

## **ANNEXURE - 2**

### **SECTION VI : WORKS REQUIREMENT SPECIFICATIONS**

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**CIVIL / STRUCTURAL WORKS**

**TECHNICAL SPECIFICATIONS - CIVIL WORKS****1. INTRODUCTION**

This contract scope includes **“Construction of Super-specialty Hospital Block and allied buildings within Lakhimpur Medical College, Fakhruddin Ali Ahmed Medical College - Barpeta and Silchar Medical College campus involving Civil, MEP Works, External Development Works”** under the umbrella of the Assam Health System Strengthening Project supported by Japanese Infrastructure Cooperation Agency “JICA”, wherein 6 nos. of Super specialty Wing at 6 Medical Colleges, 6 nos. of District Hospitals across Assam and Dedicated Training, Monitoring, Administrative Centre, Swasthya Bhawan at Guwahati is planned to be developed.

The “Assam Health System Strengthening Project” has been formulated, which aims to improve the situations and strengthen the functions of medical institutions focusing on tertiary hospitals which are core medical centers to create an environment where residents in Assam state can access equally to necessary medical services.

The Super-specialty locations considered for this contract is 3 nos. out of 6 under the AHSSP, namely, Lakhimpur, Barpet and Silchar.

The targeted clinical departments of Super-specialty hospital includes:

- Cardiology
- Cardiothoracic surgery
- Neurology
- Neurosurgery
- Nephrology
- Urology

This contract encompasses the construction of a Super-specialty Hospital Block and allied buildings within the campuses of Lakhimpur Medical College, Fakhruddin Ali Ahmed Medical College - Barpeta and Silchar Medical College. The project will involve comprehensive Civil, MEP (Mechanical, Electrical, and Plumbing) works, as well as External Development Works.

**1.1. DESIGN BASIS:**

The Hospital has been designed to provide tertiary healthcare facilities meeting the patient’s needs and comfort. Some significant concepts that have been incorporated while designing and planning are listed below:

- Smooth horizontal and vertical movement of patients, staff and visitors. All the departments are inter-linked for horizontal and vertical circulations.
- Various small waiting spaces have been dedicated for Patient and people near each department apart from common waiting areas as this will help in

decongestion in peak period.

- Smooth accessibility for the differently-abled persons.
- Natural light to all the patient rooms has been externally provided.
- Centralized air conditioning, firefighting and detection system
- Planning and allocation of services as per the National Building Code-2016 and applicable bye-laws
- Provision of solar water heating system

### **Hospital Block Planning (Floor-wise Departments) :**

#### **General**

- The hospital building of all three location are planned for G+6 storey structure.
- The hospital block has Three entry points namely OPD, Emergency, staff & services.
- All the entries on ground floor are well connected to lift lobby and staircase nearby for easy and convenient access for one and all to various departments on upper floors.
- The main/visitor entry corridor further leads into sizeable registration cum waiting area with registration counters and patient waiting.

#### **Service Blocks/ Facilities:**

Service Blocks with adequate space like Electrical Substations, HVAC Chiller Plant Room at Terrace, ETP, STP, UGT has been planned.

#### **Medical Services:-**

- Adequate Space provision has been made for CSSD, MGPS and Pneumatic Tube System inside Hospital building.
- MGPS and Mortuary have been planned as separate buildings.

#### **Waste Disposal Facility:-**



Adequate space has been planned for collection of solid waste. Also separate dedicated space has been planned for collection of Bio Medical waste generated from Hospital buildings.

#### **External Development**

##### **Site Levels:**


The proposed level of internal roads and Building Plinths has been provided based on the existing access road in front of the site and HFL data received from concern department. The Finished ground levels and building levels are given in site layout plan

:HFL data received from WRD , Lakhimpur is attached herewith.

GOVERNMENT OF ASSAM OFFICE OF THE EXECUTIVE ENGINEER NORTH LAKHIMPUR W.R. DIVISION NORTH LAKHIMPUR e-Mail ID: wrdlakhimpur@gmail.com	 GOVERNMENT OF ASSAM	অসম চৰকাৰ কাৰ্যবাহী অভিযন্তাৰ কাৰ্যালয় উত্তৰ লক্ষীমপুৰ জল-সম্পদ সংমণ্ডল উত্তৰ লক্ষীমপুৰ
No. NLWRD/C/336/2018-19/1160	Date: 03/05/2024	
✓ To, The Superintending Lakhimpur Medical College and hospital, Lakhimpur		
Sub: Submission of Flood records and HFL of different Rivers under North Lakhimpur W.R Division, North Lakhimpur.		
Ref: Letter No. LMC/674/2021 dated 26.04.2024.		
Sir, With reference to the subject cited above, I have the honour to submit herewith the last 10 years Flood occurrence Record and HFL of different Rivers under Lakhimpur W.R Division, North Lakhimpur for favour of your disposal.		
Encl: As Above.	Yours faithfully	
	 Executive Engineer North Lakhimpur W.R. Division North Lakhimpur	

Last 10 Years Flood Occurance Record of different Rivers under North Lakhimpur W.R Division, North lakhimpur

SL No.	Name of the River	Station	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Brahmaputra	Jamuguri	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
2	Pabha	N.H-15 Crossing	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
3	Subansiri	Dhunaguri ghat	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	Flood due to Erosion	No Flood	No Flood	No Flood
4	Subansiri	Bhimpara ghat	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	Flood due to Erosion	No Flood
5	Subansiri	Silkhaguri ghat	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
6	Ranganadi	Railway Bridge crossing	Flood due to overtopping	No Flood	No Flood	Flood due to Erosion	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
7	Sessa Pichola	1 No. Bikrompur	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
8	Dikrong	Sissa Pathar RCC Bridge	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
9	Singra	N.H-15 Crossing	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	Flood due to sudden slump down
10	Boginodi	N.H-15 Crossing	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
11	Durpang	Durpang Gaon	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood
12	Kakoi	N.H-15 Crossing	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood	No Flood

  
 Executive Engineer  
 North Lakhimpur W. Division  
 North Lakhimpur

Last 10 Years HFL data of different Rivers under North Lakhimpur W.R Division, North lakhimpur

SL No.	Name of the River	Station	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
1	Brahmaputra	Jamuguri	80.69 M	80.54 M	80.23 M	81.05 M	79.54 M	79.75 M	81.27 M	80.16 M	80.68 M	80.58 M
2	Pabha	N.H-15 Crossing	93.45 M	93.50 M	93.40 M	93.80 M	93.60 M	93.15 M	93.45 M	93.45 M	93.30 M	92.30 M
3	Subansiri	Dholghat	91.22 M	90.76 M	90.88 M	91.53 M	90.35 M	90.81 M	90.75 M	91.06 M	90.66 M	90.36 M
4	Subansiri	Ghancharai	88.63 M	88.50 M	88.74 M	89.33 M	88.60 M	88.87 M	88.70 M	88.88 M	88.80 M	88.77 M
5	Subansiri	Silkhaguri ghat	81.30 M	81.43 M	81.46 M	82.00 M	80.10 M	81.27 M	82.25 M	80.30 M	81.51 M	81.39 M
6	Ranganadi	Railway Bridge crossing	95.90 M	95.15 M	94.90 M	95.95 M	95.20 M	95.35 M	95.04 M	94.25 M	94.70 M	94.50 M
7	Sessa Pichola	1 No. Bikrompur	99.72 M	99.08 M	99.25 M	98.95 M	98.93 M	98.91 M	98.95 M	98.46 M	98.97 M	98.35 M
8	Dikrong	Sissa Pathar RCC Bridge	87.90 M	87.82 M	87.82 M	88.09 M	87.92 M	87.84 M	87.85 M	93.65 M	87.32 M	87.72 M
9	Singra	N.H-15 Crossing	93.41 M	94.06 M	93.99 M	93.86 M	94.16 M	93.46 M	94.96 M	93.66 M	93.76 M	94.36 M
10	Boginodi	N.H-15 Crossing	98.49 M	98.41 M	98.22 M	97.99 M	98.97 M	97.86 M	98.40 M	97.92 M	98.00 M	97.92 M
11	Durpang	Durpang Gaon	112.34 M	112.98 M	112.26 M	112.32 M	112.32 M	112.32 M	111.90 M	111.87 M	112.42 M	112.13 M
12	Kakoi	N.H-15 Crossing	94.32 M	94.17 M	94.24 M	93.86 M	94.47 M	93.94 M	93.97 M	93.77 M	93.57 M	93.77 M

  
 Executive Engineer  
 North Lakhimpur W. R Division  
 North Lakhimpur

:HFL data received from WRD , Silchar is attached herewith.

*HA*  
*Silchar*  
*27/5/24*

OFFICE OF THE  
EXECUTIVE ENGINEER, CACHAR W. R. DIVN., W. R. DEPTT., SILCHAR

No. TB/W/373/2014-15/49/208- Date : 22/05/2024.


To  
The Superintendent  
S.M. Dev Civil Hospital , Silchar

Sub : Regarding flood level records along with the HFL of the Barak River of Cachar District for last ten years.  
Ref : Your letter No. SMDCH/Corres./07/2023-24/1335 Dt.16/05/2024

Sir,

With reference to the subject cited above , I am herewith furnishing the Hydrological data pertaining to Cachar Water Resources Division , Silchar from the year 1998 to 2023 as per your requirement.

Encl : As above.

Yours faithfully,  
  
Executive Engineer,  
Cachar W. R. Division, Silchar.



