters per kg.of lime.10% Zinc Oxide shall also be added to obtain a desired shining in the white wash.

7.Oil bound distemper shall be carried out in two or more coats over one coat of suitable cement primer as per manufacturer instructions to give even shade.

8. White wash and oil bound distemper and Plaster emulsion shall be applied in specified coats by using flat brushers or spray pumps. Each coat shall be allowed to dry before next coat is applied, if additional coats than what have been specified are necessary to obtain uniform and smooth finish it shall be given at no extra cost.

9. The finished dry surface shall not show any signs of cracking and peeling nor shall it come off readily on the hand when rubbed.

PAINTING

10.Cement Base Paint : Two or more coats of cement base paint shall be applied to give even shade on internal cement plaster surfaces of parapets, soffits of chajjas, lintels, beams, and sills as shown on drawings. The shade of the paint shall be used as approved by Project Engineer /Architect. Each coat shall be cured well by wetting surfaces for at least three days.

11. Painting to wooden surfaces: All wooden surfaces shall be prepared and given a primer coat of approved quality as approved by the Architect. The surface shall then be bodied in with liquid wood filler of approved make, allowed to dry and rubbed with sand paper after moistening the surface with water; the surface cleaned then two or more coats of synthetic Enamel paint applied to give an even shade of approved quality. Tint/shade of synthetic enamel paint shall be as approved by the Project Engineer/Architect.

12.Painting to Steel Surfaces: All steel surfaces shall be prepared, cleaned with sand paper to completely remove scales and rusts and shall be painted with two or more coats of synthetic enamel paint to give an even shade over one coat of steel primer. The shade of synthetic enamel paint shall be as approved by Project Engineer/Architect.

13. Painting to CI and GI Pipes: All exposed CI and GI pipes shall be painted by applying two or more coats of oil paint. The shade and quality shall be as approved by Project Engineer/Architect.

SPECIFICATIONS FOR NON-SCHEDULE ITEMS

1. Earth for Filling

   The earth used for filling shall be free from salts, organic or other deleterious matter. Highly expensive soils like black cotton soil shall not be used, unless so specified. All clods of earth exceeding 50mm shall be broken or removed. Earth obtained from borrows pits and surplus earth from excavation, if any, shall be directly used for filling and double handling avoided.

2. Sand for Filling

   Sand for filling shall be clean, free from dust, organic and other foreign matter. It shall not contain more than 5 percent of silt/clay. This shall be dry River Sand Watered and consolidated including dressing and leveling.

3. Synthetic Polyster Triangular fiber

   Wherever synthetic polyester triangular fiber has been specified in the B.O.Q for different items of work the same should be procured from M/s Reliance Industries Ltd.

4. Flush Pre laminated shutters for doors & cupboards:

   Flush Prelaminated shutters for doors & cupboards shutters shall be solid core types with block board core as indicated in Bill of Quantity and shall conform to IS-2202 and ISI marked with black board (conforming to the requirements as per IS-1659 -1969 with frame of 1st class Hardwood and well matched commercial 3 ply veneering with vertical grains or cross bands and both faces decorative lamination 1mm thick.

5. Silicon Treatment:

   Silicon based water repellent (ready to use) Treatment to external faces of Dry Red Sand Stone Cladding/ Grit Finishes will be carried out with "WATERREPELL S" (marketed by M/s Aquatech Engineers) by brush or by spray machine. The treatment shall be applied on the finished surface after the completion of curing period. On porous surfaces WATERREPELL S provides an invisible barrier to water penetration and remains effective for many years. WATERREPELL S Prolongs the clean appearance of building, reduces chemical attack & minimize effloresces.

6. Vitrified Tiles

   Vitrified Tiles 60x60cmsx10mm and 100x100cms x10mm Thick as specified in the B.O.Q with water absorption less than 10% of 1st quality conforming to IS 15622 and of approved make. The colour/shade of the tile shall be approved by the Project Manager/Architect.

7. Aluminium Doors, Windows and ventilators:

   Providing and fixing double glazed hermetically sealed glazing in aluminium windows, ventilators and partition etc with 24 mm thick unit consist of outer glass SGG 6mm thick EVO Star ET 425 Aura Green, having 12mm air gap, and inner glass 6 mm thick clear float toughened of Saint-Gobain make with following performance. VLT-21%, Solar Factor-0.18, U value -2 .0 W/sqm K. Including providing EPDM gasket, perforated aluminium spacers, desiccants, sealant (Both primary and secondary sealant) etc. as per specifications, drawings and direction of Engineer-in-charge complete.The contractor must provide details of structural calculations of the Mullion / Transom member offered, and also provide drawings of individual profiles - Mullion, Transom, Pressure Plate, cover plate and also details of any other profiles that may be used - clearly indicating all dimensions, wall thickness and weight - kg./m. The anchoring / bracing of the curtain wall glazing's to the RCC

slab /beams / columns shall be done with non-corrosive galvanised brackets of approved design, (Galvanizing to be done conforming to IS:4759-1996 upto 610 gms. per sqm. (80-90 micron thickness) with two numbers on each beam, including providing PVC spacers between the aluminium Mullion Member and Bracket (including providing and fixing of aluminium shims of various thickness to adjust the beam level/line variations) with dash fasteners and stainless steel bolt to provide a minimum anchoring depth of 50 - 80 mm. in the concrete and to withstand the dead load of the curtain wall as well as stresses due to wind pressure etc.The glazing framework shall be aligned for the entire height of each Mullion and for the entire width of each Transom by laser beam equipment to ensure 100 per cent 'X' axis and 'Y' axis alignment.
All Sections of Aluminium work being used in the work will be Powder coated minimum thickness of powder coating 50 micron.

8. Interlocking Concrete Pavers:

Shape	:	As Per Choice Recommended/ Approved by Engineer–In Charge (Approx. 100 Shapes Available)
No. Of Layers	:	Two
Top Layer	:	1:2(6 To 8 Mm)
Bottom Layer	:	1:1:5:3
Edges	:	Chamfered
Application	:	Walkway, Driveway
Thickness	:	60 mm
Compressive Strength	:	300 Kg/Cm^2 To 500 Kg/ Cm^2
Finish	:	Smooth, Coarse, Granular
Bed Preparation	:	WBM, Lean Pcc(1:4:8 Or 1:5:10)
Fixing Medium	:	Mortar 20/25 Mm (1:6) Or Sand With Vibratory Compaction (25 To 40 Mm)
Slope/Gradient	:	Adequate (Minimum 2%, Preferably 3%) With Drainage Facility
Chemical Coating	:	Optional (Silicone, Polyurethane or Epoxy Resin Based)
Grouting	:	Dry or Wet Grouting
Edge Restraint	:	Kerbstone or Retaining Wall
Mould Used	:	High Precision Magnesium Steel Moulds

9. Glass Mosaic –

Glass Mosaic is mainly made up of sand, silicon and other raw material which melted and become small pieces of glass mosaic under high temperature. The normal size is 10x10mm,20x20mm,25x25mm,30x30mm. Besides the square type, there are also irregular shape which is needed in making the murals. Glass mosaic is probably the smallest decoration material, further more, the colour of glass mosaic is very rich, at present there are about 40 colours, therefore, it's possible to have lots of changes through different combination of colours. Glass mosaic can be combined with other paint perfectly, it can be used as a kind of paint to draw beautiful pictures you like without worrying it will comes off. For example on one surface, you may have many different ways of decoration, it can be a specific design, it can be colour degradation slightly from dark colour to light colour or it can be an ornament on other decoration material. The advantage of glass mosaic is more obvious used in the curved surface or the corner of the rooms, it can cover the curved surface or corner smoothly and perfectly. Glass Mosaic Tiles make 'CORAL MOSAIC' manufactured by TUA Infratech Ltd., New Delhi-34 or any other make equivalent to 'CORAL MOSAIC' may be used as per approval of Architect/Project manager of the works.

Installation Instructions:

1. Preparation of the wall surfaces: Make sure the wall surfaces to be smooth, flat, solid, dry and perfectly clean. We suggest creating a white base about 2mm.
2. Preparation for Laying: Score lines on the surfaces to help the sheet posited correctly.
3. Laying: Using the straight of a trowel spread out the adhesive uniformly on the wall. Make sure the adhesive covered the entire surface. One time should be not more than 1m2.
   A-Mosaic mounted on paper.
   Install the mosaic sheets with the paper side facing towards you and then using rubber float to ensure perfect adhesion. Wet the paper with a damp sponge and then remove it gently. Take out of any excess adhesive before it dries by a small spatula.
   B-Mosaic mounted on mesh. Press the fiber glass mesh backing directly into the adhesive.
4. Grouting: Using a grout for particular care. For paper –faced mosaic, ensure that titles are thoroughly cleaned and spread the grout using a rubber float. Make sure no more than 2m2 of area at a time. And then leave the grout drying.
5. Cleaning: Using a damp sponge to remove any grout.
6. Cutting Glass mosaic: Using mosaic nippers cut tile by tile. Using a cutter for cutting the whole sheet.
7. Maintenance: Using normal neutral detergents for daily cleaning. Using a slightly acidic detergent for special cleaning.

10. Ant termite Treatment

Diluting and injecting chemical emulsion for PRE-CONSTRUCTIONAL Anti-termite treatment and creating continuous chemical barrier, wall trenches, top surface of plinth filling, along the external perimeter of building, over the top surface of consolidated earth of which apron is to be laid, surroundings of pipes and conduits etc. complete as per specification. (Plinth area of the building at ground floor only shall be measured for payment). Chlorpyriphos Emulsifiable concentrates of 20% with 1% Concentration.

11. Float Glass

Float Glass Sheet of nominal thickness 4mm (weight not less than 10 kg/sqm) and 5mm (weight not less than 13.5Kg/Sq.M. Sheet glass shall be flat, transparent and clear as judged by the naked eye. It may, however, possess a light line when viewed edgewise. It shall be free from any cracks and other defects. Float Glass make "SAINT GOBAIN" or other make equivalent to "SAINT GOBAIN" may be used as per approval of Architect or Project Manager.

12. Drapery Rods:

Drapery rods shall be of 30mm OD of M.S. pipe of thickness 1.6mm with powder coating (wooden finish) including metal brackets, rings and ends. Metal brackets shall be fixed to brick walls/RCC Lintels with dash fasten.

13. Aluminium Grill

Anodised Aluminium Grill of 7.5 mm thick of approved pattern (Pan type) (minimum thickness of powder loading 50 micros) shall be fixed with Aluminium Beading 12mm x 12mm x 1.6mm thick as per manufacturer instructions.

14. Stainless Steel Railing

Non Ozone SS 304 Grade Railing of height as shown on drawing of SS grade 304grade Non Ozone hand rail of 38mm OD tube top rail of 1.6mm thick curves mounted on SS 304 grade vertical balusters of OD 38mm of thickness 1.6mm with 3 Nos SS 304 grade mild rails of 12mm OD and of thickness 1.6mm mounted on base plate of SS 304 grade of 6mm thick with the help of dash fasteners.

13. Stainless Steel Pipe

Stainless steel pipe wherever specified shall be 38mm OD of thickness 1.6mm of SS 304 grade.

14. Wooden Flooring

Wooden flooring of 25mm thick with pre laminated flat pressed three layer Engineered Hard Wood Flooring over 40mm thick PCC floor 1:2:4 (20mm graded aggregate) on Stage of Armstrong or equivalent make exterior grade including edge profiles as may be required in desired shape and size of approved colour and texture including front cladding of stage riser all as specified.

15. Proscenium

Sound & Light effects management equipment made in MS hollow tubular section and cladded with 12mm thick BWP centaury make multilayer marine ply with 4mm thick teak veneer and walnut melamine polish and necessary teak wood beadings complete job.

16. Projection Screen

Projection Screen Shall be of 100"mm motorized Matt white projection screen will all accessories as per manufacturer.

17. Curtain

Supply and fixing of motorized curtain with thick satain fabric.

18. Double Leaf Doors (Auditorium)

Fixing Auditorium double leaf doors of width 1.8mtr and height 2.1mtrs made of seasoned hard wood frame of size 100mm x 50mm with 16mm BWP ply fixed on both surfaces having infill of 50mm thick 48kg/meter cube and both surfaces of door shall be pasted with 1mm thick merino/centaury make laminate with groves at every 300 interval including door frame of 125 x 60mm made of teak wood with all necessary hardware's handles. Door closers complete job

19. AFM/Armstrong False Ceiling

AMF THERMATEX FEINSTRATOS VT- 15 Mineral Fiber Tiles Recess Regular edge (VT-15 edge), Humidity Resistance Panel upto 95% RH, NRC 0.55, white colour similar to RAL 9010 of 600mm x 600mm tile of 15mm thickness laid into an exposed grid system of 15mm grid, consisting of main runner spaced at 1200mm centers securely fixed to the structures soffit by approved hangers at maximum 1200mm centers. There should be a minimum of 1 hanger per 1500mm of ceiling area and last hanger should not be further than 450mm from the adjacent wall. 1200mm cross tees to be fixed between main runner at 600mm centers to form 1200mm x 600mm module & 600mm cross tees fitted centrally between 1200mm cross tees to create 600 x 600mm module. The product should be certified in accordance with Quality Assurance Standard to ISO 9001 and ISO 14001. The mineral panels should have RAL Seal of Approval.

20. Acoustical False Ceiling

ACOUSTICAL FALSE CEILING
Providing and fixing of Armstrong Mineral Fiber Acoustical Suspended Ceiling System with Fire fissured (Micro Look) edge tiles with Armstrong superfine 15mm exposed grid in module size 600x600x16mm with Bio Block Casting on the face of the tile. The grid shall be 15mm wide T-Section flanges colour white, main runner 1200mm & 600mm Cross Tees.

21. Structural Glazing

Supply & fixing of structural glazing at Façade of ground plus three buildings using glazing section on direct stick mullion & transom system of which mullion shall be of 80x50x1.8 mm with notch & transom to be of 50x50x1.8 mm with notch , Aluminum Glazing sections shall be powder coated with heat treatment on three surfaces in Ivory/Black colour using 6mm thick TOUGHENED SGG EVO Star ET 425 AURA GREEN HEAT REFLECTIVE GLASS VLT-24%, Solar Factor- 0.25 and U-value- 3.72 W Sqm K of Saint-Gobain make of approved colour of to be pasted with 12mm x 6 mm both side adhesive Spacer foam tape & structural silicon of Dow Corning 995 grade or its equivalent. The Weather /water sealing of glass joints shall be done with 10 mm wide Dow Corning make weather sealant of grade 789 or its equivalent. The Mullion of Aluminum structure is to be fastened with R.C.C. Slab/beam with help of Powder coated/ Galvanized MS Brackets of 75 mm length with help of M10 x 100 mm Mechanical tempered Dash Fasteners. The job Includes all necessary hardware, cleat, Screws, nut washers etc. Complete job with all material and labour as per direction of Engineer-in-charge.

22. Ceramic Designer Tiles Dado

Ceramic designer tiles of size 300x450mm to 300x600mm thickness to be specified by the manufactured as in dado (upto 2.10m height) over 15mm thick cement mortar 1:4 [1cemnet: 4 coarse sand] set, jointed with neat cement slurry & pointed with white cement using pigment to match the shade of colour of the tile. Meeting edges of the tile to be chamfered.

23. Stage Lights

Provision for internal Stage light with MS cat walk complete.

24. Sound System

Provision for internal Sound system capacity required for auditorium.

25. Ultra Permasand Finish

Surface Texture finish shall be 2mm thick in lineal finish of approved shade manufactured by Bakelite hylam Ltd. Over a base course of primer over plastered surface all as specified.

26. Vitrified Double Charged

Vitrified Tiles 605x605mm (R Series) Double Charged Matt Finish (Premium Quality) of approved colour & shade laid over 20mm thick Cement mortar 1:4 (1Cement :4 Coarse Sand) jointed and pointed in white cement mixed with colour to match the colour & shade of the tiles.

27. Poly Carbonate Sheet Roofing

Danpalon 16mm thick (with minimum1040mm wide) multicell polycarbonate sheet with standing seam on both sides & double tooth snap on locking system to ensure maximum uplift capability. The panels will be UV protected and antiglare/softlight. The cross section of one cell should not be more than 4mmX4mm & weight of single panel shall not be less than 3250 per square metre. The system will be fitted on purlins with spacing as specified by manufacturer.

28. Stainless Steel Fittings (Builder's Hardware)

Stainless Steel fittings (Builders Hardware) Shall be used as specified in the B.O.Q and should be as per approved list of makes.

29. Mineral Fibre Acoustical Ceiling System with Fine Fissured (MICRO LOOK) EDGE TILES WITH SUPRAFINE 15mm EXPOSED GRID.

The tiles should have Humidity Resistance (RH) of 99%, NRC 0.55, Light Reflectance>85%, Thermal Conductivity k=0.052-0.057 w/m K, Colour White, Fire Performance Class0/Class I (BS 476 Part 6 &7/in module size of 600x600x16mm with Bio Block coating on the face of the tile, suitable for Green Building application, with Recycled content of 63%.

The Grid should be of "Armstrong" make with 15mm wide T-section flanges colour white having rotary stitching on all T sections i.e. the Main Runner, 1200mm & 600mm Cross Tees. The T Sections have a Galvanizing of 100 grams per M2 & passed through 500 hrs of Salt test. The tile Grid system used together should carry a 15 year warrantee.

INSTALLATION: To comprise main runner spaced at 1200mm centres securely fixed to the structural soffit using Armstrong suspension system (specifications below) at 1200mm maximum centre. The First/Last Armstrong suspension system at the end of each main runner should not be greater than 450mm from the adjacent wall.

Flush fitting 1200mm long cross tees to be interlocked between main runners at 600mm centre to from 1200x600mm module. Cut cross tees longer than 600mm require independent support. 600x600mm module to be formed by fitting 600mm long flush fitting cross tees centrally between the 1200mm cross tees.

Perimeter trim to be Armstrong wall angles of size 3000x19x19mm, secured to walls at 450mm maximum centres.

ARMSTRONG SUSPENSION SYSTEM accessories manufactured and supplied by Armstrong world industries consisting of M6 Anchor Fasteners with Vertical Hangers made of Galvanised steel of size 26x26x25x1.2mm with a Galvanised thickness of 80gsm, A pre Straightened Hanger wire of dia-2.68mm of 1.83m length., thickness of 80gsm and a tensile strength of 344-413 MPa, along with Adjustable hook clips of 0.8mm thick, galvanised spring steel for 2.68 mm with a minimum pull strength of 110 kg. The adjustable clip also consists of a 3.5 mm aquiline wire to be used with the main runner.

ECOPHONE SUPERG Wall Panelling

Providing and fixing Ecophon SUPER G A with 40 mm natural square edge ,demountable panels with the option of weekly wet cleaning (Akutex T and Super G surfaces) and vacuum cleaning (Colorado surface) , manufactured from High density glass wool ,with the visible surface has an Akutex T coating , a glass fiber fabric (TEXONA)or a strong glass fibre (Super G) and the back of the tile should be covered with glass tissue . The glass wool core of the tiles should be tested and classified as non combustible according to prEN ISO 1182 .The system should have Sound Absorption NRC value of 0.9 (according to EN ISO 11654). Tiles should withstand a permanent ambient RH upto 95% at 30 * C without sagging, warping or delaminating (ISO 4611). The light reflectance of the tiles should not be less than84 % (for Akutex T surface)

PVC Flooring

Providing and installing of Accolade plus with impregnated PUR Vinyl Sheet flooring manufactured by Armstrong World Industries, Inc, 6 feet (1.83m) wide, having a nominal total thickness of [0.08 in. (2mm)]. The nominal thickness of the wear layer would be [0.08 in. (2mm)]. The wear surface shall consist of impregnated polyurethane homogeneous mixture of PVC, Plasticizers, Urethane, color pigments and filler calendared to form a sheet colors and pattern detail shall be dispersed throughout the thickness of the wear layer. Accolade plus sheet shall conform to the requirements of BS EN 649:1997, “Standard Specification for Vinyl Sheet floor covering without backing.” Accolade plus shall conform to Group P of Wear Resistance as per EN 660-2 Fire Resistance of more than 11kW/m2 as per ISO 9329-1 Critical Radiant Flux, Slip resistance of R9 as per Oil wet Ramp test (AS 4586).

Accolade plus can be used in very High traffic in commercial and in Heavy traffic in Industrial applications as per EN 685.

Installation:

It is important to ensure the sub floor on which the sheet is being laid is smooth, flat & hard 7 free from moisture, grease, etc. In case of uneven sub floor the same should be leveled by self leveling compound. The moisture level present in the subfloor should be leveled by self leveling compound. The moisture level present in the subfloor should be less than 8% before installation of the floor. The sheet should be laid using water based adhesive like VC 31 of Pixilated or similar.

The installation shall be undertaken as per the manufacturer’s installation instructions.

Water Proofing Treatment to Concrete Surfaces
(a) Water Proofing Treatment with Krystol T1-System

Cementations based dry Krystal T1 crystalline powder capable of creating crystals to seal the pores, intercedes, micro cracks in the concrete. This crystal T1 system become integral part of concrete and is not affected by surface wear and abrasion. This will be applied on wet saturated new or old concrete surfaces. The Krystal T1 is non toxic and suitable for application in drinking water tanks. It will be able

to withstand high hydrostatic pressure, stop moisture coming up through concrete to deboned any overlay system. Item will eliminate the need for surface applied membranes etc. It does not contain states, sodium or silicate and is not hydrophobic type. It will be able to grow crystal year after year should seal micro cracks (not live/moving crack) that may occur from subsequent damage to structure.

Procedure

Surface Preparation & Krystal T1 Application

1. Concrete surfaces will be cleaned and made free of contaminants and laitance.
2. Concrete must be sound.
3. Concrete will be cleaned to have an open pore surface to allow penetration of crystal. This may require mechanical preparation such as grinding, water lasing, sandblasting, or hacking.
4. Surfaces to be treated will be pre-soaked with clean water to saturated surface dry (SSD) condition. Do not leave any standing water.
5. Mix Kristal T1 to a slurry consistency (5 parts powder to 2 part clean water). Mix only enough material that can be placed in 15minuted to 20minutes.
6. Apply slurry to the concrete surface with a brush in a circular, scrubbing motion so as to achieve maximum adhesion and penetration. Apply the slurry to the entire concrete slab.
7. Apply crystal T1 with a spread rate of 1 Kg/m2.
8. Protect the area from rapidly drying out due to heat, damage by rain, excessive wind and freezing temperatures for 48 hours.
9. Testing with pending to be done after 7 days.

Chairs with Writing Tablet
(b) Water Proofing Treatment with Kristal T1+T2 System.

Cementitious crystalline based water proofing for concrete rafts, walls, water tanks, slabs, concrete floors etc. with Krystol T1/T2 system. The application to be done from -ve (negative) side on a wet open pore concrete surface with brush @ 0.8kg of Kristal T1 & 0.8kg of Kristal T2 as per manufacturer specification. including making grooves of 10x15mm size on the construction joints and treating with Kristal T1 mixed with water in ratio 5:1 (5 parts of Krystal T1: 1 part of clean water) as per manufacturers specification etc. and as per direction of Engineer-in-Charges. The rate also includes the cleaning of surface to be treated with air compressor wherever required.

BR Skate to 60mm CTC,. Rocking seat with auto tip up cushion, sheath depth 650mm wooden armrest with fabric uphoistred and with foldable writing tablet. Chair with Cover on the back side. Single Central foot for easy house keeping.

Auditorium Chairs
Metz LBR 535mm to 600mm CTC, Rocking seat with auto tip up cushion, seat depth 650mm, PPCP armrest with cup holder and fabric padding on top for comfort. Chair with Cover on the back side. Single Central foot for easy house keeping.

Kalzip Aluminium Sheet Roofing System

Kalzip Aluminium sheet roofing shall be of KALZIP 65/400 “Self Supported” Secret fix standing roofing system in 0.9mm thick AA 3004 Aluminium Alloy fixed on M.S. Truss as shown in the drawing.

Flashings will be 0.9mm thick Aluminium PVDF Finished as Kalzip 65/400.

The General Roof-Construction Shall comprise from bottom to top:

1. Steel Liner-35/200 Galvanised steel liner sheet, 0.5mm thick; 1000mm total cover width x35mm deep ribs spanning upto 2000mm centers (multiple spans). The substrate is hot dipped galvanized

steel coil. Pre-treatment is a corrosion resistant chromate conversion coating. The primer is corrosion inhibitive chromate primer, nominal thickness of 5µm plus/minus 1µm. The finish to the exposed surface of the liner will be polyester coating with a nominal film thickness of 23um plus/minus 2µm.
Top Hat-20mm Top Hat along with brackets made of galvanized steel.

2. Vapor Control Layer – A single layer of double-sided aluminium foil/polyethylene Film.

3. Insulation- A layer of Rockwool insulation of 50mm thickness minimum 48 Kg/m3 density with thermal conductivity of K=0.04 w/mk at 25 degree Celsius. Fire classification with test procedures to BS 476. Parts 6 &7.

4. Top Layer-Kalzip 65/400 profiled sheeting manufactured from Aluminium Alloy Almnlmg1-as specified in DIN 1725 (Comparable AA 3004), minimum material thickness of 0.9mm and PVDF finish. The material properties are as follows:-

   Ultimate tensile strength: minimum 185 200 N/mm^2

   0.2% Proof Stress: minimum 185 N/mm^2

   Modules of elasticity: 70,000 N/mm^2

   Including Accessories, Fasteners and ST clips and 20mm Top-hat.

   The roofing system shall be certified with a British Board of Agreement Certificate No 98/3481 plus the Institute of Biotechnical Zulassungbeschield N R -14.1 .181 the approved roofing system must also be Certified by the Factory Mutual FM Research Corporation of the USA and classified as a CLASS 1 Panel Roof. The manufacturer must produce all 3 valid certifications.

34 Carpeting

4.3mm thickness heavy commercial range flocked flooring with advantage of water proof, antifungal, allergy proof sanitized, total weight 1.8 kg/m2, fire resistant, stain resistant duly installed at floor.

35 Frame Less Toughened Glass
Frameless Toughened glass doors using 12mm plain Toughened glass with Ozone make patch fittings.

INTERNAL ELECTRICAL WORKS

TECHNICAL SPECIFICATIONS

1. WIRING

1. GENERAL

Technical Specifications in this section cover the Internal Wiring Installations comprising of:

- Wiring for lights and convenience socket outlets etc. in concealed/surface Conduit/raceways.
- Wiring for telephone outlets.
- Sub main wiring.
- Conduiting for Low Voltage System

2. STANDARDS AND CODES

Latest upto date Indian Standard (IS) and Code of Practice will apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and / or IEC Standard shall be applicable.

3. CONDUITS

3.1 STEEL CONDUITS

These shall be of mild steel 16 gauge upto 32mm and 14 gauge for sizes above 32mm, electric resistance welded (ERW), electric threaded type having perfectly circular tubing. Conduits shall be precession welded ERW and shall be fabricated from tested steel strips of thickness as per IS by high frequency induction weld process. Weld shall be smooth and of consistent of high quality to ensure crack proof bending. The conduits shall be black enamel painted inside and outside in its manufactured form. Wherever so specified, the conduit shall be galvanized. All conduits used in this work shall be ISI embossed.

3.2 MS CONDUITS

The electrical wiring shall be done in recessed MS Conduits, unless mentioned otherwise.

No conduit less than 25mm in diameter shall be used, unless otherwise specifically ask by Engineer-In-Charge.

3.3 PVC CONDUITS (IF REQUIRED)

Wiring shall be carried out in recessed /surface PVC conduits. The PVC conduits conform to latest and shall be ISI embossed. The conduits shall be heavy gauge (minimum 2 mm wall thickness) and the interiors of the conduits shall be free from all obstructions. All joints in conduits shall be sealed / cemented with approved solvent cement. Damage conduits/fittings shall not be used. Cut ends of conduits shall not have sharp edges.

3.4 BENDS

As far as possible, the conduit system shall be so laid out that it shall obviate use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two quarter bends from inlet to outlet.

3.5 CONDUIT ACCESSORIES

3.5.1 STANDARD ACCESSORIES

The conduit wiring system shall be complete in all respects, including their accessories. Bends, couplers etc. shall be solid type in recessed type of works and may be solid or inspection type as required, in surface type of works. The accessories shall conform in all respects to the relevant IS. Samples shall be got approved by Engineer-In-Charge before use.

3.5.2 FABRICATED ACCESSORIES

Wherever required, outlet/junction boxes of required sizes shall be fabricated from 1.6 mm thick MS sheets excepting ceiling fan outlet boxes which shall be fabricated from minimum 3 mm thick sheets. The outlet boxes shall be of approved quality, finish and manufacture. Suitable means of fixing connectors etc., if required, shall be provided in the boxes. The boxes shall be protected from rust by zinc phosphate primer process. Boxes shall be finished with minimum 2 coats of enamel paint of approved colour. A screwed brass stud shall be provided in all boxes as earthing terminal.

4. WIRES

Wiring shall be carried out with FR insulated 660/1100 volt grade unsheathed single core wires with electrolytic annealed stranded copper (unless otherwise stated) conductors conforming to latest IS Code. All wire rolls shall be ISI marked. All wires shall bear manufacturer's label and shall be brought to site in new and original packages. Manufacturer's certificate, certifying that wires brought to site are of their manufacture shall be furnished as required.

5. COAXIAL CABLES

The coaxial cables shall be of video band type with operation up to 300 MHz capability. Aging resistance shall comply with latest code i.e. maximum 5% increase in attenuation at 200 MHz measured by artificial aging (14 days at 80o C) cables shall meet all exceed following specifications

Center core Dia	0.8 mm
Diaelectric Dia	4.8 mm
Dielectric	PE
Outer Conductor Dia	5.4 mm
Outer Dia	7.0 mm
Bending radius	more than 30 mm
Impedance	75 ohms
DC Resistance	50 ohms/KM
Screening factor	more than 50
Attenuation	
50 MHz	6.5
100 MHz	9
200 MHz	13
300 MHz	16

6. LAYING OF CONDUITS

- Conduits shall be laid either recessed in walls and ceilings or on surface on walls and Ceilings or partly recessed and partly on surface, as required.

- Same rate shall apply for recessed and surface Conduiting in this contract.

- Stranded copper conductor insulated wire of size as per schedule of quantities shall be Provided in entire Conduiting for loop earthing.

- GI wire of suitable size to serve as a fish wire shall be left in all conduit runs to facilitate Drawing of wires after completion of Conduiting.

6.1 RECESSED CONDUITING

Conduits recessed in concrete members shall be laid before casting, in the upper portion of slabs or otherwise as may be instructed, so as to embed the entire run of conduits and ceiling outlet boxes with a cover of minimum 12 mm concrete. Conduits shall be adequately tied to the reinforcement to prevent displacement during casting at intervals of maximum 1 meter. No reinforcement bars shall be cut to fix the conduits. Suitable flexible joints shall be provided at all locations where conduits cross expansion joints in the building.

Conduits recessed in brick work shall be laid in chases to be cut by electrical Contractor in brick work before plastering. The chases shall be cut by a chase cutting electric machine. The chases shall be of sufficient width to accommodate the required number of conduits and of sufficient depth to permit full thickness of plaster over conduits. The conduits shall be secured in the chase by means of heavy duty pressed steel clamps screwed to MS flat strip saddles at intervals of maximum 1 meter. The chases shall then be filled with cement and coarse sand mortar (1:3) and properly cured by watering.

Entire recessed conduit work in concrete members and in brick work shall be carried out in close coordination with progress of civil works. Conduits in concrete members shall be laid before casting and conduits in brick work shall be laid before plastering. Should it become necessary to embed conduits in already cast concrete members, suitable chase shall be cut in concrete for the purpose. For minimizing this cutting, conduits of lesser diameter than 25 mm and outlet boxes of lesser depth than 50 mm could be used by the Contractor for such extensions only after obtaining specific approval from Engineer-In-Charge. For embedding conduits in finished and plastered brick work, the chase would have to be made in the finished brick work. After fixing conduit in chases, chases shall be made good in most workmanlike manner to match with the original finish.
Cutting chases in finished concrete or finished plastered brick work for recessing conduits and outlet boxes etc shall be done by the Contractors without any extra cost.

6.2 SURFACE CONDUITING

Wherever so desired, conduit shall be laid in surface over finished concrete and/or plastered brickwork. Suitable spacer saddles of approved make and finish shall be fixed to the finished structural surface along the conduit route at intervals not exceeding 600 mm. Holes in concrete or brick work for fixing the saddles shall be made neatly by electric drills using masonry drill bits. Conduits shall be fixed on the saddles by means of good quality heavy duty MS clamps screwed to the saddles by counter sunk screws. Neat appearance and good workmanship of surface Conduiting work is of particular importance. The entire conduit work shall be in absolute line and plumb.

6.3 FIXING OF CONDUIT FITTINGS AND ACCESSORIES

For concealed Conduiting work, the fittings and accessories shall be completely embedded in walls/ceilings leaving top surface flush with finished wall/ceiling surface in a workman like manner.

Loop earthing wire shall be connected to a screwed earth stead inside outlet boxes to make an effective contact with the metal body.

6.4 PAINTING AND COLOUR CODING OF CONDUITS

Before lying, conduits shall be painted specially at such places where paint has been damaged due to vice or wrench grip or any other reason.

If so specified, surface conduits shall be provided with 20 mm wide and 100 mm long colour coding strips as below

Use	Code colour
Low voltage	Grey
Telephone	Black
Earthing system	Green
Control system lighting	Purple

6.5 PROTECTION OF CONDUITS

To safeguard against filling up with mortar/plaster etc. all the outlet and switch boxes shall be provided with temporary covers and plugs which shall be replaced by sheet/plate covers as required. All screwed and socket joints shall be made fully water tight with white lead paste.

6.6 CLEANING OF CONDUIT RUNS

The entire conduit system including outlets and boxes shall be thoroughly cleaned after completion of erection and before drawing in of cables.

6.7 PROTECTION AGAINST DAMPNESS

All outlets in conduit system shall be properly drain and ventilated to minimize chances of condensation/sweating.

6.8 EXPANSION JOINTS

When crossing through expansion joints in buildings, the conduit sections across the joint shall be through approved quality heavy duty metal flexible conduits of the same size as the rigid conduit. The expansion joint crossing shall be done as approved by Engineer-In-Charge.

6.9 LOOP EARTHING

Loop earthing shall be provided by means of insulated stranded copper conductor wires of sizes as per Schedule of Quantity laid alongwith wiring inside conduits for all wiring outlets and sub-mains. Earthing terminals shall be provided inside all switch boxes, outlet boxes and draw boxes etc.

7. LAYING AND DRAWING OF WIRES

7.1 BUNCHING OF WIRES

Wires carrying current shall be so bunched in conduits that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not be run in the same conduit.

7.2 DRAWING OF WIRES

The drawing of wires shall be done with due regard to the following precautions:-

No wire shall be drawn into any conduit, until all work of any nature, that may cause injury to wire is completed. Burrs in cut conduits shall be smoothen before erection of conduits. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire. Approved type bushes shall be provided at conduit terminations.

Before the wires are drawn into the conduits, conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction by forcing compressed air through the conduits if necessary.

While drawing insulated wires into the conduits, care shall be taken to avoid scratches and kinks which cause breakage of conductors.

There shall be no sharp bends.

The Contractor shall, after wiring is completed, provide a blank metal/sun mica plate on all switch / outlet / junction boxes for security and to ensure that wires are not stolen till switches / outlets etc. are fixed at no extra cost the contractor shall be responsible to ensure that wires and loop earthing conductors are not broken and stolen. In the event of the wire been partly / fully stolen, the contractor shall replace the entire wiring alongwith loop earthing at no extra cost. No joint of any nature whatsoever shall be permitted in wiring and loop earthing.

7.3 TERMINATION /JOINTING OF WIRES

Sub-circuit wiring shall be carried out in looping system. Joints shall be made only at distribution board terminals, switches/buzzers and at ceiling roses/connectors/lamp holder’s terminals for lights/fans/socket outlets. No joints shall be made inside conduits or junction/draw/inspection boxes.

Switches controlling lights, fans or socket outlets shall be connected in the phase wire of the final sub circuit only. Switches shall never be connected in the neutral wire.

Wiring conductors shall be continuous from outlet to outlet. Joints where unavoidable, due to any special reason shall be made by approved connectors. Specific prior permission from Engineer-In-Charge in writing shall be obtained before making such joint.

Insulation shall be shaved off for a length of 15 mm at the end of wire like sharpening of a pencil and it shall not be removed by cutting it square or wringing.

Strands of wires shall not be cut for connecting terminals. All strands of wires shall be twisted round at the end before connection.

Conductors having nominal cross sectional area exceeding 1.5 sq. mm shall always be provided with crimping sockets. Tinning of the strands shall be done wherever crimping sockets are not available as per instructions of the Engineer-In-Charge

All wiring shall be labeled with appropriate plastic ferrules for identification.

At all bolted terminals, brass flat washer of large area and approved steel spring washers shall be used.

Brass nuts and bolts shall be used for all connections.

The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less.

Switches controlling lights, fans, socket outlets etc. shall be connected to the phase wire of circuits only.
Only certified valid license holder wiremen shall be employed to do wiring / jointing work.

7.4 LOAD BALANCING

The Contractor shall plan the load balancing of circuits in 3 phase installation and get the same approved by the Engineer-In-Charge before commencement of the work.

7.5 COLOUR CODE OF CONDUCTORS

Colour code shall be maintained for the entire wiring installation - red, yellow, blue for three phases, black for neutral and green for earth.

8. SWITCHES AND FIXTURES

8.1 SWITCHES

All 6 and 16 amps switches shall be of the modular enclosed type flush mounted 220 Volt AC of the best quality and standard or as approved by MEP/Architect/Engineer-In-Charge. The switch moving and fixed contacts shall be of silver nickel and silver graphite alloy and contact tips coated with silver. The housing of switches shall be made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material.

8.2 FLUSH PLATES

Switches, receptacles and telephone system outlets in wall shall be provided with molded cover plates of shape, size and colour approved by the Engineer-In-Charge made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material, and secured to the box with counter sunk round head chromium plated brass screws. Where two or more switches are installed together, they shall be provided with one common switch cover plate as described above with notches to accommodate all switches either in one, two or three rows.

One and two gang switch cover plate, telephone outlet cover plate, 6 and 16 amps switched/unswitched plates shall have the same shape and size. Three and four gang switch cover plates shall have the same shape and size. Six and eight gang switch cover plates shall have the same shape and size. Nine and twelve switch cover plates shall have the same shape and size. Wherever five switches, seven switches, ten switches and eleven switches are to be fixed the next higher size of gang switch cover plate to be used and extra openings shall be provided with blank-off.

8.3 EXTERNALLY OPERATED SWITCHES

Externally operated switches, shall be of general purpose type, 250 volts of the proper size and rating and shall be provided in weather proof enclosures, complete with weather proof

casketed covers. The MCB's for all externally operated switches shall be separate and of proper rating.

8.4 WALL SOCKET OUTLETS

All 6/16 Amps wall socket outlets unless otherwise mentioned on the drawings shall be switched, five/six round pin and fitted with automatic linear safety shutters to ensure safety from prying fingers. Un-switched 6/16 amp wall socket outlets where called for in the drawings shall be of five/six round pin type. The socket outlets shall be made from high impact resistant, flame retarding and ultra violet stabilized engineering plastic material.

The switch and sockets shall be located in the same plate. The plates for 6 amp switched/un-switched plugs and telephone outlets shall be of the same size and shape.

All the switched and un-switched outlets shall be of the best standard.
An earth wire shall be provided along the cables feeding socket outlets for electrical appliances. The earth wire shall be connected to the earthing terminal screw inside the box. The earth terminal of the socket shall be connected to the earth terminal provided inside the box.

8.5 LIGHTING FIXTURES

The light fixtures and fittings shall be assembled and installed complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Engineer-In-Charge.

Wires brought out from junction boxes shall be encased in GI flexible pipes for connecting to fixtures concealed in suspended ceiling. The flexible pipes shall be provided with a check nut at the fixture end.

Pendant fixtures specified with overall lengths are subject to change and shall be checked with conditions of the job and installed as directed.

All suspended fixtures shall be mounted rigid and fixed in position in accordance with drawings, instructions and to the approval of the Engineer-In-Charge.

Fixtures shall be suspended true to alignment, plumb, level and capable of resisting all lateral and vertical forces and shall be fixed as required.

All suspended light fixtures etc. shall be provided with concealed suspension arrangement in the concrete slab/roof members. It is the duty of the Contractor to make these provisions at the appropriate stage of construction.

All switch and outlet boxes shall be bonded to earth with insulated stranded copper wire as specified.

Wires shall be connected to all fixtures through connector blocks.

Flexible pipes, wherever used, shall be of make and quality approved by the Engineer-In-Charge.

9. MEASUREMENT AND PAYMENT OF WIRING

Wiring for lights, fans, convenience socket outlets and telephone outlets etc. shall be measured and paid for on POINT BASIS as itemized schedule of quantities and as elaborated as below unless otherwise stated.

9.1 PRIMARY AND SECONDARY LIGHT POINT WIRING

In respect of group control of lights (more than one light controlled by one switch or MCB), wiring upto the first light in the group shall be measured and paid for as a primary light point. Wiring for other lights looped in one group for switch controlled as also MCB controlled lights shall be measured and paid for as secondary light points. Primary light points for switch controlled lights shall include the cost of control switch whereas primary light points controlled by MCBs shall not include the switch cost. The cost of MCB controlling such lights shall not be included in the primary light point rate since the MCB shall be paid for in the item of DB.

The point wiring basis shall assume average wiring length and average conduiting length per point based on parameters stipulated in Para 9.2 below. The average wiring length and average conducting length forming the basis of point wiring payment, shall take the electrical layouts of the entire project into consideration. Tenderers are advised to seek clarifications, if they so desire, on this aspect before submitting their tenders. No claim for extra payment on account of electrical layouts in part or whole of the project requiring larger average wiring and conduiting length per point, whether specifically shown in tender drawings or not, shall be entertained after the award of contract.

9.2 PARAMETERS

Wiring shall be carried out as per following parameters in recessed/ surface conduit system.

Only looping system of wiring shall be adopted throughout. No joints excepting at wiring terminals shall be permitted.

All accessories shall be flush type unless otherwise stated.

Lights, fans and 6 amp socket outlets shall be wired as per the item given in the Bill of Quantities.

Power circuits shall normally have maximum two/one 16 amps socket outlet unless otherwise stated. Separate circuit shall be run for each Geyser, Window/Split air conditioners and similar appliances.

Wiring rates shall include painting of conduits and other accessories as required.

Wiring rates shall include cleaning of dust; splashes of colour wash or paint from all fixtures, fans, and fittings etc. at the time of taking over of the installation.

Wiring rates shall include blanking of outlet boxes to prevent damage/pilferage of wires.

Wiring rates shall include circuit wiring from DB to first control switch & shall be done as per Bill of Quantities.

9.3 DEFINITIONS

9.3.1 WIRING FOR LIGHTS
PRIMARY LIGHT POINTS

Wiring for primary light points, as defined in Para 9.1 above, shall commence at the Distribution Board terminals and shall terminate at the ceiling rose/connector in ceiling box/lamp holder via the control switch (for switch controlled lights). Rates for primary light point wiring shall be deemed to be inclusive of the cost of entire material and labour require for completion of primary light point thus defined including:

Recessed / surface conduting system with all accessories, junction/draw/inspection boxes, bushes, check nuts etc. complete as required.

Wiring with stranded copper conductor PVC insulated 660/1000 volt grade wires including terminations etc. complete as required.

Control switch with switch box and cover plate of specified type including fixing screws, earth terminal etc. complete as required. Cost of this switch is applicable only for switch controlled points. This cost shall not be applicable for DB controlled points.

Loop earthing with insulated copper wire.

SECONDARY LIGHT POINTS

Secondary light points, as defined in Para 9.1 above, shall cover the cost of interconnection wiring between group controlled light fittings and shall be deemed to be inclusive of the cost of entire materials and labour required for completion of the secondary light point thus defined including

Recessed / surface conduiting system with all accessories, junction/draw/inspection boxes, bushes, check nuts etc. complete as required.

Wiring with stranded copper conductor PVC insulated 660/1000 volt grade wires including terminations etc. complete as required.

Loop earthing with insulated copper wire.

9.3.2 WIRING FOR CEILING FANS

Wiring for ceiling fan points shall be same as for primary light points.

9.3.3 WIRING FOR EXHAUST FANS

Wiring for exhaust fan points shall be same as for primary light points and shall in addition include the cost of providing a 3/5 pin 6 amp socket outlet near the fan alongwith plug top and a 6 amp control switch at convenient location near the room entry.

9.3.4 WIRING FOR CALL BELL POINTS

Wiring for call bell points shall be the same as for primary light points. A call bell switch which include in lieu of the control switch at a convenient location as required.

9.3.5 WIRING FOR TELEPHONE OUTLETS

Wiring for telephone outlets points shall include the entire wiring and conduiting from the telephone tag block to the telephone outlet including the telephone outlet complete as required and as itemized in the Schedule of Quantities

9.3.6 WIRING FOR TV OUTLETS

Wiring for TV outlet points shall include the entire wiring and conduiting from the central point to the TV outlet including the TV outlet complete as required and as itemized in the Schedule of Quantities

9.3.7 WIRING FOR CONVENIENCE SOCKET OUTLETS

3/5 pin 6 amps and 3/6 pin 16 amps single phase switched convenience socket outlets shall be provided in the building as indicated in the layout drawings.

9.3.8 SUB MAINS WIRING

Sub mains wiring shall be measured from outer end of the boxes. Extra Loop length shall be left at each end as required.

10. ROUTINE AND COMPLETION TESTS

10.1 INSTALLATION COMPLETION TESTS

At the completion of the work, the entire installation shall be subject to the following tests:

1. Wiring continuity test
2. Insulation resistance test
3. Earth continuity test
4. Earth resistivity test

Besides the above, any other test specified by the local authority shall also be carried out. All tested and calibrated instruments for testing, labour, materials and incidentals necessary to conduct the above tests shall be provided by the contractor at his own cost.

10.2 WIRING CONTINUITY TEST

All wiring systems shall be tested for continuity of circuits, short circuits, and earthing after wiring is completed and before installation is energized.

10.3 INSULATION RESISTANCE TEST

The insulation resistance shall be measured between earth and the whole system conductors, or any section thereof with all protection in place and all switches closed and except in concentric wiring all lamps in position of both poles of the installation otherwise electrically connected together, a direct current pressure of not less than twice the working pressure provided that it does not exceed 1100 volts for medium voltage circuits. Where the supply is derived from AC three phase systems, the neutral pole of which is connected to earth, either direct or through added resistance, pressure shall be deemed to be that which is maintained between the phase conductor and the neutral. The insulation resistance measured as above shall not be less than 50 mega ohms divided by the number of points provided on the circuit the whole installation shall not have an insulation resistance lower than one mega ohm.

The insulation resistance shall also be measured between all conductors connected to one phase conductor of the supply and shall be carried out after removing all metallic connections between he two poles of the installation and in those circumstances the insulation shall not be less than that specified above.

The insulation resistance between the frame work of housing of power appliances and all live parts of each appliance shall not be less than that specified in the relevant Standard specification or where there is no such specification, shall not be less than half a Mega ohm or when PVC insulated cables are used for wiring 12.5 Mega ohms divided by the number of outlets. Where a whole installation is being tested a lower value than that given by the above formula subject to a minimum of 1 Mega ohms is acceptable.

10.4 TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor including metal conduits and metallic envelopes of cable in all cases shall be tested for electric continuity and the electrical resistance of the same alongwith the earthing lead but excluding any added resistance of earth leakage circuit breaker measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.

10.5 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 connected to the same conductor throughout, and such conductor shall be labeled or marked for connection to an outer or phase conductor or to the non-earthed conductor of the supply. In the three of four wire installation, a test shall be made to verify that every non-linked single pole switch is fitted to one of the outer or phase conductor of the supply. The entire electrical installation shall be subject to the final acceptance of the Engineer-In-Charge as well as the local authorities.

10.6 EARTH RESISTIVITY TEST

Earth resistivity test shall be carried out in accordance with latest IS Code of Practice for earthing.

10.7 PERFORMANCE

Should the above tests not comply with the limits and requirements as above the contractor shall rectify the faults until the required results are obtained. The contractor shall be responsible for providing the necessary instruments and subsidiary earths for carrying out the tests. The above tests are to be carried out by the contractor without any extra charge.

10.8 TESTS AND TEST REPORTS

The Contractor shall furnish test reports and preliminary drawings for the equipment to the Engineer-In-Charge for approval before commencing supply of the equipment. The Contractor should intimate with the tender the equipment intended to be supplied with its technical particulars. Any test certificates etc., required by the local Inspectors or any other Authorities would be supplied by the Contractor without any extra charge. All test reports shall be approved by the Engineer-In-Charge prior to energizing of installation.

2. MEDIUM VOLTAGE DISTRIBUTION BOARDS

1) GENERAL

This section covers specification of DBs.

2) STANDARDS AND CODES

The latest and amended upto date Indian Standard Specifications and Codes of Practice will apply to the equipment and the work covered by the scope of this contract. In addition the relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and/or IEC Standards shall be applicable.

3) MINIATURE CIRCUIT BREAKERS

The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system.

The MCB's shall have a rupturing capacity of 10 KA at 0.5 p.f.

The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with XLPE cable characteristic.

Type test certificates from independent authorities shall be submitted with the tender.

4) FINAL DISTRIBUTION BOARDS

Final distribution boards shall be prewired type flush mounting, totally enclosed, double door, dust and vermin proof with built in loose wire box and shall comprise of miniature circuit breakers, earth leakage circuit breakers, neutral link etc as detailed in the schedule of quantities.

The distribution equipment forming a part of the Distribution Boards shall comply with the relevant Standards and Codes of the Bureau of Indian.

The board shall be fabricated from 16 gauge CRCA sheet steel and shall have a hinged lockable spring loaded cover. All cutouts and covers shall be provided with synthetic rubber gaskets. The entire construction shall give an IP 43 (double door and four tier arrangement) degree of protection.

The bus-bar shall be of electrical grade copper having a maximum current density of 1.6 ampere per square mm and PVC insulated throughout the length. The minimum spacing between phases shall be 25 mm and between phase and earth 19 mm

Separate neutral link for each phase shall be provided.

Separate earth link for each phase shall be provided.

All the internal connections shall be with either solid copper PVC insulated or copper conductor PVC insulated wires of adequate rating.

The equipment shall be mounted on a frame work for easy removal and maintenance.

The sheet steel work shall undergo a rigorous rust proofing process, two coats of filler oxide primer and final powder coated paint finish.

All the circuits shall have an independent neutral insulated wire, one per circuit, and shall be numbered and marked as required by the Engineer-In-Charge.

A sample of the completed board is to be got approved by the Engineer-In-Charge before commencement of supply and erection.

Before commissioning, the distribution boards shall be megger tested for insulation and earth continuity.

5) **SHEET STEEL TREATMENT AND PAINTING**

Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulphuric acid and a recognized phosphate process. The steel work shall then receive two costs of oxide filler primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.

All sheet steel shall after metal treatment be given powder coated finish painted with two coats of approved shade on the outside and white on the inside. Each coat of paint shall be properly stove and the paint thickness shall not be less than 50 microns.

6) **NAME PLATES AND LABELS**

Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

3. MOULDED CASE CIRCUIT BREAKERS

1.1 GENERAL

Moulded case circuit breakers shall be incorporated in the switch board wherever specified. MCCB shall conform to IEC: 947-II or IS: 13947-II in all respects. MCCB shall be suitable for three phase 415 volts AC. Suitable discrimination shall be provided between upstream and down stream breakers in the range of 10-20 milli seconds. All MCCBs will have earth fault module (if specifically asked) and front operated. All four pole MCCB shall be suitable for three phase four wire system, with the neutral clearly identified and capable of first make last break feature.

1.2 CONSTRUCTION

The MCCB cover and case shall be made of high strength heat-resistant and flame retardant thermosetting insulating material, operating handle shall be quick make/quick break. The operating handle shall have suitable `ON' `OFF' and `TRIPPED' mechanical indicators notable from outside. All MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases. The MCCB should be suitable for disconnection and isolation with marking on front name plate.

Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be thermal-magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic tripping device shall have IDMT characteristics for sustained over load and short circuits. All MCCBs above 250 Amps will also have short circuit magnetic pickup level adjustment.

1.3 MCCBs

All MCCBs shall have variable thermal overload releases which can be adjusted at site.

Contact tips shall be made of suitable arc resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances. All MCCBs of higher ratings above 250 Amps shall be provided with separate extended arcing contacts.

1.4 INTERLOCKING

Moulded case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is in ON or OFF position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

1.5 BREAKING CAPACITY

The moulded case circuit breaker shall have a rated service. Short circuit breaking capacity of not less than 25 KA rms at 415 volts AC. Wherever required, higher breaking capacity breakers to meet the system short circuit fault shall be used.

1.6 ACCESSORIES

All the accessories like shunt, under voltage contact blocks shall be of snap fitting possible at site.

2 TESTING

a) Original test certificate of the MCCB shall be furnished.
b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

NOTE: All specifications for internal electrical works shall be read in compliance with ECBC 2007. All works to be carried out has to follow ECBC 2007.

EXTERNAL ELECTRICAL WORKS

TECHNICAL SPECIFICATIONS

A. MV CABLES

1 STANDARDS OF CODES

This chapter covers the specifications for supply and laying of Medium Voltage XLPE cables.

All equipments, components, materials and entire work shall be carried out in conformity with applicable and relevant Bureau of Indian Standards and Codes of Practice, as amended upto date. In addition, relevant clauses of the Indian Electricity Act 1910 and Indian Electricity Rules 1956 as amended upto date shall also apply. Wherever appropriate Indian Standards are not available, relevant British and /or IEC Standards shall be applicable.

2 CABLES

Medium voltage cables shall be aluminium conductor FR XLPE insulated, PVC sheathed armoured conforming to latest IS. Cables shall be rated for 1100 Volts.

All Conductor cables shall be as per BOQ.

Conductors shall be insulated with high quality FR XLPE base compound. A common covering (bedding) shall be applied over the laid up cores by extruded sheath of unvulcanised compound. Armouring shall be applied below outer sheath of PVC sheathing. The outer sheath shall bear the manufacturer's name and trade mark at every meter length. Cores shall be provided with following colour scheme of PVC insulation.

1 Core	:	Red/Black/Yellow/Blue
2 Cores	:	Red and Black
3 Cores	:	Red, Yellow and Blue
3 ½ /4 Core	:	Red, Yellow, Blue and Black

3 STORING, HANDLING, LAYING, JOINTING AND TERMINATION

3.1 STORING

All the cables shall be supplied in drums. On receipt of cables at site. It should be ensured that both ends of the cables are properly sealed to prevent ingress/absorption of moisture lay the insulation. The cables shall be inspected and stored in drums with flanges of the cable drum in vertical position. Whenever cable drums have to be moved over short distances, they should be rolled in the direction of the arrow, marked on the drum and while removing cables from the drums the drum shall be properly mounted on jacks or on a cable wheel or any other suitable means making sure the spindle, jack etc. are strong enough to take the weight of the drum.

3.2 LAYING

Cables shall be laid as per the specifications given below:

3.3 DUCT SYSTEM

Wherever specified such as road crossing, entry to building or in paved area etc. cables shall be laid in under ground ducts. The duct system shall consists of a required number of stone ware pipes, GI, CI or spun reinforced concrete pipe with simplex joints and all the jointing work shall be done according to the CPWD building specifications or as per the instructions of the Engineer-In-Charge as the case may be. The size of the pipe shall not be less than 100mm in diameter for a single cable and shall not be less than 150mm for more than one cable and so on. The pipe shall be laid directly in ground without making any special bed but wherever asbestos cement pipes are used, the pipes shall be encased in concrete of 75mm thick. The ducts shall be properly anchored to prevent any movement. The top surface of the cable ducts shall not be less than 60 cm. below the ground level. The ducts shall be laid a gradient of at least 1:300. The duct shall be provided manholes of adequate size at regular intervals for drawing the cables. The manhole cover and frame shall be of cast iron and machine finished to ensure a perfect joint. The manhole covers shall be installed flush with the ground or paved surfaces. The duct entry to the manholes shall be made leak proof with lead-wool joints. The ducts shall be properly plugged at the ends to prevent entry of water, rodents, etc. Suitable duct markers shall be placed along the run of the cable ducts. The duct markers shall at least be 15 cm. square embedded in concrete, indicating duct. Suitable cable supports made of angle iron shall be provided in the manholes for supporting the cables. Proper identification tags shall be provided for each cable in the manholes.

3.4 CABLES IN OUTDOOR TRENCHES

Cable shall be laid in outdoor trenches wherever called for. The depth of the trenches shall not be less than 75cm from the final ground level. The width of the trenches shall not be less than 45 cm. However, where more than one cable is laid, an axial distance of not less than 15 cm. shall be allowed between the cables. The trenches shall be excavated in reasonably straight line with vertical side walls and with uniform depth. Wherever there is a change in direction suitable curvature shall be provided complying with the requirements. Suitable shoring and propping may be done to avoid caving in of trench walls. The bottom of the trench shall be level and free from stone brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8 cm. in depth.

The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire cable length shall as far as possible be paved of in one stretch. However where this is not possible the remainder of the cable may be removed by "Flaking" i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted slightly over the rollers beginning from one end by helpers standing about 10 meters. apart and drawn straight. The cable should then be taken off the rollers by additional helpers lifting the cable and then laid in a reasonably straight line.

For short cut runs and sizes upto 50 sq.mm of cables upto 1.1 KV grade any other suitable method of direct handling and laying can be adopted with the prior approval of the Engineer-in-charge.

When the cable has been properly straightened, the cores are tested for continuity and insulation resistance and the cable length then measured. The ends of all cables shall be sealed immediately. In case of PVC cables suitable moisture seal tape shall be used for this purpose.

Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less 17 cms above the base cushion of sand before the protective cover is laid. In the case of vertical multi tier formation after the first cable has been laid, a sand cushion of 30 cms shall be provided over the initial bed before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30 cms as stated above. The top

most cable shall have final sand covering not less than 17 cms before the protective cover is laid.

Unless otherwise specified, the cables shall be protected by the second class bricks of not less 20 cms x 10 cms x 10 cms (nominal size) protection covers placed on top of the sand (bricks to be laid breadth wise) for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at 5 cm. over the sides of the end cables. The trenches shall be taken back filled with excavated earth free from stones or other sharp edge debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm, unless otherwise specified.

3.5 ROUTE MARKER

Cable route marker marked "Cable" shall be provided alongwith the route of the cable and location of loops. The route markers shall be of tapered concrete slab of 60 x 60cm at bottom and 50 x 50cm at top having a thickness of 10cm. Cable marker shall be mounted parallel to and 50cm away from the edge of the trench.

3.6 CABLES IN INDOOR TRENCHES

Cables shall be laid in indoor trenches wherever specified. The trench shall be made of brick masonry with smooth cement mortar finish with suitable removable covers (i.e. precast slabs or chequered plates). The dimensions of the trenches shall be determined depending upon the maximum number of cables that is expected to be accommodated and can be conveniently laid. Cables shall be arranged in tier formation in trenches and if necessary, cables may be fixed with clamps. Suitable clamps, hooks and saddles shall be used for securing the cables in position. Spacing between the cables shall not be less than 15 cm centre to centre. Wherever specified, trenches shall be filled with fine sand and covered with RCC or steel chequered trench covers.

3.7 CABLE ON TRAYS/RACKS

Cable shall be laid on cable trays/racks wherever specified. Cable racks/trays shall be of ladder,
Trough or channel design suitable for the purpose. The nominal depth of the trays/racks shall be 150 mm. The width of the trays shall be made of steel or aluminium. The trays/racks shall be completed with end plates, tees, elbows, risers, and all necessary hardware; steel trays shall be hot dip galvanized. Cable trays shall be erected properly to present a neat and clean appearance. Suitable cleats or saddles made of aluminium strips with PVC covering shall be used for securing the cables to the cable trays. The cable trays shall comply with the following requirements:

The tray shall have suitable strength and rigidity to provide adequate support for all contained cables.

a) It shall not present sharp edges, burrs or projections injurious to the insulation of wiring/cables.

b) If made of metal, it shall be adequately protected against corrosion or shall be made of corrosion resistant material.

c) It shall have side rails or equivalent structural members.

d) It shall include fittings or other suitable means for changes in direction and elevation of runs.

3.8 INSTALLATION

Cable trays shall be installed as a complete system. Trays shall be supported properly from the building structure. The entire cable tray system shall be rigid.

Each run of the cable tray shall be completed before the installation of cables.

In portions where additional protection is required, non combustible covers/enclosures shall be used

Cable trays shall be exposed and accessible.

Where cables of different system are installed on the same cable tray, non combustible, solid barriers shall be used for segregating the cables.

Cable trays shall be grounded by two nos., earth continuity wires. Cable trays shall not be used as equipment grounding conductors.

3.8.1 JOINTING AND TERMINATION

Cable jointing shall be done as per the recommendations of the cable manufacturer. All jointing work shall be done only by qualified/licensed cable jointer.

All jointing pits shall be of sufficient dimensions as to allow easy and comfortable working.

Jointing materials and accessories like conductor, ferrules, solder, flex, insulating and protective tapes, filling compound, jointing box etc. of right quality and correct sizes, confirming to relevant Indian Standards.

Each termination's shall be carried out using brass compression glands and cable sockets. Hydraulic crimping tool hall be used for making the end terminations. Cable gland shall be bonded to the earth by using suitable size copper wire /tape.

3.9 TESTING

Cable jointing shall be tested at factory as per the requirements of latest IS amendment upto date. The tests shall incorporate routine tests, type tests and acceptance tests.

Cable shall be tested at site after installation and the results shall be submitted to the Engineer-In-Charge.
Insulation resistance between conductors and neutral and conductors and earth.
Pressure test for 15 minutes.

B. EARTHING

GENERAL

This section covers the general arrangement of the earthing, i.e. all non-current carrying metal parts of the electrical installation shall be earthed as per latest IS code and general specifications for electrical works (part-1, internal) of CPWD specifications. All metal conduits, turnings, cable sheaths, switchgear, distribution boards, meters, light fixtures, fans and all other metal parts forming part of the work shall be bonded together and connected by two separate and distinct conductors to earth electrodes. Earthing shall also be in conformity with the provisions of Rule 32, 61, 62, 67 and 88 of IER 1956. The earth electrode shall not be situated less than 1.5 meters.

EARTHING SYSTEMS

It shall comprise of earth electrodes, earth strips, earth continuity conductor and all earthing conductors shall be of high conductivity copper, GI or aluminium and shall be protected against mechanical damage and corrosion. The size of earth conductors shall not be less than half that of the largest current carrying conductor. The connection of earth continuity conductors of earth bus and earth electrodes shall be strong and sound and shall be rigidly fixed to the walls, cable trenches, cable trays or conduits and cable by using suitable clamps made of non ferrous metals.

EARTHING ELECTRODES

Earthing electrodes shall be designed as per the requirement of latest IS codes. The number and size of earth electrodes shall be calculated so that under fault conditions no electrode is loaded above its maximum permissible current density. The resistance of earth electrode shall be as low as possible, the maximum allowable value being one ohm.

Earthing electrodes of either plate type or pipe type may be adopted. The choice of plate or pipe electrode shall be decided according to the anticipated fault level of the network and local soil conditions. Generally, plate electrodes shall be used for substations and large medium voltage network and pipe electrodes for small medium voltage network and installations.

1.1 LOCATION OF EARTH ELECTRODES

Normally on earth electrode shall not be situated less than 1.5 mtr from any building. Care shall be taken that the excavation for earth electrode may not affect the column footings or foundation of the buildings. In such cases electrodes may be further away from the building.

The location of the earth electrode will be such where the soil has reasonable chance of remaining moist. As far as possible, entrances, pavements and road ways, are to be definitely avoided for locating earth electrode.

1.2 WATER ARRANGEMENT

Method of watering arrangement shall comply with CPWD General Specifications.

1.3 PLATE ELECTRODE

Plate electrodes shall be made of GI plate of 6 mm thick and 60x60 cm. size. The plate shall be buried vertically in ground at depth of not less than 3.5 meters to the top of the plate, the plate being encased in charcoal to a thickness of 15 cm. all round. It is preferable to bury the electrode to a depth where sub-soil water is present. Earth leads to the electrode shall be laid in a GI pipe and connected to the plate electrode with GI bolts, nuts and washers. A GI pipe of not less than 19 mm Dia shall be placed vertically over the plate and terminated in a funnel at 5 cm. above ground. The funnel shall be provided with a wire mesh. The funnel shall be enclosed in masonry chamber of 100 x 50 cm. dimensions. The chamber shall be provided with CI frame cover of 100 x 50 cm size. The earth station shall also be provided with a suitable permanent identification label/tag.

Note: If copper plate is used it shall be of 3mm thickness.

1.4 Pipe electrode shall comprise of a 2.5 Meter. Long 40 mm Dia GI pipe buried vertically in a pit of 35 x 35 cm size and filled with alternate layers of charcoal, salt and river sand and connected at the top to a GI pipe of 19 mm, 1 Meter. Long with a funnel at the other end, 5 cm above the ground. The earth lead shall be properly fixed to the pipe electrode with brass bolts, nuts and washers. The funnel and earth lead connections shall be enclosed in a masonry chamber of 30 x

30 x 30 cm. dimensions. The chamber shall be provided with a CI frame and CI cover. Proper permanent identification tag/label shall be provided for each electrode.

INSTALLATION

All joints shall be reverted and sweated. Joints in the earth bar shall be bolted and the joints faces tinned. Where the diameter of the bolt for connecting earth bar to apparatus exceeds one quarter of the width of the earth bar, the connection to the bolt shall be made with a wider piece of flange of copper jointed to earth bar. These shall be tinned at the point of connection and special care taken to ensure a permanent low resistance contact to iron or steel. All steel bolts, nuts, washers, etc shall be cadmium plated. Main earth bars shall be spaced sufficiently away from the surface to which they are fixed, such as walls or the side of trenches to allow for easy connections. Copper earth bars shall not be fixed by ferrous fittings. The earthing shall be suitably protected from mechanical injury by galvanized iron within ground shall be buried at least 60 cm deep. The earthing lead shall be securely bolted and soldered to the plate or pipe as the case may be. In the case of the plate, the lead shall be connected by means of cable socket with two bolts and nuts. All washers shall be of the same materials as the plate or pipe. All iron bolts, nuts and washers shall be galvanized.

1.1 METHOD OF INSTALLATION OF WATERING ARRANGEMENT

In the case of plate earth electrode a watering pipe of 20 mm Dia of medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top for watering the pit. In case of pipe earth electrode a 40 mm x 20 mm reducer shall be used for accessing the funnel. The watering funnel attachment shall be housed in masonry enclosure of not less than 30 cm x 30 cm x 30 cm. A cast iron cover having locking arrangement shall be suitably embedded in the masonry enclosure.

PRECAUTIONS

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after passages of fault currents.

Joints shall be soldered, tinned and double riveted. All the joints shall be mechanically and electrically continuous and effective. Joints shall be provided against corrosion.

The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a 15 mm Dia GI pipe in case of wire and by 40 mm Dia medium class GI pipe in case of strips. Portion of this protection pipe within the ground shall be buried at least 30 cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floor to adequate depth.

TESTING

On the completion of the entire installation, the following tests shall be conducted and no earth electrode shall have ohmic resistance of more than 2 ohm and in rocky soil not more than 3 ohms.

a) Earth resistance of electrodes

b) Impedance of earth continuity conductors as per IEE regulations.

c) Effectiveness of earthing as per IEE regulations.

All meters, instruments and labour required for the tests shall be provided by the contractor. The test results shall be submitted in triplicate to the Architects for approval.

C. EXTERNAL LIGHTING

The specification covers the supply, installation, testing and commissioning of the following items (as specified in BOQ):

i) Street/Boundary lighting poles complete with all accessories e.g. looping box, clamps MCBs and required hardware etc.

ii) Street/boundary lighting fixtures complete with all accessories e.g. lamps, holders, choke, upto terminal box etc.

iii) Wiring of street light fixtures.

iv) Cable lying, earthing and inter connection. G.I. pipes for cable entry to looping box.

v) Foundation of poles and erection.

vi) All the items should be tested and installed as per the latest Indian standards specifications and all the sundry items such as clamps, bolts, nuts, racks, support miscellaneous wiring etc., required to make the installation complete shall be taken care while quoting the major items.

STEEL TUBULAR POLE

The poles for street lighting purpose shall be complete in all respects and shall confirm to Latest IS unless otherwise specified. All poles shall be complete with base plate of 400 mm x 400 mm x 10 mm thick welded to bottom. The poles shall be provided terminal box for looping in and looping out of cables and shall consists MCB as specified. The looping box shall be suitable for outdoor installation and complete with all hardware such as clamp, bolts, earthing studs, lockable door etc. and shall be paint also in the same manner as specified for poles. The poles shall be provided with two numbers of GI pipes of suitable Dia for cable entry as shown in drawing. The poles shall be painted with two coats of red oxide primer on both outside and the portion of the pole below the ground before erection and two coats of aluminium paint of approved shade after erection over the exposed portion.

ERECTION OF POLE

While loading, transporting, unloading and erecting the poles care shall be taken so that the poles do not get bent. Out of shape and where necessary such defects shall be rectified before the poles are erected in position. The poles shall be erected in plumb line and correct level as indicated in the drawing and to the satisfaction of the Engineer-in-charge. They shall be kept in this position with the help of manila ropes until the foundation is constructed (for a minimum period of 10 days) and the back filling is complete. Foundation shall be made with reinforced cement concrete (1:2:4) and not less than 200 mm thick all round. The pole base plate shall be fixed over 150 mm thick concrete bed. Foundation shall be continued upto 300 mm or more above ground level as per location of the pole to avoid ingress of water logging etc. The foundation shall be tapered suitably into a collar. The excavated portion shall be filled back with earth and consolidated. The cement concrete foundations shall be cured properly by covering the same with water soaked or moist gunny bags at least two weeks before loading the pole.

ERECTION OF LIGHT FIXTURES

Each light fixture shall be connected to the supply through MCB of a suitable rating mounted in The looping box. The fitting shall be fixed to the pole properly and securely.

WIRING OF LIGHT FIXTURES

The wiring of lighting fixtures from terminal block by means of 2.5 Sq.mm PVC insulated two Core copper conductor through a suitable rated MCB and neutral. Cost of two core connecting Cable from junction box to lighting fixture and earth wire complete with connections are Included in the quoted rate.

CABLING WORKS

All cable installation work shall be done as per relevant clauses of section cable work.

TESTS

Before handing over the installation, tests on all fittings and cables shall be carried out as per IS specification.

The tests shall include:

- Meggar test
- Continuity test
- Polarity test and phase sequence test

D. MEDIUM VOLTAGE PANELS:

1. GENERAL

Medium voltage power control centers (generally termed as switchboard panels) shall be in sheet steel clad cubicle pattern, free floor standing, totally enclosed, compartmentalized design having multitier arrangement of the incomers and feeders as per details given in the schedule of quantities. All panels shall conform to the requirements of the latest addition of IS and shall be suitable for 415 V, 3 phase AC supply or 230 V single phase AC supply as required.

2. CONSTRUCTIONAL FEATURES

The Switch Boards shall be totally enclosed, sheet steel cubicle pattern, extensible on side, dead front, floor mounting type (wall mounting if specifically asked for in BOQ) and shall have a bus bar chamber at the top and the cable entry from the bottom. (For panel requiring top cable entries if any, refer to BOQ). The cable terminations should be in side the feeder compartment only.
The Switch Boards shall be completely dust and vermin proof. Synthetic rubber gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust and vermin proof to provide a degree of ingress protection of IP 43. All doors and covers shall also be fully gasketed with synthetic rubber. All the live parts shall be properly shrouded with FRP sheets.

The Switch Board shall be fabricated with CRCA Sheet Steel of thickness not less than 2.0mm and shall be folded and braced as necessary to provide a rigid support for all components. The doors and covers shall be constructed from CRCA sheet steel of thickness not less than 1.6 mm. Joints of any kind in sheet metal shall be seam welded and all welding slag ground off and welding pits wiped smooth with plumber metal. Base channel shall be fabricated from ISMC 75 and door shall be provided at the bottom with arrangement for fixing bolts in the foundation.

All panels and door covers shall be properly fitted and square with the frame. The cutouts in the panel shall be correctly positioned.

Lifting lugs of adequate strength shall be provided on each transport section of the panels.

Fixing screws shall enter holes tapped into an adequate thickness of metal or provided with hank nuts. Self threading screws shall not be used in the construction of the Switch Boards.

3. SWITCHBOARD DIMENSIONAL LIMITATIONS

A base channel 75 mm x 5 mm thick shall be provided at the bottom.

The overall height of the Switch Board shall be limited to 2200 mm

The height of the operating handle, push buttons etc shall be restricted between 300 mm and 1900 mm from finished floor level.

4. BUS BARS

The bus bars shall be suitable for 4 wire, 415 volts, 50 Hz, system. The main bus bar shall be made of high conductivity electrolytic grade AL 91E Aluminium. The bus bars shall have uniform cross section throughout the panel. The bus bars shall be capable of carrying the rated current at 415 volts continuously. The bus bar will run in a separate bus bar chamber using bus insulators made of non-deteriorating, vermin proof, non hygroscopic materials such as epoxy fiber, reinforced polyester or molding compound (min. 25mm clearance between phase to phase & phase to neutral bus bars shall be provided). The interval between the two insulators will be designed after considering the following:

a) Strength and safe load rating of the insulator,
b) The vibrating force generated during a fault,
c) A Factor of safety of 1.25
d) A set of insulators at both ends of the bus.

Bus bars shall be sized considering maximum current density of 1 Amps/ cross section Sq.mm area. The size of the bus bar calculations must be approved by the consultants. The bus bars shall be designed to withstand a temperature rise of 45^{o}C above the ambient. To limit the temperature rise in the bus bar chamber a set of louvers can be provided at strategically places considering the air circulation.

All the bus bars shall be insulated with PVC heat shrinking sleeves throughout (except at joints) the length of the panel. The electro-galvanized high tensile steel nuts, bolts, plain or spring washers of suitable size will be used in connecting the various sections of the bus bars.

5. SWITCH BOARD INTERCONNECTIONS

All connections between the bus bars/Breakers terminations shall be through solid Aluminium strips of adequate size to carry full rated current which shall be PVC/fiber glass insulated.

For switch unit ratings upto 63A PVC insulated copper conductor wires of adequate size to carry full load current can be used. The terminations of all such interconnections shall be properly crimped.

6. CABLE TERMINATIONS

Knockout holes of appropriate size and number shall be provided in the Switch Board in conformity with the location of incoming and outgoing conduits/cables. All cable entries shall be from bottom until & unless specifically asked for in the BOQ.

The cable terminations of the circuit breakers shall be brought out to terminal cable sockets suitably located in the panel.

All outgoing links for FSU\MCB feeders shall be in the feeder compartment only.

The Switch Boards shall be complete with tinned brass cable sockets, tinned brass compression glands, gland plates, supporting clamps and brackets etc for termination of 1100 volt grade aluminium conductor PVC cables.

7. EARTHING

The panels shall be provided with an aluminium earth bus of suitable size running through out the length of the switchboard. Suitable earthling eyes/bolts (at min. two points) shall be provided on the main earthing bus to connect the same to the earth grid at the site. Sufficient number of star washers shall be provided at the joints to achieve earth continuity between the panels and the sheet metal parts.

8. INTERLOCKING

The panels shall be provided with the following interlocking arrangement.

The door of the switch-fuse compartments is so interlocked with the switch drive or handle that the door can be opened only if the switch is in `OFF' position. De-interlocking arrangement shall also be provided for occasional inspection.

It shall not be possible for the breaker to be withdrawn when in `ON' position.

It shall not be possible for the breakers to be switched on unless it is either in fully inserted positions or for testing purposes in fully isolated position.

The breaker shall be capable of being raked in to `testing' `isolated' and `maintenance' positions and kept locked in any of these position.

A safety latch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the cubicle shall be provided.

9. WIRING

All wiring for relays and meters shall be with PVC insulated copper conductor wires. The wiring shall be coded and labeled with approved ferrules for identification. The minimum size of copper conductor control wires shall be 1.5 sq.mm except for the circuits related to current transformers or circuits with current carrying capacity more than 5 Amps (for which min. 2.5 Sq.mm copper conductor wires shall be used).

10. SHEET STEEL TREATMENT AND PAINTING

Sheet Steel materials used in the construction of these units should have undergone a rigorous rust proofing process comprising of alkaline degreasing, descaling in dilute sulfuric acid and a recognized phosphate process. The steel work shall then receive two coats of oxide primer before final painting. Castings shall be scrupulously cleaned and fettled before receiving a similar oxide primer coat.

All sheet steel shall after metal treatment shall be powder coated with shade RAL 7032 (Siemens Gray) on the outside of the panel and mounting plates shall be of orange shade. Each coat of paint shall be properly stove and the paint thickness shall not be less than 50 microns (shade of paint may be changed if the Engineer In charge so desires).

11. NAME PLATES AND LABELS

Suitable engraved white on black name plates and identification labels of metal for all Switch Boards and Circuits shall be provided. These shall indicate the feeder number and feeder designation.

12. INSTALLATION

Installation shall be done by erection Contractor.

13. TESTING AND COMMISSIONING

Copies of type tests and routine test as per relevant specification, carried out at manufacturer’s work shall be submitted to the ENGINEER IN CHARGE as required.

Wiring and connections including earthing shall be checked for continuity and tightness.

Insulation shall be measured with a 500 V mugger and insulation resistance shall not be less than 100 Mega ohms

Interlocking operation to be checked as per requirement.

Tests shall be performed in presence of authorized representative of the ENGINEER IN CHARGE for which the contractor shall give due prior notice.

14. HIGH VOLTAGE TEST

A high voltage test with 2.5 KV for one minute shall be applied between the poles and earth. Test shall be carried out on each pole in turn with the remaining poles earthed, all units raked in position and the breakers closed. Original test certificate shall be submitted along with panel.

15. PRE-COMMISSION TESTS:

Panels shall be commissioned only after the successful completion of the following tests. The tests shall be carried in the presence of Architect's/Consultant's or their representatives.

- All main and auxiliary bus bar connections shall be checked and tightened.
- All wiring termination and bus bar joints shall be checked and tightened.
- Wiring shall be checked to ensure that it is according to the drawing.
- All wiring shall be tested for insulation resistance by 1000 volts Meggar.
- Phase rotation tests shall be conducted
- All relays and protective devices shall be tested for correctness of settings and operation by Introducing a current generator and an ammeter in the circuit.

16. CLIMATIC CONDITIONS

The panels & switch gear components shall be suitable for following climatic conditions:

	Maximum	Minimum
DBT	$45^{O}C$	$3^{O}C$
RH	90%	20%

17. HEATING ARRANGEMENT

The panel shall be provided with a thermostatically controlled heating arrangement for monsoon (200 Watt) to take care of high humidity conditions. A 6/16A service socket outlet (single phase) shall be provided in one of the compartments in all the panels.

E. METERING, INSTRUMENTATION AND PROTECTION

The specifications hereinafter laid down shall cover all the meters, instrumentation and protective devises required for the electrical work. The ratings, type and quantity of meters, instruments and protective devices shall be as per the schedule of quantities and drawings.

1 MEASURING INSTRUMENTS

GENERAL

Direct reading electrical instruments shall be in conformity with IEC-51, BS: 89 or IS: 1248. The accuracy of direct reading shall be 1.0 for voltmeters and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The error due to variations in temperature shall be limited to a minimum. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The design and manufacture of the meters shall ensure the prevention of fogging of instrument glass. Instrument meters shall be sealed in such a way that access to the measuring element and to the accessories within the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale marking. The pointer shall be black in colour and shall have zero position adjustment device which could be operated from outside. The direction of deflection shall be from left to right. Suitable selector switches shall be provided for all ammeters and voltmeters intended to be used on three phase supply.

a) Ammeters

Ammeters shall be moving iron type. The moving part assembly shall be with jewel bearings. The jewel bearing shall be mounted on a spring to prevent damage to pivot due to vibrations and shocks. The ammeters shall be manufactured and calibrated as per the latest edition of IS 1248 or BS 89. Ammeters shall be instrument transformer operated, and shall be suitable for 5 A. Secondary of instrument transformer. The scales shall be calibrated to indicate primary current, unless otherwise specified. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy.

b) Voltmeters

Voltmeter shall be of moving iron type. The range for 400 volts, 3 phase voltmeters shall be to 0 to 500 volts. Suitable selector switch shall be provided for each voltmeter to read voltage between any two lines of the system. The voltmeter shall be provided with protection fuse of suitable capacity.

2 INSTRUMENT TRANSFORMERS

Current Transformers

Current transformers shall be in conformity with IS: 2705 (Part-I, II, & III) in all respects. All current transformers to be used in the L.T. Electrical panels shall be low tension, ring type resin cast current transformer with the requisite currents ratio having secondary of the current transformers selected will be based on the following;

1. for energy measuring: 1.0 class of accuracy.

2. for other metering: 1.5 class of accuracy.

3. For protects on: 3.0 class of accuracy. Where a common CT is used for different functions the CT accuracy class will be equal to the best class required by any of those function.

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault of 35 MVA on medium voltage system. Terminals of the current transformers shall be marked permanently for easy identification of poles. Current transformers

shall be provided with earthing terminals for earthing chassis frame work and fixed part of the metal casing (if any). Each CT shall be provided with rating plate indicating the following:

1. Name and make
2. Serial Number
3. Transformation ratio
4. Rated burden
5. Rated voltage
6. Accuracy class

The current transformers to be selected for this panel will have at least 20% extra VA capacity available over the normal capacity based on the following details;

1. for ammeters: 3 VA
2. for current coils of KW & KWHR, PF, and KVAR meters or for all recorders: 5 VA.
3. for normal wiring: 2 VA.
4. for current coil of protection relays: 10 VA under; no circumstances the VA rating of the CT's will be less than 15 VA.

Current transformers shall be mounted such that they are easily accessible for inspection, maintenance and replacement. The wiring for CT’s shall be copper conductor, PVC insulated wires with proper termination lugs and wiring shall be bunched with cable straps and fixed to the panel structure in a neat manner.

3 CONTROL DEVICES

a) Push Buttons

The push buttons used in the panels will be rated for more than 415 volts and 2 amps. All the push buttons will be mounted on the front door and the assembly will be in two parts. All the push buttons will be mounted on the front door of the cubicle in regular symmetrical fashion as per the general norms being practiced. Only one make of push buttons will be used in the assembly of all the panels. The selection of the colour of the push buttons will be as follows

Function	Colour
Starting/Switching ON	Green
Stopping/Switching OFF	Red
Resetting	Black
Forward ON	Yellow
Reverse ON	Blue
Emergency OFF	Red/Mushroom

b) Indicating Lights

The indicating lights used in the panel will be pleasant looking and round shape having the following features;

1. A separate front lens for it's easy replacement.
2. Facility to replace the bulb from the front.
3. Bayonet pin cap bulbs of standard size to be used.
4. The shape of the lens to allow viewing from sides.
5. Series resistance with use of low voltage bulb for longer life.

6. Clear and distinct indication for light ON and OFF with differences of brightness of the lens.

The selection of the colors of the indicating lamps will be as follows:

- Red for system in operation
- Amber for system ready for operation.
- Green for system being put off.
- Red, yellow and blue for incoming supply.

4 TESTING

Instrument transformers shall be tested at factory as per IS: 2705 & IS: 3156. The test shall incorporate the following:

a) Type tests
b) Routine tests

Original test certificates in triplicate shall be provided.

Meters shall be tested as per IS: 1248. The tests shall include both type tests and routine tests. Original test certificate in triplicate shall be furnished.

a) Suitable injection tests shall be applied to the secondary circuit of every instrument to establish the correctness of calibration and working order.

b) All relays and protective devices shall be tested to establish correctness of setting and operation by introducing a current generator and an ammeter in the circuit.

F. MINIATURE CIRCUIT BREAKERS

The MCB's shall be of the completely moulded design suitable for operation at 240/415 Volts 50 Hz system. MCB’s shall be quick make and break type conforming to relevant IS. Housing shall be heat resistant and have high impact strength. MCB’s shall be flush mounting type and shall be provided with trip free manual operating liver with ON/OFF indications

MCB’s shall be provided with magnetic thermal releases for over current and short circuit protection. The overload or short circuit device shall have a common trip bar in case of DP and TPN MCB’s. The MCB's shall have inverse time delayed thermal overload and instantaneous magnetic short circuit protection. The MCB time current characteristic shall coordinate with H.R.C. fuse/PVC cable characteristic.

The MCB's shall have a minimum breaking capacity of 10 kA at 230/415 volts in accordance with IEC: 898 - 1995 and IS: 8828 - 1996

G. MOULDED CASE CIRCUIT BREAKERS

1 GENERAL

Moulded case circuit breakers shall be incorporated in the switch board wherever specified. MCCB shall conform to IEC: 947-II or IS: 13947-II in all respects. MCCB shall be suitable for three phase 415 volts AC. Suitable discrimination shall be provided between upstream and down stream breakers in the range of 10-20 milli seconds. All MCCBs will have earth fault module (if

specifically asked) and front operated. All four pole MCCB shall be suitable for three phase four wire system, with the neutral clearly identified and capable of first make last break feature.

2 CONSTRUCTION

The MCCB cover and case shall be made of high strength heat-resistant and flame retardant thermosetting insulating material, operating handle shall be quick make/quick break. The operating handle shall have suitable `ON' `OFF' and `TRIPPED' mechanical indicators notable from outside. All MCCBs shall have a common operating handle for simultaneous operation and tripping of all the three phases. The MCCB should be suitable for disconnection and isolation with marking on front name plate.

Suitable arc extinguishing device shall be provided for each contact. Tripping unit shall be thermal-magnetic type provided on each pole and connected by a common trip bar such that tripping of any one pole operates all three poles to open simultaneously. Thermal magnetic tripping device shall have IDMT characteristics for sustained over load and short circuits. All MCCBs above 250 Amps will also have short circuit magnetic pickup level adjustment.

All MCCBs shall have variable thermal overload releases which can be adjusted at site.

Contact tips shall be made of suitable arc resistant, sintered alloy for long electrical life. Terminals shall be of liberal design with adequate clearances. All MCCBs of higher ratings above 250 Amps shall be provided with separate extended arcing contacts.

INTERLOCKING

Moulded case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

Handle interlock to prevent unnecessary manipulations of the breaker.

Door interlock to prevent the door being opened when the breaker is in ON or OFF position.

Defeat-interlocking device to open the door even if the breaker is in ON position.

BREAKING CAPACITY

The moulded case circuit breaker shall have a rated service. Short circuit breaking capacity of not less than 25 KA rms at 415 volts AC. Wherever required, higher breaking capacity breakers to meet the system short circuit fault shall be used.

ACCESSORIES
All the accessories like shunt, under voltage contact blocks shall be of snap fitting possible at site.

TESTING

Original test certificate of the MCCB shall be furnished.

Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

NOTE: All specifications for external electrical works shall be read in compliance with ECBC 2007. All works to be carried out has to follow ECBC 2007.

LIGHTNING PROTECTION

TECHNICAL SPECIFICATIONS

The lightning protection system shall be of the enhanced type which is designed to attract lightning to a preferred point and safely convey the lightning energy to ground with minimal risk of side flashing via a predetermined route.

The complete lightning protection system will comprise the following key components.

a. Lightning ESE Air Terminal
b. Mounting support
c. Down conductor - HVSC
d. Lightning Strike Recorder
e. Advance Chemical Gel Earthing

A) LIGHTNING AIR TERMINAL

1) The lightning air terminal shall be an Early Streamer Emission Terminal which will respond dynamically upon leader activity in the near area.

2) The ESE Air terminal shall be tested and certified in accordance with the French National Standard – NF C 17-102 & as per IEC 60-1:1989, the ESE air terminal should successfully withstand minimum 4 current impulse equivalent to 150 KA (8/20 micro sec waveform)

3) As per NF C 17 – 102, the ESE air terminal should be tested with the “Switching Impulse Voltage” of 700 KV & “Direct Voltage” of 70 KV

4) The ESE lightning air terminal shall be configured as a spheroid which is comprised of separate electrically isolated panels surrounding an earthed central finial.

5) The insulation material used to electrically isolate the panels shall be comprised of a base polymer which provides high ozone and UV resistance with a dielectric strength of 24 – 38 KV/mm.

6) The external shape of the advanced lightning rod shall be such that it will limit the development of sharp point corona discharge under static thunderstorm conditions.

7) The central finial shall be elevated above the spheroid to a length of 90mm.

8) The upper section of the central finial shall be rated to withstand 200KA.

9) An air gap shall be provided between the individual electrically isolated panels (4 panels) and the finial tip of the central rod.

10) Arcing shall occur between the panel sections of the spheroid and the finial tip only upon the progression of a lightning leader.

11) The ESE air terminal shall have no moving parts, no electronic circuits and will have no dependence on external power supply or batteries.

12) Under a normal atmosphere all components of the advanced lightning terminal (ESE) shall be non corroding.

13) The ESE air terminal shall be insulated from all surrounding points and structure being protected.

14) The ESE air terminal shall be tested and certified from CPRI (Central Power Research Institute, Govt of India) with the minimum Impulse current of 45KA (8/20 micro sec) for the positive & negative impulse (5 shots each). After the test, the ESE terminal should not be found any degradation or any damage.
15) The ESE air terminal shall be approved from DGMS (Director General of Mines Safety) Govt of India.

B) MOUNTING SUPPORT OF LIGHTNING AIR TERMINAL

1) The mounting pole used to support the lightning air terminal shall be a circular insulated FRP (2 meters), Inline coupling unit and G.I mast of minimum height of 2 meters.

2) The mounting pole and supports shall be securely fixed with brackets and guy wires where required.

3) DOWN CONDUCTOR - (HIGH VOLTAGE SHIELDED CABLE)

4) The High Voltage Shielded Cable shall consist of a Core Filler, Stranded Copper Conductor, Insulation material, Outer Copper conductor with external conductive sheath.

5) The main copper conductor within the High Voltage Shielded Cable shall have a minimum cross sectional area of 50 sq.mm.

6) The outer diameter of the High Voltage Shielded Cable shall be less than 38mm.

7) The High Voltage Shielded Cable shall have a maximum inductance of 25nH/m.

8) The main copper conductor shall allow for direct connection to the Lightning Rod (Air Terminal) through the use of compression lug.