## HYDROLOGICAL DATA

Maximum Rainfall = 4753mm (2010)

Average Rainfall = 3400mm

Highest Water Level = 21.84m on 01-08-1989 at A. P. Ghat, Silchar

Year	Borak at Annapurnaghat	Rukni at Dholai	Sonai at S. M. Road	Total Rainfall at E&D Colony, Silchar
<b>DL</b>	<b>19.83m</b>	<b>24.58m</b>	<b>21.355m</b>	
1998	20.65m on 10-06-1998 at 0800 hrs.	27.29m on 11-08-1998 at 0100 hrs.	23.285m on 09-08-1998 at 1600 hrs.	3473.90mm
1999	19.77m on 18-07-1999 at 1100 hrs.	25.45m on 29-07-2009 at 0100 hrs.	22.6455m on 02-09-1999 at 2100 hrs.	2900.65mm
2000	20.42m on 09-09-2000 at 1000 hrs.	27.92m on 04-10-2000 at 0800 hrs.	23.405m on 09-09-2000 at 0900 hrs.	3726.70mm
2001	20.66m on 07-06-2001 at 1700 hrs.	27.25m on 06-06-2001 at 0900 hrs.	23.405m on 07-06-2001 at 2000 hrs.	2479.60mm
2002	19.93m on 24-07-2002 at 2100 hrs.	27.09m on 08-08-2002 at 1500 hrs.	22.305m on 24-07-2002 at 2100 hrs.	2911.00mm
2003	19.86m on 14-06-2003 at 2400 hrs.	26.09m on 12-06-2003 at 2300 hrs.	21.875m on 14-06-2003 at 1300 hrs.	2962.10mm
2004	21.61m on 20-07-2004 at 1400 hrs.	27.42m on 20-07-2004 at 1000 hrs.	24.665m on 20-07-2004 at 1800 hrs.	3918.80mm
2005	18.15m on 27-05-2005 at 2200 hrs.	22.55m on 27-08-2005 at 2200 hrs.	-	3054.60mm
2006	20.64m on 13-06-2006 at 1800 hrs.	27.41m on 14-06-2006 at 0100 hrs.	22.875m on 14-06-2006 at 0900 hrs.	2542.41mm
2007	21.42m on 09-09-2007 at 2200 hrs.	27.90m on 03-09-2007 at 0200 hrs.	24.015m on 09-09-2007 at 1900 hrs.	3459.22mm
2008	19.87m on 06-08-2008 at 0200 noon	26.32m on 05-08-2008 at 0600 hrs.	22.405m on 05-08-2008 at 0600 hrs.	3148.20mm
2009	19.48m on 22-08-2009 at 1200 noon	25.20m on 27-08-2009 at 2000 hrs.	21.465m on 22-08-2009 at 0900 hrs.	2884.74mm
2010	20.72m on 10-06-2010 at 2100 hrs.	27.02m on 12-09-10 at 1800 hrs.	23.26m on 10-06-2010 at 1300 hrs.	4752.98mm
2011	19.31m on 26-08-2011 at 1400 hrs.	26.19m on 22-08-2011 at 1800 hrs.	21.815m on 26-08-2011 at 0800 hrs.	2599.70mm

2012	21.11m on 28-06-2012 at 1600 hrs.	24.52m on 28-06-2012 at 1800 hrs.	-	3577.40mm
2013	19.66m on 18-08-2013 at 1200 hrs.	25.80m on 17-08-2013 at 0700 hrs.	-	2389.30mm
2014	18.54m on 15-08-2014 at 0900 hrs.	26.60m on 30-07-2014 at 0900 hrs.	-	3058.90mm
2015	20.29m on 27-08-2015 at 1400 hrs.	27.24m on 28-08-2015 at 0600 hrs.	-	2809.84mm
2016	20.63m on 20-05-2016 at 0900 hrs.	27.78m on 19-05-2016 at 0800 hrs.	-	3477.04mm
2017	20.30m on 28-06-2017 at 0500 hrs.	26.97m on 27-08-2017 at 1100 hrs.	-	3760.44mm
2018	21.33m on 16-06-2018 at 1500 hrs.	24.86m on 16-06-2018 at 1500 hrs.	-	2735.25mm
2019	20.33m on 14-07-2019 at 02.00 hrs	-	-	2832.20mm
2020	20.14m on 16-07-2020 at 15.00 hrs	-	-	2971.90mm
2021	18.42 m on 28-08-2021 at 13.00 hrs	-	-	2681.40mm
2022	21.59 m on 21-06-2022 at 18.00 hrs	26.82m on 19-06-2022 at 12:00 hrs.	24.60m on 20-06-2022 at 17:00 hrs. as on 30/06/2022	3377.20mm
2023	18.66 m on 29-08-2023 at 04.00 hrs	24.64m on 22-09-2023 at 08:00 hrs.	-	2516.90mm

Executive Engineer  
Silchar W. R. Division  
Silchar.

**For FAAMCH , Barpeta** the HFL data from the existing HFL marked by PWD in the college premise of 48.86 m at nearest Puthimari River has been considered

### Circulation & Parking

The circulation and parking has been planned to keep the pedestrian character of the complex. The open parking has been carefully disguise and softens through vegetation or totally screened off with trees/ shrubs.

### Road

The proposed construction includes 80mm paver roads for the main driveway, encompassing the parking areas. Pedestrian footpaths has been constructed with cement concrete and chequered tiles. The service entry area will feature 60mm thick paver blocks, while the

ambulance parking and emergency entry ramp has been paved with cement concrete.

### **Landscape**

Main objective of the landscape theme is to create a pleasant outdoor environmental for the patients and visitors to this prestigious complex, complementary to the character of the built form. The aim of the landscape theme is to create an enabling healing environment for the patients.

Irrigation to the plantation shall be done with the combination of modern irrigation techniques and manual irrigation methods, in line with the site conditions and local agro-climatic conditions and assist in conserving the landscapes besides saving water and ecology.

### **Compound Wall & Fencing**

On the main entrance side, the compound wall feature a AAC wall with a grill design. The internal boundary wall has been constructed using a AAC wall with GI chain link fencing.

### **Signages**

- Exterior signage will be mounted on the wall using an MS framework. The signage itself will consist of an MS pipe frame, clad with 3mm aluminum composite panels cut by CNC router. The letters will be laser-cut from 10mm clear cast acrylic, set into a cut-out fitted on 4mm 040 cast acrylic. The front of the letters will feature 3M day and night electrocut vinyl. The signage will be illuminated with backlit LED lights.
- The internal signage for Main Directory, Floor Directory, Floor Plate, and Canteen is made from 10mm casted clear acrylic sheets, laser-cut for precision. The text, all 2mm thick acrylic, is also laser-cut, partially housed and adhered onto the engraved surface of the clear acrylic base. The 10mm acrylic sheet is affixed to 25x25mm teak wood sections using crafted stainless steel pins, and then further secured to the prescribed locations with wooden dowels.
- A 1mm rigid PVC sheet containing Lumingen 3 as a base chemical, designed for high-intensity photo luminescent glow, intended for use in radiation rooms.
- Elevator signage is provided using 1.5mm polished 304 grade stainless steel plates, duly etched and filled with prescribed enamel colors to display an elevator disclaimer, sized 250x250mm.
- The prohibition signs should be made of cast acrylic with laser-cut text and images. They should be fixed using stainless steel fittings according to the design.

**1.2. SCOPE OF WORK:**

The work should be carried out in accordance with the Detailed project Report, Architectural drawings and structural drawings (proof checked/vetted by the IIT), MEP and allied services drawings and approved by the PWD, Assam. The Technical Specifications are to be read with and in general conforming to the Latest CPWD Specifications.

Contractor(s) shall provide permanent bench marks, flag tops and other reference points for the proper execution of work and these shall be preserved till the end of the work. All such reference points shall be in relation to the levels and locations, given in the Architectural and plumbing drawings. On completion of work, the Contractor(s) shall submit required number of prints of “as built” drawings to the The Engineer.

Before commencement of any item of work the Contractor shall correlate all the relevant architectural, structural, MEP and other service drawings, and specifications etc. and satisfy himself that the information available is complete and unambiguous. The Contractor alone shall be responsible for any loss or damage occurring by the commencement of work based on any erroneous and or incomplete information and no claim whatsoever shall be entertained on this account.

The Contractor shall give performance test of the entire installation(s) as per the specifications in the presence of the The Engineer or his authorized representative before the work is finally accepted and nothing extra what-so-ever shall be payable to the Contractor for the test.

The work of services will be executed simultaneously. The Contractor shall minimize the scope of making recesses, holes, opening etc. as the same shall be planned in advance and necessary grooves/niches shall be provided in shuttering of RCC.

Sample of building materials, fittings and other articles required for execution of work shall require prior approved from the The Engineer before use in the work. The quality of samples brought by the Contractor shall be judged by standards laid down in the relevant CPWD/ BIS specifications. All materials and articles brought by the Contractor to the site for use shall conform to the samples approved by the The Engineer which shall be preserved till the completion of the work.

BIS/IS marked materials except otherwise specified shall be subjected to quality test at the discretion of the The Engineer besides testing of other materials as per the specifications described for the item/material. Wherever BIS marked materials are brought to the site of work, the Contractor shall, if required, by the The Engineer, furnish manufacturer’s test certificate or test certificate from approved testing laboratory to establish that the material / procured by the Contractor for incorporation in the work satisfies the provisions of specifications / BIS codes relevant to the material and / or the work done.

The Contractor shall procure the required materials in advance so that there is sufficient time to testing of the materials and clearance of the same before use in the work. The Contractor shall provide at his own cost suitable weighing and measuring arrangements at site for

checking the weight / dimensions as may be necessary for execution of work.

Contractor shall submit minimum “Quality Assurance” plan which shall consist of:

- a. Lot size, number of required tests and frequency of testing. While deciding these criteria CPWD Specifications & provisions of BIS Code and standard practices may be referred. The mandatory test shall be in conformity with the requirements details in the latest CPWD specifications. For testing of other materials/work, the requirements as per provisions of BIS Code and standard practices shall be applicable.
- b. It should clearly indicate the Machinery and other Tool & Plants required to be deployed at site by the Contractor. Entire Machinery and T&P may not be required at the start of work, therefore, a proper time schedule by which each Machinery & T&P is to be brought at site should also be indicated.
- c. The Contractor shall maintain record of Receipt of Materials, testing of the same & Maintenance of Register of Tests.
- d. All the registers of tests carried out at Construction Site or in outside laboratories shall be maintained by the Contractor, which may be inspected by The Engineer or his/her designee at any point of time.
- e. The Contractor shall allow access to Project Management Consultant(PMC)/ Third Party Quality Assurance Agency (TPQAA) engaged by PWD-Assam/PMU-AHIDMS/PMC to have a control on quality and methodology of execution. Requisite number of Samples of materials including Cement Concrete Cubes shall be taken jointly by Contractor, PMC/TPQAA and The Engineer or their authorized representative. All arrangements for transporting and getting them tested shall be made by the Contractor.
- f. All the test in field lab setup at Construction Site shall be carried out by the Quality control team to be engaged by the Contractor which can be witnessed by The Engineer or his/her designee. A daily report of Tests to be conducted on a day shall be submitted to The Engineer or his authorized representative.
- g. All the entries in the registers will be made by the designated Engineering Staff of the Contractor.
- h. The Contractor shall be responsible for safe custody of all the test registers.
- i. Submission of copy of all test registers, Material at Site Register and hindrance register along with each alternate Running Account Bill and Final Bill shall be mandatory.
- j. All material received at site shall be entered in MAS Register and copy of Supply order, MTC & Bill-invoice shall be maintained in order. The MAS Registers including Cement and Steel Registers shall be maintained by a qualified staff of Contractor which may be inspected by The Engineer or his authorized representative at any time. The daily report of receipt of material

shall be sent to The Engineer or his authorized representative.

The Contractor shall ensure that no construction leach ate (e.g. cement slurry etc.), is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including, reduction of wasteful curing processes, collection, basic filtering and reuse. The Contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant- laden water directly to the treatment device or facility (municipal sewer line).

**Pour Card, Check-List for Execution of Work:**

- i. As and when any important item is taken up for execution, the Contractor shall submit the specifications and develop a checklist and Pour card. This sample checklist should be prior-approved from the The Engineer and should be used at site. This check list should be shown to the The Engineer or his authorized representative or PMC during inspection. This procedure is to be followed for all hidden items, CC/RCC work, Steel- reinforcement, shuttering, cast-in-situ mosaic flooring, doors & windows, plumbing, including water supply pipe lines, roof treatment, earth filling etc.
- ii. The Contractor shall render all help and assistance in documenting the total sequence of this project by way of photography, slides, audio-video recording etc. nothing extra shall be payable to the Contractor on this account.

**Shop Drawings:**

Necessary approvals have to be obtained for specialized item of works such as following shop drawings:

- i. Structural Glazing/ Aluminum/ Dry Partition,
- ii. Potable pump installation drawing
- iii. Fire Pump installation drawing
- iv. Lift
- v. Electrical Panels,
- vi. Electrical panel (HT/LT)
- vii. SLD
- viii. DG Set
- ix. Transformer,
- x. Street Light / High Mast

- xi. HVAC System,
- xii. STP,
- xiii. ETP
- xiv. WTP
- xv. Furniture etc.

Detailed shop drawings including drawings required for statutory approval like Fire Department, Electrical & Pollution Control Board etc., have to be prepared by the approved vendor, based on the GFC drawings issued by the Competent Authority.

However it is responsibility of the vendor to Design Specialized foundation for the vendor works based on the relevant codes.

Satutory Approval:

The scope of work includes liaisoning & Obtaining mandatory approvals (Pre & Post Construction) from all local bodies/ State & Central authorities/ Municipal Corporation, forest clearance, NOC from Fire Department, NOC from Airport Authority of India, BSNL/MTNL, Central Electricity authority, Muncipal Authority, Water supply & sewerage authorities, EIA, CPCB, CGWB / State Water Board, Approvals as per latest Assam local building Byelaws / Town & Country Planning (Assam) Bye laws with up to date corrections slips, etc. and any other statutory approval/Central Licensing Approving Authority etc. related to super speciality Hospital, approval from authorities required for commencing the work, execution of work & services and handing over the assets. The statutory payments to these agencies will be paid by the agency except the charges of Electrical Service connection from local supply agency to the energy meter in the premises of the building which will be initially paid by the contractor and reimbursed by the department to the contractor on producing the proof of charges paid to the local concern agency.

## **2. TECHNICAL SPECIFICATION - CIVIL**

### **2.1. EARTH WORK:**

Excavation (in surface excavation, over area, foundation, trenches etc.) in all kind of soil shall be carried out upto desired level as per structural drawings. However, care shall be taken to ensure to support the footings on firm strata as per minimum SBC specified in structural drawings. The foundation level shown in the structural & architectural drawings are for supporting the foundation on firm strata as per SBC specified therein. The minimum depth of foundation shall be 3m with respect to existing ground level at particular location. However, care shall be taken to ensure to support the footings on firm strata as per minimum SBC specified in structural drawings. The mandatory tests required in accordance with IS 10042 need to be carried out during construction by the Contractor. Subsurface conditions encountered during construction may vary somewhat from the conditions encountered during site investigation. There is likelihood of encountering localized clay seams in the type of formation that exists at site. Therefore, it is essential to examine the founding levels very

carefully during excavation and remove the same if met with till firm strata is ensured prior to laying of PCC. It should be ensured that at foundation level, no voids are there, if voids are observed the same shall be grouted. Necessary soil stabilization measures shall be implemented by the Contractor to achieve the bearing capacity as specified in structural drawings. Any deviation in earth work, concrete work, RCC work, or any other items of works will be ignored and nothing extra shall be paid on account of varying foundation level (in order to ensure supporting of foundation on firm strata and at minimum SBC specified in structural drawings). The Contractor shall quote the rate accordingly. Earth required for filling in all works like trenches, foundations, Plinth, around building, road work and other development works shall be of good quality useful for filling as per CPWD specifications. The available excavated earth suitable for filling shall be used by the Contractor. Excess earth required if any shall be procured from outside the campus for which nothing extra shall be paid. Surplus excavated earth after filling as per site conditions to be disposed outside the campus by taking required permission from concerned Government authority. No extra payment will be made for the above. All the excavated earth/soil shall be Levelled & neatly dressed.

#### Dewatering:

For works below ground level the contractor shall keep the area free from water. Subsoil water level shall be maintained at least 50cm below the P.C.C level, till the laying of water proofing treatment over PCC, laying of basement raft and retaining wall & filling of earth/sand under the basement floor & behind retaining wall. If dewatering or bailing out of water/rain water is required, the contractor shall do the same at his own cost until completion of outer retaining wall, water proofing of vertical surfaces of retaining walls and back filling behind the walls upto ground level.

De-watering required, if any, shall be done confirming to BIS Code IS: 9759 (guide lines for de-watering during construction) and / or as per the scheme / specifications approved by the The Engineer. Design of an appropriate and suitable dewatering system shall be the Contractor's responsibility. Such scheme shall be modified / augmented as the work proceeds based on fresh information discovered during the progress of work, at no extra cost. At all times during the construction work, efficient drainage of the site shall be carried out by the Contractor and especially during the laying of plain cement concrete, taking levels etc. If needed, suitable precautionary measures shall be taken by the Contractor.

Nothing extra shall be payable on this account.

(ii) Dewatering shall be carried out by suitable means with adequate stand-by arrangements and the disposal of water shall be done as per the direction of the The Engineer.

(iii) The subsoil water from dewatering may be required to be connected to the raw water grid in the area for use in horticultural purpose or contractor will make his own arrangement for disposal of sub soil water, if any approval from local body is required the contractor will get the same for which no extra payment will be made. However, only the cost of providing and laying pipe line beyond site boundary shall be paid.



(iv) In trenches where surface water is likely to get into cut / trench during monsoons, a ring bund of puddle clay or by any other means shall be formed outside, to the required height, and maintained by the Contractor. Also, suitable steps shall be taken by the Contractor to prevent back flow of pumped water into the trench. Nothing extra shall be payable on this account.

(v) The safety & stability of adjacent structure and roads etc. shall be ensured during entire period of construction.

(vi) The rates quoted by the contractor shall be inclusive of working in or under water conditions and including pumping or bailing out water encountered from any source such as rains, floods, leakage from sewer and water mains, sub soil water table being high or for reasons of stability of structure or any other cause whatsoever. The extent and decision of pumping or bailing out of water shall be as per requirements of site and stability of structure and decision of Engineer-in-charge in this regard shall be final and binding on the contractor. Nothing extra shall be payable on this account.

#### **Method of Measurement and Payment**

Payment for all Earth work shall be made on the basis of volume arrived at by measuring the length, breadth and depth.

#### **Rate:**

The rate shall include for all materials, labour charges, multiple handling transportation, lead, lift, all taxes, hire of tools and plants, testing to the satisfaction of the The Engineer etc. complete for the finished Work.

## **2.2. SAND FILLING:**

Sand shall be clean and free from dust organic and foreign matter and its grading shall be within the limits of grading zone IV or V specified in Section 3 'Mortars'. Sand filling shall be done in a manner similar to earth filling in plinth that consolidation shall be done by flooding with water. The surface of the consolidated sand filling shall be dressed to the required level or slope and shall not be covered till the The Engineer has inspected and approved the sand filling.

#### **Method of Measurement and Payment**

Payment for sand filling work shall be made on the basis of volume arrived at by measuring the length, breadth and depth.

#### **Rate:**

The rate shall include for all materials, labour charges, multiple handling transportation, lead, lift, all taxes, hire of tools and plants, testing to the satisfaction of the The Engineer etc. complete for the finished Work.

**2.3. SHORING AND STRUTTING:**

When the depth of trench in soft/loose soil exceeds 2 metres, stepping, sloping and/ or shoring and strutting of sides shall be done. In case of loose and slushy soils, the depths at which these precautions are to be taken, shall be determined by the The Engineer according to the nature of soil. Shoring and strutting shall be 'close' or 'open' depending on the nature of soil and the depth of trench. The type of Shoring and strutting shall be determined by the The Engineer. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches from collapse. The Engineer should take guidance from IS: 3764 for designing the shoring and strutting arrangements and specifying the profile of excavation. Close Shoring and Strutting Close Shoring and strutting shall be done by completely covering the sides of the trench generally with short upright, members called 'poling boards'. These shall be 250x38 mm in section or as directed by the The Engineer. The boards shall generally be placed in position vertically in pairs. One boards on either side of cutting. These shall be kept apart by horizontal wallings of strong wood at a maximum spacing of 1.2 metres cross strutted with ballies, or as directed by The Engineer. The length and diameter of the ballies strut shall depend upon the width of the trench. Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical 'wallings' which shall be strutted to similar timber pieces on the opposite face of the trench. The lowest boards supporting the sides shall be taken in the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed. The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim shall be entertained for any timber which cannot be withdrawn and is lost or buried, unless required by the Engineer-in- Charge to be left permanently in position.