9) The High Voltage Shielded Cable shall be tested as per IEC 600601, 2nd edition, 1989-11

10) The High Voltage Shielded Cable shall withstand the Lightning Impulse Voltage of minimum 200KV (positive polarity) and 250 (negative polarity)

11) The High Voltage Shielded Cable shall be installed as per manufacturer's instructions and shall not be subjected to bends of less than 0.6 meters radius.

C) LIGHTNING STRIKE RECORDER

1) The Lightning systems shall be installed complete with the lightning strike recorder.

2) The lightning strike recorder shall contain a mechanical 6 digit display which will register all lightning discharges with a sensitivity of 1500A 8/20 µs peak current impulse.

3) The lightning strike recorder shall be housed in a IP 65 rated enclosure and will operate without reliance on batteries or an external power source.

4) As per IEC 60-1:1989, the lightning strike recorder should withstand a maximum current impulse equivalent to 450 KA (8/20 micro sec waveform)

D) ADVANCE CHEMICAL GEL EARTHING

E) EARTH ELECTRODE:

1) The Electrode shall be of GI construction Dual Pipe technology.

2) The chemical earth electrode should have been tested in CPRI (Central Power Research Institute) for Peak & RMS current.

3) The Electrode shall be surrounded by resistance lowering grounding minerals to increase the overall conductive surface area in order to lower the ohmic value and also to minimize the corrosion process.

4) The Electrode shall be highly conductive and non-corrosive.

5) The Electrode should be able to carry the peak short circuit withstand current of minimum 50KA and duly tested and certified by CPRI.

6) Ohmic value should not be fluctuative.

7) Between the inner & outer pipes, it should be adequately filled with special composition of highly conductive metallic compound which will have the continuity for fast conduction & highly resistive to corrosion.

F) GROUND RESISTANCE IMPROVEMENT POWDER

1) The Ground Resistance Improvement Powder shall consist of a base electrolyte which when mixed with other compounds shall produce an earth gel of following properties:

2) A gelatinous mass within the surrounding ground soil which will not wash away.

3) Shall not contaminate ground water.

4) Shall not reduce, contract or separate from the accompanying electrode.

5) Shall be highly conductive and increase effective ground contact area.

6) Shall allow the effective dissipation of electrical surges and faults.

7) Shall be hygroscopic in nature and improve earth’s absorbing power and humidity retention capability.

8) Shall decrease the resistance of the earth.

9) Shall be maintenance free.

10) Shall maintain these properties for a span of min 20 years lifetime.

11) Use of common salt is prohibited.

12) Higher doses of compound may be used depending upon site conditions for optimum results in high resistance soil or rocky areas.

PLUMBING (INTERNAL & EXTERNAL)

TECHNICAL SPECIFICATIONS

PLUMBING/SANITARY WORKS:

1 GENERAL

The work shall be carried out in the accordance with the drawings and design as would be issued to the Contractor by the Design Consultant duly signed and stamped by him. The Contractor shall not take cognizance of any drawings, designs, specifications etc. not bearing Design Consultant signature and stamp. Similarly the Contractor shall not take cognizance of instructions given by any other Authority except the instructions given by the Engineer-In-charge in writing.

The work shall be executed and measured as per metric dimensions given in the Bill of Quantities, drawings etc.

The Contractor shall acquaint himself fully with the partial provisions for supports that may or may not be available in the structure and if are available then utilize them to the extent possible. In any case the Contractor shall provide all the supports regardless of provisions that they have been already made. Nothing extra shall be payable for situations where insert plates (for supports) are not available or are not useful.

Shop coats of paint that may be damaged during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with paint to match the finish over the adjoining shop painted surface.

The Contractor shall protect / handle the material carefully and if any damage occurred while handling by the Contractor then the sole responsibility shall be of the Contractor. Such damages shall be rectified/recovered by the Contractor at no extra cost whatsoever.

The Contractor shall, within twenty one (21) days of receipt of the Notice of Award for the Project, where applicable, complete the submission of shop drawings to the Engineer-In-charge for approval by the Design Consultants in order to conform to the contract schedule.

Preparation of shop drawings and approvals authorized body prior and after the execution of works as required.

This is the GMP contract, all the tenders should be sealed and the summary of quantities shall be based on Tender drawings, recheck and confirm. Nothing shall be paid extra to complete the work after the award of tenders. The vendor shall comply to all the documents of NBC/ IS/ TAC/ Local Fire Authority while quoting the tender.

Contractor to comply with the waste management plan (attached).

All measurements shall be taken in accordance with relevant IS codes, unless otherwise specified.

2 APPLICABLE CODES AND STANDARDS:

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practice given below as amended upto the date of submission of Tender. All equipment and material being supplied shall meet the requirements of BIS and other relevant standard and codes.

PLUMBING WORKS:

Vitreous Chinaware	-	IS:2556 - 1974 (Part - I)
	-	IS:2556 - 1981 (Part - II)
	-	IS:2556 - 2556 (Part - III)
Ball Valve	-	IS:1703 - 1977
Cistern Brackets	-	IS: 775 - 1970
Toilet Seat Cover	-	IS:2548 - 1983
Vitreous China Cistern	-	IS:2326 - 1987
Sand Cast Iron Pipes and Fittings	-	IS:1729 - 1979
Spun Cast Iron Pipes and Fittings	-	IS:3989 - 1984
GI Pipes	-	IS:1239 - 1979
Galvanizing for GI Pipes	-	IS:4736 - 1986
Pipe Threads	-	IS: 554 - 1985
Malleable Iron Fittings	-	IS:1879 - 1987
Cast Iron Sluice Valves	-	IS: 780 - 1984
Full Way Valves	-	IS: 778 - 1984
Brass Ferrule	-	IS:2692 - 1978
Stone Ware Gully Trap	-	IS: 651 - 1980
RCC Pipes	-	IS: 458 - 1971
Cast Iron Class LA Pipes	-	IS:1536 - 1989
Cast (Spun) Iron Fittings	-	IS:1538 - 1976
Pig Lead	-	IS: 782 - 1966
Induction Motors	-	IS:4691
Code for Measurements	-	IS:1200
UPVC Pipes and Fittings	-	IS:4984
Specification for Caulking Lead	-	IS:782
Code of Practice for laying of concrete	-	IS:783

3 QUALITY ASSURANCE AND QUALITY CONTROL:

The work shall conform to high standard of design and workmanship, shall be structurally sound and aesthetically pleasing. Quality standards prescribed shall form the backbone for the quality assurance and quality control system. In case quality standard prescribed does not appear in the quality standard, it shall be taken & considered as per relevant BIS/ International standard/ Manufacturer standard.

At the site, the Contractor shall arrange the materials and their stacking/ storage in appropriate manner to ensure the quality. Contractor shall provide equipment and manpower to test continuously the quality of material, assemblies etc. as directed by the Engineer-In-charge. The test shall be conducted continuously and the result of tests maintained. In addition the Contractor shall keep appropriate tools and equipment for checking alignments, levels, slopes and evenness of surface.

The Engineer-In-charge shall be free to carry out such tests as may be decided by him at this sole direction, from time to time, in addition to those specified in this Document or Requires by Statutory authority. The Contractor shall provide the samples and labour for collecting the samples. Nothing extra shall be payable to the Contractor for samples or for the collection of the samples.

The test shall be conducted at Standard Laboratory selected by Engineer-In-charge. Contractor shall keep the necessary testing equipment such as hydraulic testing machine, smoke testing machine, gauges and other necessary equipment required.

The Engineer-In-charge shall transport the samples to the laboratory.

Testing charges shall be borne by the Engineer-In-charge.

Testing may be witnessed by the Contractor or his Authorised Representative. Whether witnessed by the Contractor or not, the test results shall be binding on the Contractor.

Statutory approvals of drawing and installation of equipment shall be taken by the contractor, from statutory authority/TAC, as required.

4 SANITARY FIXTURES & C.P. FITTINGS:

SCOPE:

Work under this section shall consist of transportation, furnishing, installation, testing and commissioning and all labour as necessary as required to completely install all sanitary fixtures, brass and chromium plated fittings and accessories as required by the drawings and specified hereinafter or given in the Bill of Quantities. Or other vise considered essentials to make the installation complete in all respect.

GENERAL REQUIREMENTS

All fixtures and fittings shall be fixed with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Bill of Quantities, specifications, drawings or not.

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural design requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

Fixing screws shall be half round head chromium plated brass with C.P. washers wherever required as per directions of Engineer-In-charge.

All fittings and fixtures shall be fixed in a neat workmanlike manner true to levels and heights shows on the drawings and in accordance with the manufacturers recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, wall or ceiling surfaces shall be made good at Contractors cost.

All fixtures of the similar materials shall be by the same manufacturers.

All fittings shall be of the chromium plated materials.

Without restricting to the generally of the foregoing the sanitary fixtures shall include all sanitary fixtures, C.P. fittings and accessories etc. necessary and required for the building.

Whether specifically mentioned or not all fixtures and appliances shall be provided with approved fixing devices, nuts, bolts, screws, hangers as required. These supports shall have the necessary adjustment to allow for irregularities in the building area construction.

For the installation of the CP fittings, Teflon tape shall be used.

EUROPEAN W.C:

European W.C. of glazed vitreous china shall be wash down, single or double symphonic type, floor or wall mounted set, flushed by means of flush valve as specified in Bill of Quantities. Flush pipe/bend shall be connected to the W.C. by means of suitable rubber adopter. Wall hung W.C. Shall be supported by C.I. floor mounted chair.

Each W.C. seat cover shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C. Seat cover shall be of white solid plastic, elongated open front with heavy duty hinges. Exposed fixture trims shall be Chrome plated, and trims of similar function shall be by the same manufacturer.

Flush valves shall be of the best approved quality procurable with C.P. control valve and C.P. flush pipe.

The flush pipe/bend shall be connected to the WC by means of a suitable rubber adopter.

Dual flushing cistern to be used and shall conform to the requirements of IS:774-1971. High level cisterns shall be of cast iron unless otherwise specified. Low level cistern shall be of the same material as the water closet or as instructed by the Engineer-In-charge/Architect/ Consultant.

The cisterns shall be mosquito proof & shall fulfill the requirements of the local Authority.

The levels of the WC should be checked by placing sprit level on the W.C. W.C. should be tested on completion of fixing by putting small paper balls and flushing out. If all the paper balls are not flushed out. The fixing will have to be rectified/ re-aligned.

KITCHEN /PANTRY SINKS:

Sinks shall be of stainless steel material as specified in the Bill of Quantities/Drawings.

Each sink shall be provided with R. S. brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable angle iron clips or brackets as recommended by the manufacturer.

Each sink shall be provided with 40 mm dia Chromium Plated waste with chain and plug or P.V.C. waste with Escutcheon plates. Fixing shall be done as directed by Engineer-In-charge.

Supply fittings for sinks shall be mixing fittings or C.P. taps, angle cocks etc. all as specified in the Bill of Quantities/Drawings.

6.8 WASH BASINS:

Wash basin shall be of white vitreous china of best quality manufactured by an approved firm and sizes as specified in the Bill of Quantities.

Wash basin shall be of under counter drop in type shall be supported on a pair of rolled steel brackets of approved design and shall be mounted on a countertop. So that rim and basin bowl is exposed from top.

Wash basin shall be provided with single lever mixer with chain and rubber plug, chromium plated brass bottle trap of approved quality, design and make where hot water required. Single tap where hot water is not required.

Wash basin shall be fixed at proper location and height and truly horizontal as shown on drawing or as directed by Engineer-In-charge.

6.8 HOSE BIBB'S:

Hose Bib of Chromium Plate tap is drawing off tap with horizontal inlet and free outlet knurling on outer face to fix the hose pipe. Hose bib shall be of specified size and shall be of screw down type and shall conform to IS:781-1984. The closing device shall work by means of a disc carrying a renewable non-metallic washer which shuts against the water pressure on a seating at right angle to the axis of the threaded spindle which operate it. The handle shall be either crutch or butterfly type securely

6.8 URINALS:

Half stall wall hung urinals of glazed vitreous china shall be provided with 15mm dia, C.P. brass spreader, 32mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange and shall fixed to wall by one C.I. bracket and two C.I. clips as recommended by manufacturers complete as directed by the Engineer-In-charge.

Urinals shall be flushed by means of "NO-TOUCH" infrared operated flush valves.

Waste pipes for urinals shall be any one of the given material as directed by the Engineer-In-charge:

a) uPVC Pipes

b) Rigid PVC/High density polyethylene.

Waste pipes may be exposed on wall or concealed in chase as directed by the Engineer-In-charge.

6.9 Angle Valves

6.1.1 Regulating Angle valve – Will confirm to following specifications with gradation of Flow–Pressure

a) Material – Brass DIN EN / Noise Class I

b) Dimension: DN 15 G ½ AG x DN 15 G ½ AG
c) Chrome PU1 / Weight 0.130 KG per piece
d) With Comfort handle, with extended push rod, push rosette Ø 54 mm
e) Similar to Schell Model No. - 05 217 06 99 Comfort Angle Valve

6.1.2 Regulating Angle Valve with Filter– Will confirm to following specifications with gradation of flow-Pressure

a. Angle valve with Filter
b. Material – Brass DIN EN
c. Dimension: DN 15 G ½ AG x DN 15 G ½ AG.
d. Chrome PU1 / Weight 0.180 KG per piece
e. Similar to Schell Model No.-05 204 06 99 – Schell 1/2" x 1/2" without nut, without backflow, w/o rosette

6.1.3 Combination angle stop valve – Will confirm to following specifications –

a) Three-cornered handle with sanitary head part
b) backflow preventer (BP)
c) extension
d) push rosette Ø 54 mm
e) hose screw connection
f) Material: brass DIN EN
g) Test mark: PA-IX 2850/IA
h) Connection: 1/2“/DN 15, chrome, PU 1, W: 0,33 kg/St.
i) Similar to Schell Combination angle stop valve model no. 03 751 06 99 -

6.1.4 Angle Valve Thermostat Set – Will confirm to following specifications –

a) Thermostat Control Valve for angle valves with 3/8” outlet including pipe set.
b) Comprises: angle valve Thermostat, pipe set and Quick acting lever.
c) Technical Specification: Maximum draw-off temperature limitation,
d) Anti-Scalding protection when the hot water supply is down,
e) Max. draw-off temperature adjustment concealed by cover, only possible with tools
f) Possibility of thermal disinfection, fitting include quick-acting lever to bypass the thermostat valve and enable thermal disinfection (readjustment of temperature not required),
g) Thermostat of extending material in accordance with EN 1111 in brass-housing,
h) Chrome plated plastic cover,
i) Flow volume 13 L/min, chrome, PU 1 , W: 0.90 kg/pc
j) Similar to Schell Angle Valve Thermostat Set - 09 410 06 99.

6.1.5 Washstand Outlet OPEN– Will confirm to following specifications –

a) Non closing outlet valve,
b) G 1 1/4 ext. thread universal for washstands
c) Comprises: washstand outlet valve, sealing parts.
d) Use / Technical data: discharge 20 L/min,
e) Material: brass, chrome, PU 1, W: 0.38 kg/pc.
f) Similar to Schell Washstand Outlet OPEN -Model No. 02 002 06 99 –

6.1.6 Flexible Hose Pipes -Will confirm to following specifications –

a) with in-liner EPDM
b) With stainless steel braided wire sleeving
c) Length 500 mm
d) Chrome, PU 20, W: 0,13 kg/St.
e) I/II union nut 1/2“
f) Similar to Schell Flexible Hoses model no.- 09 042 06 99

6.1.7 Actuation plate for Concealed Flush Valve – Will confirm to following specifications –

a) Eco-Design control button for WC concealed flush valve
b) Control panel with pushbutton for economy flush and main flush
c) Mechanical hydraulic cartridge with automatic jet cleaning needle
d) Main flush volume adjustable 4.5 L to 9 L
e) Economy button 3 L
f) Flush volume regulation by means of pressure plate
g) Similar to Schell WC Control Button Edition model no.-02 804 06 99

6.1.8 Concealed flush valve roughing-in set for mechanical actuation- Will confirm to following specifications –

a) Low-noise concealed hydraulic flush system with internal isolating valve and leak-free construction plug
b) For flat wash out and wash down bowls
c) Flow pressure: 1,2 to 5 bar • flush volume: 1 - 1,3 l/s
d) Fitting connection: G 3/4" (DN 20), external thread right
e) Similar to SCHELL WC 01 194 00 99 - COMPACT II

4.8.9 Electronic wash basin mixer tap -Will confirm to following specifications –

a) HD-M (high pressure mixed water) battery operation 9 V
b) with temperature controller
c) Battery-powered single mixer in vandal-resistant all-metal design
d) comprises: electronic module with battery power level indicator and 5 programs to select incl. stagnation flush program (permanent flush 5 min, 24-h flush)
e) cartridge solenoid valve 6 V
f) 9 V alkaline battery
g) 2 flexible connection hoses Clean-Fix S G 3/8 int. thread x 380 mm
h) 2 backflow preventers with pre-filter
i) flow regulator
j) mounting accessories
k) use / technical data: flow volume: 6L/min independent of pressure, flow pressure: 0,5 to 5 bar
l) Hot water temperature max. 70 °C (short-time-use)
m) material: Housing material: brass DIN EN
n) noise class: I
o) Chrome, W: 2.36 kg/pc.
p) Similar to SCHELL electronic wash basin mixer tap PURIS E Model No. - 01 201 06 99

4.8.10 Electronic wash basin tap – Will confirm to following specifications –

a. Compact infrared sensor mixer
b. With temperature control

c. Single hole tap, vandal-proof all-metal design
d. COMPRISES: electronic module with 4 programs incl. stagnation flush program (permanent flush 20 sec, 24-h flush)
e. Cartridge solenoid valve 6 V
f. External battery compartment with 9 V alkaline battery
g. Connection cable with plug protection category IP 65
h. 2 flexible connection hoses clean-fix S G 3/8 int. thread x 380 mm
i. 2 backflow preventer with pre-filter
j. Flow regulator
k. Mounting accessories for wash basin installation
l. Use / technical data: flow volume 6 l/min at 3 bar flow pressure
m. Flow pressure 0,5 - 5 bar
n. Water temperature max. 70 °C (short-time-use)
o. Material: body out of dezincification-resistant brass
p. Noise class: 1
q. Chrome, W: 2.14 kg/pc.
r. Similar to SCHELL electronic wash basin tap CELIS E HP-M (high-pressure mixed water) battery operation 9 V model no - 01 229 06 99 –

4.8.11 Self-closing wash basin tap Will confirm to following specifications –

a. High pressure cold and pre-mixed water
b. Robust single tap in vandal-resistant all-metal design and with a plastic cartridge manual actuation and automatic closing action
c. Comprises Mounting accessories for single-hole installation
d. Use / technical data: flow pressure: 1 to 5 bar
e. Flow time: approx. 7 s (no flow time adjustment)
f. Material: Housing material: brass DIN EN
g. Flow rate: 6 l/min at 3 bar flow pressure
h. Dimension: DN 15 G 1/2 ext. Thread
i. Chrome, PU 1, W: 1.01 kg/pc.
j. Similar to SCHELL self-closing wash basin tap PETIT SC model no.- 02 122 06 99

4.8.12 Self-closing wall mounted tap (high pressure cold or premixed water) Will confirm to following specifications –
a. Robust wall-mounted tap in vandal-proof all-metal design with SCHELL self-closing cartridge, manual activation and automatic shut-off
b. Comprises: Self-closing wall-mounted tap PETIT SC with rosette Ø 60 mm
c. Use / technical data: Pressure autonomous flow volume regulation of 5,0 l/ min
d. Flow pressure 0.8 - 5 bar
e. Flow time adjustable from 6 - 15 sec (factory settings 7 seconds)
f. Material: body out of dezincification-resistant brass, functional parts cartridge plastic
g. Dimension: G 1/2 ext. Thread
h. Chrome, W: 0.88 kg/pc.
i. Similar to SCHELL self-closing wall mounted tap PETIT SC HD-K (high pressure cold or premixed water) model no.- 02 136 06 99

4.8.13 Infrared Urinal control – Flush plate (battery operation 9 V) Will confirm to following specifications –
j. Finishing set - battery-operated, touch-free flushing device
k. Comprises: Mounting frame with electronic module
l. Front panel with sensor

m. Battery compartment in mounting frame
n. 9 V alkaline cell
o. Cartridge solenoid valve with pre-filter
p. Diagnostic lamps
q. Diode for battery level, adjustment range
r. Use / technical data: Flushing time: 2-15 s, adjustable
s. Hygienic flush every 24 hours after last flush
t. Material: Front cover out of stainless steel,
u. Similar to SCHELL urinal control EDITION battery operation 9 V model no.- 02 807 28 99 -

4.8.14 Concealed Roughing-in set for mechanical and electronic actuation Will confirm to following specifications –

a) Roughing-in set for mechanical and electronic actuation; low noise concealed flush valve with internal isolating valve for installation of the SCHELL urinal actuations and urinal controls.
b) Flush valve conform to DIN EN 12541;
c) Plastic construction casing with cleaning cover
d) Pre-assembled water path with isolating valve
e) Sealing plug
f) cleaning cover
g) Use / Technical Data: flow pressure: 0,8 - 5 bar
h) Flush volume: 0,3 l/s
i) Fitting connection G 1/2" (DN 15) external thread; Connection: G 1/2" ext. Thread/ DN 15.
j) Similar to SCHELL concealed urinal flush COMPACT II model No. 01 193 00 99

4.8.15 Exposed urinal flush-Infrared for battery operation with isolating valve Will confirm to following specifications –

a. exposed urinal flush for battery operation with isolating valve
b. 6 V solenoid valve in cartridge design with integrated pre-filter
c. internal attachment connector
d. flush pipe 18 x 200 mm
e. 9 V alkaline battery
f. flow pressure: 0,5 to 5 bar
g. flow volume: 0,3 l/s according to DIN 3265
h. flush time: 2 - 15 seconds adjustable
i. hygienic flush every 24 hours
j. Similar to SCHELL infrared urinal flush valve unit - Schellomatic infra (Exposed infra) –

6.8 MEASUREMENTS:

Rate for providing and fixing of sanitary fixtures, accessories, urinal partitions shall include all items and operations stated in the respective specifications and Bill of Quantities, and nothing extra is payable.

Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangement required.

5 WATER SUPPLY:

5.1 SCOPE:

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the bill of quantities.

Without restricting to the generality of the foregoing, the water supply system shall include the following:-

i. Pipe protection & painting.
ii. Connections to all plumbing fixtures, tanks, pump etc.
iii. Providing hot water pipe lines and supply point with isolation valves, wherever required.
iv. Control valves, masonry chambers and other appurtenances.
v. Connections to all plumbing fixtures, tanks and appliances.
vi. Excavation and refilling of pipe trenches, wherever necessary.
vii. Internal galvanized water supply piping inside the toilets shaft/plant room/terrace.
viii. Testing all line and fixtures as specified.

5.2 GENERAL REQUIREMENTS:

All materials shall be new of the best quality and shall be furnished, delivered, erected, connected and finished in every detail conforming to specifications and subject to the approval of Engineer-In-charge.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Short or long bends shall be used on all main pipe lines as far as possible. Use of elbows shall be restricted for short connections.

As far as possible all bends shall be formed by means of hydraulic pipe bending machine for pipes upto 65mm dia.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc. and shall be selected and arranged so as to fit properly into the allocated building space.

Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

Valves and other appurtenances shall be located to provide easy accessibility for operation, maintenance and repairs.

Connection between dissimilar materials.

Drawings illustrating block out and penetration of pipes in the wall/floor/slab.

Unions: Contractor shall provide adequate no. of unions on all pipes to enable dismantling later and for servicing. Union shall be provided near each gunmetal valve.

5.3 INTERNAL WORKS:

5.3.1 MATERIALS (CPVC PIPES, FITTINGS & VALVES):

All pipes inside the buildings and where specified, outside the building shall be CPVC pipes tubes conforming to Specific Gravity ASTM D 792 at 23^{o}C should be 1.55 as specified. With Tensile Strength as per ASTM D 638 at 23^{o}C should be 55 N/mm^{2}

All special fittings and accessories like internally or externally threaded brass adaptors, ball valves, globe valves, unions, diaphragm valves, butterfly valves; etc shall be made of CPVC by Licensee.

The CPVC solvent cement used for installing CPVC piping systems shall conform to ASTM F493. Pipes from ½" upto 2" pipes and fittings, single step medium bodied CPVC solvent cement should be used. For CPVC pipes and fittings upwards of 2", a primer shall be used followed by heavy bodied solvent cement conforming to ASTM F493. PVC solvent cement should not be used.

5.3.2 CONCEALED PIPING

All internal concealed plumbing for water supply shall be done with CPVC. The pipes & fittings shall conform to CTS (copper tube size) SDR-11 as per ASTM D2846 OR SDR-13.5. All pipes and fittings from ½" upto 2" shall come under this category. Medium body CPVC solvent cement conforming to ASTM F493 should be used for joining pipes to fittings.

5.3.3 EXTERNAL PIPING:

The fixing, jointing and testing for ISI marked centrifugally casted (spun) ductile iron pressure pipes for water supply services with socket, spigot and flanged ends should be conforming to IS:8329 / 2000 for classification K9.

5.3.4 INSTALLATION PROCEDURE:

5.3.5 All parameters pertaining to the installation of Ductile Iron plumbing system such as cutting, joining, support spacing, expansion loops, insulation, type of support, special connections, etc. shall be as per the manufacturer's specifications.

5.3.6 All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pockets.

5.3.7 Spacing of clamps, hooks etc. shall be as per good engineering practice approved by the Project Manager.

5.3.8 UNIONS

Contractor shall provide adequate number of unions on pipes 50 mm and below to enable easy dismantling later when required. Unions shall be provided near each gunmetal valve, stop cock, or check valve and on straight runs as necessary at appropriate locations as required and/or directed by Project Manager.

5.3.9 TESTING:

After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not permit. The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm which ever is more.

The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

5.4 MEASUREMENTS:

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include CPVC pipe and CPVC fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions etc.. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

5.5 VALVES:

5.5.1 BUTTERFLY VALVES:

All the isolation valve 50cm and above on the equipment and water lines, where specified or shown on drawings shall be wafer type butterfly valves. They shall be designed to fit without gaskets, the water tight seal being obtained by EPDM seat projection at the faces compressed between the flanges. The valves shall be supplied inclusive of M.S. pipe flanges and high tensile steel bolts of dimensions recommended by suppliers of valves. The valves shall comply with following specifications:

a) Test Pressure : Body 24 Bar, Seat 16 Bar

b) Valve Component : Material of Construction

i) Body : Cast Iron, Gr. FG 260, IS:210

ii) Disc : Nylon or Epoxy powder coated heavy Duty iron, Gr, FG 260

iii) Stem : Stainless Steel or carbon steel IS: 1570, Part-II.

iv) Seat : EPDM

v) Hand Lever : Cast Iron (Mechanical Memory Stop)

vi) Bearings : PTFE or Nylon covered S.S. bush Bearings at stem and pivot.

vii) Primary Seal : Reinforced PTEE slide bearings

viii) Temperature : 80 Degree C (max.)

5.5.2 INSTALLATION:

Valve shall be installed in a manner that allows future removal and service of the valve.

Packing and gasket shall not contain asbestos.

The valve shall be of the same size as the pipe to which they are installing.

Valve above 150mm diameter shall be self locking warm gear type water proof and protory lubricated.

Provide chain operators with chain cleats for all valves more than 2.4 meters above floor.

5.5.3 NON RETURN VALVES:

All non-return valves shall be provided as shown in the drawings conforming to relevant Indian Standards and in accordance with the following specifications.

Size	Construction	Ends
Upto 50 mm.	Gun metal	Screwed
65 mm and above	Gun metal/cast iron	flanged

Non-return valves shall be of approved make. Flap type non-return valve shall be used and tested to 15 Kg/Sq.cm. pressure.

5.5.4 BALL VALVES (FLOAT VALVE):

The ball valve shall be of high pressure class and shall be confirm to IS: 1703 of sizes as specified. The nominal size of a ball valve shall be that corresponding to the size of the pipe to which it is fixed. The ball shall be of brass or gun metal as specified and the float shall be of polythene sheet. The minimum gauge of copper sheet used for making the float shall be 0.45mm for float upto 115mm dia and 0.55mm for float exceeding 115mm dia and shall be special in shape. The valve shall be constructed to permit replacing without console of the valve body from the valve line and the system shall not blow out under pressure. The jointing of the float shall be made by efficiently burnished, lapped and soldered seam or by bracing. Plastic float may also be used if specified. The body of ball valve when assembled in working conditions with the float immersed to not more than half of its volume shall remain closed against a test pressure of 10.5 Kg/Sq.cm. All ball valves shall be capable of withstanding a pressure of 14 Kg/Sq.cm.

The ball valve shall generally conform to IS specifications No. 1703-1962.

5.5.5 BALL VALVES:

The ball valve shall be of Brass or Gunmetal as specified conforming to IS: 1703. The ball valve shall be as given below:

HIGH PRESSURE:

Indicated by the abbreviation ‘HP’ for use on mains having pressure. These shall remain closed at a test pressure of 10.5 Kg/Sq.cm.

	Nominal Size of Ball Valve					
S. No.	15mm	20mm	25mm	32mm	40mm	50mm

1. Diameter of spherical float (mm)						
High Pressure	127	152	203	229	254	305
Low Pressure	114	127	178	203	203	254
Minimum weight of ball valve including back nut, body and piston (gms)	283	446	823	1149	1589	1852

The ball valves shall be of following nominal sizes 15mm, 20mm, 25mm, 32mm, 40mm and 50mm. The nominal size shall correspond with the nominal bore of the inlet shanks.

5.5.6 AIR VALVES:

Air valves shall be provided in all high points in the system to prevent air locks as shown on the drawings or directed by Engineer-In-charges.

5.5.7 TESTING:

All valves shall be tested while installed in pipe by hydrostatic pressure of 1.5 time of the working pressure 7.5 Kg/Sq.cm which ever is more.

5.5.8 MEASUREMENTS:

All valves as mentioned in Bill of Quantities shall be measured by numbers and shall include all items mentioned in the Bill of Quantities.

5.5.9 CHLORINATION OF DOMESTIC WATER LINES:

5.5.9.1 After the completion of all the hot and cold water service piping, disinfect all the fresh water supply work and water reservoirs using a chlorine solution.

5.5.9.2 CHLORINATED SYSTEMS SHALL INCLUDE:

5.5.9.3 Before handover of the system, submit to the consultant copies of the certification of performance and laboratory report (if required)

5.5.9.4 Under no circumstances the use of any portion of the fresh water system until it is properly disinfected, flushed and certified shall be permitted.

5.5.9.5 During the Chlorination work the Contractor shall take all necessary precautions to prevent site staff from drinking the system water. Such precautions shall include looking doors to ‘wet’ areas and providing warning signs in English and Hindi.

6 INTERNAL DRAINAGE: (SOIL, WASTE, VENT AND RAIN WATER PIPES)

1. SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes and fittings as required by the drawings, and given in the schedule of quantities.

2. BASIC PIPING SYSTEM

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of cast iron pipes & fittings as called for. In general wastes and vents smaller than and upto 50mm dia shall be of heavy class GI.

The soil pipes shall be circular with a minimum diameter of 100mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner's site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Joints throughout shall be made with molten lead as described under jointing of cast iron pipes. Soil pipes shall be painted as provided under `painting'. The soil pipes shall be covered on top with cast iron terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of cast iron or galvanised mild steel pipes. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that at least one wash is connected to such floor traps to avoid drying of water seal in the trap. Ventilating pipes shall be of cast iron or galvanised mild steel pipes, conforming to the requirements laid down earlier. Anti-syphon vent pipes/relief vent pipes where called for on the drawings shall be of cast iron or galvanised mild steel pipes as specified. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m upto it connection to the main drain or manhole shall be provided with an 80 / 100 mm vent pipe.

3. PIPING MATERIALS

a. Cast Iron Pipes

Cast iron pipes and fittings shall be of good and tough quality and dark grey on fracture. The pipes and fittings shall be true to shape, smooth and cylindrical, their inner and outer surface being as nearly as practicable concentric. They shall be sound and nicely cast, shall be free from cracks, taps, pinholes and other manufacturing defects.

The pipes and fittings shall conform to IS: 3989. Fittings shall be of required degree with or without access door. All access doors shall be made up with 3mm thick insertion rubber gasket of white lead and tightly bolted to make the fittings air and water tight. The fittings shall be of the same manufacture as the pipes used for soil and waste.

All CI pipes and fittings shall bear the manufacturer's name and ISI specification to which it conforms.

All pipes and fittings shall be coated internally and externally with the same material at the factory, the fittings being preheated prior to total immersion in a bath containing a uniformly heated composition having a tar/other suitable base. The coating material shall have good adherence and shall not scale off. The coating shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 77 degree C but not so brittle at a temperature of '0' degree C as to chip off when scratched lightly with a pen knife.

All pipes and fittings before installation at site shall be tested hydrostatically to a pressure of 0.45 Kg/sq. cm without showing any sign of leakage, sweating or other defects of any kind. The pressure shall be applied internally and shall be maintained for not less than 15 minutes. All these tests shall be carried out in the presence of the representative of the Project Manager. Alternatively a test certificate from manufacturers is obtained before dispatch of material to site.

Cast Iron Specialties

If required, Cast iron specialty items such as deep seal floor traps, urinal traps, trap integral pieces with integral inlet/outlet connections, manhole cover with frame, chamber cover etc. shall be fabricated to suit individual location requirements. The contractor shall arrange the fabrication of these items from an approved source.

Lead Caulked joints with Pig Lead:

The approximate depth and weights of Pig Lead for various diameters of CI pipes and specials shall be as follows:

Nominal siz of Pipe (mm	Lead per Joi (Kg)	Depth of Lea Joint (mm)
50	0.77	25
80	0.88	25
100	0.99	25
150	1.5	38

Galvanised Iron Pipes

Waste pipes of 50mm dia and below and where called for shall be galvanised iron pipes screwed and socketed conforming to the requirements of IS: 1239 of heavy grade. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws, laminations and other defects. All screw thread shall be clean and well cut. All pipes and fittings shall bear manufacturer's trade mark and conform to the IS as specified.

Cast Iron Class (LA) pipes

All drainage passing under building floor and passing through retaining wall shall be cast iron class (LA) pipes (IS : 1536)

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS: 1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS: 1538-1976). Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS: 1536 of tested quality. The pipes and fittings shall either be spigot or socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with refined pig lead conforming to IS: 27-1977, sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the pig lead to be poured in. After pouring the lead shall be caulked in to the joint with caulking tools and hammer of proper width. All surface lead shall be out and joint left flush with the rim of the socket. One continuous lead pour shall be throughly caulked at least 3 times around.

Laying

I. Fittings used for CI drainage pipe shall conform to IS: 1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee.

II. Lead Caulked joints with Pig Lead:

The approximate depth and weights of Pig Lead for various diameters of CI pipes and specials shall be as follows:

Nominal siz of Pipe (mm	Lead per Joi (Kg)	Depth of Lea Joint (mm)
80	1.8	45
100	2.2	45
125	2.6	45
150	3.4	50
200	5.0	50
250	6.1	50

III. The spigot of pipe of fittings shall be centered in the adjoining socket by caulking. Sufficient turns of tarred gasket shall be given to leave a depth of 45 mm when the gasket has been caulked tightly home. Joining ring shall be placed round the barrel and against the face of the socket. Molten pig lead shall then be poured to fill the remainder of the socket. This shall then be done in one pouring. The lead shall then be solidly caulked with suitable tools and hammers weighting not less than 2 Kgs.

IV. For lead wool joints the socket shall be caulked with tarred gasket, as explained above. The lead wool shall be inserted into the sockets and tightly caulked home skin by skin with suitable tools and hammers of not less than 2 Kg weight until joint is filled.

4. PIPES HANGERS, SUPPORTS and CLAMPS ETC.

All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slpe and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per drawings or contractor's shop drawings. Clamps shall be fixed in accordance to manufacturer's details / shop drawings to be submitted by the contractors.

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load.

Structural clamps e.g... Trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle / channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles / channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

5. INSTALLATION OF SOIL, WASTE & VENT PIPES

Soil, waste & vent pipes in shafts under the floors / suspended below slab shall consist of cast iron pipes as described earlier. Waste pipes from bottle trap to floor/urinal traps for wash basin, urinal and sink shall be GI pipes and fittings.

All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide

easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

All cast iron pipes and fittings shall be jointed with best quality soft pig lead free from all impurities conforming to IS 27.

Before jointing, the interior of the socket and exterior of the spigots shall be thoroughly cleaned and dried. The spigot end shall be inserted into the socket right up to the back of the socket and carefully centered by two or three laps of threaded spun yarn, twisted into ropes of uniform thickness, well caulked into the back of the socket. No piece of yarn shall be shorter than the circumference of the pipe. The jointed pipe line shall be at required levels and alignment. The reminder of the socket is left for the lead caulking. Where the gasket has been tightly held, a jointing ring shall be placed round the barrel against the face of the socket. Molten pig lead shall be poured to fill the remainder of the socket in one pouring. The lead then shall be solidly caulked with suitable tools by hammering right round the joints to make up for the shrinkage of the molten metal on cooling and preferably finish 3mm behind the socket face.

The depth of the lead joints for the cast iron pipes shall be 45mm for the pipes upto 100mm dia and 50mm for the pipes beyond 100mm dia respectively.

The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

Rainwater Pipes

All open terraces shall be drained by rain water down takes.

Rainwater down takes is separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. AHU's pump rooms, waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.

Balcony / Planter drainage

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager.

6. TRAPS

6.1 Floor Traps

Floor traps where specified shall be siphon type full before P or S type cast iron having a minimum 50 mm deep seal. The trap and waste pipes when buried below ground shall eb set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mixes (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and centering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

6.2 Floor Trap Inlet /Hopper

Bath room traps and connection shall ensure free and silent flow of discharging water. Where specified, contractor shall provide a special type of floor inlet fitting fabricated from gI pipe, with one, two or three inlet sockets welded on side to connect the waste pipe. All joint between waste hopper and CI inlet socket shall be lead caulked. Inlet shall be connected to a CI "P" trap. Floor trap inlet and the traps shall be set in cement concrete blocks where buried in floors without extra charge. Floor trap for the shower cubicle shall suit site and as per the approval of Owner's site representative. All fabricated hopper shall be hot dip galvanized.

6.3 Floor Trap Grating

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified in the schedule of quantities approved by the Owner's site representative.

6.4 Cleanout Plugs

Floor Clean Out Plug

Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, "Ys" and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall eb threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be lead caulked to the drain pipes.

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner's site representative. Cleanout plugs shall be of size matching the full bore of the pipe but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc. as per drawing.

7. PIPE SLEEVES

Pipe sleeves, next larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before lying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

8. PIPE PROTECTION

Cast iron soil and waste pipes under floor in sunken slabs and in wall chases (when cut specially for the pipe) shall be encased in cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate of 12 mm size) 10 cm bed and around. When pipes are running well above the

structural slabs, the encased pipes shall be supported with suitable cement concrete pillars of required height and size at intervals directed by the Project Manager.

9. CUTTING AND MAKING GOOD

Pipes shall be fixed and tested as building proceeds. The contractor shall provide all necessary holes, cutouts and chases in structural members as building work proceeds. Wherever holes are cut or left originally they shall be made good with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size) or cement mortar 1:2 (1 cement: 2 coarse sand). Cured and the surface restored to original condition.

10. PAINTING

Soil, waste, vent and rain water pipes in exposed location, in shafts and pipe space shall be painted with two or more coats of ready mix oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner's site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

11. TESTING

Testing shall be done in accordance with IS: 1172 and IS: 5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests,

All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m at the highest point of the section under test. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running atleast 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. Rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase in plastered or the pipe encased or buried.

12. EXTERNAL DRAINAGE SYSTEM: (SEWERAGE & STORM WATER):

12.1 SCOPE

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install the drainage system as required by the drawings and specified hereinafter or given in the Bill of Quantities.

Without restricting to the generality of the foregoing, the drainage system shall include: Sewer lines including excavations, pipe lines, man holes, drop connections, underground storm water drains, including pipes, man holes, catch basins and open drains, thrust blocks.

12.2 GENERAL REQUIREMENTS:

All materials shall be new of the best quality conforming to specifications and subject to the approval of the Engineer-In-charges.

Drainage lines shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws. Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority and also existing invert levels required to enter sanitary system.

Location of all manholes, catch basins, etc. shall be confirmed by the Engineer-In-charges before the actual execution of work at site.

All excavation, trenches etc shall be barricaded as per instruction of the Engineer-In-charge's Representatives.

All works shall be executed as directed by the Engineer-In-charges.

12.3 TRENCHES FOR PIPE & DRAINS:

12.3.1 ALIGNMENT AND GRADE

The drains are to be laid to alignment and gradients in continuous shown on the drawings but subject to such modifications, as shall be ordered by the Engineer-In-charge from time to time to meet the requirements of the works. No deviations from the line, depths of cutting or gradients of sewers shown in the plans and sections shall be permitted except by the express direction in writing of the Engineer-In-charge.

12.3.2 OPENING OUT TRENCHES:

In excavating the trenches at the road metaling, pavement kerbing etc. are to be placed on one side and preserved for rein statement when the trench or other excavation shall be filled-up.

Before any road metal is replaced, it shall be carefully shifted. The surface of all trenches and holes shall be restored and maintained to the satisfaction of the Engineer-In-charge. The Contractor shall not cut or break down any live fence or trees in the line of the proposed works but shall tunnel under them unless the Engineer-In-charge shall order to the contrary.

Trench to be excavated to alignment + depth required. Trench to be properly dressed and de-watered. Trench shall be kept free of water at all time. Discharge of water shall be into nearest drainage channel not on the road.

All under ground pipe to be laid in trench. Pipes to be laid and maintained at required levels and grade during course of work. All joints to be aligned and complete.

Trench shall be of 450mm wide than pipe. Concrete anchors at change in direction for C.I. pipe shall be provided. Pipe shall be rest on cushion in the trench.

The Contractor shall scrub up and clear the surface over the trenches and other excavations of all stumps, roots and all other encumbrances affecting execution of the work and shall remove them from the site to the approval of the Engineer-In-charge.

12.3.3 CONSTRUCTION ACROSS THE ROADS:

All the pipe line or drain crossing existing road, the road crossing shall be excavated at a time, the second half being commenced after the pipes have been laid in the first half and the trench refilled. Necessary safety measure for traffic as directed shall be adopted. All type of pipes, water mains, cables etc. met within the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the electrical and communication cable removal of which is necessary shall be arranged by the Engineer-In-charge or the Contractor shall arrange to support and protect them during excavation.

12.3.4 EXCAVATION TO BE TAKEN TO PROPER DEPTH:

The trenches shall be excavated to such depth and width that the sewers pipe shall rest on cushion so that the inverts may be at the levels given on the section/plan. In bad ground the Engineer-In-charge may order the Contractor to excavate to a greater depth than that shown on the drawings and to fill up the excavation to the level of the sewer with such materials as decided by Engineer-In-charge in writing.

12.3.5 REFILLING:

The filling shall be done in layers not exceeding 15mm in depth. Each layer shall be watered, rammed and consolidated. Ramming shall be done with iron rammers where possible and with blunt end of the crow brass where rammers can not be used. Special care shall be taken to ensure that no damage is caused to the pipes, drains, masonry or concrete in the trenches.

Filling in trenches shall be commenced soon after the joints of pipes, cables; conduits etc. have been tested and approved by Engineer-In-charge. The space

around the pipes shall be cleared of all debris where the trenches are excavated in hard/soft soil. The filling shall be done with earth on the sides and tops of pipes in layers not exceeding 15mm in depth. Each layer shall be watered rammed and consolidated. The clods and lumps of earth exceeding 8cm in any direction shall be broken or removed before the excavated earth is used for filling. Generally no test is done to determine the instu diversity of filled earth but on the discretion of Engineer-In-charge the 95 proctor's compaction test may be done to ensure the in situ density after filling. Consolidation is removal of water from the pores and compaction is the explosion of air from the pores. In case of refilling consolidation places most important role as the watering of the each layer is being done properly. If required by the Engineer-In-charge proctors needle may also be used for the proper checking of the refilling items of in situ density.

12.3.6 CONTRACTOR SHALL RESTORE SETTLEMENT AND DAMAGES:

The Contractor shall at his own cost make good promptly during the whole period the works are in hand, any settlements that may occur in the surfaces or roads, beams, footpaths, gardens, open spaces etc. Whether public or private caused by his trenches or by his other excavations due to not using the method of compaction as given in clause 7.3.5 and he shall be liable for any accidents caused thereby.

He shall also at his own expense and charges, repair and make good any damage done to the building and other properties.

12.3.7 DISPOSAL OF SURPLUS SOIL:

The Contractor shall at his own cost and charge, dispose off from the site all surplus excavated material not required to be used on the works.

i. The width of excavated trench shall be as per table given below:

Excavation upto	Upto 100 mm Dia pipe	Upto 150 mm dia pipe
90 cms depth	33 cms	33 cms
90 - 150 cms depth	60 cms	60 cms
150 - 300 cms depth	75 cms	75 cms
300 - 500 cms depth	90 cms	100 cms

12.3.8 PROTECTION OF EXISTING SERVICES:

All pipes, water mains, cables etc encountered in the course of excavation shall be carefully protected and supported. In case of any damage caused the same shall be made good at no extra cost failing which necessary works will be carried out by the Engineer-In-charges Representative and contract charged to the Contractor.