**Open Shoring And Strutting:**

In case of open Shoring and strutting, the entire surface of the side of the trench is not required to be covered. The vertical boards 250 mm wide & 38 mm thick, shall be spaced sufficiency apart to leave unsupported strips of 50 cm average width. The detailed arrangement, sizes of the timber and the distance apart shall be subject to the approval of the Engineer-in- Charge. In all other respect, specifications for close Shoring and strutting shall apply to open Shoring and strutting.

**Method of Measurement and Payment**

Payment for Shoring and Strutting Work shall be made on the basis of area arrived at by measuring the length and depth.

**Rate:**

The rate shall include for all materials, labour charges, multiple handling

transportation, lead, lift, all taxes, hire of tools and plants, testing to the satisfaction of the Engineer incharge etc complete for the finished Work.

#### **2.4. BORED CAST-IN-SITU REINFORCED CONCRETE PILES**

##### **General**

The piles are formed within the ground by excavating or boring a pile within it with or without the use of temporary casing and subsequently filling it with plain or reinforced concrete. When the casing is left permanently it is termed as cased pile and when the casing is taken out it is termed as uncased pile.

Equipment: The equipment and accessories used for bored cast-in-situ piles shall depend on subsoil strata, ground water conditions, type of founding material and penetration etc.

The equipment is applicable for bored piles without the use of bentonite.

Boring operation shall be done by rotary percussion type drilling rigs using direct mud circulation or reverse mud circulation methods to bail out the cuttings or as specified. In soft clays and loose sand, bailer and chisel method should be used with caution to avoid the effect of suction. Rope operated grabbing tool Kelly mounted hydraulically operated grab are also used. This method of advancing the hole avoids suction. The size of cutting tool shall be as per [IS 2911 (Part I Section 2)] and not less than the diameter of pile by more than 75 mm.

Permanent casing where specified shall be used to avoid aggressive action of water. Boring for installing Pile

Installation of Piles : Installation of piles shall be as accurate as possible and as per design and drawings. The vertically or the required batter should be correctly maintained. Particular care shall be taken in respect of installing either single pile or piles in two pile groups.

- (i) Deviation and Tolerance : The deviation/tolerance should be as per IS 2911 (Part 1/Sec.1). The piles should not deviate more than 75 mm or  $D/4$  whichever is less (75 mm or  $D/10$  whichever is more in case of piles having diameter more than 600 mm) from their designed position at the working level.
- (ii) In case of a single pile under a column, the positional deviation should not be more than 50 mm or  $D/4$  whichever is less (100 mm in case of piles having diameter more than 600 mm. Greater tolerance may be prescribed for piles driven over water and for raking piles.

##### **Procedure of Driving Pile Bore**

- (iii) Bored cast-in-situ concrete piles are installed by making a bore into the ground and removing out the material.

- (iv) The ground shall be roughly leveled and position of pile marked. The boring shall be done with or without the use of temporary casing. The sides of bore hole; shall be stabilized with the aid of temporary casing or with the aid of drilling mud of suitable consistency.
- (v) The equipment and accessories shall depend upon the type of bored pile chosen for the job, consideration of sub-soil strata, ground water condition, type of founding material. Boring operation normally are done by rotary or percussion type drilling rigs using direct mud circulation on reverse mud tool shall be as detailed in IS 2911 (Part 1/Sec.2).
- (vi) In case permanent/temporary casing is not used then bored pile is stabilised with drilling fluid. Bentonite supplied to site shall conform to IS 2720 (Part V). A certificate shall be obtained by the Contractor from the manufacturer showing properties of each consignment and should be submitted to the The Engineer. Bentonite shall be mixed thoroughly with fresh clean water to make a suspension which will maintain the stability of the pile excavation for the period necessary to place concrete and complete construction. The temperature of the water used in mixing the bentonite suspension and when supplied to bore hole shall not be lower than 5°C. Consistency of the drilling fluid suspension and when controlled throughout the boring as well as in concreting operations in order to keep the hole stabilized as well as to avoid concrete getting mixed up with thick suspension of mud.  
  
Frequency and methods of testing drilling fluid shall be as specified and the test results shall be as specified in IS 2720 (Part V).
- (vii) Bored cast-in-situ piles in soils which are stable may often be installed with a small casing length at the top. A minimum of 2.0 m length of top of bore shall; invariably be provided with casing to ensure against loose soil falling in to drilling mud, or a suitable steel casing. The casing may be left in place permanently especially in cases where the aggressive action of the ground water is to be avoided, or in the cases of piles built in water or in cases where significant length of piles could be exposed due to scour.
- (viii) For bored cast-in-situ piles, casing/liner shall be driven open ended with a pile driving hammer capable of achieving penetration of the liner to the length shown on the drawing or as directed by the The Engineer. Materials inside the casing shall be removed progressively by air lift, grap or percussion equipment or other approved means.
- (ix) Where bored cast-in-situ piles are used in soils liable to inflow, the bottom of the casing shall be kept low enough in advance of the boring tool; to prevent the entry of soil into the casing, thus presenting the formation of settlements in

the adjoining ground. The water level in the casing should generally be maintained at the natural ground water level for the same reasons. The joints of the casing shall be made as tight as possible to minimize inflow of water or leakage of slurry during concreting.

- (x) Boring shall be carried out using rotary or percussion type equipment. Unless otherwise directed by the The Engineer the diameter of the bore holes shall be not more than the inside diameter of the liner.
- (xi) After the boring has reached the required depth, the steel reinforcement shall be lowered in position maintaining the specified size of cover on all sides. The bore shall then be flushed with bentonite slurry and concreting shall be taken up exactly as described under clause 20.1.6.8 (IS 2911).

A proper record of pile driving and other details such as sequence of installation of piles, dimension of piles, depth bored, time taken for concreting etc. shall be maintained in sequence of occurrence at site as per clause 20.1.3.6. (IS 2911)

While drilling mud is used, the specific gravity of fresh supply and contaminated mud in the hole before concreting is taken up shall be recorded for first ten piles and subsequently at interval of 10 piles or as specified.

Sl.No.	IS No.	Subject
1.	IS-1200 (Part 23)	Method of measurement of building and Civil Engineering Works – Piling.
2	IS-2911 (Part 1/Sec. 2)	Code of practice of Design and Construction of pile foundation. Bored Cast-in-situ piles.
3	IS-2911 (Part 3)	Code of practice for Design and Construction of pile foundation. Under reamed piles.
4	IS-2911 (Part 4)	Code of practice for design and Construction of pile foundation. Load test on piles.
5	IS-5112	Safety Code for piling and other deep foundations.
6	IS-6426	Specification for pile driving hammer.
7.	IS-6427	Glossary of terms relating to pile driving.
8.	IS-6428	Specification for pile frame.
9.	IS-9716	Guide for lateral dynamic load test on piles.
10.	IS-14362	Pile boring equipments. General requirements.

#### **Reinforcement:**

- (i) The design of reinforcing cage varies depending upon the driving and installation conditions, the nature of the sub-soil and the nature of load to be transmitted by the shaft, axial or otherwise. The minimum area of longitudinal reinforcement of any type or grade within the pile shaft shall be 0.4 per cent of the sectional area calculated on the basis of the outside area of the casings of the

shaft.

- (ii) The curtailment of reinforcement along the depth of the pile, in general, depends on the type of loading and sub-soil strata. In case of piles subjected to compressive load only, the designed quantity of reinforcement may be curtailed at appropriate level according to design requirements. For piles subjected to uplift load, lateral load & moments, separately or with compressive loads, it may be necessary to provide reinforcement to the full depth of the pile. In soft clays or loose sands, or where there is likelihood of danger to green concrete due to driving of adjacent piles, the reinforcement should be provided up to full pile depth, regardless of whether or not it is required from uplift & lateral load considerations. However, in all cases, the minimum reinforcement specified in Para (i) above should be provided in full length of the pile.
- (iii) Piles shall always be reinforced with a minimum amount of reinforcement as dowels keeping the minimum bond length into the pile shaft below its cut-off level, and with adequate projection into the pile cap, irrespective of design requirements.

Note: In some cases the cage may lift at bottom or at the laps during withdrawal of casing. This can be minimized by making the reinforcement “U” shaped at the bottom and up to well secured joints. Also the lifting 5 percent of the length should be considered not to affect the quality of pile.

- (iv) Clear cover to all main reinforcement in pile shaft shall be not less than 50 mm and shall be maintained by suitable spacers. The laterals of reinforcing cage may be in the form of links or spirals. The diameter and spacing of the same is chosen to impart adequate rigidity of the reinforcing cage during the handling and installation. The minimum diameter of links or spirals shall be 6 mm and the spacing of the links or spirals shall be not less than 150 mm. The minimum clear distance between two adjacent main reinforcement should normally be 100 mm for full depth of the cage.
- (v) The reinforcing cage should be left with adequate protruding length above the cut off level for proper embedment in the pile cap. Prior to the lowering of reinforcement cage into the pile shaft, the shaft shall be cleaned of all loose materials.
- (vi) Reinforcement in the form of cage shall be assembled with additional support, such as spreader forks and lacings; necessary to form a rigid cage hoops, links, or helical reinforcement has to fit closely around the main longitudinal bars and shall be tied by binding wire of approved quality. The ends of the binding wire shall be turned into the interior of the pile. Reinforcement shall be placed and maintained in correct position. The reinforcements shall be joined

wherever necessary by welding and the procedure of welding be followed as described in IS 2751.

### **Concrete**

**Cement :** Cement shall be as specified in agreement item or as specified under sub- head 3.0 of CPWD Specifications. However, high alumina cement shall not be used.