12.4 RCC PIPES:

12.4.1 All underground storm water drainage pipes and sewer lines where specified (other than those specified cast iron) shall be centrifugally spun RCC pipes NP2 for general and NP3 where road crossing. Pipes shall be true and straight with uniform bore throughout. Cracked, wrapped pipes shall not be used on the work. All pipes shall be tested by the manufacturer and the Contractor shall produce, prior to use on site, a certificate to that effect from the manufacturer.

The pipes shall be with or without reinforcement as required and of the class as specified. These shall conform to IS: 458 - 1971. The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process.

All pipes shall be true to shape, straight, perfectly sound and free from cracks and flaws. The external and internal surface of the pipes shall be smooth and hard. The pipes shall be free from defects resulting from imperfect grading of the aggregate mixing or molding. The pipes shall be R.C.C. light duty, NP2 and NP3 type.

12.4.2 LAYING

R.C.C. spun pipes shall be laid on cements concrete bed or cradles as specified and shown on the detailed drawings. The cradles may be pre-cast and sufficiently cured to prevent cracks and breakage in handling. The invert of the cradles shall be left 12mm below the invert level of the pipe and properly placed on the soil to prevent any disturbance. The pipe shall then be placed on the bed concrete or cradles and set for the line and gradient by means of sight rails and boning rods, etc. Cradles or concrete bed may be omitted, if directed by the Engineer-In-charges.

12.4.3 JOINTING: (RIGID SPIGOT AND SOCKET JOINT):

Hemp rope soaked in neat cement wash shall be passed round the joint and inserted in it by means of caulking tool. More skein of yarn shall be added and rammed home. Cement mortar with one part of cement and one part of sand and with minimum water content but on no account soft or sloppy, shall be carefully inserted, punched and caulked into the joint and more cement mortar added until the space of the joint has been filled completely with tightly caulked mortar. The joint shall then be finished off neatly outside the socket at an angle of 45 degree.

12.4.4 CURING:

The joint shall be cured for at least seven days.

12.4.5 CEMENT CONCRETE FOR PIPE SUPPORTS:

a) Unless otherwise directed by the Engineer-In-charge cement concrete for bed, all round or in haunches shall be laid as follows:

Pipes in open ground (no sub soil water)	Upto 1.5m depth (5')	Upto 3m depth (10')	Beyond 3m depth (10')
RCC/C.I pipes in sub soil water	all round (1:5:10)	in haunches (1:3:6)	all round (1:5:10)
RCC/C.I. pipes (in all conditions)	all round (1:3:6)	in haunches (1:3:6)	in haunches (1:3:6)
RCC/C.I pipes under road or building	all round (1:3:6)	all round (1:3:6)	all round (1:3:6)

b) RCC pipes or CI pipes may be supported on brick masonry or pre-cast RCC or

in situ cradles. Cradles shall be as shown on the drawings.

c) Pipes in loose soil or above ground shall be supported on brick or stone masonry pillars as shown on the drawings.

12.4.6 TESTING:

All lengths of the sewer and drain shall be fully tested for water tightness by means of water head maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subjected to a test pressure of at least 1.5 metres head of water at the highest point of the section under test. The pipes shall be plugged preferably with standard drain plugs (with rubber rings) on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

12.4.7 MEASUREMENT:

Excavation:

Measurement for excavation of pipes trenches shall be made per linear meter.

Trenches shall be measurement between outside walls of manholes at top and the depth shall be the average depth between the two ends to the nearest cm. The rate quoted shall be for a depth upto 1.5 meter or as given in the Bill of Quantities.

Payment for trenches more than 1.5 m in depth shall be made for extra depth as given in the Bill of Quantities and above the rate for depth upto 1.5 m.

RCC pipes shall be measured for the length of the pipe line per linear meter i.e.:

Length between manholes shall be recorded from inside of one manhole to inside of other manhole.

Length between gully trap and manhole shall be recorded between socket of pipe near gully trap and inside of manhole.

12.5 SEWER APPURTENANCES:

INSPECTION CHAMBERS AND MANHOLES:

i. SIZE OF CHAMBERS/MANHOLES:

The size given in Bill of Quantities and drawings shall be internal finished size of chamber. The work shall be done strictly as per standard drawing and following specifications.

ii. BED CONCRETE:

Shall be in 1:4:8 cement concrete 200 mm thick).

iii. BRICK WORK:

Brick work shall be with best quality bricks in 1:6 cement mortars.

iv. PLASTER:

Inside of the walls of chamber/manhole shall be plastered with 12/15 mm

thick cement plaster 1:3 (1 cement: 3 coarse sand) and finished smooth with a floating coat of neat cement. Manholes shall be plastered from out side as above but with rough plaster.

Water proofing compound as approved by the Engineer-In-charge shall be added in the cement sand mortar ratio as specified by manufacturer.

v. BENCHING:

Channel and benching shall be done in cement concrete 1:2:4 rendered smooth with neat cement. The following depth of channel and benching shall be adopted:

Size of Drain	Top of channel at the centre above Bed conc.	Depth of benching at side walls above bed conc.
10 cm	15 cm	20 cm
15 cm	20 cm	30 cm
20 cm	25 cm	35 cm
25 cm	30 cm	40 cm
30 cm	35 cm	45 cm

vi. MANHOLE COVERS AND FRAMES:

The covers and frames shall conform to IS: 1726-1960 and shall be of the following grades and types:

a) Heavy Duty:

These shall be denoted by the letters 'HD' circular solid type for use under heavy vehicular traffic conditions.

b) Medium Duty:

These shall be denoted by the letter 'MD' circular or rectangular solid type for use under light traffic conditions such as foot paths, carriage drives and cycle tracks.

c) Light Duty:

These shall be denoted by the letters 'LD' or rectangular size for use in domestic premises of where they are not subjected to wheeled traffic loads.

The covers and frames shall be leanly cast and they shall be free from air and sand holes and from cold shuts. They shall be nearly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage gas inclusion or other causes. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip.

The covers shall be capable of easy opening and closing and it shall be fitted in the frame in workmanship like manner. The cover shall be gas tight and water tight.

The size of covers specified shall be taken as the clear internal dimensions of the frame.

The approximate weights of the various types of manhole covers and frames shall be as in table given below:

Description of C.I. Manhole Cover	Weight of Cover Kg	Weight of Frame Kg	Total Weight of Cover and Frame Kg
HD 560 mm dia	108	100	208
LD, rectangular 455x610mm (single seal)	23	15	38
MD 500 mm dia	58	58	116

2 ½% variations in weight shall be permissible on either side.

Covers and frames shall be coated with a black bituminous composition. The coating shall be smooth tepacious. It shall not flow when exposed to a temperature of 63 Deg. and shall not be brittle as to chip off temp. Of 0 Deg. C.

The frame of manhole cover shall be firmly embedded to correct alignment and levels in RCC slab or plain concrete, as the case may be on the top of the masonry.

After completion of the work, manhole covers shall be sealed by means of thick grease.

vii. FOOT RESTS:

All manholes deeper more than 0.6 m shall be provided with plastic foot rests (Polypropylene is injection moulded around a 12mm dia steel reinforcing bar). These shall be embedded 20cm, deep with 20 x 20 x 10cm blocks of cement concrete 1:2:4 (1 cement :2 coarse sand :4 graded stone aggregate 20cm, nominal size). The block with plastic foot rest placed it's centre shall be cast in situ along the masonry and surface finished with 12mm thick cement plaster 1:3 (1 cement :3 coarse sand) finished smooth.

viii. All cast iron and Mild Steel items shall be provided with two coats of bitumastic paint.

MEASUREMENT:

Manhole shall be measured in numbers as indicated in the Bill of Quantity. The depth of manhole shall be measured from invert of channel to the top of manhole cover. Quoted rate shall cover the range of ± 0.24 meter on the depth specified in schedule and also the cost of items specified in the Bill of Quantities and Specifications viz.

i) Bed concrete.
ii) Brick work.
iii) Plastering.
iv) R.C.C. Top slab, benching and channeling including drop connections.
v) Supply and fix M.S. foot rests.
vi) Keeping holes and embedding pipes for all the connections.
vii) Excavation, refilling, necessary dewatering and disposing off surplus soil to a place as directed by Engineer-In-charge.
viii) Curing.
ix) Cost of frame and cast iron cover including reinforcement, angle frame and embedding the frame in concrete bed.
x) Testing.
xi) De-watering of chambers.

GULLY TRAP:

Gully traps shall be fixed in cement concrete 1:5:10 mix and a brick masonry chamber 30 x 30cms C.I. sealed cover and frame weighting not less than 7.3 Kgs to be constructed as per standard drawings. Where necessary, sealed cover shall be replaced with C.I. grating of the same size (1 cement: 5 coarse sand: 10 stone aggregate: 40mm nominal size).

MEASUREMENTS:

Gully traps shall be measured by the number and rate which shall include all excavation, foundation, concrete, brick masonry, cement plaster inside and outside, CI grating and sealed cover and frame.

DROP CONNECTIONS:

In case where branch pipe sewer enters the manhole of main sewer, a drop connection should be provided. H.C.I. pipes and specials conforming to IS: 1729-1964 as revised from time to IS: 1729-1964 as revised from time to time shall be of the size same as of the branch pipe sewer.

For 150 x 250mm main line, if the difference in level between the water line (peak-flow-level) and the invert level of branch line is less than 60cm, a drop connection may be provided within the manhole by giving ramp. If the different in level is more than 60 cm the drop should be provided externally.

EXCAVATION:

The excavation shall be done for the drop connection at the place where the branch line meets the manhole. The excavation shall be carried upto the bed concrete of the manhole and to the full width of the branch line.

LYING:

At the ends of branch sewer line Cast Iron tee shall be fixed to the line which shall be extended through wall of the manhole by horizontal piece of Cast Iron pipe form an inspection on cleaning eye, the open end shall be provided with chain and lid. The Cast Iron drop pipe shall be connected to the tee at the top and to Cast Iron bend at the bottom. The end shall be extended through the wall of the manhole by a piece of Cast Iron pipe which shall discharge into the channel. Necessary channel shall be made with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate to 20mm nominal size) and finished smooth to connect the main channel. The joint between Cast Iron pipe to fittings shall be lead caulked. The joint between Cast Iron tee and RCC branch line shall be made with cement mortar 1:1 (1 cement: 1 fine sand). The exposed portion of the drop connection shall be encased all-round with minimum 15 cm thick concrete 1:3:6 (1 cement: 3 fine sand: 6 graded stone aggregate 40mm nominal size) and cured. For encasing the concrete around the drop connection, necessary centering and shuttering shall be provided.

The holes made in the walls of manholes shall be made good with brick work in cement mortar 1:5 (1 cement: 5 fine sand) and plastered with cement mortar 1:3 (1 cement: 3 coarse sand) on the inside of the manhole wall. The excavated earth shall be back filled in the trench in level with the original ground level.

12.6 MAKING CONNECTIONS:

The Contractor shall connect the new sewer line to the existing manhole by cutting the walls, benching and restoring them to the original conditions. A new channel shall be cut in the benching of the existing manhole for new connections. The Contractor shall remove all sewage and water if encountered in making the connection without additional cost to the Engineer-In-charge.

12.7 MEASUREMENTS:

Item for making connection to municipal sewer shall be paid for by number and shall include all items given in the Bill of Quantities.

13. TUBE WELL:

13.1 SCOPE:

Work under this section shall consist of providing materials and labour necessary and required for boring of tube well as per drawings and specified hereinafter in the Schedule of Quantities.

Whether specifically mentioned or not, all fixtures, fittings and appliances shall be provided with necessary devices as required.

13.2 GENERAL REQUIREMENTS:

13.2.1 The work in general shall comprise of the following operations:

- Obtaining any approval from the Municipal or other relevant authorities for sinking of the tube well.
- Boring the necessary hole of required dia with sinking of necessary casing pipe and removal of the same after the work is over or completing the bore to required depth without casing pipe.
- Shrouding with graded gravel around the slotted, blind and housing pipes as described in the schedule.
- Giving yield tests as directed by the Engineer-In-charge and other works as described in the schedule. Tube well yield shall be minimum capacity 20 m^3/hour, or as stated in Schedule of Quantities.
- The entire work shall be carried out in a workman like manner and strictly in accordance with IS: 2800.
- The boring of the tube well shall be done by rotary/percussion or any standard method by means of drilling rig or manually subject to site conditions.
- The tube well pipe shall be shrouded with pea gravel of size 1/6” to 3/16” size.

The rates quoted shall be as per running meter depth of boring through the soils. The casing pipe will not be paid for and will be the property of the contractors. No compensation will be paid for the casing pipe if left within the ground or after commissioning of the tube well.

13.2.2 The rates quoted shall be as per running meter depth of boring through the soils. The casing pipe will not be paid for and will be the property of the contractors. No

compensation will be paid for the casing pipe if left within the ground or after commissioning of the tube well.

13.2.3 The Contractor shall make his own arrangement for the supply of water and power necessary for the work and workman. All other necessary materials and equipment shall be arranged by the Contractor without any additional cost to the Engineer-In-charge.

In case it is necessary to abandon (with approval of the Engineer-In-charge) the tube well at any stage of construction, no payment will be made to the Contractor for the transport of his plant and equipment or for boring and sinking of casing pipe. No compensation on any account is admissible in this regard.

The Contractor shall not be entitled for any compensation for delay of completion on account of any break-down or dropping of tools, tackles in the bore hole or the time of lowering housing pipe/blind/slotted pipe or lifting the casing pipe.

13.3 PERFORMANCE GUARANTEE:

The contractor shall guarantee the system to maintain flow requirements as per the specifications and drawings.

13.4 INFORMATION TO BE FURNISHED BY THE CONTRACTOR:

The contractor shall furnish the following information:

a) Method of drilling adopted
b) Date of starting drilling
c) Date of completion
d) Pilot hole or test hole Bit Type / Size
e) Boring Done – hours – from _____ to _____
Bit Type / Size
f) Recovery from _____ to _____
g) Reaming– hours – from _____ to _____
Bit Type / Size

h) Total Depth of Bore hole
i) Electrical
j) Lithological log from _____ to _____ formation
k) Assembly of Production Well Size
Length Type
Perforation per meter
Housing Pipe
Blind pipe
Strainer
Bail Plug
l) Type of Tube Well above / below ground level
m) Size of gravel
n) Quantity used before development
o) Method used for development & Testing
p) Total hours of development
q) Total hours of testing
r) Stage drawn down test
s) Type of test

t) Speed
u) Rpm
v) Discharge period from _____ to _____
w) Aquifer performance test
x) Time of test
y) Spend
z) Rev/minute
aa) Lpm
bb) Discharge
cc) Static water level
dd) Rated discharge in lpm
ee) Depression head of the production well
ff) Sand contents at the rate of discharge after 20 minutes of the start of pump
gg) Sand contents in RPM at 1.5 times the normal depression after 20 minutes of the start of pump.
hh) Sand contents in RPM @ 20% in excess of rated discharge, if 50% extra depression can not be arranged
ii) Samples of starts neatly packed in sample bags (They shall be obtained from the bore hole and collected in glass jars indicating the depth at which it is encountered)
jj) Chart of pipe assembly lowered – state the variations in diameter of pipe at different depths
kk) Results of mechanical analysis of samples of unconsolidated starts.
ll) Verticality test on prescribed form
mm) Physical/Chemical and bacteriological analysis of tube well water

14. RAIN WATER HARVESTING:

14.1 GENERAL

Surface water is inadequate to meet our daily water demand and we have to depend on ground water. Due to rapid urbanization, infiltration of rain water into the sub-soil has decreased drastically and recharging of ground water has diminished. The result of this in decline in water levels in most of the country.

To overcome with the problem mentioned above. The right solution is to use the rain water harvesting techniques.

DEFINITION OF WATER HARVESTING:

14.2 In scientific terms, water harvesting refers to collection and storage of main water and also other activities aimed at harvesting surface and ground water, prevention of losses through evaporation and seepage and all other hydrological studies and engineering interventions, aimed at conservation and efficient utilization of the limited water endowment of physiographic unit such as a water shed.

14.3 In general, water harvesting is the activity of direct collection of rain water. The rain water from the roof or from the surface can be directly stored for direct use or can be recharged in the ground water.

14.4 Most of the people are not aware that the rain water is the first form of water in the hydrological cycle, hence is a primary source of water for us. The other source like rivers, lakes and groundwater are all secondary source of water. In present times, we depend entirely on such secondary sources of water. In the process, it is forgotten that rain is the ultimate source that feed the water to all the secondary sources and remain ignorant of its

value. Water harvesting means to understand the value of rain and to make optimum of rain water at the place where it falls.

14.5 NECESSITY OF WATER HARVESTING:

14.6 In India there is a lot of rain, yet there is no water. The annual rainfall over India is higher compared to the global average rainfall. However, this rainfall occurs during short spells of high intensity. Due to such high intensities and short duration of heavy rain, most of the rain falling on the surface tends to flow away rapidly to these secondary sources as mentioned above, and very little rain water is left for the recharging of the ground water.

14.7 It is necessary to implement measures to ensure that rain falling over a region is tapped as much as possible through water harvesting, either by recharging it into the ground water aquifers or storing it for direct use.

14.8 AMOUNT OF WATER HARVESTED:

14.9 The total amount of water that is received in the form of rainfall over an area is called rain water endowment of the area. Now out of this the amount that can be effectively harvesting is called the water harvesting potential. Water harvesting potential is rainfall (mm) x collection efficiency.

14.10 The collection efficiency accounts for the fact that all the rain water falling over an area cannot be effectively harvested because of evaporation, spillage etc. Factor like runoff coefficient and the first flush wastage are taken into account when estimating the collection efficiency.

14.11 ADVANTAGES OF RAIN WATER HARVESTING:

The advantages by adopting Rain Water Harvesting is as under:

a. Provides self-sufficiency to water supply system.

b. Reduce the cost for pumping of ground water.

c. Provides high quality water, soft and low in minerals.

d. Improves the quality of ground water through dilution when recharged to ground water.

e. Reduces soil erosion in urban areas.

f. The roof top rain water harvesting is less expensive.

g. Rain Water harvesting system is simple which can be adopted by individuals.

h. An ideal solution of water problem in areas having inadequate water resources.

i. Reduces the runoff which chokes the storm water drains.

14.12 METHOD OF RAIN WATER HARVESTING:

The method of rain water harvesting are of two types. One by storage of rain water on surface for future use. Second by recharging to ground water.

The storage of rain water on surface is a traditional technique and structures used were underground tanks, ponds, check dams, weirs etc. and recharge to ground water is a new concept of rain water harvesting and name of few of them are recharge pits, trenches, dug wells, hand pumps, recharge wells, recharge shafts, lateral shaft and bore wells shaft with bore wells etc.

NOTE: All specifications for plumbing works shall be read in compliance with ECBC 2007. All works to be carried out has to follow ECBC 2007.

FIRE DETECTION AND ALARM SYSTEM

TECHNICAL SPECIFICATIONS

A. GENERAL:

The work shall consist of furnishing, installation, testing & commissioning of a complete high quality advanced technology early detection Intelligent Analogue Soft Addressable fire alarm system as shown on the drawings and specified herein.

1) REFERENCES FOR INSTALLATION:

German Standards VDE (Verband Deutcher Electrotechniker)
DIN VDE14675 and VDE 0833 Fire Alarm Systems

NFPA- National Fire Protection Association
NFPA 72

British Standard Institute / European Standards

All Applicable codes and standards including BS EN 54

2) SUBMITTALS:

Product data - for fire alarm system components including dimensioned plans, sections, and lavations showing minimum clearances, installed features and devices, and list of materials and data.

Shop drawings - System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project.

Product certification - signed by the manufacturer of the fire alarm system components certifying that their products comply with any one of the referenced standards, completely with specifications and ds approval or equal.

3) TRANSPORTATION, HANDLING AND STORAGE:

a) All the components of fire alarm system shall be provided in manufacturer's original new and unopened packing bearing manufacturer's name and label.

b) Store materials, not in actual use, in covered and well ventilated area and protect them from dirt, dust, moisture, direct sunlight and extreme temperatures.

c) For further requirements follow manufacturer's written instructions regarding storage and handling.

4) WARRANTY

Submit written guarantee signed by the contractor, manufacturer and installer of fire alarm system for the period of 1 year from the date of substantial completion. The guarantee shall cover the repair and replacement of material with manufacturing defects and workmanship as directed by the engineer.

5) QUALITY ASSURANCE:
Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems

and components, whose products have been in satisfactory use in similar services for not less than 3 years period, and be subject to approval of engineer.
Installer Qualifications: An experienced specialist sub-contractor who is authorized by the system manufacturer, and subject to approval of the engineer.

All the components and installations shall comply with the requirements of DIN VDE 14675 & VDE 0833 for design & installation.

Provide system and components specified in this section that are listed and approved by Vds & conform to equivalent DIN/EN standards.

Single source responsibility: All components and accessories shall be product of single manufacturer.

B. PRODUCTS

1) SYSTEM DESCRIPTION:

The fire detection and alarm system shall comprise of Automatic Soft Addressable Modular design main fire alarm control panels, Dual optical smoke & heat MULTI Sensors, Blue LED Optical Smoke & Heat MULTI Sensors, Optical Smoke / Heat/ CO Gas MULTI sensors, Loop powered Dual Optical Smoke/Heat sensor with integral Sounder / Flasher / Speech units, manual call points, electronic wall mounted Alarm sounder/flasher/speech combined devices, Transponder interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system shall conform to the relevant and applicable requirements and recommendations of DIN EN 54. The system shall be fully programmed to accommodate fire alarm zones. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to existing buildings/network on site.

The fire alarm and detection system shall provide the following facilities as a minimum:

The system shall be intelligent in operation with advanced decentralized intelligence technology. Each detector shall have its own processor with algorithms built in the device to take a fire or fault decision. System with centralized intelligence by providing signal levels to the control panel is not acceptable.

The system will be capable of providing fire, fault disablement and supervisory monitoring facilities as required by DIN EN 54 Pt 2. All devices on a loop shall have built in short circuit line isolators for wiring fault isolation to protect the system. “Group Circuit Monitors” which isolate/protect sections of a loop circuit, i.e. a group of field devices are not acceptable.

All system components and devices shall be connected to two-wire loop circuits (as shown in the typical schematics) with each component having its own individual built-in isolator, should have sensors with integrated sounder in a same unit and no extra cabling should require to power up the sounder. Removal or disconnection of any component from the loop shall not affect the functioning and performance of other components and the system. Please note that the group isolators, which are used to isolate a section of a loop in case of fault, are not acceptable.

System shall be of automatically addressable type i.e. all the devices on the loops of the FACP shall be allocated addresses automatically from the PC / panel at the time of system power. The loop devices shall also be able to commission by using PC interface without the need of FACP.

And also given an address during commissioning, the value of which shall be stored in non-volatile memory, within the electronics module of the outstation. This value shall be read during loop allocation and provided it is valid shall be used to setup the outstations primary address.

Automatic Addressing shall cover the benefits of Soft Addressing and also overcome the limitations of Hard Addressing. This means that If the devices are inserted or removed all the existing devices shall keep the same address and programmed activations and use labels remain unchanged. The panel with PC shall allocate the address to ensure that it is impossible for two devices to have the same address. Fire Detection and Alarm Systems, which rely only on Coding, Programmer or hard addressing techniques are not acceptable.

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions:

- The power supply to the loop /s;
- For open-circuit, short-circuit, earth fault and any other fault condition in the loop wiring;
- For communication failure and errors in all cards and loops
- For faults in keyboard and printer circuits
- All devices, etc. shall be installed on the same loop.

All devices shall be assigned a maximum of 25 character or 2 lines of max. 30 characters each with a ¼ VGA Display. In case of fire, fault or warning, the label of device sensing threshold shall appear on visual display unit of the panel.

Any event i.e. Fire, fault or warning shall be recorded with time, date and place of occurrence in the memory of FACP. These events can either be displayed on normal or ¼ VGA Display of the FACP or printed, as required. Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset. The detectors shall have auto learn sensitivity adjustments. The main fire alarm control panels shall be located as shown on the schematics and the floor drawings.

All major component of fire alarm system shall be product of a single manufacturer and shall conform to the requirement of EN54, Vds approved and be designed acc. to DIN VDE14675 and VDE 0833 Fire Alarm Systems CODE OF PRACTICE FOR SYSTEM DESIGN, INSTALLATION AND SERVICING.

The power supply breakers for FDA system shall be marked " DO NOT DISCONNECT. FIRE ALARM SUPPLY"

2) ANALOGUE ADDRESSABLE FIRE ALARM CONTROL PANEL (FACP)

In the event of a fire being reported from the smoke/heat Detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows: If a fire condition is reported from a smoke detector then the evacuation will be done initially by the local integral sounder. Then after a certain delay (to be agreed at the time of commissioning) the evacuation message shall be announced on that fire zone only. If after 3 minutes the alarm has not been acknowledged, the evacuation message shall also be announced on the other adjacent zones. All other zones shall be given the Alert message. The evacuation of the building shall be staged in phases to allow orderly movement of people.

If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected fire zone plus the adjacent zones.

Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as a part of the overall engineering policy.

- Signal to all elevator machine rooms indicating fire status (to control lifts)
- Release doors normally locked by magnetic devices.
- Release doors normally held open by magnetic devices
- Shutdown mechanical equipment ventilation plant
- Shutdown general exhaust fans
- Start up smoke extract fans
- Start up exhaust make up fans
- Start up stair vestibule pressurization fans
- Automatically operate fire dampers
- Initiate alert signals to panels in the adjacent office tower.
- Sprinkler valves, flow switches and other monitored valves shall be directly supervised by the fire alarm systems.

These shall include but not limited to the following:

- Building automation system via WINMAG OPC
- Emergency lighting system
- Security system.

3) SYSTEM COMPONENTS AND DEVICES

3.1 FIRE ALARM CONTROL PANEL:

The panel shall be modular Multifunctional computer controlled using 32 bit processor. De-centralized control and monitoring functions to be realized on the loop and spur.. The panel shall be complete with, but not limited to, the following elements:

- Visual display unit capable of displaying 8 lines 40 characters backlit display / VGA display as
  Optional.
- Built-in optional 40 character internal protocol thermal printer or external.
- Built-in full numeric keyboard with function keys.
- Optional 64 Single Zone Indicator expandable upto 192 SZI.
- Key switch to prevent unauthorized operation of keypad.
- Integral sealed lead acid battery and charger, with 24 hour back up in the event of supply mains failure.
- Essential controls – Delay, panel reset, Audible alarm off, Disconnect master box, additional messages, verify/cancel fault buzzer. Fire, Pre-Alarm, Trouble, Disconnection lamps. Each lamp shall also have appropriate indication (Releasing Systems activated, Master box, Delay, Verify, CPU failure, In operation normal condition & failure of power supply / battery) Simple menu driven function keys with password protection shall allow users to an extensive range of software based features such as:

- Overview
- Service
- Time functions
- Information’s
- Last 10000 system events
- Current fault and warning logs.
- Interrogation of sensor cleanliness
- On/Off, Enable/ disable sensors, zones, sounders, interface unit channels.
- Status of detectors
- Alarm counters

- Printer on, off, line feed and test facilities.

All control buttons and keyboard shall be enclosed behind a lockable cover,Up to 127 device capacity per 3.5km loop and a TTY/ RS 485 communication option.

In addition to the above, all other necessary controls, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of DIN EN 54.

3.1.1 LOOP PARAMETERS:

- Individual loop circuits will be capable of accommodating the following.
- Up to a maximum of 127 addressable devices on 3.5 kms loop length
- Up to 32 loop powered IQ8 Alarm addressable Sounders.
- Up to 32 loop powered IQ8 Alarm electronic Strobes.
- Up to 32 loop powered combined electronic sounders and strobes
- Up to 80 sensors with integral alarm sounder
- The detection loop shall have the ability to support both sensors and sounders Connected on the same 2 core loop circuit.
- Up to 127 loops powered input modules.
- Should have the ability to spur off the detection loop without using 'T' breaker devices, without any degradation.

3.1.1 SYSTEM EVENT PRINTER

The system printer shall be 40 character thermal printer optional in-built on the main control panel, and shall log all events, change of status, alarm and fault messages along with time of the day and date. An external 80 column dot matrix printer along with system PC is also recommended.

The printer shall provide the following:

- Hard copy of every event occurring
- Status read out of every addressable point
- Devices tested on a walk test
- Contaminated detectors needing replacement
- Single point scan printout of analogue values
- Hard copy of historic log.

3.2 FIELD DETECTION DEVICES

3.2.1 GENERAL: ANALOGUE DETECTORS & BASES

All analogue detectors and bases shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible.

All analogue detectors shall have real intelligence itself. This means even without control panel the detector can make decision, adapt to different environmental condition and diagnose itself. They shall have decentralized intelligence, automatic function self test, CPU failure mode, alarm and operating data memory and integrated short circuit line isolators. The detector bases for interfacing between the loop wiring and the detector head shall be manufactured by means of injection moulded ABS plastic colored white and shall not contain

any electronics for addressing. The base fixings should be suitable for any industry standard BESA or conduit boxes. All bases shall include the option to provide a programmable relay output for interfacing, providing a dry contact for third party.

All bases shall be provided with a plastic removable dust cover for protection during site construction as well as an IP rated sealing gasket to prevent dirt and moisture from entering through from the fixing surface.

Each base shall include a lock and removal of locked detectors shall be achievable only through the use of the appropriate removal tools as specified by the manufacturer of the detectors. Detectors removal tools are to be handed over on completion of the contract as part of the spare parts to the client.

Removal of a detector from its associated base shall not affect the continuity of the detection loop.

The Fire alarm manufacturer shall have the complete range of following analogue addressable detectors with decentralized intelligence as standard so as to meet the specific applications of the site.

1) Heat Detectors (fixed & ROR temperature)
2) Optical Smoke Detector
3) Optical Smoke & Heat Detector
4) Dual angle Optical/Heat Detector
5) Blue Light Optical / Heat Smoke Detector
6) Optical Smoke, Heat & CO gas Detector
7) Optical Smoke detector with integral Sounder
8) Dual angle Optical/Heat detector with integral Flasher
9) Dual angle Optical/Heat detector with integral Sounder
10) Dual angle Optical/Heat detector with integral Speech Sounder
11) Dual angle Optical/Heat detector with integral Flasher and integral speech sounder
12) Duct mounted sensor
13) Radio Frequency wireless analogue detectors
14) Manual Call Points

All of the above shall be compatible with the aforementioned base providing inter-changeability between detector heads, without the requirement for switch settings. All detectors shall also have an integral short circuit isolator, which in the event of a single cable fault will isolate the “culprit” piece of cable and retain all devices on the loop operationally.

Each detector shall possess two integral LED giving a red flashing indication for fire and green for normal operation. For remote locations, each detector shall be capable of connection to a remote LED unit by means of 2 core wire connection.

Detectors shall be white in colour and manufactured from ABS plastic. All electronics and associated sensing elements will be housed within this unit, these components being hermitically sealed to prevent their operation from being impaired by dust, dirt and humidity.

The sensitivity off all detectors shall be adjustable from software. It shall be possible to programme detector sensor sensitivity directly on the loop using interface with a laptop PC and appropriate programming software from manufacturer.

For MULTI SENSOR detectors, disablement of each sensor element shall be possible individually or for whole loop. Also this disablement feature shall be possible to have manually or time / event controlled.

All detectors shall be provided with a plastic removable dust cover for protection during site construction.

A semi-flush recessing kit for analogue detectors shall be available for each detector type incorporating the standard detector base.

3.2.2 HEAT DETECTORS

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 and shall be VdS approved. This shall be a dedicated heat only detector to provide fixed temperature heat as well as rate of rise sensing. It should be fully compliant with EN54 part 5 to provide grades of A1.

3.2.3 OPTICAL SMOKE DETECTOR

Install as shown in the drawings .Analogue Addressable Optical Smoke Detectors. These shall be of Automatic addressable Optical type with inbuilt isolator in a single head. The optical element shall detect visible smoke from slow smoldering fires. Smoke sensing design shall comply with EN 54 part 7 and shall be VDS approved. It shall have microprocessors, short-circuit isolators and all electronic components and circuitry suitable for an Analogue addressable system. The detectors shall also have 360 degree viewing LED fire indicator.

Detectors mounted in the false ceilings shall be provided with semi flush mounting kits.

3.2.4 OPTICAL SMOKE /HEAT DETECTOR

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. These detectors shall have combined two individual sensing elements to provide excellent cover for both types of fires (slow smoldering & fast free burning fires). These detectors shall be of Automatic addressable Combined Optical/Heat type with inbuilt isolator in a single head.

Optical sensing shall be carried out by means of an Infra-red LED transmitting a pulse of light across an obtuse angled chamber & heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

3.2.5 DUAL ANGLE OPTICAL/HEAT DETECTOR

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. This device shall combine two individual sensing elements to provide excellent cover for both “types” of fires. (Slow shouldering and fast free burning).

Optical sensing shall be carried out by 2 infra-red LED transmitters across 2 separate Optical detection angles. This sensor shall process both the forward and backward scattered Light caused by entering the detection chamber of device, allowing the detector to differentiate between real smoke and non-smoke particles e.g. Steam & Dust.

Heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

3.2.6 BLUE-LIGHT OPTICAL SMOKE / HEAT DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7. The optical measurement chamber shall be provided with latest developed blue LED

sensor technology, enabling the detection of open fire, smouldering fires and fires with high heat generation (Invisible smoke sensing). These detectors shall be capable of identifying the TF1 & TF6 test fires described in EN 54-9 specifications. These detectors shall be intelligent with time related signal analysis, signal correlation of sensor data & decentralized

Heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

3.2.7 OPTICAL SMOKE DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings (Hotel guest rooms / suits).These shall comply with the requirements of EN 54: Part 3 & 7. The sensor element of the optical detector sounder shall be as per the specification for the optical smoke detector; however the device shall incorporate an internal electronic sounder.

The internal electronic sounder shall be an integral part of the detection device comprising of a piezo sounder output device providing the low and high frequency output.

The combined detector sounder shall provide a sound pressure level of 92dBA at 1 meter.
The audible volume levels shall be individually selectable for each device and there should also be a configurable soft start feature that ramps up the volume gradually rather than switching on at full level.

It shall be possible to connect a maximum of 80 combined detector sounders to a detection loop.

A minimum of 19 Different tone types are stored in the detector sounders. Upto 4 different tone types shall be combined in a signal set and activated in case of alarm. Individual detector sounder volume levels shall be adjustable at the main control panel or via the use of the remote programmer unit coupled with a laptop PC and appropriate programming software from the manufacturer.

Activation of the sounder shall be independent of the detection of a fire condition by the sensing element. All sounder outputs shall be synchronized with all other loop powered detector sounder devices and other loop powered audible visual units on the panel.

Each sounder shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

3.2.8 DUAL ANGLE OPTICAL/HEAT DETECTOR WITH FLASHER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7.

The sensor element of the dual angle optical/heat detector flasher shall be as per the specification for the dual angle optical/heat detector.

The integral flasher element shall utilize a high power red LED for strobe effect. LED pulsing shall be synchronized with all other loop powered audible visual units located on the fire alarm and detection panel. The flasher LED shall be fault monitored for working operation.

It shall be possible to connect a maximum of 48 combined dual angle optical/heat detector flasher to a detection loop.

Activation of the flashers shall be independent of the detection of a fire condition by the sensing element.

Each flasher shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

3.2.9 DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector sounder sounder shall be as per the specification for the dual angle optical/heat detector.

The sounder element of the dual angle optical/heat detector sounder. shall be as per the specification for the optical smoke detector with integral sounder.

It shall be possible to connect a maximum of 80 combined dual angle optical/heat detector sounder to a detection loop.

3.2.10 DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SPEECH SOUNDER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with speech shall be as per the specification for the dual angle optical/heat detector.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech.

Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) shall be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronized with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

3.2.11 DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL FLASHER & SPEECH SOUNDER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angle optical/heat sensor.

The sounder element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angel optical/heat sensor sounder.

The integral strobe element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angel optical/heat sensor strobe.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech. Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) can be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

As standard, the microprocessor shall contain the following messages:

Evacuation: Alarm Message 1 (Voice)	"This is a fire alarm. Please leave the building immediately by nearest available exit"
Evacuation: (Voice)	"Attention please"
Evacuation Alarm Message 2: (Voice)	"This is an emergency. Please leave the building immediately by the nearest available exit"
Alert Message	"An incident has been reported in the building. Please await further instructions"
Clear Message: (Voice)	"The emergency is now cancelled. We apologise for any inconvenience"
Test Message	"This is a test message, no action is required"

All the voice messages shall be synchronized across the detection loops by means of a regular synchronization signal generated by the fire alarm control panel. In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronized with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

3.2.12 DUCT MOUNTED SENSORS

Venture principle air duct detector kit shall be used. The kit with IP 54 protection ABS plastic with filters shall be mounted outside air ducts. The Venture tube dips into the air duct. The airspeed in the duct shall not exceed 1 m/s to max 20 m/s. This device shall employ the aforementioned Optical/Heat detector to provide environmental information. Probes are fitted to pick up smoke in ventilation ducts. This unit is particularly suitable for sensing smoke particles in ducting which is likely to be in large quantity and flowing fairly quickly.

3.2.13 MANUAL CALL POINTS

Install as shown in the drawings. The manual initiation devices shall be electrically compatible with all of the aforementioned detector types and shall be complete with all electronic components and circuitry for an automatic safe addressable device. The manual call point shall have an inbuilt short circuit isolator and an inbuilt microprocessor to ensure a response time of less than 1 second.

The MCP unit shall also handle all communication to the control panel. All electronic devices contained within the MCP shall be hermetically sealed so as to prevent damage from hostile environment conditions: e.g. dust with minimum rating of IP43.

The MCP operating voltage shall be 8-42 volts DC, RED similar to RAL 3020. If the MCP are located in public areas a transparent cover shall be provided as a protection to prevent inadvertent activation. MCP shall be available in two designs Large & small for aesthetic purposes to architects.

The MCP shall have an input facility to connect conventional devices. It should have an option of using either frangible glass allowing for complete removal upon operation or plastic pane resettable function. There shall be no text but SYMBOLS on the MCP (burning house / press to break).

The device can be tested functionally without the need to either remove the front cover and/or breaking the glass, with a special test key (supplied as standard). The key shall insert the underside of the MCP ensuring easy access of the key at all times.

These devices will comply fully with EN 54 part 1.

3.2.14 LINEAR HEAT DETECTOR MODULE & SENSOR CABLE

Line heat detector module enables early detection of fires & over heating. This should be specifically designed in narrow rooms, cable alleys & rough ambient condition. This should consist of evaluation unit & sensor cable. The sensor cable shall be connected into evaluation unit.

Maximum sensor cable length connected to evaluation unit shall be 300 meters. Unit shall monitor the resistance of sensor cable. The operating voltage of the unit shall be 9-30V. The evaluation unit needs to be connected with main fire panel. It should be VDS approved as per EN 54-5A1.

3.2.15 FIELD ALARM DEVICES

Electronic sounders, combined sounder/strobe and standalone strobes shall be loop powered for direct connection to the 2 core detection loop shall be electrically compatible with all initiation devices. These wall mounted units shall be available in red or white and suitable for both indoor and outdoor applications with an ingress protection rating of IP31 and IP65 respectively.

All electronic sounders, sounder/strobe and strobe only versions shall have alarm signals synchronized across all the detection loops of the fire alarm control panel.

All alarm devices shall have a short circuit isolation device provided as an integral component of the device.

All sounders shall have a ‘soft start’ feature controlled by the fire alarm panel, whereby a low initial volume can be set and then increased at a defined rate upto a maximum volume setting.

All alarm devices shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible The Fire alarm manufacturer shall have the complete range of following alarm devices with built in short circuit line isolators so as to meet the specific applications of the site.

3..2. 16.2 ADDRESSABLE SOUNDER / FLASHER

A combined electronic sounder and flasher shall be capable of providing a minimum sound level of 97dBA ± 2dBA @ 1 meter.
The sounder shall be capable of providing 4 different sound signals which are selected/configured from 19 tone types store in the device.

The unit shall have its own microprocessor to handle loop communications and monitoring of the internal flasher element for faults in both the quiescent and alarm conditions. The microprocessor shall also monitor the sound producing element during an alarm condition to ensure that faulty devices can be automatically identified during the weekly test procedure.

All associated electronic components shall be hermetically sealed to provide protection from Hostile operating environments.

The frequency of the electronic flasher light output shall be 1Hz

The unit shall be manufactured from ABS plastic with a polycarbonate lens. Body and lens colour shall be Red body / red lens.

These devices shall allow for direct connection to the detection loop. It shall be possible to connect upto 32 combined electronic sounder/flasher to each detection loop of the fire alarm control panel.

3.2.16 FIELD INTERFACE TRANSPONDERS

These devices shall be directly connected to the loop, four variants shall be available as standard, these being:

- 4 In / 2 Out interface unit
- 1 In interface unit
- 32 LED output interface unit
- 12 Relay output Interface unit.

These units shall be self-contained wall mountable units, similar in finish to the main control panel.

3..2. 16.2 4 IN / 2 OUT INTERFACE UNIT

Interface units shall be capable of accepting 4 input signals, 2 output signals. Dependent upon the specific application, input signals may be interpreted by the system as any of the following:

- Fire signal input
- Fault signal input
- Supervisory signal input
- Event signal input

The exact nature of which shall be selected by means of the commissioning software. These units will accept and or supply clean contact signals either normally open or normally closed (configurable) OR switched voltage inputs from conventional detectors or MCP's.

The output contacts shall be rated at 30V / 1 amp. DC output of the unit shall be provided with single pole change over contacts for control of plant, door release units or power output to drive conventional bells, sounders etc. Both the outputs on the interface shall be individually programmable. External power supply 12V / 24 VDC shall be provided to this unit.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications. Product shall be approved by VdS.

3..2. 16.2 RELAY OUTPUT INTERFACE UNITS

These interface units contain 12 clean relays which are individually programmable with the commissioning software. All relays can be configured as NO or NC.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications.

3.2.17 NETWORKING OF CONTROL PANELS

It shall be possible to network connect up to 31 controls as a secure network connection. All messages from a panel should be transmitted in both directions on the ring structure. Any wire-break or short-circuit on the ring shall not effect data transmission. The network shall be configurable so that single panels, groups of panels or all panels on the network operate the same site configured cause and effect fire plan.

The network shall also be configured to allow master control from any one of the control panels on the network. To cover longer distance repeaters or fiber optical cable and converters can be used between two panels.

The network shall be able to accommodate intruder alarm panels.

There shall be extensive diagnostic functions on the panel to be used to localize faults caused by interference or wiring, Networking shall be capable of carrying out using a data cable e.g. IBM type 1 or CAT5. The distance between each panel shall be standard 1200 meters and capable of extending upto 3000 meters using booster repeaters.

3.2.18 NETWORKED LCD OPERATING PANELS / REPEATER PANELS

The Repeat Panel shall be sited at the Rear Entrance, guard house or location where it is manned 24 hrs.. It shall provide system repeat facilities to repeat all of the liquid crystal display messages as well as the common indications. Repeat panel shall be interfaced for network fire alarm control panels, designed for standardized display and operation as per DIN EN 54 part 2 and DIN VDE 0833 part 2. Installation and connection to FACP shall be via the short circuit and open circuit resistant essence. System network. RS 485 interface or TTY interface for connecting remote printers, and fire brigade shall be available. The repeaters shall have minimum three common relays freely programmable, monitored, potential free upto 24 VDC.

3.2.19 BATTERIES

Batteries shall be provided and shall be the dry sealed lead-acid type. The batteries shall have ample capacity. With primary power disconnected, to operate the fire alarm system for a period of 24 hours with an optional 72 hours battery backup. Following this period of operation via batteries. The batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 30 minutes.

3.2.20 WIRING

All cables associated with Fire Alarm installation shall be of fire resistant 2 core 1.5 sq. mm twisted pair. Cables shall comply with BS 6207 Part 1. The cable is to BS 6207: Part 1 having, Typically no more than 2 cores each core having 1.5 sq. mm cross sectional area, A red cover sheath (preferred for alarm applications), Having continuous metal sheath encapsulation, Fire resistant tested to BS6387 categories CWZ.

C. EXECUTION

1. INSTALLATIONS

The entire fire alarm system shall be installed in accordance with DIN / BS EN54/NFPA Standards and manufacturer's approved shop drawings, written instructions and recommendations.

2. TESTING

Fire alarm system shall be tested in accordance to Local Civil Defense regulations and put into operation by the manufacturer or his authorized representative in the presence of engineer. Fault and alarm conditions shall be simulated and all data and alarm indicators checked with full events recorded on system printer according to the testing procedure.

PUBLIC ADDRESS SYSTEM

SCOPE:

All the equipment of Public Address System namely Controllers, Routers, Call Stations, Keypads, Speakers, Mic's, amplifiers shall be of one make only Without compliance to the above clause, the tender would be cancelled.

The voice alarm system shall be the integrated solution for BGM (Back ground Music) and EVAC (Emergency Voice Alarm). The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifier switching, loudspeaker line surveillance, digital message management and a fireman's panel interface – shall be combined.