**Water:** Water to be used for concreting shall be as specified under sub-head 3.0 of CPWD Specifications.

**Fine Aggregate:** Fine aggregate to be used for concreting shall be as specified under sub- head 3.0 of CPWD Specifications.

**Coarse Aggregate:** For tremie concreting, coarse aggregate having nominal size more than 20 mm should not be used. Natural rounded shingle of appropriate size may also be used as coarse aggregate. It helps to give high slump with less water cement ratio.

**Chemical Admixtures:** Admixtures to be used in the concrete shall be as per IS 9103.

### **Concrete Grades to be adopted**

- (i) Concreting of piles shall be done only with design mix of appropriate grade with weigh batching of constituents. The grade of concrete to be kept as per nomenclature of the item.
- (ii) Only concrete Grade M-30 and/or higher grades shall be used for concreting the piles. The exact grade of concrete to be used shall mainly depend upon the nature of work and the general design consideration. However, Concrete Grade M-15 and Grade M-20 shall not be used for concreting piles under any circumstances, even with weigh batching. The minimum cement content shall be 400 kg/m<sup>3</sup> in all conditions.
- (iii) When concreting under water or drilling mud 10 per cent additional cement over the minimum cement content for the particular grade shall be used subject to a minimum cement content of 370 kg/cum.

**Workability of Concrete:** The minimum slump shall be 100 mm when the concrete for the piles is being vibrated and when the concrete is not vibrated the maximum permitted slump is 150 mm. The degree of workability in both the cases is considered as very high.

### **Placing of Concrete**

- (i) Before commencement of pouring of concrete, it shall be ensured that there is no ingress of water in the casing tubes from bottom. Further, adequate control during withdrawal of the casing tube is essential so as to maintain sufficient

head of concrete inside the casing tube at all stages of withdrawal.

- (ii) Wherever practicable concrete should be placed in a clean dry hole where concrete is placed in dry hole and when casing is present, the top 3 m pile shall be compacted using internal vibrators. The concrete should invariably be poured through a tremie, with a funnel so that the flow is directed and concrete can be deposited in the hole without segregation. Care shall be taken during concreting to prevent as far as possible the segregation of the ingredients. The displacement or distortion of reinforcement during concreting and also while extracting the tube shall be avoided.
- (iii) Where the casing is withdrawn from cohesive soils for the formation of cast-in-situ pile, the concreting should be done with necessary precautions to minimize the softening of the soil by excess water. Where mud flow conditions exist, the casing of cast-in-situ piles shall not be allowed to be withdrawn.
- (iv) The concrete shall be self compacting and shall not get mixed with soil, excess water, or other extraneous matter. Special care shall be taken in silt clays and other soils with tendency to squeeze into newly deposited concrete and cause necking. Sufficient head of green concrete shall be maintained to prevent inflow of soil or water into concrete. The placing of concrete shall be continuous process from the toe level to the top of pile to prevent segregation, a tube of tremie pipe as appropriate shall be used to place concrete in all piles. To ensure compaction by hydraulic static heads, rate of placing concrete in the pile shaft shall not be less than 6 m (length of pile) per hour.
- (v) The diameter of the finished pile shall not be less than specified and a continuous record shall be kept by the Engineer as to the volume of concrete placed in relation to the length of pile cast. After each pile has been cast and any empty pile hole remaining shall be protected and back filled as soon as possible with approved material.
- (vi) The minimum embedment of cast-in-situ concrete piles into pile cap shall be 50 mm. Any defective concrete at the head of the completed pile shall be cut away and made good with new concrete. The clear cover between the bottom reinforcement in pile cap from top of pile shall not be less than 30 mm. The reinforcement in the pile shall be exposed for full anchorage length to permit it to be adequately bonded into the pile cap. Exposing such length shall be done carefully to avoid damaging the rest of the pile. In cases where the pile cap is to be laid on ground a leveling course with cement concrete of 1:4:8 and of 100 mm thickness shall be provided.
- (vii) Normally concreting of piles should be uninterrupted. In exceptional case of



interruption of concreting, but which can be resumed within 1 or 2 hours, the tremie shall not be taken out of the concrete. Instead it shall be raised and lowered slowly from time to time to prevent the concrete around the pipe from setting. Concreting should be resumed by introducing a little richer concrete with a slump of about 200 mm for each displacement of the partly set concrete. If the concreting cannot be resumed before final set of concrete already laid, the pile so cast may be rejected.

- (viii) In case of withdrawal of tremie out of concrete, either accidentally or to removed a choke in the tremie, the tremie may be re-introduced to prevent impregnation of laitance scum lying on the top of the concrete already deposited in the bore. The tremie shall be gently lowered on to the old concrete with very little penetration initially. A vermiculite plug should be introduced in the tremie. Fresh concrete of slump between 150 mm and 175 mm should be filled in the tremie which will push the plug forward and swill emerges out of the tremie displacing the laitance/scum. The tremie will be pushed further in steps masking fresh concrete sweep away laitance scum in its way. When the tremie is buried by about 60 to 100 cms, concreting may be resumed.
- (ix) The top of concrete in a pile shall be brought above the cut-off level to permit removal of all laitance and weak concrete before capping and to ensure good concrete at the cut-off level for proper embedment into the pile cap.
- (x) Where cut-off level is less than 1.5 metres below the working level concrete shall be cast to a minimum of 300 mm above cut-off level. For each additional 0.3 m increase in cut-off level below the working level additional coverage of 50 mm minimum shall be allowed. Higher allowance may be necessary depending on the length of the pile. When concrete is placed by tremie method concrete shall be cast to the piling platform level to permit overflow of concrete for visual inspection or to a minimum of one metre above cut off level. In the circumstances where cut-off level is below ground water level the need to maintain pressure on the unset concrete equal to or greater than water pressure should be observed and accordingly length of extra concrete above cut-off level shall be determined.

### **Placing Concrete under Water**

- (i) Before concreting under water, the bottom of the hole shall be cleared of drilling mud and all soft loose materials very carefully. In case a hole is bored with use of drilling mud, concreting should not be taken up when the specific gravity of bottom slurry is more than 1.2. The drilling mud should be maintained at 1.5 m above the ground water level. Concreting under water for cast-in- situ concrete piles may be done either with the use of tremie method

or by the use of approved method specialty designed to permit under water placement of concrete. General requirements and precautions for concreting under water are as follows:

- (a) The concreting of pile must be completed in one continuous operation. Also for bored holes, the finishing of the bore, cleaning of the bore, lowering of reinforcement cage and concreting of pile for full length must be accomplished in one continuous operation without any stoppage.
- (b) The concrete should be coherent, rich in cement with high slump & restricted water cement ratio.
- (c) The tremie pipe will have to be large enough with due regard to the size of the aggregate. For 30 mm aggregate the tremie pipe should be of diameter not less than 150 mm and for larger aggregate, larger diameter of tremie pipe may be necessary.
- (d) The first charge of concrete should be placed with a sliding plug pushed down the tube ahead of it to prevent mixing of water and concrete.
- (e) The tremie pipe should always penetrate well into the concrete with an adequate margin of safety against accidental withdrawal if the pipe is surged to discharge the concrete.
- (f) The pile should be concentrated wholly by tremie and the method of deposition should not be changed part way up the pile to prevent the laitance from being entrapped within the pile.
- (g) All tremie tubes should be scrupulously cleaned after use.

When concreting is carried out under water a temporary casing should be installed to the full depth of the bore hole or 2 m into non collapsible stratum, so that fragments of ground cannot drop from the sides of the hole into the concrete as it is placed. The temporary casing may not be required except near the top when concreting under drilling mud.

### **Ready Mix Concrete**

Alternatively, the Contractor can be allowed to use Ready Mix Concrete (RMC) with the permission of The Engineer, provided that the manufacturer assures that for RMC supplied for the particular work contains the minimum cement content and it is in conformity of approved design mix. The manufacturer of RMC has also to agree to the sampling and testing procedure as specified under clause 20.1.7 of relevant IS. or alternatively he can propose his own sampling and testing procedure which should in turn be approved by the The Engineer. Normally, RMC supplied to site are mixed with certain admixtures which enables the concrete to be used within 3 hours of supply at site. In case RMC supplied is not consumed within 3 hours of supply the

quantity of RMC remaining unused beyond 3 hours shall be rejected and removed from site.

**Important Note:**

The number of piles can be finalized only after the completion of the initial pile load test as per IS—2911 Part-4

The Pile design is based on Empirical formula and necessary revisions will be made after verification of load carrying capacity test as per 2911-Part 4 and results should be submitted for verification.

**A) Vertical load carrying capacity of Pile in CPRF:**

- The ultimate capacity of the piles is used in CPRF design.
- The ultimate load carrying capacity of 750mm diameter pile for a length of 20m is 230 Ton ( taken for CPRF design)

**B) Field test for CPRF:**

The relevant test required at field level ,for the CPRF with respect to the geotechnical engineering aspects should be carried out by the contractor as per the direction of the Engineer.

The protocols of the acceptance procedure and the measured values have to be included into the examination, the following aspects shall be considered in field,

1. Load Value: The piles must sustain a load of 230 tonnes during the initial load test.The load-settlement behavior and the load transfer within a CPRF should be monitored by a geotechnical engineer.
2. Settlement Criterion: The settlement of the piles under this load should not exceed 30mm.
3. The load is increased gradually until reaching the specified test load of 230 tonnes.

**2.4.1 Measurement**

Dimensions shall be measured nearest to a cm. Measurement of length on completion shall be along the axis of pile and shall be measured up to the bottom of pile cap. No allowance shall be made for bulking, shrinkage, cut off tolerance, wastage and hiring of tools, equipment for excavating, driving etc.

**2.4.2 Rate**

The rate includes the cost of material and labour involved in all the operations described above including pile embedded in pile cap except reinforcement, pile cap and grade beam

### 2.4.3 Water Pressure Relief Pipe

HDPE 100mm diameter pipe shall be provided at RCC base raft slab to a spacing of 4m c/c and rigidly fixed with raft reinforcement. The spacing and height of pressure relief pipe shall be varies at time of execution and water pressure test.

The pipe shall extend at bottom of PCC leveling coarse below raft slab. Filter media 40 mm size aggregate shall be provided at each pressure relief pipe lower end portion below PCC as sepcified in drawing and engineer's direction. And the pipe shall be inserted into the (Filter madia). After completion of entire work the pipe hole shall be sealed / grouted with high strength micro silica concrete.

## 2.5. STONE COLUMN

### Scope of Work:

This specification lays down the provisions for carrying out Ground improvement using vibro-floated Stone Column.

By stone column treatment, the non-plastic soils will be compacted for the following requirement:

- Making the soil Dense and mitigating the Liquefiable nature of the Soil ground
- Ground improvement to improve in-situ soil safe bearing capacity
- Ground improvement to limit settlement values as required for foundation design conditions.

The Stone Columns shall be executed by Vibro-displacement method and it shall be by dry bottom feed method or Wet Top feed method.

This specification lays down the requirements, methods and tests used / employed during the execution of the stone columns by wet bottom feed process.

The Contractor shall submit the detailed specification for the items not covered in this specification for approval by PMC/The Engineer during execution.

### Conflicts & Deviations

If conflicting statements exist within this document or between this document and other applicable specifications, Standard Drawings, Industry standards, codes, etc., it shall be brought to The Engineer / PMC notice for clarification and proper approval shall be obtained before implementation. Decision of The Engineer / PMC shall be final.

**Applicable Codes**

The relevant Indian codes, standards and specifications which are to be referred shall be the latest edition including all applicable official amendments and revisions.

- IS 15284 (Part 1):Code of practice for Design and Construction for Ground Improvement
- BS EN 14731:2005: Execution of special geotechnical works – Ground treatment by deep vibration.
- IS: 3764: Safety code for Excavation Work.
- IS: 1892 : Code of practice for Subsurface Investigation for foundations
- IS: 2386 (Part IV): Method of Test for Aggregates for concrete – Mechanical Properties.
- IS: 383: Specification for coarse and fine aggregates from Natural Sources.
- IS 15284 (Part 1): Code of practice for Design and Construction for Ground Improvement
- BRE 391 – 2000: Specifying vibro stone columns.
- IS 1893 - 2016: Criteria for earthquake resistant design of structures

**Ground Preparation**

The area where stone columns need to be executed shall be levelled / graded by filling / cutting the earth until the cut-off level required for the Stone Columns. Wherever filling is performed for grading purposes, the same shall be performed in layers of maximum 150 mm and compaction shall be performed to 95% dry density.

**Installation of Stone Columns**

Stone columns of required diameter shall be installed as per the procedure given below and as per the details and layout / construction drawing, by Vibro-floatation technique. Length of stone column from cut-off level shall be as per the Geotechnical Investigation Report and / or the Construction Drawings. The Stone columns shall be terminated in the firm stiff clay or medium dense sand with a minimum 500 mm embedment within this layer or as specified in the Soil report / Tender guide drawings / approved construction drawing. The termination depth for each zone shall be certified by the The Engineer. The Termination Criteria defined here is generally opted. However, the same shall be re-established as per the Soil Conditions or the Geotechnical Investigation Report.

- a) A borehole shall be formed at the location of stone column using vibro-float down to the required depth. The vibro-float shall be of adequate capacity to install stone columns as per the specified termination criteria and to achieve required compaction. Compaction criteria shall be established during installation of test stone columns.

- b) After reaching the required depth, the borehole shall be filled with well graded angular stones from 50mm down 8mm sieve. The individual particles of Stone aggregates shall conform to IS: 383 and should be clean, chemically inert, hard and resistant to breakage. All relevant tests (e.g., grain size, crushing value, impact value and abrasion value, etc) shall be carried out as per IS: 383 and results shall be furnished to The Engineer for approval. The amount of charge fills to be placed at one time shall be restricted, so that the compacted column of not more than 1m height is formed at a time.
- c) The vibro-float shall be withdrawn slowly in stages while compacting the granular fill. The compacting energy shall be adequate to form minimum the required diameter compacted stone column.
- d) The process shall be repeated till the stone column is formed until the cut-off level.
- e) Contractor shall maintain the records of the data as specified below for all test / working stone columns.
  - i) Overall depth of stone column and of embedment in firm stiff stratum.
  - ii) Total and average quantity of backfill material per linear metre of the column.
  - iii) Total time required to complete one stone column.
- f) The depth of stone column remaining un-compacted immediately below the cut-off level due to lack of adequate confining pressure, close to the top, shall be informed by the Contractor. A vibratory roller or any other mode of compaction shall be indicated by the Contractor. The compaction of the loose depth shall correspond to 85% minimum relative density or its equivalent.
- g) The empty boring portion above stone column cutoff level up to working platform level shall be backfilled with stone/sand.
- h) Cut off-level  
The cut off level shall be as per GFC drawings with provision for 500mm granular blanket layer
- i) Depth of Treatment  
Depth of liquefiable depth shall be assessed based on the individual boreholes within proposed structures and geotechnical recommendations. However, the general guideline for depth of treatment shall be considered up to a SPT, N value of 25 or equivalent  $Q_c$  for sandy soils.
- j) Termination Criteria

Termination shall be as per Approved GFC drawings. In case of refusal at early

or extending to deeper layers the Contractor shall take approval from the The Engineer by submitting necessary construction records. The decision taken by The Engineer shall be final.

### **Granular Blanket**

The treated area shall be cleared off muck and any undulation will be filled with sand and compacted to get a finish grade level surface up to the cut-off elevation of Stone Columns over which the granular blanket shall be constructed.

Granular blanket shall be laid over the top of stone column for minimum of 500mm thickness or as per the governing design criteria where raft foundation directly resting on stone columns.

The granular blanket shall be compacted to a relative dry density of 85 percent. Compaction shall be carried out with rollers or by any other suitable mechanical equipment. Granular blanket shall be laid in layers of 150mm and compacted to achieve desired compaction. The Stone Sand Blanket shall be constructed with mixture of 75 mm and down stone aggregates and well graded medium to coarse sand of Fineness Modulus not less than 2.2. The proportions for mix ratio of 2:1 (2 Stone Aggregates: 1 sand).

Percentage fines (silt & clay) shall be limited to less than 5% and shall be free of vegetation.

### **Sequence of Works (Stone Columns and RCC Piling Works Integration)**

Stone columns shall be performed before piling works. Integrated Layout of stone columns with RCC piling works shall be arranged so as to leave space for RCC Piling works. Stone columns layout shall consider soil condition, depth of stone columns required for liquefaction mitigation, Piling Layout.

**Integrity of pile:** Extreme care and caution should be taken to integrate the stone columns within the pile grids. The design of stone columns in terms of their arrangement and efficacy, when embedded in between the pile grids, should be thoroughly checked and the integrity of the RC pile shall never be affected in the process.

### **Ground Improvement**

The treated ground should satisfy the following requirements:

- Spacing of stone columns and depth shall be arrived based on the pile layout drawings/ shallow foundations.
- Liquefiable layers shall be considered as per Borehole details.
- The factor of safety against liquefaction shall be more than 1 after ground improvement.

- The allowable bearing capacity and settlement for raft shall be satisfied.

The ground improvement including improvement in SBC, reduction in settlement and liquefaction mitigation after construction shall be verified by reputed agency such as IIT/NIT through relevant field test. All the cost for field verification and charges payable to IIT/NIT shall be bound by the contractor.

### **Requirements of field verification**

Geotechnical report giving information on soil profile is attached with this tender document for guidance purpose. It reveals presence of entrapped liquefiable layers of soil which vary in location and thickness. If necessary, the Contractor will carry out additional geotechnical investigation at his own cost to firmly establish soil parameters, especially presence of liquefiable layers. If there are any major design variations, PMC will review the soil profile and design details before starting the execution of work.

#### **1) For mitigation of soil liquefaction potential**

The diameter and spacing of stone columns should be adequate to densify the liquefiable layer around pile in case of pile foundations with sufficient measure to convert it into non liquefiable layer. The target N (penetration) value to be reached in order to cross this threshold shall be derived for each liquefiable layer shall be derived using the methodology given in IS 1893 Part 1:2016.

The number of stone columns should be adequate to reach the target N value.

- a) The internal spacing as well as extent of stone columns beyond periphery of pile group in case of pile foundation and periphery of footings in case of open foundations shall be sufficient to satisfactorily cover zone of influence all around.
- b) Besides mitigation of liquefaction around local foundations, ground improvement by stone columns shall address overall stability of structure under seismic condition in terms of overall and differential settlement due to liquefaction.

#### **2) For improvement in net safe bearing capacity**

- a) The diameter and spacing of stone columns should be adequate to densify the soil below the footings in sufficient measure to achieve net safe bearing capacity as specified on the drawings.
- b) The internal spacing as well as extent of stone columns beyond periphery of footings shall be sufficient to satisfactorily cover zone of influence (i.e. pressure bulb) all around.
- c) The internal spacing as well as extent of stone columns beyond periphery of footings shall be sufficient to limit both overall and differential settlement to allowable values as per IS code.



- d) Ground improvement by stone columns shall be such as to provide overall stability of structure for under all applicable combinations of loads.

### **Field verification of SBC, Settlement and Liquefaction mitigation**

During the initial stone column plate load test carried out as per IS 15284 part 1, if the test results do not match with the design requirements in terms of SBC, settlement and liquefaction mitigation necessary design revision will be carried out by PMC and revised GFC drawings will be issued. Nothing extra will be paid in account of any revision made by PMC.

### **Submittals**

Before commencement of the work, the Contractor shall submit to the The Engineer for his approval for construction methodology, quality control procedure, method statement, procedure for carrying out initial & routine load test and post construction monitoring procedure after stone column and piles.

After completion of works at site, the Contractor shall submit complete test reports that include summary of drilling records, and other relevant information.