The system shall provide for emergency call (EMG), business call and BGM audio, up to 60 zones, 8 call stations and two remote control panels. The voice alarm system shall be a one channel/two channel system. It shall be compatible with BGM sources and 100 V booster amplifiers. It shall be capable of connecting to EVAC compliant loudspeakers and accessories for an integrated public address and voice alarm solution.

The system shall be fully IEC 60849 compliant. It shall have full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager for 255 pre-recorded messages and chimes. It shall be possible to merge messages to allow even more flexible use of pre-recorded announcements and evacuation messages. It shall be possible for each message to have any length within the total available capacity. The memory shall have a capacity of 16 MB. It shall be possible to upload from a PC via USB into the memory, after which the unit shall operate without PC connection. The standard WAV-format shall be used for the messages and sample rates of 8 kHz up to 24 kHz with 16-bit word length (linear PCM) shall be supported.

Volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls. All current override schemes shall be supported (3-wire and 4-wire override schemes i.e. standard 24V and failsafe). Upon a call or an activated trigger input these contacts shall be activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

A 24Vdc output shall be available to supply power to external relays, so no external power supply shall be required for that purpose. A LED VU-meter shall allow for monitoring of the master output.

The maximum allowed total cable length between the controller and the last router in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the last call station in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the RC panel shall be 1000 meters.

The controller and each connected router shall have 12 trigger inputs to start business and emergency messages. Each shall be configurable for a message consisting of a sequence of up to 8 wave files. It shall be possible for wave files to be used in different combinations with other messages, optimizing flexibility and used storage space.

As the basis of the voice alarm system, the controller shall have all the essential functionality for compliance with IEC 60849 standard, including full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager The messages shall be mergable to allow even more flexible use of pre-recorded announcements and evacuation messages. The controller shall be used as a stand-alone system with up to 6 zones, or

expanded to up to 60 zones using additional 6-zone routers. Up to 8 call stations shall be connectable. Interconnections shall be made using standard RJ45 connectors and CAT5 cable.

It shall be possible to connect 480 watts per router. The audio output shall use standard analog audio 100 V line switching for full compatibility with public address equipment and EVAC-compliant loudspeakers. The system shall be configured using DIP switches for basic functionality and a PC for more advanced functions. It shall be possible to specify 16 priority levels.
A built-in 240 W booster amplifier shall provide the power for the emergency call channel and BGM. It shall be possible to add additional booster amplifiers as spare, to provide two-channel operation or if the total power requirement exceeds 240 W (maximum 480 W per 6 zones). All booster amplifiers shall be supervised.

The maximum/rated output power of the internal booster shall be 360 W / 240 W. max mains inrush current shall be 8A @ 230 VAC / 16A @ 115 VAC

The frequency response shall be 60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. rated output. The distortion shall not exceed 1% at the rated output, 1 kHz. The controller shall have tone controls to allow for adjustment of the BGM sound. It shall have separate bass and treble controls. The controller shall have two BGM source inputs and a mic/line input with configurable priority, speech filter, phantom power and selectable VOX activation. It shall be possible to select 16 priority levels for microphone, call stations and trigger inputs for optimum system flexibility. It shall have two connectors to connect the call stations. It shall have 12 input triggers with 6 supervised trigger inputs. Furthermore it shall have one tape output on cinch connectors. The trigger outputs shall be on floating relays with a rating of 250V 7A. The controller shall have an emergency active relay, a fault relay and two general purpose relays, for control purposes. The fault relay shall be failsafe.

The output section shall have six transformer-isolated 100 V constant voltage outputs for driving 100 V-loudspeakers in six separate zones. All zones shall be individually selectable from the front panel and the BGM output level in each zone shall be individually settable in 6 steps. The BGM output shall be connected to the 70V line, thus it shall be possible to connect a total load of 480 Watts in a two channel system combined with a 480 Watt booster.

The output of the booster shall be also available as a separate output on 100V and 70 V. A separate 100 V Call Only output shall be provided for addressing an area where BGM is not required but where priority announcements are. Six configurable volume override output contacts shall be available for overriding local volume controls during priority calls. A LED VU-meter shall monitor the output.

The voice alarm router shall be an expansion unit adding 6 zones as well as 12 input- and 8 output contacts to the voice alarm system. It shall be able to use the booster built in the voice alarm controller. It shall provide outputs and inputs for one or two boosters in a multi amplifier one- or two-channel system. It shall provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones, using two booster amplifiers. Also single channel operation shall be possible with only one booster.

The router shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups. Each of the zones shall be switched between the call channel (upon call-station selection or all-call microphone or emergency activation), the BGM channel (upon front panel selection), or off. The zone power handling capacity of the router shall be 480 Watts. The router shall also have 12 input triggers. 6 triggers shall be supervised for EMG purposes.

The 6-zone call station shall be a stylish high quality call station with a stable metal base, a flexible microphone stem and a unidirectional condenser microphone. It shall be intended for making calls to selected zones. The special design shall allow for neatly flush mounting in desk tops. Using dip switches on the bottom of the call station, the call station ID shall be selectable. The call station shall have selectable gain, speech filter and limiter for improved intelligibility.

On each call station it shall be possible to select 6 zones with the possibility to connect a call station keypad to increase the number of zones or zone groups that can be selected.

It shall have LED indications for zone selection, fault and emergency state. The call station extension shall provide seven additional zone and zone group keys

On each call station it shall be possible to select 6 zones with the possibility to connect up to 8 call station keypads to increase the number of zones or zone groups that can be selected. Selected zones are indicated with LEDs on the call station, three additional LEDs give visible feedback on the active state of the microphone and the system. Green
Indicates microphone active, amber indicates that the system has detected a fault (IEC 80649) and red indicates that the system shall be in the emergency state.

The power supply voltage range shall be 18 – 24V with a current consumption of less than 50 mA. The nominal sensitivity shall be 85 dB SPL (gain preset 0dB). The nominal output level shall be 700 mV. The maximum allowable sound pressure level shall be 110 dBSPL. The microphone shall have a limiter. The distortion shall be less than 0.6% at maximum input. The equivalent input noise level shall be no more than 30 dB SPLA. The frequency range shall be 100Hz – 16 kHz. The speech filter shall be a 315 Hz, high-pass, 6 dB/oct filters. The output impedance shall be 200 Ohms. The stem length with microphone shall be 390 mm.

Mains voltage shall be both 230Vac and 115Vac, ±15%, 50 / 60Hz (selectable) Power consumption of the Controller shall not exceed 600 Watts, and the router shall not exceed 50Watts. Battery backup provisions shall be implemented; the battery voltage shall be 24Vdc, +20% / -10%. All low level connections and volume override shall be on MC1, 5/XX-ST-3,5 type connector blocks. All high level connections except mains shall be on MSTB 2, 5 /XX-ST. The input contact shall have supervision based on a series and parallel resistor.

The router and controller shall be rack mountable with removable rack mounts. The router shall be not higher than 2U. The controller shall be not higher than 3U. The rack mounting kit shall be included.

The operating temperature range shall be -10°C to +55°C. The storage temperature range shall be -40°C to +70°C.

The system shall comply to the following standards:
- EVAC compliance acc. to IEC 60849
- EMC emission acc. to EN 55103-1
- EMC immunity acc. to EN 55103-2
- Safety acc. to EN 60065

The system shall be the Bosch Plena Voice Alarm System.
The controller shall be the Bosch Plena Voice Alarm Controller 1990/00.
The router shall be the Bosch Plena Voice Alarm Router 1992/00.
The call station shall be the Bosch Plena Voice Alarm Call Station 1956/00.
The cal station shall be the Bosch Plena Voice Alarm Call Station Keypad 1957/00

1 - GENERAL REQUIREMENT

The design, supply, delivery, installation, testing, commissioning and maintenance of the Public Address System shall include, but not limited to the following:

- Recessed mount (ceiling), surface mount, column and / or horn speakers, sound projectors, Box and bi-directional box speaker’s c/w line matching transformers and volume controls, where applicable;

- Termination of all cables to speakers, power amplifiers, etc.;
- Equipment rack complete with forced air ventilation fan(s), mounting brackets blank panels, Terminal boards, etc.
- Main equipment and all associated auxiliary equipment;
- Distribution cabling, including fire rated cables, where applicable, cable ladders, racks and Cable supporting systems (cable trucking and concealed metal conduits)
- All other works and materials necessary for the efficient operation of the whole audio system Complete with power supply requirements and surge arrestors and filters.

The primary objective of the system is to provide clear announcements during public addressing And one-way voice communication during an emergency; the secondary function shall be to provide background music where required.

The system shall be capable of fulfilling the following requirements:

- Clear, un-distorted announcements to selected areas during public addressing;
- Clear, un-distorted paging to all zones; either individually or collectively. Selection of groups of Zones shall be programmable from time to time; and
- Background music to selected areas when the other functions are not selected.

The loudspeakers shall be wired up in zones and with supervision; localized volume controls as Specified shall be provided so that the desired volume adjustments may be made. Locations of Localized volume controls are as indicated in the Schedules and /or drawings.

The zones shall further be grouped according to function so that it shall be possible to make an Announcement by depressing just one switch on the call station.

To allow flexibility in the system, it shall be designed to be expandable with easy installation without changes in controller.

Then the zones are selected for public addressing, a chime shall first be heard, followed by the announcement. The system shall have a range of tones such that it shall be possible to programme different tones for call stations.

It shall be possible for the system to function with different call stations in operation, provided there is no conflict in the zones being called by the call stations. An emergency call station shall be provided for emergency.

The controller shall have a system of priorities such that, should a conflict situation arise, the station or user key with the top priority will override the others. This sequence of priorities shall be determined and programmed during the commissioning stage; it shall be possible to change the sequence by on-site as well as off-site re-programming, as and when the need arises.

The system shall comply with country Public Address Evacuation Code of practice or IEC 60849 for the one-way emergency voice communication system in all aspects.

All control and switching equipment shall be centralized and decentralized as specified and located in equipment racks in the FCC and equipment rooms. No other equipment except the volume controls and cable patch panel shall be located outside the equipment rack.

All equipment supplied shall be from the same manufacturer. Equipment supplied shall strictly be Standard Products from Public Address Product Manufacturer. No tailor- made product shall be acceptable. The tendered shall submit catalogues of all equipment offered and upon delivery; certificate of country of origin, Certificate of Conformity and Certificate of Evacuation for the proposed PA Equipment shall be submitted.

Zoning for the passenger lifts shall be provided as provision and shall complete with the necessary wiring to be terminated in a termination box near the control panel in each lift motor room. Group zoning for the lifts shall be allowed for evacuation announcement.

2 - MATERIALS

All materials shall be of new and unused quality. All equipment and materials previously installed or used shall be rejected. Materials and equipment shall be stored in such a manner-as to be in a new condition when installed and to avoid damage from weather and site conditions. Damaged, deformed and cracked equipment or materials shall be rejected. Replacement shall be the responsibility of the Sub-Contractor at no additional cost to the Government.

Materials and equipment to be incorporated into the works (as called for in this specification) are required to meet the quality / testing standards of designated institutes, societies and standards associations. However, equivalent materials and equipment items meeting other authoritative standards which ensure an equal or higher quality than the standards mentioned may also be accepted if the consultant gives his approval.

Should the contractor propose to furnish materials and equipment other than those specified as permitted by the ‘or approval equivalent’ clause, he shall submit a written request for any such substitution. Such requests shall be accompanied by complete descriptive (manufacturers, Certifications, brand name, catalog number, etc) and technical data for all items, samples of both the specified and the proposed substitute items.

Acceptance or rejection of the proposed substitutions shall be subjected to the approval of the consultant.

The expenses incurred by any such exercise shall be borne in full by the Contractor.

3 - SYSTEM REQUIREMENT

For general office and public areas, the system shall be capable of delivering a sound pressure level of 85 dB at the listening level.

For M & E areas such as plant rooms, etc where the noise level is higher (assumed to be $\leq$80 dB), the system shall be able to deliver 95 dB at the listening level.

The listening level shall be taken to be 1.5 m above floor level.

The reinforced sound shall be distributed evenly throughout the listening area; the total variation in each area shall not exceed ±4 dB.

An articulation loss of consonants of less than 15% shall be maintained. (Generally, the reverberation time of the various locations shall be assumed to be not more than 1.9 seconds).

Paging announcements shall be possible from any of the microphone call stations, or from the microphone paging station to any zones within the network systems.

Call station shall be using CAT 5 cable with RJ 45 connector to transmit calls.

The microphone paging station shall have the flexibility of selecting any number of user keys (selection buttons) at any one time. It shall be able to program each user key for function.

The central controller shall have a means of monitoring, to continuously monitor the system from the microphone of the call station onwards; any faults shall be displayed on the central unit.

High quality signals shall be maintained at the output of the power amplifiers to compensate for losses in the audio distribution lines.

Each power amplifier with 30% spare capacity shall be provided to drive all loudspeakers during an emergency without overloading.

Each power amplifier shall have a built-in self-restoring protection circuit to guard against hazards of operation such as mis-loading at its input, short-circuiting of its output and connection mistakes.

The power amplifiers shall also have built-in line transformers for 100V loudspeaker matching, DC input of emergency operation. It shall have amplifier monitoring and auto-changeover over circuits & automatic volume control features built-in.

The power amplifiers shall have control inputs and audio inputs for interfacing for fire alarm signals. This control inputs shall be supervised, freely programmable for any system actions and with priorities setting.
A built-in amplifier monitoring circuits shall continuously monitor the functioning of the power amplifiers and shall automatically switch in a spare power amplifier in case of failure of any of the amplifiers. Upon detection, the status of the fault shall be indicated in the Central or local Monitoring. The number of spare power amplifiers to be provided shall be ten percent of the total quantity of each range of power amplifiers.

All speaker lines shall be supervised for open circuit fault, short circuit fault, and short to ground fault. Upon detection, the status of the fault shall be indicated in the Central Monitoring.

The loudspeakers shall be located such that they meet the necessary requirements. Rooms with on / off volume control units as required are indicated in the schedule of tables. Facilities shall be incorporated to override these volume control units, including those in the “off” position to enable emergency announcements to be broadcast. In general, one ceiling speaker shall be provided for every 25 square meters in each room such as offices and corridors, while a minimum of one ceiling speaker shall be provided for areas less than 25 square meters such as booths, pantry and toilets. Horn speakers shall be provided for all plant rooms, generator rooms and outdoor areas with high ambient noise.

The system shall also have the means to cut-off the music sources during emergency paging and shall enable the emergency announcement to be heard in these areas. All volume controls as specified shall be overridden during emergency announcements.

There shall be background music to selected areas. It shall be possible to pre-program any of the output music to any of these zones. Sources provided shall be a continuous cassette player, MP3, an integrated compact disc player with digital tuner.

All equipment such as the central network controller and power amplifiers shall be housed in 19-inch equipment racks.

4 - SYSTEM SPECIFICATIONS

The Public Address System shall be the integrated solution for BGM and emergency voice alarm system (EVAC). The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifier switching, loudspeaker line surveillance, digital message management and a fireman's panel interface shall be combined. The Public Address System shall be flexible and easy to operate

The main equipment shall be housed in standard 19-inch equipment racks.

Cabling between a call station and the central network Controller shall merely comprise CAT 5 cable while standard loudspeaker cables shall be used between the power amplifiers and the loudspeakers.

Cabling within the main equipment shall be via CAT 5 cable with purpose built connectors located at the back of each equipment.

The system shall be designed to handle maximum 180 zones from Call Station zone selection or from controller or remote control panel with different commands simultaneously; as such, there shall be a system of priorities to cope with conflict situations.

It shall be possible to program different priorities on different user keys of the microphone call station; it shall also be possible to expand to 180zones selection buttons and to be paged from different call stations simultaneously provided there is no conflict situation.

The system shall be flexible in design that allows adding and removing of equipment anywhere in the network without affecting the performance of other units to meet the complete tender requirements.

A paging call station shall comprise a table stand fitted with a high performance condenser microphone mounted on a flexible system for easy adjustability. It shall include LED's, for monitoring and 'engaged' and 'ready-to-talk' indication and cascaded keypads with 8 button user-keys each.

Each call station shall have a built-in amplifier for line level output, plus a compressor / limiter in order to maintain signal strength regardless of changes in the speaking distance from the microphone. A built-in Speech filter improves intelligibility and prevents clipping of audio input.

Each user key on the call station shall be programmable via the Central Configuration PC. Call Station shall be capable of being programmed with a priority hierarchy, signal tones, digitally stored messages and routing instructions prior to a call. Each user key when depressed shall activate a zone or group of zones of speakers according to type of announcement to be made.

Supervised control inputs and audio inputs shall provide the interface between the inputs and the central PA/EVC/BGM system. Each input is supervised and freely programmable for any system actions with priorities setting.

The central controller shall manage the operation of the system; that is, detection of the user keys being depressed, routing of the microphone and attention signal tones, setting of the priority levels and switching of the loudspeaker volume control override circuits. It shall also act as the 'watchdog,' continuously checking the system hardware.

A digital message module shall be stored in the central controller for broadcasting of message in case of emergency. The status of these messages shall be monitored.

For evacuation and emergency procedures, signals shall be programmed to precede a pre-recorded announcement from a call station, or they shall be capable of being broadcast independently by activation from fire alarm system.

Signals shall be capable of being programmed to precede an announcement from a call station or may be used independently as alarms for evacuation or emergency procedures.

Multi-program applications shall be made easy, with several channels being used simultaneously to distribute music or radio broadcasts. The system controller shall be capable of altering music programme allocation where necessary.

Whatever signal is being transmitted, the emergency and alarm calls shall always have top priority. They shall be broadcast immediately and at full volume, even in those zones where loudspeaker are currently switched off or set at a low volume.

All equipment shall be housed in standard 19" racks; as far as possible, all inter-connections shall be by means of standard cables and connectors, for ease of service ability.

The contractor shall supply, install and wire up the proposed loudspeakers. All speakers shall be designed for music and public address application. They shall have a minimum opening angle of 60° at 4,000 Hz or higher.

The uniformity of sound pressure level distribution at 1.5 meters above the floor level shall not vary beyond ±4 dB for frequency up to 4,000 Hz and not more than ±8 dB for frequency up to 8,000 Hz.

The ceiling loudspeakers so chosen shall have uniform frequency response ranging from 100 Hz to 16,000 Hz within ±3 dB variations

Each loudspeaker assembly shall incorporate a flush-mounted baffle, a 100V line matching transformer and a high efficiency loudspeaker in order to keep the operating power at a minimum

Each loudspeaker shall be capable of generating an on-axis sound pressure level of at least 91 dB at 1 meter distance, with 1W input.

The remote volume control units shall be sufficiently rated to handle the total number of ceiling loudspeakers it has to serve and shall have a speech restoration circuit, which shall permit announcements always at full volume regardless of the control setting.

The horn speakers shall have a minimum frequency response of 400 to 3,900 Hz, while the surface mount speakers and the column speakers shall have a minimum response of 200 Hz to 12,500 Hz.

5 - EQUIPMENT SPECIFICATIONS

The central controller shall be the integrated solution for BGM and emergency voice alarm system (EVAC). The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifier switching, loudspeaker line surveillance, digital message management and a fireman’s panel interface – shall be combined.

5.1 CENTRAL CONTROLLER

It shall have the following functions:

The system shall provide for emergency call (EMG), business call and BGM audio, up to 60 zones, 8 call stations and two remote control panels. The voice alarm system shall be a one channel /two channel system. It shall be compatible with BGM sources and 100 V booster amplifiers. It shall be capable of connecting to EVAC compliant loudspeakers and accessories for an integrated public address and voice alarm solution.

The system shall be fully IEC 60849 compliant. It shall have full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager for 255 pre-recorded messages and chimes. It shall be possible to merge messages to allow even more flexible use of pre-recorded announcements and evacuation messages. It shall be possible for each message to have any length within the total available capacity. The memory shall have a capacity of 16 MB. It shall be possible to upload from a PC via USB into the memory, after which the unit shall operate without PC connection. The standard WAV-format shall be used for the messages and sample rates of 8 kHz up to 24 kHz with 16-bit word length (linear PCM) shall be supported.

Volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls. All current override schemes shall be supported (3-wire and 4-wire override schemes i.e. standard 24V and failsafe). Upon a call or an activated trigger input these contacts shall be activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

A 24Vdc output shall be available to supply power to external relays, so no external power supply shall be required for that purpose. A LED VU-meter shall allow for monitoring of the master output.

The maximum allowed total cable length between the controller and the last router in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the last call station in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the RC panel shall be 1000 meters.

The controller and each connected router shall have 12 trigger inputs to start business and emergency messages. Each shall be configurable for a message consisting of a sequence of up to 8 wave files. It shall be possible for wave files to be used in different combinations with other messages, optimizing flexibility and used storage space.

As the basis of the voice alarm system, the controller shall have all the essential functionality for compliance with IEC 60849 standard, including full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager The messages shall be mergable to allow even more flexible use of pre-recorded announcements and evacuation messages. The controller shall be used as a stand-alone system with up to 6 zones, or expanded to up to 60 zones using additional 6-zone routers. Up to 8 call stations shall be connectable. Interconnections shall be made using standard RJ45 connectors and CAT5 cable.

It shall be possible to connect 480 watts per router. The audio output shall use standard analog audio 100 V line switching for full compatibility with public address equipment and EVAC-compliant loudspeakers. The system shall be configured using DIP switches for basic functionality and a PC for more advanced functions. It shall be possible to specify 16 priority levels.

A built-in 240 W booster amplifier shall provide the power for the emergency call channel and BGM. It shall be possible to add additional booster amplifiers as spare, to provide two-channel operation or if the total power requirement exceeds 240 W (maximum 480 W per 6 zones). All booster amplifiers shall be supervised.

The maximum/rated output power of the internal booster shall be 360 W / 240 W. max mains inrush current shall be 8A @ 230 VAC / 16A @ 115 Vac.

The frequency response shall be 60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. rated output. The distortion shall not exceed 1% at the rated output, 1 kHz. The controller shall have tone controls to allow for adjustment of the BGM sound. It shall have separate bass and treble controls. The controller shall have two BGM source inputs and a microphone/line input with configurable priority, speech filter, and

phantom power and selectable VOX activation. It shall be possible to select 16 priority levels for microphone, call stations and trigger inputs for optimum system flexibility. It shall have two connectors to connect the call stations. It shall have 12 input triggers with 6 supervised trigger inputs. Furthermore it shall have one tape output on cinch connectors. The trigger outputs shall be on floating relays with a rating of 250V 7A. The controller shall have an emergency active relay, a fault relay and two general-purpose relays, for control purposes. The fault relay shall be failsafe.

The output section shall have six transformer-isolated 100 V constant voltage outputs for driving 100 V-loudspeakers in six separate zones. All zones shall be individually selectable from the front panel and the BGM output level in each zone shall be individually settable in 6 steps. The BGM output shall be connected to the 70V line, thus it shall be possible to connect a total load of 480 Watts in a two Channel system combined with a 480 Watt booster.

The output of the booster shall be also available as a separate output on 100V and 70 V. A separate 100 V Call Only output shall be provided for addressing an area where BGM is not required but where priority announcements are. Six configurable volume override output contacts shall be available for overriding local volume controls during priority calls. A LED VU-meter shall monitor the output.

The voice alarm router shall be an expansion unit adding 6 zones as well as 12 input- and 8 output contacts to the voice alarm system. It shall be able to use the booster built in the voice alarm controller. It shall provide outputs and inputs for one or two boosters in a multi amplifier one- or two-channel system. It shall provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones, using two booster amplifiers. Also single channel operation shall be possible with only one booster.

The router shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups. Each of the zones shall be switched between the call channel (upon call-station selection or all-call microphone or emergency activation), the BGM channel (upon front panel selection), or off. The zone power handling capacity of the router shall be 480 Watts. The router shall also have 12 input triggers. 6 triggers shall be supervised for EMG purposes.

The 6-zone call station shall be a stylish high quality call station with a stable metal base, a flexible microphone stem and a unidirectional condenser microphone. It shall be intended for making calls to selected zones. The special design shall allow for neatly flush mounting in desktops. Using dipswitches on the bottom of the call station, the call station ID shall be selectable. The call station shall have selectable gain, speech filter and limiter for improved intelligibility.

On each call station it shall be possible to select 6 zones with the possibility to connect a call station keypad to increase the number of zones or zone groups that can be selected.
It shall have LED indications for zone selection, fault and emergency state. The call station extension shall provide seven additional zone and zone group keys.

On each call station it shall be possible to select 6 zones with the possibility to connect up to 8 call station keypads to increase the number of zones or zone groups that can be selected. Selected zones are indicated with LEDs on the call station, three additional LEDs give visible feedback on the active state of the microphone and the system. Green indicates microphone active, amber indicates that the system has detected a fault (IEC 80649) and red indicates that the system shall be in the emergency state.

The power supply voltage range shall be 18 – 24V with a current consumption of less than 50 mA. The nominal sensitivity shall be 85 dB SPL (gain preset 0dB). The nominal output level shall be 700 mV. The maximum allowable sound pressure level shall be 110 dBSPLA. The microphone shall have a limiter. The distortion shall be less than 0.6% at maximum input. The equivalent input noise level shall be no more than 30 dBSPLA. The frequency range shall be 100Hz – 16kHz. The speech filter shall be a 315 Hz, high-pass, 6-dB/oct filter. The output impedance shall be 200 Ohms. The stem length with microphone shall be 390 mm.

Mains voltage shall be 230Vac and 115Vac, ±15%, 50 / 60Hz (selectable) Power consumption of the Controller shall not exceed 600 Watts; the router shall not exceed 50Watts. Battery backup provisions shall be implemented; the battery voltage shall be 24Vdc, +20% / -10%.

All low-level connections and volume override shall be on MC1, 5/XX-ST-3, 5 type connector blocks. All high level connections except mains shall be on MSTB 2,5 /XX-ST. The input contact shall have supervision based on a series and parallel resistor.

The router and controller shall be rack mountable with removable rack mounts. The router shall be not higher than 2U. The controller shall be not higher than 3U. The rack mounting kit shall be included.

The operating temperature range shall be -10°C to +55°C. The storage temperature range shall be -40°C to +70°C.

The system should be certified with the following standards:
EVAC certified acc. to IEC 60849
EMC emission acc. to EN 55103-1
EMC immunity acc. to EN 55103-2
Safety acc. to EN 60065

The Public Address system shall be from single brand supplier. The controller, router, call station, call station keypad, amplifier, volume control, speaker shall be from a single brand System.

5.2 POWER AMPLIFIERS:

It shall meet the following minimum requirements:

The main function of the power amplifier is the amplification of audio signals for the loudspeakers. It shall be possible to select the output voltage between 100V, 70V or 50V by changing output. The power amplifiers are provided with compact 19", 2U & 3U high housing for tabletop use and rack mounting, while the maximum amplifier wattages varies from 120w to maximums 960w.

The amplifiers are protected against overload and short circuits. A temperature-controlled fan ensures high reliability at high output power and low acoustic noise at lower power output. Additionally, all booster amplifiers have an overheat protection circuit that switches off the power stage if the internal temperature reaches a critical limit due to poor ventilation or overload.

Balanced input and a loop-through connector shall be available for easy connection of multiple booster amplifiers to increase the available output power. The power amplifier shall obtain two balanced inputs with priority control, each with a loop-through facility. This allows for easy and automatic switching between e.g. a local music source and a priority announcement from a remote system.

An additional 100V line input is provided to connect the booster amplifiers to a 100V loudspeaker line, for additional output power e.g. on remote locations. Sensitivity or level control is located on the rear of the unit to avoid accidental setting change. A VU-meter with LED-bar shows the output level.

The amplifiers not only provide 70V and 100V outputs for constant voltage loudspeaker systems, a low impedance output for 8 Ohm loudspeaker loads is available for different usage.

The booster amplifiers operate both on mains power and on a 24V battery power supply for emergency backup, with automatic switchover. Amplifier front panel with LED shall show as an indicator when it operates on the battery or AC supply.

The power amplifier shall be with the following approval: -

• EMC emission acc. to EN 55103-1
• EMC immunity acc. to EN 55103-2

5.2.1 - PERFORMANCE

• Frequency response 50 Hz – 20 kHz (+1/-3 dB, @ -10 dB ref. rated output)
• Distortion <1% @ rated output power, 1 kHz

5.2.2 - INPUTS

• Line input (3-pin XLR, 6.3mm phone jack, balanced)
• Sensitivity 1 V
• Impedance 20 kOhm
• CMRR >25 dB (50 Hz-20 kHz)
• Line input 1, 2 (3-pin XLR, balanced)
• CMRR >25 dB (50 Hz-20 kHz)
• 100V input (Screw, unbalanced)
• Sensitivity 100 V
• Impedance 330 kOhm

5.2.3 - OUTPUTS

• Line loop through output t (3-pin XLR, 6.3mm phone jack, balanced)
• Nominal level 1 V
• Impedance direct connection to line input
• Line loop through output 1,2 (3-pin XLR, balanced)
• Impedance direct connection to line input
• Loudspeaker outputs (Screw, floating)
• Output power @ 24 V
• Battery operation -1 dB ref. rated power

5.2.4 - ENVIRONMENTAL CONDITIONS

• Operating temperature range -10 to +550C
• Storage temperature range -40 to +700C
• Relative humidity <95%

5.3 - INTEGRATED COMPACT DISC PLAYER WITH DIGITAL TUNER

The CD-player shall play normal audio CDs and CD-Rs with MP3-encoded files. The CD-player is designed to allow for high quality uninterrupted music playback from a single MP3-disc. Music shall be organized on a disc in multiple folders with music selection for different occasions, with programming facilities for up to 999 tracks. Repeat and random play modes are also provided.

The digitally controlled FM/AM tuner uses a frequency synthesizer for accurate capture of radio stations and 10 presets for FM and 10 presets for AM to store favorite radio stations
Both the CD-player and the tuner operate simultaneously on different outputs to facilitate two-channel BGM distribution.

5.4 POWER SUPPLY

The contractor shall make provision for all necessary power supply units, voltage regulators, etc, to ensure that the equipment will perform satisfactorily c/w necessary surge arrestors and filters.

All necessary power supply (s/s/o's etc) required for the operation of the sound equipment shall be designed supplied and installed by the contractor.

5.5 EMERGENCY OVERRIDE UNIT

The emergency override unit when activated from the Fire Command Center, it will override all incoming signals to allow emergency messages to pass through.

6 - SYSTEM TESTING

The contractor shall test the system in the presence of the Superintending Officer to show that its performance satisfies the requirement of this specification. All test equipments shall be professional and supplied by the contractor. A sound pressure meter will be required. No claim is allowed for this test. The cost shall be deemed to be included in the schedule of rates for the equipment.

6.1 - GENERAL DESCRIPTION
6.1.1 - FUNCTION AND FACILITIES SUMMARY

6.1.1.1 - BUILDING FACILITIES

The following facilities are to be provided at building:

- PA system cabinet
- Operator Control Room (OCR) Call station
- Reception Call station(s)
- Loudspeakers

The detailed descriptions of above mentioned equipment is described below.

6.1.1.2 - BUILDING FUNCTION

- Operator Control Room call station: The Security Supervisor can make an announcement to any zone or any combination of zones of that building via the OCR call station. The type of announcements, that are allowed from the OCR call station, are:
- Live announcements
- Pre-recorded announcements
- Background music
- Pre-recorded emergency announcements
- Reception Control Panel Announcements: At the reception control panel, the operator can make live announcements to that building with pre-defined areas.
- Emergency Announcements: The pre-recorded announcements can be initiated by the fire alarm signal that is sent from the fire alarm system.
- Pre-recorded Announcements: The pre-recorded announcement can be activated from the pre-defined keys at the OCR call station, and can be scheduled to be played at specific times.

6.2 - LOUDSPEAKER

6.2.1 - CEILING TYPE LOUDSPEAKER

A flush-mounting ceiling loudspeaker is available for general application. These full range loudspeakers are suitable for both speech and music reproduction in the building. The speaker assembly consists of a single piece, 24 W dual cone loudspeaker and frame with a 100 V matching transformer mounted on the back.

6.2.1.1 - SPECIFICATION

Maximum power	36 W
Rated power (PHC)	24W (24 – 12 – 6 W)
Sound pressure level at 6 W/ 1 W (SPL, at 1 kHz, 1m)	106dB/ 92dB
Effective frequency range (-10 dB)	60 Hz to 18 kHz
Opening angle (at 1 kHz/4kHz –6dB)	$160^o/60^o$
Rated voltage	100 V
Rated impedance	417 Ω
Ambient temperature range	-25 to + 55^oC
Safety	EN 60065

6.2.2 - METAL CABINET LOUDSPEAKER

Voice alarm loudspeakers are specifically designed for use in buildings where performance of systems for verbal communication announcements is governed by regulations. The LBC 3018/00 is designed for use in voice alarm systems and is compliant with British Standard BS 5839 part 8.

The loudspeaker has built-in protection to ensure that, in the event of a fire, damage to the loudspeaker does not result in failure of the circuit to which it is connected. In this way, system integrity is maintained; ensuring loudspeakers in other areas can still be used to inform people of the situation. The loudspeaker has a ceramic terminal block, thermal fuse and heat-resistant, high-temperature wiring.

The cabinets are equipped with a high efficiency dual cone loudspeaker offering a wide frequency range suitable for both speech and music reproduction.

6.2.2.1 - SPECIFICATION

Maximum power	9 W
Rated power (PHC)	6 W (6 –3 – 1.5 W)
Sound pressure level at rated power6 W/1 W (SPL, at 1 kHz, 1 m)	102 dB/94 dB
Effective frequency range (-10 dB)	150 Hz to 20 kHz
Opening angle (at 1 kHz/4 kHz, -6 dB)	$120^o/55^o$
Rated voltage	100 V
Rated impedance	1667Ω
Ambient temperature range	-25 to +55^oC

6.2.3 - PROSOUND CABINET LOUDSPEAKER

The LBC 3800/10 100 W stage loudspeaker is compact yet powerful. Its excellent sound reproduction capability is attributed to the use of arrayed professional quality components. It contains a high-quality 12" woofer with a 1-3/8" voice coil titanium high-frequency driver, linked via a special crossover/equalizer network for optimal sound reproduction. A self-restoring passive element protects the high-frequency driver against incidental overload.

6.2.3.1 - SPECIFICATION

Loudspeaker Type	2-way speaker system
Rated Power (PHC)	100 W
Long-Term Input Power	200 W
Short-Term Input Power	250 W
Sound Pressure Level at	118 dB/98 dB
100 W/1 W (at 1 kHz, 1 m)	
Effective Freq. Range (-10 dB)	70 Hz to 20 KHz
Crossover Frequency	3.5 kHz (-12 dB)
Opening Angle (at 1 kHz/4 kHz, -6 dB)	
Horizontal	110° / 65°
Vertical	110° / 75°
Rated Voltage	100 V
Rated Impedance	100 ohm
Ambient Temperature	-25 to +55°C (-13 to 131°F)

6.3 - BACKGROUND MUSIC SOURCE

The CD-player is a high quality source unit, comprising a CD-player with single CD slot loading. The track selection keys of the CD-player include Random and Repeat to facilitate BGM (background music) operation. The CD-player operates in mono, as required for BGM, and simultaneously on different outputs, to facilitate two-channel BGM distribution. The output level can be adjusted via rear panel presets.

6.3.1 - SPECIFICATION

Mains voltage	230Vac/115Vac, ±15%, 50/60Hz
Max mains power consumation	25VA

6.4 - CD-PLAYER

Performance	
Frequency response	20Hz – 20 kHz (+1/-3dB)
Distortion	<0.1%
S/N	85dB
OUTPUTS	
CD-player output	(Cinch, 2 x mono)
Nominal level	500mV

6.4.1 - ENVIRONMENTAL CONDITIONS

Operating temperature range	-10 to +55ºC
Storage temperature range	-40 to +70ºC
Relative humidity	<95%
EMC emission	acc. to EN 55103-1
EMC immunity	acc. to EN 55103-2
19" mounting brackets	included

6.5 - VOICE ALARM CONTROLLER

6.5.1 - SPECIFICATION

Mains Voltage	230 / 115 VAC, ±10%, 50 / 60 Hz
Main Power Consumption	60 VA
Max/Rated Output Power	360 W / 240 W
Mains Current	

System Idle	0.26 A = 60 VA
System Idle with Pilot Tone	0.6 A = 136 VA
Maximum Load*)	3.6 A = 830 VA
24 V Current	
System Idle	0.9 A
Maximum Load*	14 A
Performance	
Frequency Response	60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. Rated output)
Distortion	<1% @ rated output, 1 kHz
Bass Control	-8/+8 dB @ 100 Hz
Treble Control	-8/+8 dB @ 10 kHz
Inputs Mic / Line	
Input Type	XLR, 6.3 mm jack
Sensitivity	1 mV / 1V
S/N	63 dB (flat at max volume)
S/N	75 dB (flat at min volume/muted)
Headroom	25 dB
Speech Filter	-3 dB@ 315 Hz, high-pass, 6 dB/oct
Phantom Power Supply	12 V
VOX Trigger Level	–20 dB (100 V mic / 100 mV line)
or via input contact	
Limiter	Automatic
BGM and PC Call Station	
Input Type	Cinch stereo (converted to mono)
Input Level	200 mV – 2 V
Impedance	22 kOhm
S/N	70 dB (flat at max volume)
S/N	75 dB (flat at min volume/muted)
Headroom	25 dB
Trigger Inputs	6 EMG, 6 businesses
Type	MC1,5/14-ST-3,5
Activation	Programmable
Supervision	On EMG inputs, programmable
Supervision Method	Series / parallel resistor
100 V Input	MSTB 2,5 /16-ST
Power Handling Capacity	480 Watts

Maximum load means; maximum power out, maximum load 24V out, maximum number of Call stations

6.6 - ROUTER:

6.6.1 - SPECIFICATION

Mains Voltage	230 VAC / 115 VAC, ±15%, 50 / 60 Hz
Max Mains Power Consumption	50 VA
Max Mains Inrush Current	1.5 A @ 230 VAC / 3A @ 115 VAC
Trigger Inputs	6 EMG, 6 businesses
Activation	Programmable
Supervision	On EMG inputs, programmable
Supervision Method	Series / parallel resistor
100 V Inputs	MSTB 2,5 /16-ST
Booster 1	100 V / 70 V / 0 V
Booster 2	100 V / 0 V
Power Handling Capacity	1000 Watts
Outputs	

100 V / 70 V Outputs	MSTB 2, 5 /16-ST, floating
100 V Outputs	1000 W rated per zone
Volume Override	Type 3 wire, 4 wires (24 V), failsafe
Output Contacts	
All Contacts	
Connector Type	MC1,5/12-ST-3,5
Rating	250 V 7A voltage free
General Purpose Relays (2x)	NO / COM
Operating Temperature	+5°C to +55°C
Storage Temperature	-25°C to +55°C
Relative Humidity	<95%
Dimensions	88 x 430 x 260 mm
(19" wide, 2U high)	
Rack Building	Rack mounting kit included

6.7 - CALL STATION:

6.7.1 - SPECIFICATION

Power Supply Voltage Range	18 – 24 V
Current Consumption	<30 mA Call Station
	<15 mA Key Pad
Performance	
Nominal Sensitivity	85 dB SPL (gain preset 0 dB)
Nominal Output Level	700 mV
Maximum Input Sound Level	110 dB SPL
Gain Preset	+6 / 0 / -15 dB
Limiter Threshold	2 V
Compression Ratio Limiter	20: 1
Distortion	<0.6% (maximum input)
Equivalent Input Noise Level	25 dB SPLA
Frequency Response	100 Hz – 16 kHz
Speech Filter	-3 dB @ 315 Hz, high-pass,
6 dB/oct	
Output Impedance	200 ohms
Operating Temperature	-10°C to +55°C
Storage Temperature	-40°C to +70°C
Relative Humidity	<95%

6.8 - AMPLIFIERS:

6.8.1 - Specifications:

Frequency Response	60 Hz to 15 KHz
XLR Input/ Outputs	Direct 100V input for power expansion
S/N Ration	80 dB
Multiple Outputs	4 ohm, 8 ohm, 70 V, 100 V

6.9 - BUILDING OPERATIONS FUNCTION

6.9.1 - BUILDING ZONING

The building is divided into several zones, dependent upon the physical arrangement of the building. BUILDING OPERATION

6.9.2 - NORMAL OPERATION

6.9.2.1 - OCR CALL STATION

The OCR call station allows the building supervisor to broadcast an announcement to any zone or combination of zones within the building. The destination zones can be selected at the zone selection keys at the call station. The status of the zone is indicated by an LED when that zone is selected. The zone selection keys operate in latching mode.

The announcements, to the selected zones, can be initiated by pressing the 'press to talk' key at the call station throughout the announcement. The 'press to talk' status LED indicates the status of the announcement.

The pre-recorded announcement can be activated from the pre-defined keys at the OCR call station, and can be scheduled to be played at specific times.

The background music can be activated by the 'Back Ground Music' key, which operates in latching mode and the status of the background music key is indicated by an LED.

6.9.1.2 - RECEPTION CALL STATION

The reception call station allows the operator to generate announcements to the associated areas. The call can be initiated by pressing the 'press to talk' key at the reception microphone throughout the announcement. The status of the reception call station will be given by means of LED.
Announcements from the reception call station can override the OCR announcements.

6.9.1.3 - EMERGENCY OPERATION

In the event of emergency, i.e. fire, the PA system will receive fire alarm signal from the fire alarm system to initiate the pre-recorded emergency announcement to peoples and staff in the building. The PA system will address all zones within that building with the emergency message.

In the event that the PA system fails to receive the fire alarm signal, the emergency messages can be activated/ deactivated the OCR call station.

The emergency announcement can be overridden by an announcement from the OCR and reception call stations.

6.10 - PRIORITY

The priority of announcements in the building is as follows:

1. Local announcement from the OCR call station and the reception call station
2. Local emergency broadcasts from pre-recorded emergency announcements
3. Timed local broadcasts
4. Local background music

6.10.1 - INTERFACE TO OTHER SUB-SYSTEMS

6.10.2 - INTERFACING TO FIRE ALARM SYSTEM

The PA system requires the fire alarm signal from the fire alarm system at building to initiate the pre-recorded emergency announcement. The means of interface is a single dry contact from the fire alarm system to the alarm input at the PA system cabinet at control room. The contact is normally close, which

means that the contact will be opened when the fire alarm system sends alarm signal to the PA system and the contact will open when there is no fire alarm signal from the fire alarm system.

In the event that the fire alarm system fails to send the alarm signal to the PA system, the operator can either initiate the pre-recorded emergency announcement or make a live announcement manually at the OCR call station for the building, the broadcast may be made manually from the appropriate administration office.

6.10.3 - CABLE AND WIRING

6.10.3.1 - LOUDSPEAKER CABLE

The loudspeaker cable connected from power amplifiers to the loudspeakers operates at 100 volts. The generic type of cable shall be 3x1.5 mm^2, with a rated voltage of 600 volt. In the event of fire, the cable shall have enhanced characteristics with the insulation integrity for minimum of 180 minutes and functional maintenance for minimum 30 minutes. The cable type using for connecting PA loudspeakers for the initial system is (N)HXH-FE180/E30.

6.10.3.1.1 - CABLE DESIGN

Construction designed on the basis of DIN VDE 0266 and DIN 4102 part 12

Conductor	: plain Cu conductor, single or multi-wire
Construction of the conductor	: According to VDE 0295 and IEC 228 Class 1 or 2
Core insulation	: taped using mica tape and insulation of flame-retardant cross-linked polymer compound, type HI1 according to VDE 0207 part 23
Core identification	: colour coded as per VDE 0293 for permanent installation without green-yellow protective earth conductor for 2 cores with green-yellow protective earth conductor for 3 or more cores
Lay-up	: common lay-up of cores in layers
Sheath	: of glass fiber tape, overlapping
Sheath colour	:sheath material of flame-retardant polyolefin compound, type HM4 according to VDE 0207 part 24, halogen-free Orange

HVAC WORKS

TECHNICAL SPECIFICATIONS

A. SYSTEM DESIGN DATA

1.0 General

The basis of design, system selection, estimated requirements and other relevant data are outlined in this section.

1.1 Scope of Work

The scope of work includes supply, installation, testing and commissioning of central air-conditioning and ventilation system to provide designed conditions in the Building.

1.2 Basis of Design

a) Site location

Rourkela	Orissa, India
Latitude	22.12° North
Altitude	MSL+219 mts

b) Outdoor Design Conditions

Outdoor design (average peak) conditions considered as per NBC & ISHRAE handbook data at one percent annual cumulative frequency of occurrence (1percentile) are as follows:

Summer	:	40.8^0C DB,	24.8^0C WB
Monsoon	:	32.2^0C DB,	28.0^0C WB
Winter	:	8.4^0C DB,	7.7^0C WB

Average monsoon rainfall, mainly of South-West direction 1010 mm

Above data is used for the purpose of calculating heat loads of the building. The combination may rarely be achieved in actual weather conditions.

c) Indoor Design Conditions

For air-conditioned spaces the indoor design conditions shall be:
corridors, auditorium, seminar, offices
24 ± 1^0C DB, 55 ± 5%RH

1.3 ESTIMATED LOAD BASIS

a) Design parameters for Cooling Loads:
Outdoor conditions as mentioned above
Indoor design conditions as mentioned above
Occupancy = 20persons/sqM of nett occupiable space (70%) - NBC
OA = 17cfm/person – NBC
Windows glass – outside shading screen double pane, medium color
Actual glass factor will be known on glass selection

Based on above design parameters, the estimated cooling loads are as under:

1.4 System Design

Basic requirements of an average institute / university, housing modern equipment, computers & accessories:

1. Indoor temperature ≤24.1°C ±1.1°C, & RH ≤65%
2. High air flow to avoid collection of moths & insects. The additional air flow shall be achieved by ceiling fans
3. Individual AHU flow & temperature control thru VFD & 2 way valve
4. Individual unit shall be shut down in case of fumigation of selected zones

1.5 Drawings

Drawings forming part of these specifications indicate broadly the proposed scheme for equipment layout, location and air distribution system. The vendor shall have to execute the scheme as proposed. However, minor changes in air distribution layout shall be permitted to suit the interiors, subject to the Engineer-In-Charge's approval. The fabrication and working drawings shall be prepared by the Vendor and got approved by the Engineer-In-Charge before erection.