### **Records**

The following details shall be recorded during the Stone Column execution works and shall be submitted to The Engineer:

#### **Inspection & Test Plan**

- Request for Inspection
- Setting out Co-ordinates
- Material testing
- Measurement of Ground Level
- Daily Progress record for Ground Improvement
- Plate load test/ eCPT on Improved Ground
- Load Increment Chart
- Field Record For Plate Load Test/ eCPT
- Reaction and measuring gauged details

### **Post Treatment Performance Tests**

- a. **For Liquefaction Assessment postground improvement**
- i. Electric Cone Penetration Tests (eCPT) (or SPT) shall be carried out to check the efficacy of the ground improvement methods.
  - ii. Frequency: One eCPT (or SPT) shall be conducted for every 625

Sq.m of structure footprint area or minimum one number for each structure.

For SBC & Settlement assessment

- i. Initial & Routine Single and Group column load tests shall be carried out as per the procedure outlined in IS 15284 – Part 1.
- ii. Frequency for Routine Load Tests:  
One load test shall be carried out for every 625 Sq.m of structure footprint area or minimum one number for every structure

Suitable Measures and additional improvement methods shall be considered by contractor wherever load test are not qualified.

**b. Test note for mitigation of soil liquefaction potential**

The achievement of targeted N value after carrying out ground improvement shall be confirmed by carrying out cone penetration test for each liquefiable layer in numbers as directed. If N value is found to be less than the targeted value, the Contractor shall carry out additional measures without extra cost to achieve the targeted value.

**Test note for improvement in net safe bearing capacity**

The Contractor shall carry out vertical load test as per specification to confirm achievement of required net safe bearing capacity after carrying out ground improvement at the location and in numbers as directed.

**Load Tests On Trial Stone Columns**

The following Specifications shall be followed while performing the required tests on the Trial Stone Piles

- a) Load tests shall be performed on the trial stone columns at the test site to evaluate the load settlement behavior of the stone columns. These shall be conducted on single as well as on a group of three columns. Minimum of seven columns for single column test and fifteen columns for a three-column group test shall be constructed in a Triangular pattern. In case of Square Pattern, Minimum of nine columns for single column test and sixteen columns for a three-column group test shall be constructed. These are the minimum recommendations for the number of Test Columns. However, the same shall be established as per the area of improvement, soil conditions and design requirements.
- b) The load test site shall be closer to critical loading locations as far as possible.
- c) A granular blanket of, minimum 500 mm thick shall be spread over the test area before the commencement of the load tests. The blanket shall be compacted to a relative density of 85%.
- d) The diameter of the reinforced concrete footing / Steel plate shall be equal to the

spacing of stone columns in the case of a single column test with the center of the concrete footing/steel plate coinciding with the center of the stone column.

- e) In the case of a three column test the diameter of the concrete footing / steel plate shall be 1.81 times the spacing of the columns with its center coinciding with the center of area of the three columns laid in a triangular pattern.
- f) If the area is waterlogged, the water level shall be maintained at the concrete footing base level throughout the tests by dewatering. However, care shall be taken to prevent drawing out of water by centering the blanket on the subsoil.
- g) Application of Load and Settlement considerations:
  - 1) The load shall be applied to the concrete footing by a suitable reaction loading taking care to avoid impact, fluctuations or eccentricity. The Contractor shall submit a schematic diagram showing the arrangement of loading & procedure for testing for approval.
  - 2) The settlement shall be recorded by four dial gauges fixed at diametrically opposite ends of the plate / footing having sensitivity of 0.02mm.
  - 3) The Kent ledge weight should be such that it can safely ensure application of a test load. Minimum Kent ledge weight shall be 1.25 times the test load and shall be indicated by the Contractor. However, safe and efficient working of the loading arrangement is entirely the Contractor's responsibility and an impediment resulting in failure of the test arrangement may debar the Contractor from payment for the test. Alternatively, it may make the Contractor liable to repeat the test on a fresh series of columns without any extra payment to the Contractor for the stone columns.
  - 4) Each stage of loading shall be 1/10 of the design load and it shall be maintained till the settlement rate is less than 0.05mm/hr. The next stage of loading shall be applied only after approval of the Engineer. The maximum test load shall be established by the Soil Specialist as per the design requirements.
  - 5) The design load shall be maintained for a minimum period of 48hrs after the settlement have acquired the desired settlement rate. The maintenance period may be increased if the Engineer finds evidence of continual large cumulative settlements with the sustained design load.
  - 6) Settlement may be observed for each increment of load at intervals of 1, 2, 4, 8, 15, 30 and 60 minutes, 1 ½hrs, 2hrs, 4hrs, and so on till the desired rate of settlement has been achieved. These intervals, if required, may be modified after mutual discussions depending upon the test observations.
  - 7) Load versus time settlement graphs for each stage of loading shall be plotted and approval shall be taken from the The Engineer. The settlements occurring at the design load shall be clearly indicated on the load-settlement graph.
  - 8) The performance of the test columns shall be approved by the Engineer -

in-charge based on the field loading tests by the following criteria:

- 10mm to 12mm settlement at the design load for a single column test.
- 20mm to 30mm settlement at the design load for a three-column group test.

- 9) This is the general recommendation. However, this criterion shall be established by the Geo- Technical Specialist as per the Soil Conditions and Design Requirements.
- 10) The maximum test load shall be removed in five stages. Each un-loading stage shall be maintained till stabilization of settlements has taken place. Settlements shall be recorded at each stage as per para 6 above and load versus settlement graph shall be plotted as per para 7 above.

### **Load Tests On Working Stone Columns**

In order to ascertain the quality of job columns, a few single column tests shall be performed on the working columns depending upon the discretion of the The Engineer. The Contractor shall take necessary rectification measures like installation of additional columns, without any extra cost, if the working columns fail to meet the above performance criteria.

### **Sketches showing Stone column arrangement**

- ANNEXURE I - Sample Load Test Plans for Single / Group of Stone Columns (1 Sheet)
- ANNEXURE II- Sample Schematic Diagram of Standpipe (Casagrande) Piezometer (1 Sheet)

### **Schedule**

The Contractor shall complete the work as per the Time Schedule. The Contractor shall clearly mention the time frame / duration required for each of the above activities including initial, routine test, duration of stone column, piles and stone sand blanket etc,

### **Quality Assurance:**

Contractor shall provide respective method statement and Quality Control Plans (QCP) following the material specifications and other project specifications. Quality Control Plan are to be get approved by the Engineer duly before commencing of the work. Compliance of QCP does not relieve the Contractor from overall responsibility to render best quality of materials and work in conformity will all relevant specifications and best engineering practices.

The Contractor shall intimate about the selection of a Quality inspection agency or laboratory for acceptance test, sampling, material testing etc., to perform field quality assurance. The Contractor shall submit laboratory and onsite tests results to the The Engineer & PMC for approval.

The Contractor shall intimate about the selection of a Quality inspection agency or laboratory for acceptance test, sampling, material testing etc., to perform field quality assurance. The Contractor shall submit laboratory and onsite tests results to the The Engineer & PMC approval.

Stone Columns shall be carried out by approved execution procedures. The Contractor shall employ sufficient of experience personnel who are familiar with the Stone Columns execution described in this specification.

**IMPORTANT NOTE:**

- ❖ A qualified Geotechnical engineer with minimum of 10 years relevant experience in ground improvement works, he/ she should be appointed by the contractor during the execution of stone columns and piling works. The geotechnical engineer CV should be approved by PMC/ The Engineer.
- ❖ All the field tests including intial load tests, routine load tests etc., should be carried by the contractor, which needs to be approved by IIT/NIT, including the testing procedure and the test results. The test needs to be jointly witnessed by the representative of the Engineer, and an authorized representative of IIT/NIT.

**FIELD TEST:**

**Initial Load Test:**

Stone columns will be tested by

- 1.For the ultimate load capacity of stone column  
(or)
- 2.At least 1.5 times the design load.

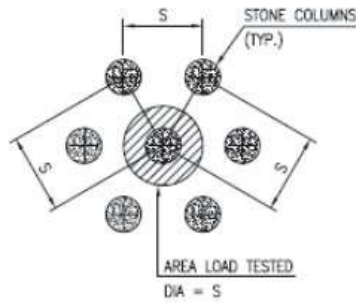
Importance of Load Testing:

1. Select a representative stone column for testing.
2. Apply load in increments as specified in the code.
3. To validate the load carrying capacity calculations
4. Measure settlement corresponding to each load increment.
5. Plot load-settlement curve and compare with design expectations.

**B) Routine Load Test:**

The stone columns will undergo routine load testing with loads up to 1.1 times the safe load.