1.6 Test Data

Following tests shall be undertaken by vendor at no extra cost to owners. All instruments shall be arranged by vendor at own cost:

a. 72 hours continuous running test of entire installation.
b. Capacity test for water chilling machines, pumps, cooling towers, AHUs
c. Summer & monsoon tests to maintain designed indoor conditions during/near peak outdoor conditions

1.7 Technical Data

The Vendor shall furnish complete technical data on the equipment offered by him as required under the heading `Technical Data'. Actual unit capacities shall be confirmed under given working conditions

1.8 Performance Data

The vendor shall guarantee that the air-conditioning installation shall maintain the inside design temperatures and relative humidity as specified.

The Vendor shall also guarantee that the actual capacity of various components as well as the whole system shall not be less than specified.

1.9 Reference Standards

a) Relevant Bureau of Indian Standards (BIS) Codes with specific reference to the following:

IS:277		Galvanized steel sheet (Plain & Corrugated)
IS:655		Metal air ducts
IS:659		Air conditioning (Safety Code)
IS:660		Mechanical Refrigeration (Safety Code)
IS:822		Code of procedure for inspection of welds.
IS:1239 (Part-I)		Mild steel tube
IS:1239 (Part-II)		Mild steel tubular and other wrought steel pipe fittings.
IS:2379		Colour code for the identification of pipelines
IS:2551		Danger notice plate
IS:3103		Code of practice for Industrial Ventilation
IS:4736		Hot-dip zinc coatings on steel tubes
IS:4894		Centrifugal Fan
IS:5312 (Part-I)		Swing – check type reflux Non return valves for water works.
IS:8623		Low voltage switchgear and control gear Assemblies (Requirement for type/partly type tested assemblies)
IS:8828		Circuit Breakers for over current protection for house hold and similar installation.
IS:10810		Methods of test for cables.
IS:13947 (Part-I)		General rules for low voltage switch gears and control gears.
IS:13947 (Part-II)		Circuit Breakers
IS:13947 (Part-III)		Switches, disconnections and fuse for low voltage switch gear and control gear
IS:13947 (Part-IV)		Low voltage switch gear and control gear for contactors and motor starters.
IS:13947 (Part-V)		Control Circuit Devices

b) Other Relevant Standards

BS: EN:779 : Filters
ASHRAE Hand Books : American Society of Heating Refrigeration and Airconditioning Engineers
ASHRAE Indoor air quality Standard 62-2001.

Duct construction standards in accordance with relevant BIS codes & SMACNA standards.
Air filters in accordance with ASHRAE 52.1
Indoor Air Quality in accordance with ASHRAE 62-2001

2) FAN COIL UNITS

SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of fan coil units conforming to these Specifications and in accordance with the requirements of the Drawings and Schedule of Quantities.

TYPE

The fan coil units shall be vertical type for floor mounting, horizontal type for ceiling-suspension. Floor-mounted vertical units shall have vertical top discharge; and horizontal units mounted within ceiling space shall have horizontal discharge and shall be duct able. All units shall be complete with chilled water coil, one or more centrifugal fans and motor, cleanable fabric filters, double-wall insulated condensate drain pan.

CAPACITY

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

CABINETS

Cabinets for floor mounted FCU shall be constructed of 18 gauge die-formed cold -rolled galvanized sheet steel, bonder zed and painted with approved shade of powder coating finish. The cabinets shall be of sufficient size to enclose all piping and control valves, and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal. Horizontal furred-in type units mounted within ceiling space shall be provided with a cabinet housing, the coil and fan section with provision to mount filters within the fan section.

INTERIOR CHASSIS

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bonder zed and painted with approved shade of powder coating finish. All ceiling suspended vertical fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

DRAIN PAN

Primary drain pan shall be fabricated from 18 gauge cold rolled galvanised sheet steel with all corners welded, and an additional inner bottom panel of 18 gauge cold rolled galvanised sheet steel shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 15 mm thick expanded polystyrene or 8 mm thick expanded polyethylene insulation sandwiched between top and bottom panels to effectively prevent condensation. The pan shall be of sufficient size to catch all drip page of condensation from any part of the unit. In all cases pan shall be large enough to cover cooling coil supply and return water headers and bends, and control valves. A secondary (auxiliary) condensate pan similar to primary drain pan may be provided by the manufacturer of these units which are so identified in Schedule of Quantities. All drain pans shall be with powder coating finish as per interior chassis defined above.

COOLING COIL

All cooling coils shall be standard three-row staggered seamless copper tube with aluminium sine wave fins. The coil shall be fitted with dielectric coupling for connection with MS pipes. Tubes shall be minimum 10 mm OD and wall thickness shall be minimum 0.5 mm. Fin spacing shall be 10 to 12 fins per inch. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Tubes shall be mechanically / hydraulically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from back side of FCU without disturbing the other Installations. All coils shall be factory tested at 21 KG per sq. cm (300 psig) air pressure while submerged in water.

FANS

Fans shall be centrifugal forward curve double inlet ductile, direct driven by a shaded-pole motor.

MOTOR

Motor shall be 220 ± 6% volts, 50 cycles single phase, energy efficient, six pole, shaded pole type, speed not exceeding 1000 rpm at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

INSTALLATION

Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through rubber-in-shear vibration isolator suspenders.

ACCESSORIES

All fan coil units shall be equipped with copper piping connections, dielectric union and manual air vent at the cooling coil outlet header. In addition, the following accessories may be required at fan coil units; their detailed Specifications are given in individual sections and quantities separately identified in Schedule of Quantities.

Imported fan coil units as specified in Schedule of Quantities shall be factory fitted with Ball valves at inlet and outlet. Ball valve with `Y' strainer shall be installed in the tapping of the chilled water pipe installed in riser/shaft or as shown on Drawings and in Schedule of Quantities.

ALTERNATELY Ball valve with 'Y' strainer and ball valve as shown on Drawings and in Schedule of Quantities.

Adjustable discharge air grille as shown on Drawings and in Schedule of Quantities.

PAINTING

Shop coats of paints that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

PERFORMANCE DATA

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium/high speed. Fan performance rating and power consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

TESTING

Cooling capacity of various fan coil 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 anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

3) **AIR HANDLING UNITS (DOUBLE SKIN)**

GENERAL
The air handling units shall be complete in all respects and shall generally comply with the specifications as given in the following paragraphs.

SCOPE

Scope of work under this section comprises the supply, erection, testing and commissioning of double skin air handling units of capacities specified in the Bill of Quantities.

a. AIR HANDLING UNITS (FOR NORMAL RECIRCULATION):

The air handling units shall be double skin, horizontal, draw through type and shall include pre filter with filter section, cooling coil with coil section, plenum/plug fan with fan section etc. as mentioned below.

FAN SECTION

The Plenum / Plug fans shall be of the un-housed direct drive centrifugal type. The Fan plate shall be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence. Panels and framework shall be constructed of heavy gauge, precision laser cut and die formed galvanized steel to provide a rigid structure to support the shaft and bearings and reduce low frequency vibration. Fan base angles shall be recessed to reduce overall width of the assembly.
The fan wheel shall be non-overloading airfoil centrifugal type. Wheels shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. The fan wheel shall be manufactured with a minimum of 12 continuously welded aluminum airfoil blades to move the blade pass frequency into the mid-octave bands. The entire wheel shall be constructed of aluminum to reduce the rotational weight of the wheel and vibration. The wheel shall use 6063-T5 extruded aluminum blades to ensure precision blade tolerances, improve efficiency and reduce vibration. Wheel hubs shall be cast of 319 aluminum alloy. Aluminum fan wheels shall not require finish coating.

FAN MOTOR

Motors shall meet or exceed EPACT (Energy Policy ACT)/ EFF1 efficiencies. Motors shall be NEMA/IEC T-frame 750, 1000, 1500 or 3000 RPM in 50 Hz, Totally Enclosed Fan Cooled (TEFC).

CHILLED WATER CASSETTE UNIT

1. GENERAL

Chilled water Cassette air conditioners units shall be factory assembled and tested complete in all respect and confirming to Indian/ASHRAE standards.

2. CASSETTE UNIT (IN-DOOR UNIT)

These units shall be installed between the bottom of finished slab & top of false ceiling. The maximum allowable height for the cassette type units shall be 300 mm.
The unit must have in built drain pump, suitable for vertical lift of 750 mm. The unit casing shall be Galvanized Steel Plate.
Unit must be insulated with sound absorbing thermal insulation material, Polyurethane foam. The noise level of unit at the highest operating level shall not exceed 42 dB(A), at a vertical distance of 1.5 m from the grille of the unit.
Unit shall have provision of connecting fresh air without any special chamber & without increasing the total height of the unit (300 mm maximum).
The unit shall be supplied with suitable decorative panel.
The unit shall be supplied with Resin Net filter with Mold Resistance. The filter shall be easy to remove, clean & re install.
The unit will be connected in series to a suitable Chilled water supply & it must be possible to operate the unit independently, through corded/ cordless remote specified in the "Bill of quantities".
The unit will be further connected to Intelligent Building Management System (To be supplied by other vendors) & it shall be possible to operate the unit through this IBMS system.

The unit shall be supplied with following from the factory
Operation Manual
Installation Manual
Paper pattern for installation
Drain hose/ Clamp metal/ Washer fixing plate/ Sealing pads/ Clamps/ Screws/ Washer for hanging bracket/ Insulation for fitting

FLOW MONITORING STATION

Flow monitoring station shall monitor the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Volumetric flow to be calculated from empirically derived formulas based on testing by the fan manufacturer. Flow monitoring station shall not use air restricting probes that reduce fan performance or create additional fan sound. Flow monitoring station shall accurately measure the pressure differential to within +/- 3%. Flow monitoring station shall be installed by the fan manufacturer as part of the standard fan assembly. Flow monitoring station shall be supplied with electronics package that includes pressure transmitter and LCD digital readout.

QUALITY ASSURANCE FOR FAN

Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA seal for air and sound performance. Each fan shall be test run at the factory at the specified FRPM. Amp draw at free air shall be recorded.

COOLING / HEATING COIL: (ARI CERTIFIED)

The cooling coil shall be of seamless copper tubes, not less than 0.4 mm thick and 12 mm O.D. The coils shall have 0.16mm thick aluminum fins. The fins shall be spaced by collars forming integral part of the fins. The tubes shall be staggered in the direction of air flow. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coils shall have 10 to 12 fins per inch.

The water headers shall be of copper pipes, to connect all the tubes. The headers shall be complete with water in/out connections, vent plug on top and drain at the bottom, and designed to provide water velocity between 0.6 to 1.8 m/s (2 to 6 fps).

Acceptable coils are to have ARI Standard 410 certification and bear the ARI symbol. Non-certified coils or coils outside ARI's rating range will be considered if the manufacturer is a current member of the ARI air-cooling and air-heating coils certification program and the coils have been rated in accordance with ARI Standard 410.

The coils are to be recognized component for equipment listed under UL1995, CAN/CSA C22.2, No. 236-05 - Standard for Safety Heating and Cooling Equipment.

Coils are to be tested to UL207 – Hydrostatic Tests and CSA C22.2 No. 140.3

FILTER SECTION:

Each AHU shall include pre-filters of 90% efficiency by weight. Pre-filter shall be washable type.

DRAIN PAN:

The sandwiched drain pan shall be of 18 gauge stainless steel.

COIL AND FILTER HOUSING:

The cooling coils, special and standard filters etc., shall all be housed in a separate enclosure of suitable size and length.

The enclosure shall be sized to accommodate the absolute and high efficiency filters. The inspection doors shall have double synthetic rubber seals doors and locking arrangements. The gaps between filter frames and housing shall have synthetic rubber packing, to eliminate any air leakage. All filter frames shall be of aluminum.

AHU ENCLOSURE/HOUSING:

The AHU housing shall be made of double skin design with main structure made of structural channel frame work in different sections. The panels shall be double skin sandwich type with 0.6mm galvanized powder coated/ pre-painted sheet on the outside and 0.6 mm aluminum sheet on inside with 25 mm thick injected polyurethane foam insulation material in between. All sections shall be bolted to each other with neoprene rubber gasket in between them for perfect airtight joints.

Controls:

Each air handling unit shall be provided with temperature sensor and a 2 - way modulating valve for temperature control, conforming to specifications. Prices of these items shall be covered separately in BOQ.

a) Air handling unit starter shall be compatible to connect with BMS System.

b) Fan starter shall be provided with motor protection devices.

c) ACCESSORIES:

d) Each air handling unit shall be complete with:

e) Stem type thermometers at coil inlet and outlet, with tubing and gauge cocks (priced separately).

f) Pressure gauge with cock at inlet and outlet of the coil, with tubing and gauge cocks (priced separately).

g) Butterfly valves at coil inlet and outlet and balancing valve at coil outlet (priced separately).

h) Insulated Drain line from the unit upto drain trap (priced separately).

i) Fire rated double canvas flexible connection between the fan outlet and duct (Priced separately).

j) Vibration isolators (price inclusive).
k) Vibration isolators shall be provided with all air handling units vibration isolators shall be cushy foot mounting type.

TESTING:

The air handling unit shall be tested to measure air quantity and coil performance by measuring temperature difference, water pressure drop across coil and then calculating the capacity. Power consumption shall be completed from measurement of incoming voltage and current.

LIMITATIONS:

a) The air velocity across the cooing coil shall not exceed 500 FPM.

b) The fan outlet velocity shall not exceed 2500 FPM.

c) The air velocity across the filters shall not exceed 500 FPM.

FRESH AIR INTAKES:
An adjustable manual damper of M.S./G.I. Sheet along with birdscreen, air inlet louvers and air filters shall be provided for fresh air entry.

AIR MEASURING STATION FOR FRESH AIR INTAKE INTO AHU ROOM:

Fresh air entry into AHU room will be through Air Measuring Station. The unit will consist of air inlet louvers, manually adjustable extruded aluminum construction damper and Polycarbonate Honeycomb air Straightened with properly sized pressure transducer that outputs a signal proportional to cfm. A factory supplied controller will use the transducer's signal to adjust the damper to the target set-point; and will display the cfm readings on a LCD screen.

4) **VENTILATION FANS:**

6.1 <u>IN-LINE FANS</u>

Duct mounted supply, exhaust or return fans shall be of centrifugal belt driven in-line type. The fan housing shall be of the square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.

Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. Motors shall be heavy duty ball bearing type, carefully matched to the fan load and furnished at the specified voltage, phase and enclosure. Motors and drives shall be mounted out of the airstream.

Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum cataloged operating speed.

Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for system balancing.

All fans shall bear the AMCA Certified Ratings Seal for both sound and air performance.

6.3 **Axial Flow Fan (Fire Rated)**

6.3.1 GENERAL

The fans shall be of the direct drive axial type with cast aluminum airfoil propellers. The casing shall be constructed of continuously welded steel and include integral punched inlet and outlet flanges to prevent air leakage. The casing and motor base shall be constructed from precision laser cut and formed members of heavy gauge steel to prevent vibration and rigidly support the motor. Motor support brackets shall be welded to fan casing for increased strength. Motors for emergency smoke ventilation shall use insulation class H.

Blades shall be airfoil design. Hub and blades shall be a high strength cast aluminum alloy. Blade pitch shall be manually adjustable with out removing from the fan casing. Rotors shall be statically and dynamically balanced. A tapered lock bushing shall be used to mount the propeller to the motor shaft.

All the Steel casings and structural components shall be coated with Permatector, an electrostatically applied thermosetting polyester urethane. Minimum coating thickness to be 2 mils. Paint must exceed 1,000 hour salt spray under ASTM B117 test method.

Fan performance shall be based on tests conducted in accordance to AMCA 210 (meets BS848 part 1), licensed to bear the AMCA air label in accordance with AMCA Publication 211 and comply with the requirements of the AMCA Certified Ratings Program.

Fans shall be UL listed as "Power Ventilators for Smoke Control Systems" for 500 °F (260o C) maximum temperature for a minimum of 4 hours of operation. The fan shall be certified for UL Standard 705, "Power Ventilators"

The UL Power ventilators for smoke control sticker shall be fixed to the fan housing.

6.3.2 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air performance.

B. Classification for Spark Resistant Construction Conform to AMCA 99.

6.4 MIXED FLOW FANS

6.4.1 WORK INCLUDED

A. Belt Drive Mixed Flow Inline Fans

6.4.2 RELATED SECTIONS

A. All sections, drawing plans, specifications and contract documents.

6.4.3 REFERENCES

A. AMCA 99, "Standards Handbook"
B. ANSI/AMCA Standard 204-96, "Balance Quality and Vibration Levels for Fans"
C. ANSI/AMCA Standard 210-99, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating"
D. AMCA Publication 211-05, "Certified Ratings Programme - Product Rating Manual for Fan Air Performance"
E. AMCA Standard 300-96, "Reverberant Room Method for Sound Testing of Fans"
F. AMCA Publication 311-05, "Certified Ratings Programme - Product Rating Manual For Fan Sound Performance"
G. UL Standard 705, "Power Ventilators"

Fans shall UL listed as "Power Ventilators for Smoke Control Systems" for a maximum of 260 Deg C for a minimum of 4 Hours of operation.

6.4.4 SUBMITTALS

A. Provide dimensional drawings and product data on each mixed flow inline fan.
B. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
C. Provide outlet velocity of axial fans and both inlet and outlet sound power readings for the eight octave bands.
D. Strictly adhere to QUALITY ASSURANCE requirements as stated in section 1.5 of this specification

6.4.5 QUALITY ASSURANCE

A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA seal for air and sound performance.
B. Classification for Spark Resistant Construction Conform to AMCA 99.
C. Each fan shall be given an electronic vibration analysis in accordance with ANSI/AMCA Standard 204-96, while operating at the specified fan RPM. The vibration signatures shall be taken on each bearing in the horizontal, vertical and axial direction. The maximum allowable fan vibration shall be 0.15 in/sec peak velocity, filter-in as measured at the fan RPM. Report shall be provided at no charge to the customer upon request.

6.4.6 DELIVERY, SOTRAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions.
C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

6.4.7 GENERAL

A. Base fan performance at standard conditions.
B. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
C. Each fan shall be belt drive in AMCA arrangement 9.
D. Fans are to be equipped with lifting lugs.
E. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.

6.4.8 FAN HOUSING AND OUTLET

A. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
B. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked
C. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
D. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge.
E. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations.
F. An access door shall be supplied for impeller inspection and service.

6.4.9 FAN IMPELLER

A. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
B. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Polyester Urethane Paint, electrostatically applied and baked.
C. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

6.4.10 FAN MOTORS AND DRIVE.

A. Motors shall meet or exceed EPACT (Energy Policy ACT) efficiencies. Motors to be UL listed and can be Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC).
B. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
C. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
D. Fan shaft bearings shall be Air Handling Quality, bearings shall be heavy-duty grease lubricated, self-aligning or roller pillow block type.
E. Air Handling Quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for

noise and vibration by the manufacturer. Bearings shall be 100% tested to insure the inner race diameter is within tolerance to prevent vibration.

F. Bearings shall be selected for a basic rating fatigue life (L-10) of 80,000 hours at maximum operating speed for each pressure class.

G. Bearings shall be fixed to the fan shaft using concentric mounting locking collars, which reduce vibration, increase service life, and improve serviceability. Bearings that use set screws shall not be allowed.

H. Bearings shall have extended lube lines with Zerk fittings to allow for lubrication.

6.4.11 INSTALLATION

A. Install fans systems as indicated on the contract drawings.

B. Install fans in accordance with manufacturer instructions.

5) DUCT WORK AND OUTLETS

a) MANUAL FABRICATED DUCT WORK AND OUTLETS:

GENERAL:

Supply, fabrication, installation and testing of all sheet metal ducts & supply, installation, testing and balancing of all grilles, registers and diffusers, in accordance with these specifications and the general arrangement shown on the drawings.

Duct work shall mean all ducts, casings, dampers, access doors, joints, vanes, stiffeners, hangers and supports etc.

All ducts shall be fabricated from galvanized steel sheets of the following thickness as indicated in schedule of quantities & as described in the IS:655 with latest edition.

RECTANGULAR DUCT:

Dimensions of Ducts	GI sheet		Type of Joints	Type of Bracing
	Thick-ness (mm)	Gauge		
Upto 750	0.63	24	G.I. Flange at 2.5 Centre	Cross Bracing
751 to 1500	0.80	22	25x25x3mm angle iron frame with 8mm dia nuts and bolts.	25x25x3mm M.S. angle bracing at 1500mm from joints.
1501 to 2250	1.0	20	40x40x5mm angle iron be cross braced diagonally with 10mm dia nuts & bolts at 125 centre.	40x40x3mm M.S. angle bracing at 1200mm from joints or 40x40x3 mm M.S. angle diagonal bracing.
2250 and above	1.25	18	50x50x6mm angle iron frame with 10mm dia nuts & bolts at 125 centre.	50x50x3mm M.S. angle bracing at 1200mm from joints or 50x50x3 mm M.S. angle diagonal bracing.

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to BIS 655, BIS 277, BIS 737. Sheets used shall be produced by Hot dip process and galvanizing shall be Class VIII.

HANGERS FOR DUCT:

Duct Size (mm)	Spacing (M)	Size of MS angle (mm x mm)	Size of rod dia (mm)	
	Upto 750	2.5	25 x 3	8
	751 to 1500	2.0	40 x 3	10
	1501 to 2250	2.0	50 x 3	12
2251 to above	2.0	50 x 3	12	

FABRICATION:
All ducts irrespective of size shall be fabricated and installed in workman like manner, generally conforming to IS: 655 (Latest Rev.)/ BIS Code.

a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section `Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.

b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.

c) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a center line radius equal to one and a half times the width of the duct. Air turns shall be installed in all vanes, arranged to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.

d) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration, breathing or oil canning.

e) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size.

INSTALLATION:

a) All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

b) 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 Engineer In Charge's site representative in all its parts and details.

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

d) If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Engineer In Charges site representatives.

e) All duct work shall be independently supported from building structure. Duct shall be supported to the ceiling with the help of raw plugs by drilling holes in concrete slab and inserting raw plug and bolts. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed of MS rods and angle iron under ducts at not greater than 2 meter centers. All vertical duct work shall be supported by structural members at each floor. Duct shall be supported to the ceiling with the help of fasteners and cleat as shown in drawings.

   a. If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm than duct should be supported by wall mounted brackets of 40 x 40 x 3 mm angle.

   b. Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Engineer In Charge's site representative. In no case shall any duct by 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 contractors on the building.

f) Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.

g) All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer canvas or neoprene coated fiber glass fire resistant flexible connection. The flexible connections located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation and shall be class ‘O’ smoke rated.

h) Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvass sleeve. Each sleeve shall minimum 150mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet and shall be class ‘O’ smoke rated.

i) All ducts above 450 mm are to be cross broken to provide rigidity to the ducts.

b) FACTORY FABRICATED DUCT WORK AND OUTLETS (SMACNA):

MATERIAL

a) All the ducts shall of LFQ (Lock Forming Quality) grade prime1 G.I. raw material furnished with accompanying Mill Test Certificates. Galvanizing shall be 120gms\sq.m.(total coating on both sides). Approved manufacturer for GSS coil are National\Tata\Jindal\Ispat.

b) In addition, if deemed necessary, samples of raw material, selected at random by Engineer In Chagres’s site representative shall be subject to approval and tested for thickness and zinc coating at contractor’s expense.

c) The 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.

GOVERNING STANDARDS

Unless otherwise specified here, the construction, erections, testing and performance of the ducting system shall conform to the SMACNA standards 2005 (Third Edition).

DUCT CONNECTORS AND ACCESSORIES

All the transverse duct connectors (Flanges\Cleats) and accessories related hardware such as support system shall be zinc coated (galvanized).

FABRICATION STANDARDS

a) All the ductwork including straight sections, tapers, elbows, branches, shoe pieces, collars, terminal boxes and other transformation pieces shall be factory-fabricated. Equivalency will require fabrication by utilizing the following machines and process to provide the requisite quality of ducts and speed of supply.

b) Coil Lines to ensure location of longitudinal seams at corners\folded edges only to obtain the required duct rigidity and low leakage characteristics. No longitudinal seams permitted along any side of the ducts.

c) All ducts, transformation pieces and fittings shall be made on CNC profile cutters for required accuracy of dimensions, location and dimensions of notches at the folding lines.

d) All edges shall be machines treated using lock-formers and rollers for funning up edges.

e) SELECTION OF G.I. AND TRANSVERSE CONNECTORS

f) Duct Construction shall be in compliance with 1” (250 Pa) w.g. static norms as per SMACNA.

g) All transverse connectors shall be 4-bolt system.

h) To avoid any leakage additional sealant shall be used.

i) The specified class of transverse connectors and duct gauge for a given duct dimensions shall be 1” (250 Pa) pressure class.

j) Non-toxic, AC-application grade P.E. or PVC gasketing shall be provided between all mating flanged joints. Gasket sizes shall conform to flange manufacturer’s specifications.

DUCT CONSTRUCTION:

a) The fabricated duct dimensions shall be as per approved drawings and all connecting sections shall be dimensionally matched to avoid any gaps.

b) Dimensional Tolerances: All fabricated dimensions shall be within + 1.0mm of specified dimension. To obtain required perpendicularity, permissible diagonal tolerance shall be + 1.0 mm per meters.

c) Each duct pieces shall be identified by coded sticker, which shall indicate specific part numbers, job name, drawing number, duct sizes and gauge.

d) Ducts shall be straight and smooth on the inside. Longitudinal seams shall be airtight and at corners, which shall be either Pittsburgh or snap Button Punch as per SMACNA practice, to ensure air tightness.

e) Changes in dimensions and shape of ducts shall be gradual (between 1:4 and 1:7) Turing vanes or air splitters shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

f) Plenum shall be factory fabricated panel type and assembled at site.

g) Factory fabricated ducts shall have the thickness of the sheet as follows and length of the piece not more than 1200 mm and should have beading at every 300 mm.

Recommended SMACNA Standard at 4 Feet Transverse Joint Reinforcement

Duct static pressure in Inches	1"	2"	3"	4"	6"
Duct Size (mm)					
150-250	B-26	B-26	B-26	B-26	C-26
251-300	B-26	B-26	B-26	C-26	C-24
301-350	B-26	C-26	C-26	C-26	C-24
351-400	B-26	C-26	C-26	D-26	D-24
401-450	C-26	C-26	C-26	D-26	E-24
451-500	C-26	C-26	D-24	D-24	E-24
501-550	C-26	C-26	D-24	E-24	F-22
551-600	C-26	D-26	E-24	E-24	F-22
601-650	C-26	D-26	E-24	E-24	F-22
651-700	C-26	D-26	E-24	F-22	G-22R
701-750	C-26	E-24	E-24	F-22	G-20
751-900	D-26	E-24	F-22	G-22R	H-20 R
901-1000	E-24	F-22	G-22 R	H-20 R	I-18 R
1001-1200	E-24	G-22	H-20 R	I-18 R	I-18 R
1201-1300	F-22	H-20 R	I-18 R	I-18 R	J-18 R
1301-1500	F-22	H-20 R	I-18 R	I-18 R	-
1501-1800	H-22R	I-18 R	J-18 R	-	-
1801-2100	I-20 R	J-18 R	-	-	-
2101-2400	I-18 R	J-18 R	-	-	-
2401-2700	I-18 R	-	-	-	-

Note:

- SMACNA – Sheet Metal & Air Conditioning Contractor National Association Inc. " HVAC Duct construction standard Metal & Flexible" – 2005 USA.

- In 1" static pressure i.e. comfort cooling application optional " C&S and C&SS cleats joints can be used Upto 450mm duct size use C&S Cleats

- 451 mm to 750mm duct size use " C&SS cleats. Over 750mm duct size use TDC Flanges with respective gauges as mentioned above.

- Alphabets B, C, D, E, F, G, H, I and J per SMACNA 2005, transverse joint reinforcement table 1-12m (T-25b flanged).

- R means reinforcement with Zeebar Stiffener.

a. The gauges, joints and bracing for sheet metal ductwork shall further conform to the provisions as shown on the drawings.

b. Ducts larger than 600 mm shall be cross broken, duct sections upto 1200 mm length may be used with bracing angles omitted.

c. 12.6.10 Changes in section of ductwork shall be affected by tapering the ducts with as long a taper as possible. All the branches shall be taken off at not more than 45 DEG. Angle from the axis of the main duct unless otherwise approved by the Engineer-In-charge.

DOCUMENTATION TO MEASUREMENT

a. For each drawing, all supply of ductwork must be accompanied by computer-generated detailed bill material indicating all relevant duct sizes, dimensions and quantities. In addition, summary sheets are also to be provided showing duct areas by gauge and duct size range as applicable.

b. Measurement sheet covering each fabricated duct piece showing dimensions and external surface area along with summary of external surface area of duct guage-wise.

c. All duct pieces shall a part number, corresponding to the serial number assigned to it in the measurement sheet. The above system shall ensure speedy and proper site measurement, verification and approvals.

TESTING

After duct installation, a part of duct section (approximately 5% of total ductwork) 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).

DAMPERS:

a) At the junction of each branch duct with main duct and split of main duct, splitter dampers must be provided. Dampers shall be two gauges heavier than gauge of the large duct, and shall be rigid in construction to the passage of air. This item shall be a part of ducting and shall not be charged separately.

b) The volume control dampers shall be of opposed blade type, lever operated and complete with locking devices, which will permit the dampers to be adjusted and locked in any positions. Quantity of volume control dampers for ducts, plenum and grills shall be covered separately in BOQ.

c) Automatic and manual volume opposed blade dampers shall be complete with frames and bronze bearings as per drawings. Dampers and frames shall be constructed of 1.5 mm steel and blades shall not be over 225 mm wide. The dampers for fresh air inlet shall additionally be provided with fly mesh screen, on the outside, of 0.8 mm thickness with fine mesh specking.

d) Wherever required for system balancing, provide a volume balancing opposed blade damper with

quadrant and thumb screw lock. Provide damper rod and damper block with upset screws. Quantity of volume control dampers shall be covered separately in BOQ.

e) After completion of the duct work, dampers are to be adjusted and set to deliver the required amounts of air as specified on the drawings.

f) The fire dampers shall be provided in all the main supply and return air ducts weather shown in the drawings or not. The damper shall be multi-blade type as per drawings.

ACCESS PANEL:

A hinged and gasketed access panel shall be provided on duct work at each control device that may be located inside the duct work.

FIRE & SMOKE DAMPERS:

Combination Fire Smoke Damper –

Combination Fire Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of the latest edition of NFPA 90A, 92A, and 92B.

Dampers shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555 and 555S. Dampers shall have a UL555 fire rating of 1 1/2 hours. Each damper shall be equipped with a heat responsive device which has been tested and approved for use with the damper assembly in accordance with UL555. The heat responsive device shall have a temperature rating of (specifier select one of the following) 74 C or 100 C. Dampers shall be UL labeled for use in dynamic systems. The damper shall have a dynamic closure airflow rating equal to or greater than the airflow at the damper's installed location and a dynamic closure pressure rating of 101.6 mm H2O.

Dampers shall have a UL555S Leakage rating of Class I and a Temperature rating of 177 C. Dampers shall have a UL555S operational airflow rating equal to or greater than the airflow at its installed location and an operational pressure rating of 101.6 mm H2O. Damper actuators shall be factory mounted and qualified for use with the damper in accordance with UL555S. Damper actuators shall be electric type for 220 /24 volt operation. Actuator shall be of Honeywell or Be limo make.

All UL555 and 555S Dynamic Closure Ratings, Operational Ratings and Leakage Ratings shall be qualified for airflow and pressure in either direction through the damper. UL ratings shall allow for mounting damper vertically (with blades running horizontal) or horizontally.

The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.

Damper blades shall be 1.6 mm galvanized steel 3 Vee type with three longitudinal grooves for reinforcement. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 13 mm are unacceptable).

Damper frames shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Jamb seals shall be stainless steel compression type.

SUPPLY AND RETURN AIR REGISTERS:

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminium anodised in black colour shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.

b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivot able to provide pattern with 0 to +45 degree horizontal arc and upto 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be anodised aluminium in mat black shade.

SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities these shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.

b. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminium diffusers shall be provided with removable central core and concealed key operation for volume control damper.

c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.

d. Slot Diffuser shall be extruded aluminium construction multislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

PAINTING:

a) All grilles, and diffusers shall be anodised or powder coated, as required, before installation.

b) All ducts immediately behind the grilles/diffusers etc. Are to be given two coats of black paint in matt finish.

TESTING:

a) After completion of sections all duct systems shall be tested for air leakage.

b) The entire air distribution system shall be balanced to supply the air quantity for each area and the final balance of air quantity for each area shall be submitted to the Engineer-in-charge, for approval. The entire instrument required for testing and balancing i.e. rotating vane anemometer, thermometer, ducthood, inclined manometer etc. shall be provided by the Contractor.

6) PIPE WORK:

GENERAL:

All piping work shall conform to quality standards and shall be carried out as per specifications and details given hereunder:-

1.1 PIPES:

- All pipes in sizes upto 50 mm dia shall be M.S. E.R.W tube (black steel) heavy class as per IS: 1239-79, Part-I with Amendment-I of January 1981.

- 1.1.2 All pipes in sizes 65 mm & above shall be M.S. E.R.W. Tube (black steel) heavy class, as per IS: 1239/79 Part-I with Amendment-I of January 1981.

1.2 FITTINGS:

a. The dimensions of the fittings e.g. concentric, eccentric, tees, reducers, unions etc. shall conform to IS: 1239/69 Part-II unless otherwise indicated, in the specifications.

b. All bends in sizes upto and including 150 mm dia shall be ready, made of heavy duty, wrought steel of appropriate class not site manufactured from pipe sections.

c. All bends in sizes 200 mm and larger dia shall be as above.

d. All fittings such as branches reducers etc. In all sizes shall be fabricated from pipes of the same dia and thickness, and its length should be at least twice the dia of the pipe.

e. The branches may be welded straight to the main line, without making a separate fitting, where specified on drawings or required by Developer’s Representative.

f. Blank ends are to be formed with flanged joints and 6 mm thick + line size valve with capped end blank between flange pair for 150 mm and over, in case where, a future extension is to be made otherwise blank end discs of 6 mm thickness are to be welded on, with additional cross stiffeners

from 50 mm x 50 mm M.S. Heavy angles, for sizes upto 350 mm. All ends larger than 400 mm dia shall have dished ends.

1.3. FLANGES:

a) All flanges shall be of mild steel as per IS: 6392/71 and shall be steel slip-on-type, welded to the pipes, flange thickness shall be to suit class-ii pressures. No site manufactured flanges, bolt & gasket sets.

b) Flanges may be tack welded into position, but all final welding shall be done with joints dismounted. 3 mm thick gaskets shall be used with all flanged joints. The gaskets shall be fibre reinforced rubber as approved by the Developer's Representative. Special adhesive compound shall be used between flanges of steam, air and gas lines.

c) Flanges shall be used as follows:

d) Counter flanges for equipment having flanged connections.

e) Flanged pairs shall be used on all such equipment, which may require to be isolated or removed for service e.g. Pumps, refrigeration machines, air handling units etc.

f) All threaded valves shall be provided with nipples and flanged pairs on both sides to permit flange connections, for removal of valves from main lines for repair/replacement.

1.4 VALVES:

1.4.1 Butterfly valves - Wafer Type:

a) The butterfly valve shall consist of cast iron body preferably in single piece construction.

b) The disc shall consist of disc pivot and driving stem shall be in one piece centrally located.

c) The valve seat shall be EPDM/Nitrile material suitable for water duty. It shall line the whole body.

d) The disc should move in slide bearings on both ends with `o' ring to prevent leakage. Valves from 200 & above shall be gear operated.

e) The handle should have arrangement for locking in any set position.

f) The valve should be suitable for 16 kg/Sq.cm working pressure.

g) The check valves shall be dual plate wafer type. The body shall be of cast iron and the plate of aluminium bronze. The valve shall have plain face and shall have a synthetic seal. The valve shall be suitable for 14 kg /cm^2 pressure.

h) All gauge cocks shall be of gunmetal plug type, complete with siphon (brass chrome plated).

i) All drain valves shall be of gunmetal with a hose union connection of one hand.

j) All valves on the return line of fan coil units shall be as in 5.6 but without integral water strainer.

1.4.2. Balancing Valves:

a) The balancing valves upto 65 mm dia shall be orifice type of gunmetal/ductile iron screwed type

confirming to BS: 5154 or equivalent specifications & C.I. body, flanged ends from 80mm & above.

b) The valve shall be cast gunmetal ASTM B-62 and complete with non rising spindle. PTFE disc seal cast metal hand wheel.

c) The port opening shall permit precise regulation of flow rate, by accurately measuring the pressure drop across the port.

d) The valve shall be complete with two ports for connections to a mercury manometer, to measure the pressure drop, as well as a drain port.

e) Balancing valves intervals as disc, shafts etc. coming in contact with water shall be of brass/stainless steel.

f) The spindle shall have a shielded screw to set the flow at the desired level.

g) This valve shall be used wherever specified.

1.5. STRAINERS:

a) The strainers shall either be `Y' type with cast iron or fabricated steel body, tested upto pressure applicable for the valves as shown on the drawings.

b) The strainers shall have a perforated bronze sheet screen with 3 mm perforation and with a permanent magnet, to catch iron fillings.

c) `Y' strainers shall be provided with flanged ends & blow down valve.

d) The strainers shall be designed to facilitate easy removal of filter screen for cleaning, without disconnection of pipe line.

1.6. EXPANSION TANK:

The expansion tank for chilled water shall be of MS/HDPE construction (6 mm thick) open type. The tank shall be insulated with 50 mm thick insulation and be complete with float valve, gauge glass, drain, overflow and make up connections, with B gate valves and vent piping whenever required. The tank should be located at pump suction side at the highest point of the system.

1.7. POT STRAINERS:

The Y-strainer & Pot strainer comprising to SSPL: 107 & SSPL:106 shall have cast iron body and factory tested at works at 10 kg/cm^2 pressure. The screen shall be made out of 3mm perforated stainless steel sheet. It should be easily removable when required to be cleaned. Isolating butterfly valves at either end of the pot strainer shall be provided.

Color scheme for the equipment/materials:

a) Screw Chilling Machine : As per Manufacturer’s standards

b) Pump Sets : Battle ship gray

c) Condenser Water pipes : Light green

d) Direction of flow of water : Black arrows

e) Supports for Ducts : Silver

1.8. AIR VALVES:

Automatic Air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valve. 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.

THRUST BLOCKS:

In case of bigger pipes (80 mm dia and above), thrust blocks of cement concrete 1:2:4 (1 cement:2 coarse sand:4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends as directed by the Developer's Representative.

JOINTING:

a) All pipe lines shall be welded type.

b) Square cut plain ends will be beveled for pipes upto and including 100 mm dia.

c) All pipes 125 mm dia or larger will be beveled by 35 Deg. before welding.

MISCELLANEOUS:

Provide all pipe work as required to make the apparatus connected complete and ready for regular and safe operation. Unless otherwise noted, connect all apparatus and equipment in accordance with manufacturer's standard details, as approved by Developer's Representative.

Unless otherwise specified, pitch the lines of piping as follows:-

All condensation drainage shall be pitched in the direction of flow to ensure adequate drainage, with an adequate trap seal to prevent leakage of air due to static pressure developed by air conditioning units. Pitch, 20 mm per meter wherever possible, but not less than 10 mm per meter piped to nearest drain.

a) Provide valves and capped connections for all low points in piping system, where necessary or required for draining systems. Provide isolating valves & drain valves in all risers to permit repairs without interfering with the rest of the system.

b) During construction, temporarily close, open ends of pipes with sheet metal caps, where necessary, or required to prevent debris from entering the piping system.

c) Support piping independently of all equipment so that the equipment is not stressed by the piping weight or expansion.

d) To facilitate the maintenance, repair and replacement:

e) Provide shut-off valves where indicated and for individual equipment, units at inlet and outlet, to permit unit removal for repairs, without interfering with the remainder of the system. Additional shut-off valves shall be provided as required to enable all systems to be fully sectionalized. By-pass and stop valves shall be provided for all automatic control valves as specified.

f) Arrange piping for maximum accessibility for maintenance and repair, locate valves for easy

access and operation. No valves shall be installed with handles pointing down, unless unavoidable.

g) Cut the pipes accurately according to measurements, established at building site & work into place without springing or forging.

h) Pipe supports shall be either with Clevis Hangers or Trapeze Hangers adjustable for height and prime-coated with rust preventive paint & finish coated with gray paint, both as approved by Developer's Representative. The spacing of pipe supports shall not be more than that specified below:-

Nominal Pipe Size Mm	Spacing (Metres)
15	1.25
20 & 25	2.00
32,30,50 & 65	2.50
80,100 & 125	2.50
150 & above	3.00

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stresses on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic approved concrete inserts and riser glands.
Insulated piping (if any) shall be supported in such a manner as not to put undue pressure on the insulation, blocks, shields etc.

1.12 HANGERS & SUPPORTS:

a) Hangers and supports shall be provided and installed for all piping and tubing wherever indicated, required or otherwise specified. Wherever necessary, additional hangers and supports shall be provided to prevent vibration or excessive deflection of piping and tubing.

b) All hangers and supports shall be made of steel or other durable and non-combustible materials, galvanized or plated. Wood wire or perforated strap iron shall not be used as permanent hangers or supports.

c) Hangers shall be supported from structural steel, concrete inserts & pipe racks, as specifically approved.

d) No hangers shall be secured to underside of light weight roof decking and light weight floor glass.

e) Mechanical equipment shall be suspended midway between steel joists and panel points.

f) Drilling or punching of holes in steel joist members will not be permitted.

1.13. SLEEVES:

a) Where pipes pass through floors, walls, etc. provide galvanized steel pipe sleeves 50 mm larger than outside diameter of pipe. Where pipes are insulated, sleeves shall be large enough to ample clearance for insulation, ending 50 mm above FFL.

b) Where pipes pass through outside walls or foundations, the space between pipe and sleeve shall be caulked with lead wool and oakum or link seals.

c) The centre of pipes shall be in the centre of sleeves, and sleeves shall be flush with the finished surface and annular surface filled with fire proof materials like putty, fire seal etc.

d) Sleeves in floors shall finish 50mm above finished floor level.

1.14. Expansion or Contraction:

The contractor shall provide for expansion and contraction of all piping installed by the use of swing connections and expansion loops.

1.15. ARRANGEMENT AND ALIGNMENT OF PIPING (TO BE COORDINATED WITH OTHER TRADES):

a) All piping shall be arranged and aligned in accordance with the drawings as specified. Where special conditions are encountered in the field, the arrangement and alignment of piping shall be as directed by the Developer's Representative.

b) The piping shall be installed in a uniform manner, parallel to or perpendicular to walls or ceilings, and all changes in directions shall be made with fittings. The horizontal piping shall be run at right angles and shall not run diagonally across rooms or other piping. Wherever possible all piping shall be arranged to provide maximum head room.

c) All piping shall be installed as directly as possible between connecting points in so far as the work of other trades permits. Where interference occurs with another trade whose work is more difficult to route, this contractor shall reroute his pipes as required to avoid interference, at the discretion of the Developer's Representative.

d) All piping shall be carefully installed to provide for proper alignment, slope and expansion.

e) The stresses in pipe lines shall be guided and pipes shall be supported in such a manner that pipe lines shall not creep, sag or buckle.

f) Anchors and supports shall be provided wherever necessary to prevent any misalignment of piping.

g) Small tubing gauges, controls or other equipment installed on any apparatus, shall not be coiled nor excessive in length, but shall be installed neatly, carefully bent at all changes in direction, secured in place and properly fastened to equipment at intervals to prevent sagging.

h) The piping shall be grouped wherever practical and shall be installed uniformly in straight parallel lines in either vertical or horizontal positions.

i) The piping connection to all dynamic equipment e.g. AHUs chillers, pumps, cooling towers etc. shall be of flexible type. This item shall be treated as a part of piping and shall not be charged separately.

1.16. TESTING:

a) In general, tests shall be applied to piping before connection of equipment and appliances. In no case shall the piping, equipment or appliances be subjected to pressures exceeding their test ratings.

b) The tests shall be completed and approved before any insulation is applied. Testing of segments of pipe work will be permitted, provided all open ends are first closed, by blank-offs or flanges.

c) After tests have been completed the system shall be drained and flushed 3 to 4 times and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings

and debris.

d) All piping shall be tested to hydraulic test pressure of at least one and half times the maximum operating pressure but not less than 10 kg/Sq.cm for a period of not less than 12 hours. All leaks and defects in the joints revealed during the testing shall be rectified to the satisfaction of the Developer's Representative, without any extra cost.

e) All the piping systems shall be tested in the presence of the Developer's Representative or their authorized representative. Advance notice of test dates shall be given and all equipment, labour, materials required for inspection, and repairs during the test shall be provided by the contractor. A test shall be repeated till the entire systems are found to be satisfactory to the above authority. The tests shall be carried out for a part of work if required by Developer's Representative in order to avoid hindrance in the work of the insulation contractor.

f) All steam and condensate pipes shall be tested and proven tight under hydrostatic pressure of 20 kg/Sq.cm, unless otherwise stated, for a minimum period of 4 hours without drop in pressure.

g) The contractor shall make sure that proper noiseless circulation is achieved through all piping systems. If due to poor bond, proper circulation is not achieved, the contractor shall bear all expenses for carrying out the rectification work including finishing of floors, walls and ceiling damaged in the process of rectification.

h) The contractor shall provide all labour and materials to make provision for removing water and to the proper place, during the testing or/and after the testing to avoid damages to employer or other contractors properties. Any damages caused by the contractor to the employer or other contractors properties, shall be borne by the contractor.

1.17. DRAIN PIPING:

a) The drain piping shall be medium class galvanized steel as per IS:1239/1979.

b) The fittings shall be of 'R' brand or equal forged with screwed connections.

c) The gate valves shall be of gun metal as described earlier.

d) Pipe crosses shall be provided at bends, to permit easy cleaning of drain line or plugged tees.

e) The drain line shall be provided upto the nearest drain trap and pitched towards the trap.

f) Drain lines shall be provided at all the lowest points in the system, as well as at equipment, or to remove condensate and water from pump glands.

PAINTING:

a) All pipes supports, hangers, etc., Shall be given two coats of red oxide primer.

b) All pipes, which are not to be insulated, shall then be given one coat of finish paint, of a type and colour, as approved by the Developer's Representative.

GAUGES:

The water pressure gauges shall be of robust construction, with minimum 100 mm dial, of suitable range and accurately calibrated.

THERMOMETERS:

The thermometers shall be mercury filled industrial stem type, with metal casing and threaded fixing arrangement.

SPECIFICATIONS FOR PRESSURE INDEPENDENT DYNAMIC CONTROL VALVE

Pressure independent Dynamic balancing control valves are to be used on each FCU, AHU/ FAHU circuit. No valves are to be mounted on the main, raisers or branches.

The Valve should be self balancing dynamic flow control valves that are pressure independent, two-way, modulating to accept digital or analog input signals and provide flow feedback signal to the control system. The flow feedback signal should be a feature of the valve itself without any need for additional device/instrument.

Pressure Independent Dynamic balancing control valves 15-40mm; shall the valve meet the specified flow within either +/- 10 % or +/- 2% of the maximum cartridge flow rate. Valves shall contain replaceable, visible cartridges that are externally field adjustable to no less than 39 different settings. The actual setting and thereby flow rate needs to be available from the outside by looking at the cartridge itself. The relations between the setting and the flow rate shall be available in the supplier's literature. The cartridges shall be available in at least two pressure ranges, ranging between 16-400 kPaD. Larger ranges then mentioned is accepted, but not lower ranges. The specific range is selected based upon the system requirements.

VALVE ACTUATOR

1. Valve actuator housing shall be rated to IP43.
2. Actuator shall be driven by a 24V AC power supply, and shall accept (0)2-10V DC, (0)420mA signal.
3. Actuator shall be capable of proving 0-10V DC feedback signal to the control system.
4. Actuator shall use full span and provide full authority.
5. Actuator Cover : Fireproof ABS cover.

Flow Regulation Unit

6. Flow regulation unit shall consist of glass-reinforced polyphenyl-sulfide with a hydrogenated acrylonitrile-butadiene-rubber diaphragm.
7. Flow regulation unit shall be readily accessible by removing the cartridge and without dismantling the valve, for change-out or maintenance.
8. Flow regulation unit shall be externally adjustable to 1 to 39 different flow rates; minimum range shall be capable of being activated by minimum 16 Kpa operation ranges; shall be capable of controlling the flow within +/-10% of rated flow or +/-2% of maximum flow.

Pressure Independent Dynamic balancing control valves 25-150mm; shall the valve meet the specified flow within either +/- 5 % or +/- 2% of the maximum flow rate. Each valve should have an adjustable maximum flow rate setting to enable flow limitation and balancing to the coils. It should be externally field adjustable to no less than 51 different settings. The actual setting and thereby flow rate needs to be available from the outside by looking at the DIP switch settings itself. The relations between the setting and the flow rate shall be available in the supplier's literature. The valve shall be available between 35-400 kPaD pressure ranges. Larger ranges then mentioned is accepted, but not lower ranges. The specific range is selected based upon the system requirements.

The actuator shall be microprocessor based with a self-calibrating feature. The actuator shall be capable of providing 4-20mA or 2-10 V DC feedback signal to the control system. External LED read-out of current valve position and maximum valve position setting shall be available.

VALVE ACTUATOR

1. Valve actuator housing shall be rated to IP42.
    a. Actuator shall be driven by a 24V AC / 30V DC power supply, and shall accept 2-10V DC, 4-20mA, 3-point floating or pulse width modulating electric signal and shall include resistor to facilitate any of these signals.
2. Actuator shall be capable of proving 4-20 mA or 2-10V DC feedback signal to the control system.
3. Turn Time : 150 seconds (from closed to fully open valve)
4. Direction of rotation : Bi-directional
5. Humidity rating : Fully coated electronic board
6. Housing material : Aluminium
7. Optional fail safe system to power valve to either open or closed position from any position in case of power failure shall be available.
8. External LED read-out of current valve position and maximum valve position setting shall be available.

FLOW REGULATION UNIT

Flow regulation unit shall consist of stainless steel and hydrogenated acrylonitrile-butadiene-rubber and shall be capable of controlling flow within +/-5% of rated flow rate or +/-2% of maximum flowrate.
Flow regulation unit shall be accessible, for change-out or maintenance.

VALVE SPECIFICATIONS

	For 15-40 mm	For 25-40 mm	For 50 to 150 mm
Flow rate	Up to 22 GPM	Upto 37 GPM (above 22 gpm)	Upto 468 GPM
Static Pressure	2500 kPa, 360 psi	4000 kpa, 580 psi	4000 kpa, 580 psi
Media Temperature	+1 ° to 110 °C	-20 ° to 120 °C	-20 ° to 120 °C
Ambient Temperature	+1 °C to 50 °C	-10 ° to 54 °C	-10 ° to 54 °C
Body material	Forged Brass ASTM CuZn39Pb2	Ductile Iron, ASTM A536-65T, Class 60-45-18	Ductile Iron, ASTM A536-65T, Class 60-45-18
Internal Components	Stainless steel	AISI Type 316 Stainless Steel	AISI Type 316 Stainless Steel
Test Ports/ Body Tapings	Standard, If reqd	1/4” ISO (Test Ports)	1/4” ISO (Test Ports)
End Connections	Fixed female ISO or NPT, or union end connection	Union end connection	Wafer style (by others)
Stem Seals	EPDM “O” Ring	EPDM	EPDM
Maximum Close Off Pressure	400kPa, 58 Psi	600 kPa, 87 psi	600 kPa, 87 psi
Maximum Operational Delta P	400 kPaD, 58 PsiD	320 kPaD, 58 psiD	400 kPaD, 58 psiD

7) INSULATION:

This section deals with supply and fixing of thermal insulation of ducts, pipes etc. as per the specification given in this section.

MATERIAL OF INSULATION

The insulation material of the following kind shall be used for cold insulation.

A. RESIN BONDED FIBRE GLASS WOOL SLABS

The Thermal conductivity values in W/m.K of fibreglass shall conform to following:

Mean Temperature ^{O}C	Density in KG/M^3	Thermal Conductivity W/m.K
For Duct Insulation		
25 ^{O}C	24	0.033
For Acoustic lining of Duct:		
25 ^{O}C	32	0.030

B. EXPANDED POLYSTYRENE FOR PIPE INSULATION

The density of expanded polystyrene shall not be less than 30 kg per cubic meter and the thermal conductivity shall not exceed 0.031 Kcal./hr.m ^{O}C at $10^{O}C$ mean temperature. The material shall be of TF quality. The thickness of insulation upto 100mm dia pipes should be 50mm and above 100mm dia pipe it should be 75mm.

The sample of insulation material shall be submitted for approval to the Consultant. Adhesive used for setting the insulation shall be non-flammable, vapour proof, CPRX compound.

INSULATION ON SHEET METAL DUCTING

The air handling ducts shall be insulated with nitrile rubber.

Duct insulation thickness shall be as follows:

a) Duct in Conditioned Space - 13 mm thick
b) Duct in Unconditioned Space - 19 mm thick

INSTALLATION

a. Clean the surface with a wire brush and make it free from rust and oil.

b. Apply one coat of primer compatible with the adhesive to be followed. Adhesive can be CPRX compound or bitumen 5/25 grade or equivalent.

c. The duct insulation shall be of pre-laminated with nitrile rubber of above specifications. Pre-lamination should be of minimum thickness as above with vapour barrier.

d. All insulation joints shall be butted together and care taken to see that no sagging of insulation occurs at any point.

INSULATION OF PIPES (WITH TF QUALITY EXPANDED POLYSTYRENE):

The chilled water and drain pipes shall be insulated with TF quality expanded polystyrene in the form of preformed pipe sections. The thickness of the insulation for chilled water pipes shall be as per BOQ.

Installation:

Chilled Water and Drain Piping:

a) The pipe shall be thoroughly cleaned with a wire brush and rendered free from all rust and grease.

b) The pipes shall be treated with a coats of hot 85/45 or 80/25 grade bitumen conforming to IS:702-1961.

c) The insulation preformed section shall be fixed tightly to the surface taking care to seal all joints with 50mm wide aluminium adhesive tape (transverse and circumferential).

d) Wrap the insulation with 500 Ga polyethene sheet.

e) The insulation shall be tied with PVC band not less than 6mm width and 25 Ga 4 bends per metre or equivalent plastic band using G.I. sheet clamp crimped at the joints.

f) The insulation than shall be covered with 0.63 mm x 19 mm mesh wire netting.

g) The insulation shall then be covered with 12mm sand cement plaster in the ratio of 4:1 in two layers of 6mm each.

h) Following additional treatment shall be done for pipes laid underground in trenches or exposed weather:

i) Over the insulation provide polythene based hessian (500 Ga) overlapping 100mm on all joints (transverse and circumferentials) and stitched at the joints.

j) The hessian shall be covered with 15mm x 20mm hexagonal chicken wire mesh.

k) Over the wire mesh, the surface shall be covered with two layers of tar felt Grade – II and Type – II with bitumen between layers overlapping 100mm on all joints (transverse and circumferential).

l) Over the second layer of tar felt final coat of hot bitumen not less than 6mm thick shall be applied.

4.0 ACOUSTIC LINING:

a) The acoustic lining shall consist of 25mm resin bonded glass wool of density 32 kg/m^3 (min) then it shall be covered by 0.5mm perforated aluminium sheets having 3mm perforation at 6mm centers.

b) Installation:

i. The duct surface shall first be cleaned from inside.
ii. The insulation boards shall be wrapped in RP Tissue paper with the end stitched.
iii. Then the boards shall be fixed inside the duct.
iv. The insulation shall then be covered with 0.5mm perforated aluminium sheets.
v. The sheets and the insulation shall be secured to the duct by means of cadmium plated bolts, nuts and washers. The ends should be completely sealed off, so that no insulation material is exposed.

ROOF INSULATION:

The RCC under deck roof surface shall be insulated with Extruded Polystyrene (XPS) Rigid Thermal Insulation Boards having the following technical parameters:

Thermal Resistance R-Value	°F.ft².h/btu	15
Density (Minimum)	Kg/m³	31-35
Thermal Conductivity (90 Days, 10°c)	W/mK	<=0.026
Thermal Conductivity (90 Days, 24°c)	W/mK	<=0.028
Compressive Strength	Kpa	>=250
Tensile Strength	Kpa	300
Flammability		5 (Class A)
Water Vapor Permeability	Ng/(pa.s.m²)@25.4mm	<=63
Water Absorption	%(v/v)	<=0.1
Temperature Limits	°C	Minus 50 to 70

5.1 Installation should be followed as:

a) 5.1.1 4 (Four) holes of 6 mm depth per every square metre shall be made into the RCC Under-Deck surfaces.

b) PVC Sleeves of dimensions 35mm x 8mm shall be driven into the Above-mentioned holes in order to secure M.S. Screws.

c) M.S. Screws of dimensions 75mm x 8mm shall be secured into place.

d) The Bonding Agent i.e. CPRX Compound shall be evenly applied onto the Extruded Polystyrene (XPS) Rigid Thermal Insulation Boards and allowed to dry for 10-15 minutes prior to Installation.

e) The Extruded Polystyrene (XPS) Rigid Thermal Insulation Boards shall be affixed onto the RCC Under-Deck surfaces to be insulated with the help of the CPRX Compound.

f) G.I. Washers of dimensions 50mm x 50mm shall be used in conjecture
   I. with the pre-installed M.S. Screws to secure the Expanded Polystyrene
   II. (EPS) Rigid Thermal Insulation Boards firmly into place and complete the Installation.

14) MODE OF MEASUREMENTS:

1.0 UNIT PRICES IN THE SCHEDULE OF QUANTITIES:

1.1 The item description in the Schedule of Quantities is in the form of a condensed resume. The unit price shall be held to include every thing necessary to complete the work covered by this item in accordance with the specifications and drawings. The sum total of all the individual item prices shall represent the total price of the installation ready to be handed over.

1.2 The Unit Price of the Various Items shall include the following:

1.2.1 All equipment, machinery, apparatus and materials required as well as the cost of any tests which the Design Consultant may request in addition to the tests generally required to prove quality and performance of equipment.

1.2.2 All the labour required to supply and install the complete installation in accordance with the specifications.

1.2.3 Use of any tools, equipment, machinery, lifting tackle, scaffolding, ladders etc. Required by the contractor to carry out his work.

1.2.4 All the necessary measures to prevent the transmission of vibration.

1.2.5 The necessary material to isolate equipment foundations from the building structure, wherever necessary.

1.2.6 Storage and insurance of all equipment apparatus and materials.

1.3 The Contractor's unit price shall include all equipment, apparatus, material and labour indicated in the drawings and/or specifications in conjunction with the item in question, as well as all additional equipment, apparatus, material and labour usual and necessary to make in question on its own (and within the system as a whole) complete even though not specifically shown, described or otherwise referred to.

2.0 MEASUREMENTS OF SHEET METAL DUCTS, GRILLES/DIFFUSERS ETC.

2.1 SHEET METAL DUCTS:

a) All duct measurements shall be taken as per actual outer duct surface area including bends, tees, reducers, collars, vanes & other fittings. Gaskets, nuts, bolts, vibration isolation pads are included in the basic duct items of the BOQ.

b) The unit of measurements shall be the finished sheet metal surface area in meters squares. No extra shall be allowed for lapse and wastage.

c) All the guide vanes, deflectors in duct elbows, branches, grille collars quadrant dampers etc. shall be measured for actual sheet metal surface and paid for at the same rate as duct of same thickness.

d) The unit duct price shall include all the duct hangers and supports and making, exposing of concrete reinforcement for supports and good of the same as well as any materials and labour required to complete the duct frame.

2.2 Grilles/Diffusers

All grilles/diffusers are as per tender requirements shall be tested as a lump sum item. Where extra grilles diffusers are ordered upto award of work, they should be measured as follows:

a) All measurements of grilles/diffusers shall be the actual outlet size excluding the outer flanges.
b) The square or rectangular grilles/diffusers shall be measured in plain m^2.
c) All round diffusers shall be measured by their diameters in cm.
d) All linear diffusers shall be measured as per actual length in metres.

3.0 MEASUREMENTS OF PIPING, FITTINGS, VALVES, FABRICATED ITEMS:

3.1 Pipes: Including water piping, steam piping and all other piping required to be executed at site for completion of the work:

a) All pipes shall be measured in linear metre (to the nearest cm) along the axis of the pipes and rates shall be inclusive of all fittings and branches e.g. tees, bends, reducers, elbows etc. deduction shall be made for valves in the line.

b) Exposing reinforcement in wall and ceiling and floors of possible and making good the same or installing anchor fasteners and inclusive of all items as specified in specifications and Schedule of Quantities.

c) Rates quoted shall be inclusive of providing and fixing vibration pads and wooden pieces, wherever specified or required by Engineer-In-Charge.

d) Flexible connections, wherever required or specified shall be measured as part of straight length of same diameter, with no additional allowance being made for providing the same.

e) The length of the pipe for the purpose of payment will be taken through the centerline of the pipe and all fittings (e.g. tees, bends, reducers, elbows, etc.) as through the fittings are also presumed to be pipe lengths. Nothing extra whatsoever will be paid for over and above for the fittings for valves and flanges.

3.2 Valves and Flanges

3.2.1 All the extra cast iron and cast metal flanged valves shall be measured according to the nominal size in mm and shall be measured by number. Such valves shall not be counted as part of pipe length will be made wherever valves occur.

3.2.2 All gun metal (gate & globe) valves shall include two numbers flanges and two numbers 150 mm long M.S. nipples, with one side threaded matching one of the valves, and other welded to the M.S. Slip-on-flange. Rate shall also include the necessary number of bolts, nuts and washers, 3 mm thick insertion gasket of required temp. grade and all items specified in the specifications.

3.2.3 The rates quoted shall be inclusive of making connections to the equipment, tanks, pumps etc. and the connection made with an installed pipe line shall be included in the rates as per the Schedule of Quantities.

3.3 Structural Supports

Structural supports including supports fabricated from pipe lengths for pipes shall be measured as part of pipe line and hence no separate payment will be made. Rates shall be inclusive of hoisting, cutting, jointing, welding, cutting of holes and chases in walls, slabs or floors, painting supports and other items as described in specifications, drawings and schedule of quantities or as required at site by Engineer-In-Charge.

4.0 INSULATION

4.1 The measurement for vessels, piping and ducts shall be made over the bare un-insulated surface area of the metal.

4.2 Pipes, Ducts & Vessels:

4.2.1 The measurements for installation of piping shall be made in linear meters through all valves, flanges, and fittings. Pipes/bends shall be measured along the centerline radius between tangent points. If the outer radius is R1 and the inner radius is R2 the center line radius shall be measured as (R1+R2)/2. Measurement of all valves, flanges and fittings shall be measured with the running metre of pipe line as if they are also pipe length. Nothing extra over the above shall be payable for insulation over valves, flanges and fittings in pipe line/routings. Fittings that connect two or more different sizes of pipe shall be measured.

4.2.2 Duct:

Measurements for insulation of ducts shall be made in actual net square metres of bare un-insulated duct surface through all dampers, flanges and fittings. In case of bends the area shall be worked out by taking an average of inner and outer lengths of the bends. Measurements for the dampers, flanges, fittings shall be for the surface dimension for the connecting duct, nothing extra over the above shall be payable for insulation over dampers, flanges and fittings in duct routing.

4.3 Accessories Insulation

4.3.1 The unit of measurement for accessories such as expansion tank, pumps, chiller heads etc. shall be un-insulated area in square metres.

4.3.2 In case of curved or irregular surfaces, measurements shall be taken along the curves.

4.3.3 The unit insulation price shall include all necessary adhesives, vapour proofing and finishing materials as well as additional labour and material required for fixing the insulation.

4.4 Acoustic Duct Lining

4.4.1 In case of acoustic lining of air ducts, measurements of the bare inside duct surface in square metres, shall be final for billing purposes.

4.4.2 The insulation/acoustic panels shall include cost of battens, supports, adhesives, vapour proofing, finished tiles/boards/sheets as well as additional labour and materials required for completing the work.

15) BALANCING AND COMMISSIONING:

1.0 GENERAL:

Perform following testing and commissioning to approval:

Air balancing of each system (each supply air system, fans, cooling tower blower, air handling units.

Hydronic tests (testing and balancing) including water flow balancing and thermal capacity testing of chilled water system, circulating pumps and chiller.

Excessive noise & vibration testing.

2.0 CRITERIA:
Systems shall be balanced and adjusted to give design/operating conditions under following criteria:

c) Tolerance of air flow quantities : 3% S.A. Ducts, 5% other ducts

d) Tolerance of water flow quantities : 5%

e) Maximum noise level reading : NC-35 in occupied spaces.

f) Maximum current load on motors : 100% of nameplate capacity

3.0 REPORTS:
3.1 On completion, supply at least six copies of balancing and test report, suitably bound, 8 ½" x 11" size for checking and review. submit completed reports within three weeks of testing and balancing.

3.2 Reports shall include all design data together with recorded data of all tests for comparison and schematic of each system and components.

3.3 Report all temperatures in Degree Celsius. For convenience, reports may also show temperature in Fahrenheit but only as secondary data.

3.4 Reports should show schematic of each system. Location of each traverse should be mark and each outlet should have corresponding number.

3.5 Keep a record of all tests and have these signed by General Contractor's superintendent and where applicable, equipment Manufacturer's Representative. Show in an approved schedule form, record of systems or parts of systems tested or intended to test, date of test, circumstances such as pressure, temperature, duration of test and any special remarks pertaining to events during test.

3.6 Final Report Shall Include:

g) Specified and achieved total air quantities per system.
h) Specified and achieved individual air quantities per outlet with supporting schematic diagrams.
i) Specified and actual fan total SP with breakdown showing inlet and discharge pressure.
j) Sheaves and belt sizes and quantities per unit.
k) Each pump suction pressure, head pressure, amps and voltage, nameplate amperage and voltage.
l) Specified and achieved total water flow per system.

m) Specified and achieved individual water flow, and pressure drop though Cooling Tower

and Chiller.

4.0 TESTING:

4.1 Carry out all tests specified. Test equipment to requirement of and where necessary, in presence of equipment manufacturer.

4.2 Tests for balancing shall proceed only after system installation has been completed and system has been put into continuous operation.

5.0 EXHAUST SYSTEMS:

5.1 Test each system as herein described. Pre-set system as follows:

e) Basement exhaust dampers to fully open position.

f) Close doors for those rooms being exhausted.

g) Start related supply air system.

5.2 Check fan speed, motor amperage and voltage. Compare to shop drawing data. Adjust fan speeds (except for direct drive fans) to within 5% of shop drawings figure.

5.3 Make pitot tube traverse, velocity and static pressure readings in ducts wherever needed as specified for test.

5.4 When airflow capacity is within 5% of design, test and balance individual inlets starting with those closets to fan.

5.5 Adjust system to normal operating audition and record all data.

6.0 MISCELLANEOUS AIR FLOW AND PRESSURE TESTING:

After all systems are balanced, set supply air systems to maximum outdoor air and maximum relief position and test building pressures in main lobby relative to atmosphere. Adjust air flows to direction of engineer when unsuitable building pressure occurs.

7.0 FLUID CARRYING SYSTEMS:

7.1 Test adjust and balance each fluid carrying system as further described by use of flow meter, fittings and pressure drop and temperature readings for components. Submit full test report listing actual data versus design and manufacturer data. Include in report, schematics, reference numbers, any changes that may have occurred, electrical and other pertient information like noise level, vibration, etc. Relative to particular system or components. Make visible all settings of adjusting devices showing proper setting of each device, valve or fitting.

7.2 Test each circulating pump for shut off head. Open valves gradually to obtain design flow rate as required and measured by flow meter. Record pump pressures for suction and discharge. Test and record motor data and load (amperage and voltage).

7.3 Test each alternate or standby pump in same manner for each zone and service and adjust balance valve to suit each zone flow rate and head.

7.4 Adjust and record all water flows to specified requirements through individual chilled water coil, heat exchanger; circulating pumps, chiller and through the cooling tower. Insure that water temperature drop is based on unit Manufacturer’s Catalogue ratings for conditions at time of test.

7.5 Test and balance each complete system by means of flow meter and system valves.

8.0 CHILLED WATER SYSTEM:

8.1 Test and balance complete system by means of flow meter and system valves. Test primary chilled water circuit by means of flow meter. Adjust as required. Test each chilled water pump for shut-off-head. Open valve gradually to obtain design flow rate as measured by flow meter. Record pump pressure for suction discharge. Test and record motor data and load (amperage and voltage).

8.2 Test and balance the water flow through the chiller and ice storage circuits. Adjust flow as required.

8.3 When testing and chiller, make voltage and current readings in each phase condition. Check and set operation of safety cutouts, controls and interlocks. Verify chiller operates to required performance in safe and efficient manner.

8.4 Perform temperature testing on each piping circuit.

9.0 TEMPERATURE TESTING:

9.1 Record temperatures of air and liquid flow for all heat exchangers, refrigeration machines and DX coils on air and water sides as applicable. Calculate heat exchange performance in BTU/hour, compare to design data.

9.2 Record for each room DB^{O}C and WB^{O}C temperatures and R.H. and re-adjust readings for local conditions at time of test.

10.0 EXCESSIVE NOISE & VIBRATION TESTING:

10.1 Test and explore all sources of excessive noise generation or vibration caused by mechanical system. Perform octave band sound measurements at locations requested by Architect/ Engineere Incharge. Tests shall be done after systems have been balanced.

NOTE: All specifications for HVAC and Ventilation works shall be read in compliance with ECBC 2007. All works to be carried out has to follow ECBC 2007.

OZONE GENERATING SYSTEM

Ozone Generator

1. Ozone Generator shall be self contained unit, with all components factory assembled in one neat, compact package, suitable for duct mounting

2. Components in contact with air shall be enclosed in stainless steel casing 18 G thick with sufficient stamped integral openings to allow adequate flow of air over the corona discharge plates

3. Method of ozone production shall be by principle of corona discharge, with multiple numbers of double sided corona plates. Production density of ozone per unit surface area of corona surface shall be very low. Ozone shall be produced from the supply air of AHU/Fan. Air pressure over the corona surface shall not exceed air pressure in the duct. Electrical frequency applied on corona plates shall be the same as line frequency (60 Hz or 50 Hz). All corona plates shall be housed in a common stainless steel enclosure.

4. Detection/Sensing of VOC and production of ozone shall be in the same gaseous medium

5. Corona plates shall be mounted on generator head, specially manufactured to close tolerance, of material that repels accumulation of sediments from tar, nicotine and grease

6. The Transformer shall be electrical induction type. Solid state voltage converter shall not be acceptable. The Transformer shall be Cross Ferro Magnetic Type. Secondary windings shall not burn, generate smoke, or elevate greater than 90ºF (32ºC), even if the high voltage secondary output is short circuited for extended period of time, in full load conditions. Upon removal of the short circuit, the transformer shall revert to normal operation without any damage or loss of efficiency, or reduced insulation capacity, or blow out of fuse, or trip of circuit breaker.

7. The transformer shall be fully encapsulated. The encapsulation is to ensure the transformer windings and core are fully impregnated with epoxy rated for use in electrical equipment. The epoxy shall penetrate into various layers of primary and secondary windings, and into the various sections of the core. This is to ensure electrical spark, if any, shall be contained and isolated within the specific spot of occurrence in the windings, and temperature elevation if any shall be contained and isolated within the specific spot of occurrence of the winding or in the layers of the core. The epoxy for encapsulation shall be fire rated to UL94V0. The electrical properties of the epoxy for this encapsulation shall be ;

   a. Dielectric strength at 23ºC not less than 425 volt/mil
   b. Voltage resistivity at 23ºC not less than 2 x 10^{15} Ohm Cm

8. The encapsulation of the transformer shall be done in a one piece die cast metallic enclosure 18 G CRS. The top cover shall be riveted with a fire rated epoxy to UL 94V0. This shall ensure the transformer is completely fire rated and non flammable.

9. The metallic enclosure and encapsulation shall also render the transformer totally safe to operate even if there is settlement and deposition of moisture or water on the transformer due to carry over moisture from Cooling Coil. The transformer shall not burn, short circuit or be damaged, even if fully immersed in water.

   These are essential safety prerequisites as the Transformer/Generator is installed in the Air Conditioning Duct, and the facility houses human occupants.

10. Entire Transformer shall be Tested to UL2043: Fire Test for Fire & Visible Smoke Release for Discreet Products & Accessories Installed in Air Handling Space, and Recognized to UL506: Safety Specialty Transformer.

11. Penetration of high voltage conductor from Transformer Enclosure to Corona Enclosure shall be through Embedded Porcelain SS Solid Transmitter. Cable insulation, rubber, synthetic or ceramic bushing shall not be used as reliable insulation for enclosure penetration of high voltage.

12. Primary of Transformer shall be rated for input voltage varying from 0 to 110V (0 to 220V)

13. High voltage electrical wire from the transformer secondary terminal to Porcelain Embedded Transmitter, and further from Transmitter to Corona contact plates shall be rated for 20KV, 150ºC, certified to be ozone and corona resistant, have high flexibility, and shall be silicone insulated. Wire diameter shall not be less than 18 AWG. The wire shall be rated to UL3239 and VW-1 Flame Test. These shall be stamped on the wire. This is essential and cannot be waived from safety standpoint, as this wire carries high voltage.

14. The generator shall be suitable for mounting in duct with airflow in horizontal or vertical or angular direction, and for air flow in either direction, right to left, or top to bottom, or vice versa

15. The generator shall have the feature for interlock to motor of the AHU, to prevent start of the generator unless the fan is energized

16. Each and every part and component of the generator including bushing, grommet, corona plate, standoff, paint, and ink in printing labels, shall be fire resistant, and individually listed to UL standards.

17. All parts and components, bonding compound, bushing, standoff, paint, and screen printing ink shall be individually listed to highest UL standards.

18. The generator shall be provided with stainless steel flange in either side to enable mounting to metal frame, to be installed inside the duct

19. Ozone Generator shall be manufactured to permit easy withdrawals and refitting in duct with minimum use of tools or hardware to refit the generator to duct

20. Generator output shall be suitable for modulation by automatic or manual controls

21. The generator shall be rated for operation on 0 to 100 % RH

22. The generator shall be suitable for operation on electrical supply 220 to 240 (110 – 220) Volts, Single Phase, 50/60 Hz 3 wire system.

23. The Generator shall be Classified to UL 1995 ABQK and Tested and Certified for Safety against Fire and Smoke to UL 2043. It shall be CE Certified.

VOC SENSOR CONTROLLER

1. Regulation of IAQ device (Ozone generator) shall be automatically modulated and controlled by Auto VOC Sensor and Variable Load Controller modules. They shall be housed in one neat, compact, 18G CRS Powder Coated Satin Finish Enclosure.

2. Sensor and Controller shall be rated for continuous operation.

3. It shall be suitable for operation in air 0 to 100% RH non condensing.

4. Wiring between Sensor and Controller Modules, and for powering the Sensor element shall be factory provided within the enclosure.

5. Sensor element shall be HMOS, rated for continuous online, 24/7 uninterrupted operation, without requiring recalibration.

6. The Sensor shall be factory calibrated to Isobutylene gas 100 (or 1000) PPM for full span, and controlled clean air for zero span. Factory stamped calibration certificate with date of calibration shall accompany each unit.

7. The VOC Sensor shall be capable of detecting broad range of commonly occurring VOC in indoor applications. Each gas sensed is related by the sensor to its corresponding concentration value to isobutylene.

8. The Sensor shall provide 4 distinct signals, one each for Clean, Low, Medium and High levels of concentration of the polluting VOC. The Sensor shall have 5 LED displays to provide visual indication for the 4 levels, and warm up phase. It shall be possible to field adjust sensitivity of the sensor.

9. The sensor shall provide 0 to 10 VDC analog proportional output, for interface to Automated Building Management System.

10. In the event of power failure, or if the system is turned off, the Sensor shall retain the pre set sensitivity.

11. The sensor shall be provided with device to adjust the 4 levels of pollution, one for each, independent of one another.

12. Controller Module shall be solid state, mounted alongside the Sensor Module, in the same common enclosure. It shall be fully factory assembled and wired. Field provided connections shall be limited to wiring for power in, power out, and electrical interlocks (if used).

13. The Controller shall be suitable for accepting signals from the Sensor Module. Based on the signals received, it shall provide variable output to operate IAQ devices.

14. Input voltage to controller shall be 120 Volts, 1 Ph, 60 Hz (or 220 to 240 Volts, 1 Ph, 50 Hz). It shall be suitable for load rating of 15 Amps on 120 Volts, or 7.5 Amps on 220 Volts (choose any one).

15. Controller shall be provided with terminal block to connect incoming power, variable outgoing power, and for interlock to AHU motor or other air moving device, and to safety device such as high ozone cut out switch. In principle, the interlocks may be used for any field device chosen by user.

16. Controller shall be provided with rocker switch to choose Automatic or Manual Mode of operation. In the Manual Mode, voltage output of the Controller shall be 100% of input voltage, regardless of level of VOC or input voltage signal.

17. The controller element shall be IGBT to minimize voltage spikes.

18. Controller element shall have Current Limiter to prevent current spikes

19. Controller element shall be housed in Epoxy Compound Housing and epoxy shall be flame rated to UL 94 VO.

20. As this is a switching device, the outer enclosure shall be metal to prevent harmonic spikes.

21 The Sensor Controller shall be Listed to UL 916 Standard for Safety for Energy Management Equipment, and CE Certified.

SUPERVISORY OZONE MONITOR

1) Supervisory Ozone Monitor comprising Sensor and Controller shall be provided to track continuously 24/7 concentration of ozone in air. The Monitor shall comprise sensor section and inbuilt controller section.

2) Sensor Section shall comprise Metal Oxide Sensor Element rated for continuous duty, and 3 1/4 inch monochrome LED Display Screen. The Screen shall display ozone concentration down to 2 PPB in increment of 1 PPB. Full range of display shall be 120 PPB. The LED Screen shall also display activation of relay contact, alarm condition, over range (above 120 PPB), and Fault Codes with Identification Number for each fault.

3) The system shall be equipped with Watch Dog Device to perform self diagnosis; upon start of Monitor, and continuously every 2 seconds. Self diagnosis shall be performed on every part and component of the system including sensor, calibration, ageing and drift of sensor, hardware and software, integrity of electronic circuitry, continuity and integrity of traces in the circuit boards, and perform functions of microprocessor. Self diagnosis shall also include verification of free and uninterrupted air flow through sample air circulating fan. Self diagnosis shall also include tests for software and flipping of binary digits generated by the microprocessor. Any fault detected shall be reported on the display panel with corresponding Fault Code Number. If any fault is detected in critical components, relay is activated to shut down the Ozone Generator and activate fresh air fan or other air quality correctional device.

4) The Monitor shall be factory set at 40 PPB to activate the relay and 50 PPB to activate audible alarm. Can be factory set to 80 PPB and 100 PPB respectively, if called for.

5) Monitor shall be provided with audible alarm to beep if any defect is detected and provide continuous sound to 85 dB if alarm condition is reached.

6) The Monitor shall be provided with unit mounted circulation fan to ensure continuous passage of sample room air. Watch Dog Device shall perform diagnosis every 2 seconds to ensure the fan is in operation and air passage is not restricted or blocked. If such condition is detected, it shall report with Fault Code Number on the LED Display.

7) The Monitor shall provide 0-10 VDC and 4-20 mA Analog Signal corresponding to Ozone Generator to BAS/BMS.

8) Relay Contact shall be provided with 1 NO and 1 NC potential free dry contact, rated for 250 VAC, 10 Amps (based on resistive current).

9) The Monitor shall be suitable for operation 24/7 in indoor or outdoor air.

10) Operating temperature of the Monitor shall be -22ºF (-30ºC) to +194ºF (+90ºC), 0 to 100 % RH (Non Condensing).

11) For failsafe and long time operation, sensor and display circuit boards shall be gold plated to 24 Carat 3 Micron thickness. This is to reduce or prevent loss of accuracy due to oxidation of the

conductor surface over time. The populated boards shall be conformal coated to prevent damage from duct, moisture, condensation, traces of acid, and ozone.

12) All parts and components of the Monitor shall be lead free and comply to RoHS.

13) UL Listed and or approved Power Adaptor 100 to 240 VAC / 12 V for power supply to Monitor shall be factory provided.

14) All parts and components of the Monitor shall be housed in one neat, compact, 18 G CRS powder coated satin finish enclosure.

15) All parts and components used in the Monitor shall be UL Listed or UL Recognized. This requirement cannot be waived.

FIRE FIGHTING

TECHNICAL SPECIFICATION

SECTION-I: FIRE PROTECTION SYSTEM

1. SCOPE

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows :

a. The Fire Suppression System shall comprise the Fire Hydrants System, the Sprinkler System (Wet type) and Hand Appliances.

b. Water from the one number RCC underground Fire Water Storage Tank (220000 Ltrs) shall be supplied for the uses listed below.

   i. Fire Hydrant System (Pressurised) for the internal landing valves and the hose reels at landings.

   ii. Sprinkler System (Wet Type)

c. The Hydrant System and the Sprinkler System, under normal conditions, shall be pressurized by means of the electric motor driven Jockey Pump.

d. The Hydrant/ Sprinkler System shall be provided with two pump sets, one of which will be diesel engine driven and the other electric motor driven.

e. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.

f. Terrace Pump

g. The electric motor driven Hydrant/ Sprinkler Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason or electric failure the electric motor driven Hydrant/Sprinkler Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant/ Sprinkler Pump starts at the preset pressure.

h. The Hydrant/ Sprinkler Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.

i. The Sprinkler Pump shall be started automatically at a preset pressure but shall be stopped only manually.

j. Contractor shall ensure that all false ceiling voids greater than 800 mm are provided with sprinkler.

k. Tenderer shall ensure Hydro Testing of the complete system.

l. The Tenderer shall obtain the necessary approval of the drawings and the schemes from the local authority / TAC as per the requirement. The tenderer shall also take care of any other requirement so that insurance cover can be obtained, if required at minimum premium at a later date.

m. The tenderer shall design and after approval of Services Consultant/ Engineer In Charge/ Engineer-In-Charge display a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's near each stair case landing

for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc shall be as directed by the Services Consultant/Engineer In Charge/Engineer-In-Charge.

2. PIPE WORK

2.1 GENERAL REQUIREMENTS

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipework. All pipework shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

2.1 PIPING

Pipes of following types are to be used:

Sprinkler and Hydrant system pipes shall be Mild Steel black pipes as per IS: 1239 heavy grade (for pipes of sizes 150 mm N.B. and below) and IS: 3589 heavy grade (for pipe sizes above 150 mm NB). M.S. pipes buried below ground shall be primered by anticorrosive pyp kote primer and suitably wrapped with bitumin base 4 mm pyp kote wrapping ang coating.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanised before use at site. Welding of galvanised clamps and supports shall not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be throughly galvanised after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, which ever is highest including testing for water hammer effects.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines of strategic points to facilitate erection and subsequent maintenance work.

For pipes under ground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand: 8 stone aggregate) of size 380x380x75 thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shall be laid at least 2.0 metre away from the building.

2.2 PIPING INSTALLATION & SUPPORT

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-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

Pipe Dia (mm)	Hanger Rod Dia (mm)	Spacing between Supports (m)
Up to 25	6	2
32 to 50	10	2.7
80 to 100	12	2.7
125 to 150	16	3.6
200 to 300	19	5.3

The end of the steel rods shall be threaded and not welded to the threaded bolt.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes 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 reduces shall be used for the piping to drain freely. In other locations, concentric reduces may be used.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

2.3 PIPE FITTINGS

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc and all such connecting devices that are needed to complete the piping work in its totality.

Fabricated fittings shall not be permitted for pipes diameters 50mm and below.

When fabricated fittings are used, they shall be fabricated, welded in workshops. They shall be inspected by Engineer-In-Charge before dispatch from the workshop. The welding procedures of the workshop should have been approved by the rules for sprinkler system and applicable to hydrant and sprinkler system. For “T” connection, pipes shall be drilled and reamed. Cutting by gas or electrical welding shall not be permitted.

2.4 JOINTING

A. WELDED JOINTS :

Joints between MS pipes and fittings shall be made with the pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner. But welding without “V” groove shall not be permitted.

All joints in the pipe line with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

B. FLANGED JOINTS (65 MM DIA AND ABOVE)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

a. Straight runs at intervals not exceeding 25-30m on pipe lines of 50 mm dia and above and as directed by the Engineer-In-Charge.

b.For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings.

c.Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

C. UNIONS (UPTO 50 MM DIA)

Approved type of dismountable unions shall be provided on pipe lines of 40 mm dia and smaller dia, in locations similar to those specified for flanges.

3. AIR CUSHION TANK

Every wet riser shall be provided with an air cushion tank at its top most point. The air cushion shall be provided with an automatic air release cock, 20 mm dia drain pipe, drain valve and shut off valve.

4. SYSTEM DRAINAGE

The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

5. VALVE CHAMBERS

Provision of suitable brick masonary chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

6. VALVES

8.1 SLUICE VALVES

Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for.

The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS: 780-1969 and IS: 2906.

8.2 BUTTERFLY VALVE

The butterfly valve shall be suitable for waterworks and rated for 300 P.S.I

The body shall be of cast iron to IS: 210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.

The valve seat shall be of high grade elastomer or nitrile rubber. The valve is closed position shall have complete contact between the seat and the disc throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

8.3 BALL VALVE

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

8.4 GUN METAL VALVES

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. The Valves shall bear certification as per IS: 778

The body and bonnet shall be of gun metal to IS: 318. The stem gland and gland nut shall be of forged brass to IS: 6912. The hand wheel shall be of cast iron to IS: 210.

The Hand wheel shall be of high quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non rising type.

8.5 NON-RETURN VALVE

Non-Return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

8.6 PRESSURE RELIEF VALVE

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.

7. PRESSURE SWITCH

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be die cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP: 55 water and environment protection.

8. PRESSURE GAUGE

Pressure gauge shall be provided near all individual connections of the hydrant system with isolation valves and near each flow switch assembly of the sprinkler system. Pressure gauge shall be 50 mm dia

gunmetal bourdon type with gunmental isolation ball valve, tapping and connecting pipe and nipple. The gauge shall be installed at appropriate height for easy readability.

9. PAINTING

All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

Painting shall be expertly applied; the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

10. EXCAVATION

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be burried with a minimum cover of 1 meter or as shown on drawings.

Wherever required Contractor shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

On completion of testing in the presence of the Engineer-In-Charge and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

Contractor shall dispose off all surplus earth as directed by the Engineer-In-Charge.

11. ANCHOR / THRUST BLOCK

Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure

Thrust blocks shall be provided at all bends, tees and such other location as determined by the Engineer-In-Charge.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Engineer-In-Charge prior to execution of work.

12. FIRE HYDRANTS

15.1 INTERNAL HYDRANTS

a. Contractor shall provide on each landing and other locations as shown on the drawings double headed gunmetal landing valve with 100 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Contractor shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long ruberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine would with GI wire (hose to IS:636 type 2 and couplings to IS:903 with IS certification), fire hose reel, gunmetal branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

d. Contractor shall provide standard fire hose reels of 20mm dia high pressure dunlop rubber hose 36.5 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS:884 and shall be mounted vertically . This shall be measured and paid for separately.

e. Each internal hydrant hose cabinet shall be provided with a drain in the bottom plate. The drain point shall be lead away to the nearest general drain.

f. Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.

g. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

15.2 HOSE REEL

Hose reel shall conform to IS : 884, heavy duty, 20 mm dia length shall be 36 metre long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

15.3 FIRE HOSE

All hose pipes shall be of 63 mm diameter RRL/ CP as required, conforming to IS : 636 or IS : 8423. The hose shall be provided with copper alloy delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

15.4 BRANCH PIPE, NOZZLE

Branch pipes shall be of gun metal with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

15.5 HOSE CABINET

Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16 gauge MS powder coated sheet of fully welded constrcution with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with "FIRE HOSE" written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

15.6 INTERNAL HOSE CABINET

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16 gauge thick MS sheet and spray painted to shade No. 536 of IS: 5. The hose cabinet shall be of size to accommodate the following:

a. Landing Valves (Single/double headed)

b. Hose pipe

c. Hose reel (36.5 mtr.)

d. Branch pipes, nozzles (2 sets)

e. Fire man's axe and hand appliances

13. SPRINKLER SYSTEM

15.1 GENERAL SPECIFICATION

The scope of work shall include supply, commissioning, testing of the system as a whole. The sprinkler heads are to be fixed into heavy quality black steel pipes, conforming to IS 1239 or any other approved specification. The size of pipe will vary from 20 mm to 150mm to suit the hydraulics of the system. The System shall conform to CFO Rules for the installation of sprinkler systems in general for 'Ordinary Hazard' category-in respect of design, density and spacing of sprinkler heads.

Reduction in pipe sizes shall not be made by use of bushings. All piping shall be done by means of welding, screwed & flanged jointing as per codes.

Due care shall be taken that sprinklers are not applied with paint at the time of applying paint to piping and fittings.

All control, drain, test and alarm valves shall be provided with signs to identify their purposes, functions, direction of flow the satisfaction of the Consultants.

15.2 QUARTZOID BULB AUTOMATIC SPRINKLER

Sprinkler heads shall be made of brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector & the colour of the liquid filled in the bulb shall be according to the temperature rating as per HFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority. The inlet shall be screwed.

The sprinklers shall have 15mm nominal size of the orifice for ordinary hazard.

The orifice size shall be marked on the body or the deflector of the sprinkler.

Metal guards for protection of sprinkler against accidental or mechanical damage shall be provided as desired by the Engineer-In-Charge.

Contractor shall submit detailed submittal and discharge spray pattern for the Sprinkler for the approval of consultant.

15.2.1 OPERATING TEMPERATURE

The Operating temperature at which the quartzoid bulb of the sprinkler head shall actuate, shall be 68 degree C or as specifically mentioned.

15.2.2 SPRINKLER INSTALLATION

Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the TAC regulations and the NFPA 13-1994 Rules.

Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost. The Fire Protection Services Trade shall co-ordinate with the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general, all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% more sprinklers and pipework than required in TAC and NFPA Rules shall be included in this sub-contract. Chrome plated wire mesh guards shall be used to protect the sprinkler heads which are liable to accidental or mechanical (at no extra cost) damage.

15.3 FLOW REQUIREMENTS

The flow requirement for sprinkler heads shall be specifically approved for the designated area of installation.

15.4 ORIFICE PLATES

For restricting pressure at lower levels in the sprinkler system, orifice plates of appropriate sizes shall be fitted at different floor levels, at the branching points from Riser Main.

The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50mm dia. These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3mm for pipe size upto 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia. Such orifice plate must have a projecting identification tag.

The orifice plate shall fitted not less than two pipe internal diameters down stream of the outlet from any elbow or brand.

Contractor shall submit the design and identify location on drawing before installation.

15.5 INSTALLATION CONTROL VALVES

Each installation shall be provided with a set of installation control valves comprising:-

a. An Alarm Valve.

b. A Water Motor Alarm & Gong.

c. Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

d. Contractor shall submit detailed shop drawings showing the exact location, details of installation of the valves/alarm in all respects.

e. Installation valve shall comprise of a cast iron body with gunmetal trim, and double seated clapper check valves, pressure gauges, test valve and orifice assembly and drain valve with pressure gauges, turbine water gong including all accessories necessary and required and as

supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

15.6 INSPECTION AND TEST VALVE ASSEMBLY

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing.

15.7 FLOW SWITCH

Flow switch shall have a paddle made of flexible and strudy material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The flow switch shall have connections for wiring the seat shall be of S.S to the Annunciation Panel. The flow switch shall have IP: 55 protections.

The flow switches work at a triggering threshold bandwidth (flow rate) of 4 to 10 GPM. Further, it shall have a ‘Retard’ to compensate for line leakage or intermittend flows.

15.8 THE MAIN STOP VALVE

These shall be of cast iron body of requisite size. When closed, these will shut off supply of water to the installation.

A location plate must be fixed on the outside or an external wall, as near to the main stop valve as possible, bearing the following words on raised letters or other approved type letter.

A. Sprinkler Stop Valve Inside : The word `sprinkler stop valve' shall be in letters of at least 35mm and the word "INSIDE" at least25mm in height. The words shall be painted white on black ground.

B. All stop valves shall be right handed i.e. they shall be so constructed that in order to shut the valve the spindle shall turn from left to right. There shall be an indicator which will show whether the valve is open or shut.

15.9 PIPES FOR DRAINAGE:

Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.

In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.

-20 mm valves for pipes upto 50mm dia.
-25 mm valves for 80mm dia pipe.
-50 mm valves for pipes larger than 80mm dia.

15.10 SYSTEM DESIGN

The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed between 2.5 bars and 3.5 bars.

14. HAND HELD FIRE EXTINGUISHERS

16.1 HAND APPLIANCES

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consist of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

16.2 GENERAL REQUIREMENTS

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS:2190.

16.3 MEASUREMENT

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

16.4 ABC TYPE DRY POWDER EXTINGUISHER

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 4308, Part II, shall be 5 Kg +/-2% or 10 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS 2190 - 1992

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm^2

Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body, shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzle shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 5 Kg capacity and 12 mm for 10 Kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 30 Kg/cm^2 for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

16.5 WATER TYPE EXTINGUISHER (GAS PRESSURE TYPE)

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 9 ltr +/- 5%

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze, and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handle fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 600 mm long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS, and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 25 Kg/cm2. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS 940).

16.6 CARBON DIOXIDE EXTINGUISHER

The Carbon Dioxide Extinguisher shall be as per IS: 2878

The body shall be constructed of seamless tube conforming to IS:7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanisim shall be through a control valve conforming to IS:3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high quality unbreakable plastic with gradually expanding shape, to

convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The gas shall be conforming to IS:307 and shall be stored at about 85 Kg/cm2. The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:
Cylinder: 236 Kg/cm2
Control Valve: 125 Kg/cm2

Burst Pressure of Hose: 140 Kg/cm2 minimum

It shall be an Upright type. The cylinder, including the control valve and high pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

The Extinguisher including components shall be IS marked.

SECTION-II : ELECTRICAL INSTALLATION

1 SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

2 GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply system.

3 CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be 3b construction. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant BIS Codes.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size

and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4 WIRING SYSTEM

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium conductor armoured cables, Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit.

5 CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the "ON" position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in 'ON' position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6 INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar `ON' lamps shall be provided on all outgoing feeders.

7 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic aluminium complying with requirement of grade E91E of IS:5082-1981 and shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm^2 cross section area.

8 TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant IS Codes.

9 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the control panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

10 MOULDED CASE CIRCUIT BREAKER (MCCB)

All MCCB's shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's rated 200 Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru' energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB's shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant IS and IEC Codes.

The MCCB's shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

11 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

12 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

13 LABELS

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

14 METERS

a. All voltmeters and indicating lamps shall be through MCB's.

b. Meters and indicating instruments shall be plug type.

c. All CT's connection for meters shall be through Test Terminal Block (TTB).

d. CT ratio and burdens shall be as specified on the Single line diagram.

15 CURRENT TRANSFORMERS

Current transformers shall be provided for Control panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

16 SELECTOR SWITCH

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

17 STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic.

18 CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class "E".
Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

19 THERMAL OVERLOAD RELAY

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

20 TIME DELAY RELAYS

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

21 INDICATING LAMP AND METERING

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 MCB. Other indicating lamps shall be backed up with fuses as called for in Schedule of Quantities.

22 TOGGLE SWITCH

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

23 PUSH BUTTON STATIONS

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

24 CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16 gauge upto 32 mm dia and 14 gauge above 32 mm dia conduit. Screwed G.I.conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or GI Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	Maximum number of wires within conduit size(mm)				
	20	25	32	40	50
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

25 CABLES

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

26 CABLE LAYING

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity.

Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

27 WIRE AND WIRE SIZES

1100 volts grade PVC insulted copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:

I.	Upto 5 HP motors/ 5 KW heaters	3 x 4 sq. mm copper conductor wires.
II.	From 6 HP to 10 HP motors	3 x 6 sq. mm copper conductor wires
III.	KW to 7.5 KW heaters	
IV.	From 12.5 HP to 15 HP wires	2 Nos. 3 x 6 sq. mm copper conductor wires
V.	From 20 HP to 25 HP motors	2 Nos. 3 x 10 sq. mm copper conductor wires
VI.	From 30 HP to 35 HP motors	2 nos.3x 16 sq.mm aluminium conductor armoured cable.
VII.	From 40 HP to 50 HP motors	2 Nos. 3x25 sq.mm aluminium conductor armoured cable.
VIII.	From 60 HP to 75 HP motors	1 No. 3 x 70 sq. mm aluminium conductor armoured cable.
IX.	100 HP motors	1 No. 3 x 150 sq. mm. aluminium conductor armoured cable
X.	200 HP motor	2 No. 3 x 150 sq. mm.aluminium conductor armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

CAPACITY	TYPE OF STARTER	CONTACTOR CURRENT	OVERLOAD RANGE	RELAY
5 HP Motors	D O L	16 amps	6-10 amps	
7.5 HP motors	D O L	16 amps	9-15 amps	
10 HP Motors	D O L	25 amps	9-15 amps	
12.5 HP Motors	Star Delta	16 amps	9-15 amps	
15 HP Motors	Star Delta	25 amps	9-15 amps	
20 HP Motors	Star Delta	32 amps	14-23 amps	
25 HP Motors	Star Delta	32 amps	14-23 amps	
200HP Motors	DOL	325 amps	CT Operated relay	

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

28 EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires .The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper

conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

I.	Motor upto and including 10 HP rating.	2 Nos. 3 mm dia copper wires.
II.	Motor 12.5 HP to 40 HP capacity	2 Nos. 4 mm dia copper wires
III.	Motor 50 to 75 HP capacity.	2 Nos. 6 mm dia copper wires
IV.	Motor above 75 HP.	2 Nos. 25 mm x 3 mm copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires' tapes as follows:

I.	3 phase switches and control panels upto 60 amps rating.	2 nos. 3 mm dia copper wires.
II.	3 phase switches, and control panels 63 amps to 100 amps rating.	2 Nos. 4 mm dia copper wires.
III.	3 phase switches and control panels 125 amps to 200 amps rating.	2 Nos. 6 mm dia copper wires.
IV.	3 phase switches, control panels, bus ducts, above 200 amps rating.	2 Nos. 3 mm x 25 mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be rivetted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

29 DRAWINGS

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

30 TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Engineer-In-Charge. Testing of the panels shall be as per relevant BIS Codes :

31 PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

32 MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lumpsum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities.

33 RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

SECTION-III :: COMMISSIONING & GUARANTEE

1 SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before preforming any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rotameters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Engineer-In-Charge.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2 PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipework and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

    i. Remove oil, grease and foreign residue from the pipework and fittings;
    ii. Pre-condition the metal surfaces to resist reaction with water or air.
    iii. Establish an initial protective film;

d. After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.

e. Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

f. Check all clamps, supports and hangers provided for the pipes.

g. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydrotest of the system as for (b) above.

h. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

3 STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

4 FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5 REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.
After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

6 WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Engineer In Charge.

7 HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Engineer In Charge’s site representative and all testing and commissioning documents shall be handed over to the Engineer In Charge’s site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Engineer In Charge’s site representative.

8 PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground / Base Colour	First Colour Band	Second Colour Band
1	Cooling Water	Sea Green	French Blue	
2	Condensate	Sea Green	Light Brown	

3	Drinking Water (All cold water lines after filter)	Sea Green	French Blue	Single Red
4	Treated Water (Soft Water)	Sea Green	Light Orange	
5	Domestic Hot Water	Sea Green	Light Grey	
6	Compressed air upto 15/Kg/Sqcm	Sky Blue		
7	Drainage	Black		
8	Oils Diesel (indicated by letter HSD / as applicable)	Light Brown		
9	Medical Gases : Air	Sky Blue	White	
	Oxygen	Canary Yellow	Black	
	Nitrous Oxide	Canary Yellow	White	
	Vaccum	Sky Blue	French Blue	
			Black	

Colour Code to Conform to IS:2379:1990

SOLAR POWER GENERATING SYSTEM

I DEFINITION

The Solar Power Generating System consists of mainly three components viz. the solar photovoltaic (SPV) array, module mounting structure and the power conditioning unit (PCU)/ inverter. The SPV array converts the solar energy into DC electrical energy. The module mounting structure holds the modules in required position and the DC electrical energy is converted to AC power by the PCU, which is connected to the power grid. The AC power output of the inverter is fed to the AC distribution boardthrough metering panel and isolation panel. The 415 V AC output-3Ø of the system can be utilized or as an option it could be stepped up to the required voltage level and after synchronizing with the grid, can be exported to the grid.

II Codes & Standards

The quality of equipment supplied shall be controlled to meet theguidelines for engineering design included in the standards and codes listed in the relevant ISI and other standards, such as :

a) IEEE 928: Recommended Criteria for terrestrial PV power systems.

b) IEEE 929 Recommended practice for utility interface of residential and intermediate PV systems.

c) IEEE 519 Guide for harmonic control and reactive compensation of Static Power Controllers.

d) National Electrical NFPA 70-1990 (USA) or equipment national standard.

e) National Electrical Safety Code ANSI C2 (USA) or equipment national standard.

III PV MODULE (S)

(i) The PV module bidder should have IEC 61215-2nd Edition and IEC 61730-2 qualification certification for PV modules.

(ii) The PV module(s) shall contain crystalline silicon solar cells.

(iii) The power output of the module (s) should match minimum of rating required as per BOQ Modules of minimum 125 W output each or above output should be used. Photo / electrical conversion efficiency of SPV module shall be greater than 13.5%.

(iv) All materials used shall have a proven history of reliable and stable operation in external applications.

It shall perform satisfactorily in relative humidity up to 100% with temperatures between -10 Deg C and +85 Deg C and with stand gust up to 200km/h from back side of the panel.

(v) A strip containing the following details should be laminated inside the module so as to be clearly visible from the front side.
a. Name of the Supplier or distinctive Logo
b. Model or Type No.
c. Serial No.
d. Year of make.

IV EARTHING AND SURGE PROTECTIONS

(i) The array structure of the PV modules shall be grounded properly using adequate numbers of earthing pits. All metal casing/ shielding of the plant shall be thoroughly grounded to ensure safety of the power plant.

(ii) The SPV power plant shall be provided with lightning & over voltage protection. The source of over voltage can be lightning, atmosphere disturbance etc.

V MECHANICAL COMPONENTS

(i) Metallic frame structure of hot dip galvanized steel with stands to be fixed on the roof of the building to hold the SPV module (s) one feet above roof level. The frame structure should have provision to adjust its angle of inclination to the horizontal between 0 and 45, so that it can be installed at the specified tilt angle i.e. inclined at 25 degree to horizontal facing due south. All hardware, nuts, bolts should be stainless steel.

VI POWER CONDITIONING UNIT:

The power conditioner unit shall convert DC produced by SPV array and adjust the voltage & frequency levels to suit the Grid.

Type &technology -IGBT based.Utilize a circuit topology and components suitable for meetingthe specifications.

PCU Rating (Nominal) – KVA- As mentioned in BOQ

Output voltageon AC side - 415 +10%, - 15% V AC

Output Frequency 50 + 1.5Hz, - 3.5 Hz

A dedicated isolation transformer housed in the PCU enclosure shall be supplied.

DC system - The electrical safety of the array installation is of the utmostimportance. Array electrical configuration shall be in such a waythat, the MPPT shall operate with maximum efficiency, betweenthe low and high temperature of the site.

Maximal Current ripple 5% PP

Power Factor 0.95 inductive to 0.95 capacitive

Ambient room temperature 5 to 55 deg C

Housing Cabinet

a) PCU shall be housed in suitable switch cabinet, with minIP 55 degree of IngressProtection, powder coated.
c) Components and circuit boards mounted inside theenclosures clearly identified with appropriate permanentdesignations, which shall also serve to identify the items on thesupplied drawings.
d) All doors, covers, panels and cable exists shall be gasketedor otherwise designed to limit the entry of dust and moisture. Alldoors shall be equipped with locks.

Other important features

Electrical safety Protections

A – General:

The PCU shall include appropriate self protective and selfdiagnostic feature to protect itself and the PV array from damage inthe event of PCU component failure or from parameters beyondthe PCU's safe operating range due to internal or external causes.

The self-protective features shall not allow signals from the PCUfront panel to cause the PCU to be operated in a manner whichmay be unsafe or damaging. Faults due to malfunctioning withinthe PCU, including commutation failure, shall be cleared by thePCU protective devices and not by the existing circuit breaker in ACDB.

B - Over-under voltage and frequency protection.

C - Over voltage protection against atmospheric lightning

D - Protection against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.

MOV type surge arrestors on AC and DC terminals for over voltage protection from

lightning-inducedsurges shall be used.

E - Full protection against accidental open circuit and reverse polarityat the input.

F - Inbuilt protection for internal faults including excess temperature,commutation failure, overload and cooling fan failure.

G - Galvanic isolation is provided to avoid any DC component being injected into the grid and the potential for AC componentsappearing at the array.

H - Earth Fault Supervision

Disconnection &Islanding

A - Automatic disconnection shall take place on:
Neutral voltage displacement
Over current
Earth fault &
Reverse power

In each of the above cases, tripping time shall be less than 0.5 seconds.

B - Automatic reconnection after the faults / failure is resorted.

DC-AC conversion efficiency - 93% for output ranging from 20% to full load

Maximum power point tracker is integrated in the power conditioner unit to maximize energy drawn from the array. The MPPT shall be micro processor based to minimize power losses. The MPPT shall have provision (manual setting) for constant
voltage operation.

Idling current at no load shall not exceed 2% of the full loadcurrent.

DC isolation Provided at the output by means of a suitable isolatingtransformer

Unbalanced output load PCU is able to withstand an unbalanced output load to the extentof 30%.

PCU generatedharmonicsShall not exceed a total harmonic current distortion of 5%, asingle frequency current distortion of 3%, and single frequencycurrent distortion of 1%, when the first through the fiftieth integerharmonics of 50Hz are considered.

Internal wiring shall be done with Standard PVC, FR Copper wire. All Terminations shall be Tagged and thru Thimble. PVC Channel shall be used to house the wire.High voltage &power circuits should be separated from low voltage& control circuits.

PCU shall not produce EMI which cause malfunctioning ofelectronic & electricalinstruments including communicationequipments which are located within the facility in which the PCUis housed.

Display on front panel &indicators
a) Instantaneous PCU ac power output and the DC voltage current and power input
b) Accuracy of display : 3% of full scale factor or better
c) Display visible from outside the PCU enclosure.

d) Operational status of the PCU, alarms, trouble indicators andAC and DC disconnect switch positions shall also becommunicated by indicator lights on thefront cover of the PCU enclosure.

Emergency OFF - Emergency OFF button to be located at an appropriate position on theunit

Grounding PCU includes ground lugs for equipment and PV arraygroundings. The DC circuit ground is a solid single point ground connection.

Metering :

a) PV array energy production: Meter to log the actual amount of AC energy generated / consumed by the PV system shall have to be provided.

b) Solar irradiance : An integrating pyranometer (Class II or better) to be provided, with the sensor mounted in the plane of the array. Readout shall be integrated with data logging,

Data Logging System :

a) All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital front panel at any time the current values, previous values for up to a month and the average values.

The following parameters shall be accessible via the operating interface display :
AC voltage
AC output current
Output power
DC input voltage
DC input current
Time active
Time disabled
Time Idle
temperatures (C)
Converter status
Protective function limits (VIZ-AC over voltage, AC under voltage, Over frequency, under frequency, ground fault, PV starting voltage, PV stopping voltage, over voltage delay, under voltage delay over frequency, ground fault delay, PV starting delay, PV stopping delay.

Testing:

a) Tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.
b) Operation of all controls, protective and instrumentation circuits demonstrated by direct test if feasible or by simulation operation conditions for all parameters that can not be directly tested.
c) Demonstration of utility service interface protection circuits and functions, including calibration and functional trip tests of fault sand isolation protection equipment.
d) Operation of start up , disconnect and shutdown controls also to be tested and demonstrated, stable operation of the PCU and response to control signals shall also be tested and demonstrated.
e) Factory testing include measurement of phase currents, efficiencies, harmonic content and power factor. All tests shall be performed 25, 50, 75 and 100% of the rated nominal power.
f) Factory test report (FTR) : Should be supplied with the unit after all tests. The FTR shall include detailed description of all parameters tested qualified and warranted.

VII CABLES & ACCESSORIES

All the cables which shall be supplied shall be conforming to IS 1554 / 694 Part 1 of 1988 & shall be of 650V/ 1.1 kV grade as per requirement. Only PVC copper cables shall be used. The size of the cables between array interconnections, array to junction boxes, junction boxes to PCU etc shall be so selected to keep the voltage drop and losses to the minimum.

VIII CONTROL ROOM :

The required control room shall be constructed at additional cost if required.

IX SPARE PARTS :

One set of essential spares for the PCU shall be provided and made available at the plant.

X DOCUMENTATION :

A - BILL OF MATERIAL

The bidder should provide the following documents for approval by the consultant of the project:

(i) Bill of materials of each set
(ii) Technical Details of the components and system
(iii) Schematic Drawing

B–INSTALLATION MANUAL

Two sets of installation manual / user manual shall be supplied along with the each power plant. The manual shall include complete system details such as array lay out, schematic of the system, inverter details, working principle etc. Step by step maintenance and trouble shooting procedures shall be given in
the manuals.

The following minimum details must be provided in the Manual

(a) About Photovoltaics
(b) About solar PV system – its components and expected performance.
(c) About PV module
(d) Clear instructions about mounting of PV module (s)
(e) About electronics
(f) DO's and DONT's
(g) Clear instructions on regular maintenance and trouble shooting of solar power plant.
(h) Name and address of the person or service center to be contacted in case of failure or complaint.

C – GUARRANTY

The PV module (s) will be warranted for a minimum period of 10 years from the date of Commissioning and the solar PV power plant will be warranted for a period of Five years from the date of Commissioning.

During the warranty period State Agencies/users reserves the right to cross check the

performance of the systems with the minimum performance levels specified in the specifications.

Warranty Certificate shall be submitted which shall also contain following details:

1. Name & Address of The Bidder/Bidder of the System
2. Name & Address of Purchasing Agency
3. Date of supply of the system
4. Details of PV Module (s) supplied in the System
   - Make (Name of the Bidder)
   - Model
   - Serial No(s)
   - Wattage of the PV Module (s) under STC
   - Warranty valid up to

5 Details of Battery:
   - System Make (Name of the Bidder)
   - Model
   - Batch/Serial No(s)
   - Rated V & AH capacity at C/20 or C/10 rate at 20 C
   - Warranty valid up to

6. Details of Electronics & other BOS items.
   - System Make (Name of the Bidder)
   - Model
   - Serial No(s)
   - Warranty valid up to
   - Designation & Address of the person to be contacted for claiming Warranty obligations.

LIST OF APPROVED MAKES/BRANDS/AGENCIES

THE OWNER/CONSULTANT RESERVES THE RIGHT TO SELECT ANY OF THE BRANDS INDICATED IN THE LIST OF APPROVED MAKES WITHOUT ANY EXTRA CLAIM FROM THE CONTRACTOR. FOLLOWING MAKES/ BRANDS ARE ALSO APPROVED IN ADDITION TO THOSE MENTIONED IN THE ITEM OF WORKS AS DESCRIBED IN BOQ & SPECIFICATIONS.

CIVIL WORKS

SL. No.	ITEM	MAKE
1	**GREY CEMENT(43 GRADE)**	**ACC, GUJARAT AMBUJA, J.K, BIRLA; ULTRA TECH, OCL,(KONARK)**
2	**WHITE CEMENT**	**JK, BIRLA WHITE,SIKA**
3	**WALL PUTTY**	**BIRLA, J.K, SIKA**
4	**REINFORCEMENT/STRUCTURAL STEEL**	**SAIL, TATA STEEL.**
5	**CLAY BRICK** **FLYASH BRICK**	**REPUTED BRAND, APPROVED BY PROJECT ENGINEER.** **APPROVED BY PROJECT ENGINEER.**
6	**ANTI-TERMITE TREATMENT**	**PEST CONTROL INDIA LTD, PEST CON INDIA, PEST CONTROL INCORPORATED.**
7	**CONCRETE ADDITIVE**	**KRYTON, CICO, FAIRMATE, PIDILITE,SIKA**
8	**FLUSH DOOR/ SHUTTERS**	**GREEN PLY, DURO, CENTURY, GODREJ, MAYUR.**
9	**PLYWOOD / BLOCK BOARD / SOFT BOARD**	**DURO, GREEN, CENTURY, MAYUR.**
10	**PRELAMINATED PARTICLE BOARD**	**NOVAPAN, ANCHOR, GREEN LAM, MAYUR.**
11	**LAMINATES**	**CENTURY, GREEN LAM, DURO, EURO, MAYUR.**
12	**ADHESIVE FOR WOOD WORK**	**DUNLOP, FEVICOL, VAMICOL, PIDILITE.**
13	**POLYURETHANE SEALANT**	**KRYTON, PIDLITE, FAIRMATE,**
14	**POLYETHELENE BOARD/ BACK UP ROD**	**DUTRON SUPREME INDUSTRIES OR EQUIVALENT.**
15	**ALUMINIUM SECTIONS**	**JINDAL, HINDALCO, INDAL,**
16	**STAINLESS STEEL**	**OZONE, DORMA.**
17	**EXPANSION/ FASTNERS**	**FISHER, HILTI, ANCHOR**
18	**FLOAT GLASS/**	**SAINT GOBAIN, AIS GLASS,GOLDEN FISH**

	TOUGHENED GLASS	
19	**CERAMIC TILES**	**RAK, KAZARIA, ASIAN,JOHNSON,NITCO**
20	**VITRIFIED PORCELINE TILES**	**RAK, KAZARIA, JOHNSON, ASIAN.**
21	**INTERLOCK TILES/GRASS PAVER BLOCKS**	**NIMCO PREFAB, UNISTONE, MODERN, DURASTONE, ULTRA, SPECTRA.**
22	**TERRAZZO TILES**	**NITCO, MODERN, HINDUSTAN,DURACON**
23	**CEMENT CONCRETE TILES**	**ULTRA, EUROCON, NITCO, DURACRETE.**
24	**SYNTHETIC ENAMEL PAINTS**	**BERGER (LUXOL GOLD), ASIAN (APCOLITE), ICI DULUX (GLOSS)**
25	**OIL BOUND DISTEMPER**	**ASIAN (TRACTOR), BERGER (BISON), NEROLAC.**
26	**CEMENT PAINT**	**SNOWCEM PLUS, BERGER (DUROCEM EXTRA), ULTRATECH**
27	**PLASTIC EMULSION PAINT**	**ICI, ASIAN, MAS PAINT (ULTRATECH), NEROLAC.**
28	**OTHER PAINTS/PRIMERS**	**ICI DULUX, ASIAN, BERGER, NEROLAC, ULTRATECH**
29	**PAINT**	**BERGER, ASIAN PAINTS, ICI, ULTRATECH, NEROLAC.**
30	**SURFACE TEXTURED PAINT (EXTERIOR)**	**ULTRATECH, SPECTRUM,ASIAN**
30A	**EXTERIOR PAINT**	**ULTRATECH, SPECTRUM**
31	**DOOR/ WINDOWS /PATCH FITTINGS**	**EBCO, GODREJ, HETTICH, DORMA, OZONE, HECHETTE**
32	**ANTI BACTERIAL/ANTI FUNGAL PAINT**	**MAS PAINT (ULTRATECH) OR EQUIVALENT**
33	**LOCKS**	**EBCO, EVERITE, GODREJ, HARRISON.**
34	**WARDROBE/ CUBBOARDS**	**EBCO, GODREJ, HECHETTE**
35	**NON METALLIC HARDENER COMPOUND**	**CICO, RECRON, FAIRMATE,SIKA**
36	**POLYSULPHIDE SEALANT**	**PIDLITE, FORROC.**
37	**PAVEMENT TILES**	**PAVIT, ASIAN, RAK,KAJARIA.**
38	**VINYL FLOORING**	**TARQUET, ARMSTRONG.**
39	**MS PIPE**	**JINDAL, HISAR, PRAKASH- SURYA.**
40	**LAMINATION**	**GREENLAM/DURO/CENTURY**
41	**HINGES**	**SUZU/GARG/HETICH**
42	**DOOR CLOSER**	**DORMA, INDOBRASS**
43	**WALL PANELLING**	**ARMSTONG**
44	**FALSE CEILING**	**ARMSTONG**
45	**WOODEN FLOORING**	**ARMSTONG**
46	**GLASS MOSAIC TILES**	**CORAL GLASS MOSAIC, BISAZZA**
47	**CARPET**	**INTER FACE FLOOR, ACE**
48	**ROOF SHEETING**	**DANPALON**

49	**CHAIRS AUDITORIUM**	**KRISHNA QUINETTE SEATS PVT. LTD.**
50	**SCREENS**	**HEAVY QUALITY**
51	**SYNTHETIC TRIANGULAR FIBRE**	**RECRON, RELIANCE**
52	**FRAMELESS TOUGHENED GLASS DOORS/WINDOWS/VENTILATORS**	**ASI, SAINT-GOBAN, MODI.**

EXTERNAL & INTERNAL SERVICES

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
	ELECTRICAL WORKS	
1.	**MS BLACK ENAMELLED/ GALVANIZED ERW CONDUITS & ACCESSORIES**	**BEC / AKG/ NIC**
2.	**PVC CONDUIT (FRLS HEAVY DUTY)**	**AKG/BEC/PRECISION**
3.	**GI/MS PIPES**	**JINDAL / PARKASH SURYA/TATA**
4.	**COPPER CONDUCTOR PVC INSULATED WIRES**	**FINOLEX/ PAGODA/ LAPP**
5.	**MODULAR SWITCHES, SOCKET OUTLETS AND WIRING ACCESSORIES WITH MOULDED COVER PLATE (COLOUR APPROVAL SHALL BE DONE BY PROJECT MANAGER/ARCHITECT)**	**MDS -LEGRAND (MOSAIC SERIES)/ CRABTREE/MK/CLIPSAL/SIEMENS/ STEP SWITCHES**
6.	**A/C OUTLETS**	**MDS-LEGRAND/ CLIPSAL/CRABTREE**
7.	**DATA OUTLETS**	**LEVITON / SIEMON / CORNING**
8.	**LIGHT FIXTURES**	**PHILIPS/WIPRO/CROMPTON**
9.	**CEILING/EXHAUST FANS**	**CROMPTON GREAVES/HAVELLS/ USHA**
10.	**DISTRIBUTION BOARDS**	**SCHNEIDER / SIEMENS/ L&T /ABB/ADHUNIK**
11.	**POWER & CONTROL CABLES**	**CCI (MUMBAI) / PAGODA/ UNIVERSAL(SATNA)**
12.	**RISING MAINS /BUS DUCT (AIR INSULATED TYPE)**	**SCHNEIDER/ABB/ ADHUNIK/NEC**
13.	**SPLITTER BOX**	**SHYAM ANTENNA/ CAT VISION/ SWIFT AUDIO VIDEO**
14.	**CABLE TRAY**	**SCHNEIDER/ABB/ Advance Panels & Switch Gear Pvt. Ltd.**
15.	**HT XLPE 11/ 33 KV CABLE**	**UNIVERSAL(SATNA)/ POLY CAB/ HAVELLS/ KEI/Pagoda**
16.	**HT CABLE TERMINATION/ JOINTING KIT**	**RAYCHEM/3M**

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
17.	**TWO POLE STRUCTURE**	**AS APPROVE BY ENGINEER-IN-CHARGE/CONSULTANTS**
18.	**HT PANEL BOARD**	**SCHNEIDER/ABB/Siemens - Advance Panels & Switch Gear Pvt. Ltd.**
19.	**BATTERY CHARGER**	**AE/ VOLTSTAT/WAVE ELECTRONICS**
20.	**FREE LEAD ACID BATTERY**	**EXIDE/ AMRON/ AMCO**
21.	**DISTRIBUTION TRANSFORMER**	**AREVA/SIEMENS/ POWER WARE**
22.	**MCB/ELCB/RCBO/DB**	**MDS/ HAGER / SIEMENS /MG/ ABB/ADHUNIK**
23.	**MCCB**	**L&T / SIEMENS / MERLIN GERIN(NSX)/ ABB/ADHUNIK**
24.	**ACB**	**L&T / SIEMENS / MERLIN GERIN (NW)/ABB/ADHUNIK**
25.	**MV CONTACTORS/TIMER/ STARTERS**	**L&T/ SIEMENS/ MG /ABB/ADHUNIK**
26.	**ALL METERS**	**CONZERV / MG /AE**
27.	**PROTECTIVE RELAYS**	**ALSTOM/ABB/ SIEMENS/ L&T / MG**
28.	**INDICATION LAMPS/PUSH BUTTON**	**L&T/SCHNEIDER/SIEMENS**
29.	**CAPACITOR**	**SIEMENS/ ABB/ L&T**
30.	**APFCR**	**L&T/DUCATI/ MG**
31.	**TERMINAL BLOCKS**	**BCH/INDUSTRIAL CONTROL/ L-MAK**
32.	**CHANGE OVER SWITCH**	**HPL/L&T/ SIEMENS**
33.	**SELECTOR SWITCH**	**L&T/ KAYCEE/ SIEMENS**
34.	**L.T. PANEL BOARDS/SUB-PANEL/ METER BOARDS**	**SCHNEIDER/ABB/SIEMENS/ ADHUNIK/NEC**
35.	**SUB-STATION SAFETY EQUIPMENT**	**ISI MARKED**
36.	**UPS**	**AAL/GUTOOR/GE**
	FIRE DETECTION & ALARMS	
1.	**FIRE ALARM PANEL**	**ESSAR/FIREFINDER/GENTS/SIMPLEX**
2.	**ADDRESSABLE DETECTORS**	**ESSAR/FIREFINDER/GENTS/ SIMPLEX**
3.	**MODULES/ MCP**	**ESSAR/FIREFINDER/GENTS/ SIMPLEX**
4.	**TRANSPONDER/MODULES**	**ESSAR/FIREFINDER/GENTS/ SIMPLEX**
5.	**RESPONSE INDICATOR**	**AS APPROVED BY CONSULTANT/CLIENT**
6.	**FIRE SURVIVAL CABLE**	**TYCO/PAGODA/JULIE**
	PAVA	
▪		**ATEIS**
▪		**BOSE**
▪		**ESSER**
	PLUMBING	
1.	**VITREAUS CHINA WARE**	**PARRYWARE, HINDWARE, SANITARY WARE, CERA**
2.	**PVC CONNECTORS**	**SUPRIME OR EQUIVALENT**

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
3.	**SEAT COVER (HEAVY DUTY)**	**COMMANDER, DIPLOMAT, BESTOLITE, PRINCE, HINDWARE, PARRYWARE CERA**
4.	**STAINLESS STEEL SINK**	**PRESTIGE, KINGSTON, NEELKANTH, JAYANA, NIRALI, AMC,PARRY,FRANKE**
5.	**AUTO URINAL FLUSH SYSTEM**	**AOS AUTO ROBO FLUSHING SYSTEM, TOSHI, UTEC SYSTEM**
5A.	**URINAL/WC FLUSHING SYSTEM**	**JAGUAR/MARC.**
6.	**CP BRASS SANITARY FITTINGS AND TOILET ACCESSORIES**	**JAQUAR,GEM, ESS-ESS,MARC,LEADER,ZALOTO AQUAPLUS,CHILLY,KINGSTON,PARKO/MAYUR/OTHELO**
7	**FLOOR DRAIN FIXTURE, RAIN WATER OUTLETS & CHANNEL GRATINGS**	**NEER-GMGR OR EQUIVALENT**
8	**C.P. GRATING FOR FLOOR TRAP**	**CHILLY COCKROACH TRAP,SEIKO,COBRA,NEELKANTH**
9	**CAST IRON PIPES & FITTINGS MANHOLE COVERS AND FRAMES**	
10	**AS PER IS:3989 (PIPES & FITTINGS)**	**NECO, HEPCO**
11	**AS PER IS:1726 (MANHOLE COVERS AND FRAMES)**	**NECO , BC, SKF,RAJ IRON FOUNDRY AGRA OR EQUIVALENT**
12	**AS PER IS:1536- C.I. (LA)PIPES**	**KESORAM CALCUTTA, ELECTRO STEEL CALCUTTA, IISCO, SUPRA**
13	**C.I. L.A FITTINGS**	**KARTAR, KESORAM, ELECTROSTEEL, NECO**
14	**PIPE CLAMPS**	**CHILLY OR EQUIVALENT,**
15	**GI PIPES (IS : 1239 AND IS : 3589)**	**TATA STEEL, JINDAL , PRAKASH-SURYA**
16	**GI PIPES FITTINGS(IS:1239)**	**UNIK, ZOLOTO,KS, R BRAND,UNCO**
17	**PVC PIPE**	**SUPREME, AJAY, FINOLEX, PRINCE**
18	**CPVC PIPES & FITTINGS**	**FINOLEX,ASTRAL,SUPREME,PRINCE**
19	**RCC PIPE(IS:458)**	**PRAGATI CONCRETE UDYOG,JAIN SPUN PIPE CO ,INDIAN HUME PIPE**
20	**STONEWARE PIPES, GULLY TRAPS(IS:651)**	**PERFECT,RK, BURN,S MARKED**
21	**DI PIPES(IS:8329)**	**ELECTRO STEEL,TATA,JINDAL**
22	**GM / FORGED BRASS VALVES**	**LEADER, ZOLOTO, RB IBP(ISI MARKED)**
23	**SLUICE VALVES / NON RETURN VALVES**	**KIRLOSKAR, INDIAN VALVE COMPANY, KALPANA,LEADER,CIM,VENUS**

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
24	**BUTTERFLY VALVE**	**CASTLE,AUDCO, KSB,KEYSTONE/KIRLOSKAR**
25	**WAFER TYPE CHECK VALVE**	**CASTLE, KIRLOSKAR,AUDCO**
26	**PRESSURE REDUCING VALVE**	**LEADER, ZOLOTO, RBM**
27	**AIR RELEASE VALVE**	**ZOLOTO, OR,RBM**
28	**Y STRAINER / POT STRAINER**	**EMERALD OR EQUIVALENT APPROVED MAKE**
29	**STORM WATER DRAINAGE SUMP PUMPS**	**DP, GRUNDFOS, KSB,CALPEDA**
30	**SEWAGE HANDLING PUMPS**	**DP, GRUNDFOS, KSB, CALPEDA**
31	**COUPLINGS**	**LOVEJOY**
32	**ANTI VIBRATION MOUNTING AND FLEXIBLE CONNECTIONS**	**KANWAL INDUSTRIAL CORPORATION, DUNLOP, RESISTOFLEX**
33	**PRESSURE SWITCH**	**DANFOSS / SYSTEM SENSOR / INDFOSS**
34	**PRESSURE GAUGE**	**H GURU, FIEBIG**
35	**LEVEL CONTROLLER (WATER)**	**TECHNIKA, MINILEC, PUMPTROL**
36	**LEVEL INDICATOR (WATER)**	**TECHNIKA, MINILEC**
37	**LEVEL INDICATOR (OIL)**	**FORBES MARSHALL OR EQUIVALENT APPROVED MAKE**
38	**MH/WATER TANK STEPS**	**KGM OR EQUIVALENT APPROVED MAKE**
39	**WATER TREATMENT PLANT**	**THERMAX, ION EXCHANGE**
40	**FILTER FOR WTP**	**AVENTURA/ PENTAIR/MMP**
41	**WATER TREATMENT PURIFIER**	**THERMAX, ION EXCHANGE, FONTUS**
42	**ULTRA VIOLET WATER PURIFIER**	**ALFA/CREATIVE/HI-TECH**
43	**DOSING PUMPS**	**LMI, TOSCHON PULSER FEEDER, SEKO**
44	**INSULATION FOR HOT WATER PIPES**	
45	**CLOSED CELL NITRILE INSULATION**	**ARKC, A-FLEX, OWEN'S CORNINGS**
46	**WATER HEATER (GEYSER)**	**VENUS, BAJAJ, RACOLD, KHAITAN OR USHA**
47	**FLANGES MS**	**CLASS 150 TABLE H**
48	**AIR BLOWER**	**KAY, EVEREST**
49	**SEWAGE TREATMENT PLANT**	**ION-EXCHANGE, THERMAX,**
50	**SCREW PUMP**	**ROTOPUMP, WATER SUPPLY SPECIALISTS**
51	**WELDING RODS**	**ADVANI, VICTOR OR EQUIVALENT ISI MAKE DRH**
52	**FASTENER**	**HILTI, FISHER**

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
53	**SOLAR HEATING SYSTEM**	**TATA/M3 SOLAR/ SUN TECNICS OR MNRE APPROVED**
54	**CABLE TRAY**	**SCHNEIDER/ABB/ ADHUNIK/NEC**
55	**PVC INSULATED COPPER WIRES**	**FENILAX/ PAGODA/LAPP**
56	**ELECTRICAL PANELS**	**SCHNEIDER/ABB/ ADHUNIK/NEC**
57	**POWER CABLES/ CONTROL CABLES**	**UNIVERSAL (SATNA)/CCI(MUMBAI)/ PAGODA**
58	**SOLAR ENERGY SYSYTEM**	**PHILLIPS/HBL/EMVEE SOLAR**
59	**OVERHEAD TANK**	**SINTEX**
60	**MIRROR**	**FLOAT GLASS(MODIGUARD/AGI)**
	LIGHTENING PROTECTION	
1.	**ESE TERMINALS**	**LPI – AUS., FOUDRETECH – FRANCE, E.F. – SWITZERLAND**
2.	**DOWN CONDUCTOR**	**LPI–AUS., FOUDRETECH – FRANCE, E.F. – SWITZERLAND**
3.	**GROUND RESISTANCE IMPROVING COMPOUND**	**LPI–AUS., FOUDRETECH – FRANCE, E.F. – SWITZERLAND**
4.	**SURGE COUNTER**	**LPI–AUS., FOUDRETECH – FRANCE, E.F. – SWITZERLAND**
	HVAC	
1.	**PRECISION AHU'S (PAHU) / DX UNITS (PEX)**	**EMERSON / LIEBERT / STULTZ**
2.	**AIR HANDLING UNITS: (WITH IMPORTED FAN)**	
3.	**I) AIR HANDLING UNITS / FAN COIL UNITS**	**MEI / KLIMAK/ DIVINE**
4.	**II) COOLING COIL**	**GREENHECK / PRECISION (USA)/ CRC (USA)**
5.	**III) PLENUM / PLUG FAN**	**GREENHECK / COOK / ACME**
6.	**IV) HEAT RECOVERY WHEEL**	**GREENHECK / AIR EXCHANGE USA /**
7.	**ENGINEERED OZONE SYSTEM**	**ROOKS/ TRIMED**
8.	**HOT WATER GENERATOR**	**EMERALD / RAPID COOL / SANT**
9.	**CASSETTE UNITS**	**YORK/TRANE/CAREER**
10.	**VENTILATION FANS:**	
11.	**I) MIXED FLOW**	**GREENHECK / COOK / ACME**
	II) PROPELLER	**GREENHECK / COOK / ACME**
	III) AXIAL FAN	**GREENHECK / COOK / ACME**
	IV) INLINE	**GREENHECK / COOK / ACME**
12.	**M.S. PIPES:**	

S. NO.	DETAILS OF EQUIPMENT/ MATERIAL	MANUFACTURERS
13.	**I) UPTO 150MM DIA**	**TATA / JINDAL /SAIL/ PARKASH SURYA**
14.	**II) ABOVE 150MM DIA**	**TATA / JINDAL /SAIL/ PARKASH SURYA**
15.	**BUTTERFLY VALVES**	**AUDCO / ADVANCE / KEYSTONE /CASTLE**
16.	**NON RETURN VALVE**	**AUDCO / ADVANCE / KEYSTONE /CASTLE**
17.	**BALANCING VALVES (MANUAL)**	**AUDCO / ADVANCE / KEYSTONE /CASTLE**
18.	**BALANCING VALVES (AUTOMATIC)**	**FLOWCON,DENMARK/GRISWOLD,USA/WARREN CONTROLS, USA**
19.	**2-WAY PRESSURE INDEPENDENT DYNAMIC BALANCING CUM CONTROL VALVE FOR AHU & FCU**	**FLOWCON,DENMARK/GRISWOLD,USA/WARREN CONTROLS, USA**
20.	**POT/Y-STRAINERS/SUCTION GUIDE (SPECIAL DESIGN WITH LARGE AREA & LOW PRESSURE DROP – SSCPL MODEL)**	**RAPID COOL / EMERALD / SANT / ANERGY INSTRUMENTS**
21.	**PRESSURE GAUGE**	**H. GURU / FEIBIG OR EQUIVALENT**
22.	**THERMOMETERS**	**H.GURU / FEIBIG OR EQUIVALENT**
23.	**AUTO AIR VENT**	**ANERGY / RAPID COOL OR EQUIVALENT**
24.	**G.I. SHEETS**	**SAIL / TATA /JINDAL**
25.	**FIRE DAMPERS**	**GREENHECK / AMERICAN WARMING / TWIN CITY**
26.	**FACTORY FABRICATED DUCT**	**UNIDUCT / ZECO / RAVISTAR**
27.	**GRILLS/DIFFUSERS**	**MEI / CARYAIRE / RAVISTAR**
28.	**FRESH AIR LOUVERS**	**MEI / CARYAIRE / RAVISTAR**
29.	**T.F. QUALITY EXPANDED POLYSTYRENE**	**ARKC / BEARDSELL / STYRINE**
30.	**CLOSED CELL NITRILE RUBBER**	**A-FLEX / VIDO-FLEX / ARKC**
31.	**XPS**	**OWENS CORNING / ARKC/ISO BOARD**
32.	**GLASS WOOL**	**OWENS CORNING / KIMCO /ARKC**
33.	**FLEXIBLE COUPLING**	**RESISTOFLEX / KANWAL**
34.	**ISOLATING SWITCHES**	**L&T/ ABB/ MG**
35.	**STARTERS / SWITCHES / CONTACTORS**	**L&T/ SIEMENS / SCHINIDER**
36.	**ACB/MCCB**	**L&T / MERLIN GERIN / SIEMENS/**
37.	**MCB AND ISOLATORS**	**L&T / MERLIN GERIN / SIEMENS/**
38.	**CABLE TRAY**	**L&T / MERLIN GERIN / SIEMENS/**
39.	**HVAC/AHU PANELS**	**L&T / MERLIN GERIN / SIEMENS/ NEC**
40.	**AIR MEASURING STATION**	**MEI, GREENHECK, DIVINE**