**Annexure – I**

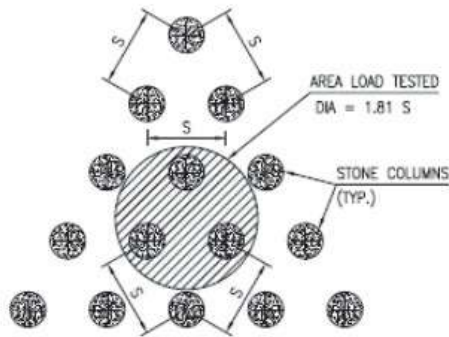


**LOAD TEST ON A SINGLE STONE COLUMN**

NOTE:-

1. S = SPACING OF STONE COLUMNS IN TRIANGULAR GRID PATTERN ( 1.8m ).

1) S= Spacing of stone columns Spacing as per approved design



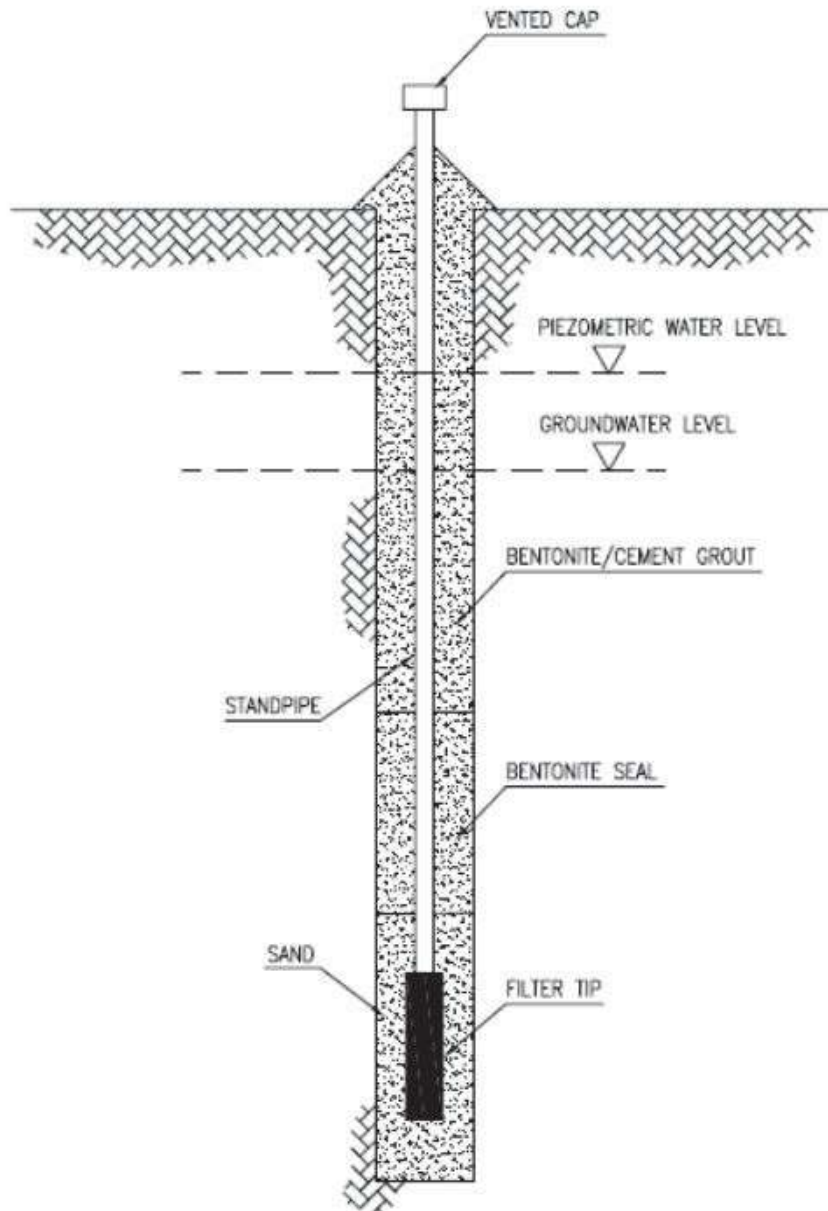
**LOAD TEST ON A GROUP OF THREE STONE COLUMNS**

NOTE:-

1. S = SPACING OF STONE COLUMNS IN TRIANGULAR GRID PATTERN ( 1.8m ).

1) S= Spacing of stone columns Spacing as per approved design

**Annexure II**



STANDPIPE (CASAGRANDE) PIEZOMETER

**2.6. CONCRETE WORKS:**

All concrete works shall be carried out in general as per CPWD Specifications 2019, Volume-I & II with up to date revisions/ amendments / correction slips issued till last date (including any extension, if any) of submission of bid. Unless specified otherwise, all the PCC work shall be of 1:4:8 Cement content of 174 kg and thickness of PCC shall be 100mm for foundations and 1:5:10 and thickness of PCC shall be 100mm for flooring

**2.7. RCC WORKS:**

Foundation shall be with RCC pile, isolated/combined, strip, raft type footing & retaining walls as per structural drawing using specified grade of concrete. The foundation level shown in the structural & architectural drawings are for supporting the foundation on firm strata as per SBC specified therein. The minimum depth of foundation shall be 3m with respect to existing ground level at particular location. However, care shall be taken to ensure to support the footings on firm strata as per minimum SBC specified in structural drawings. The mandatory tests required in accordance with IS 10042 need to be carried out during construction by the Contractor. Subsurface conditions encountered during construction may vary somewhat from the conditions encountered during site investigation. There is likelihood of encountering localized clay seams in the type of formation that exists at site. Therefore, it is essential to examine the founding levels very carefully during excavation and remove the same if met with till firm strata is ensured prior to laying of PCC. It should be ensured that at foundation level, no voids are there, if voids are observed the same shall be grouted. Necessary soil stabilization measures shall be implemented by the Contractor to achieve the bearing capacity as specified in structural drawings. Any deviation in earth work, concrete work, RCC work, or any other items of works will be ignored and nothing extra shall be paid on account of varying foundation level (in order to ensure supporting of foundation on firm strata and at minimum SBC specified in structural drawings). The Contractor shall quote the rate accordingly. RCC retaining shall be provided as per drawings and site condition. Unless specified otherwise, all structural members like footings, Columns, Beams, slabs etc. shall be provided with specified grades of concrete as under –

S. No.	Structural Element	Grade of Concrete
1	Foundations (Isolated or combined Footings, Pedestals, Rafts, Strip footings etc.	M-30
2	Pile Foundations	M-30
3	Columns and Shear Wall	M-40
4	Beams	M-30
5	Slabs	M-30



6	STP	M-35
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### **Design Mix Concrete (from Batch Mix Plant or from RMC Plant)**

Design mix is to be carried out as per IS 10262, IS 456, IS 4926, and other relevant IS codes / CPWD Specifications amended up to last date (including extended date, if any) of submission of bid. The Contractor shall carry out design mixes for each class of concrete indicating that the concrete ingredients and proportions will result in concrete mix meeting requirements specified. The cement shall be actually weighed as presumption of each bag having 50 kg shall not be allowed. In case of use of admixture, the mix shall be designed with these ingredients as well. All the ingredient shall confirm to relevant Indian standard as well as the CPWD specification.

The Contractor shall install fully automatic Batch Mix Plant at each site wherever permissible. Under special circumstances, Contractor will arrange concrete from RMC (Ready Mix Concrete) producing plants (located within 10 km distance from the site of work) with prior approval from The Engineer. Nothing extra shall be payable for sourcing concrete from RMC plant. For all purposes, the Contractor shall carry out fully, the responsibilities of the “placement Contractor” and the “manufacturer of concrete”.

Mobile Batching Plant of capacity 7 to 9 Cu.m. should mandatorily be Set-up within the Site boundaries for carrying out the M40 grade concreting work on continuous supervision of the PMC members & The Engineer representative.

The The Engineer will reserve the right to inspect at any stage and reject the concrete if he is not satisfied about quality of product at the user’s end.

The The Engineer reserves the right to exercise control over the: -

Ingredients, water and admixtures purchased, stored and to be used in the concrete including conducting of tests for checking quality of materials, recording of test results and declaring the materials fit or unfit for use in production of mix.

- i. Calibration check of the Fully Automatic Batching plant /RMC.
- ii. Weight and quantity check on the ingredients, water and admixtures added for batch mixing.
- iii. Time of mixing of concrete.
- iv. Testing of fresh concrete, recordings of results and declaring the mix fit or unfit for use. This will include continuous control on the workability during production and taking corrective action, if required.

All stone aggregate and stone ballast shall be of hard stone variety to be obtained from

approved quarries. Coarse sand should be obtained from approved sources. The same shall be clean and sharp angular grit type. The coarse sand shall be screened before using, if required. If the sand brought to site is dirty, it must be washed in clean water to bring the sand to the required specifications. Nothing extra shall be payable on this account.

For exercising such control, the The Engineer shall periodically depute his authorized representative at the fully automatic batching plant/ RMC. It shall be responsibility of the Contractor to ensure that all necessary equipment, manpower & facilities are made available to Engineer-in- Charge and/or his authorized representative at fully automatic batching plant/ RMC.

All required relevant records of produced and used concrete shall be made available to the Engineer- in-Charge or his authorized representative or PMC. The Engineer shall, as required, specify guidelines & additional procedures for quality control & other parameters in respect of materials, production & transportation of concrete mix which shall be binding on the Contractor. Only concrete as approved in design mix by The Engineer shall be produced and transported to the site.

The terms machine batched, machine mixed and machine vibrated concrete used elsewhere in agreement shall mean the concrete produced in concrete batching and mixing plant and if necessary transported by transit concrete mixers, placed in position by the concrete pumps, tower crane and vibrated by surface vibrator /needle vibrator / plate vibrator, as the case may be to achieve required strength and durability.

No fly ash mixing at site would be allowed. However, with prior approval of The Engineer, flyash mixing can be allowed at the Batching plants at site with proper handling mechanism and quality of fly ash as per codal requirement,

Under Special circumstances, Contractor can be allowed to procure concrete from RMC plant approved by the Engineer. However, nothing extra shall be payable to the Contractor on this account.

The concrete mix design with and without admixture will be carried out by the Contractor, at his own cost, through one of the following laboratories/Test houses to be approved by Engineer-in- charge: -

- i. IIT Guwahati
- ii. National Institute of Technology
- iii. Govt. Engineering College as approved by Engineer- In Charge
- iv. In the event of all the above laboratories being unable to carry out the requisite design/testing; the Contractor shall have to get the same done from any other reputed laboratory with prior approval of the The Engineer.

**Ultrasonic Pulse Velocity Method of Test for RCC**

- a) The underlying principle of assessing the quality of concrete is that comparatively higher velocities are obtained when the quality of concrete in terms of density, homogeneity and uniformity is good. The consistency of the concrete as regards its general quality gets established. In case of poorer quality lower velocities are obtained. If there are cracks, voids or flaws inside the concrete which come in the way of transmission of pulse, lower velocities are obtained.
- b) The quality of concrete in terms of uniformity, incidence or absence of internal flaws, cracks and segregation etc. indicative of the level of workmanship employed, can thus be assessed using the guidance given in table below, which have been evolved for characterizing the quality concrete in structure in term of the ultrasonic pulse velocity.

**Velocity criterion for Concrete Quality Grading**

S.No.	Pulse Velocity by Cross Probing (Km/Sec)	Concrete Quality grading
1	Above 4.5	Excellent
2	4.5 to 3.5	Good
3	3.5 to 3.0	Medium
4	Below 3.0	Doubtful

- c) Pulse velocity method of test of concrete is to be conducted for as a routine test. The acceptance criteria as per the above table will be applicable which is as per IS 13311 (part-1): 1992. From the above “Good” and “Excellent” grading are acceptable and below these grading the concrete will not be acceptable.
- d) At least 5% of the total number of RCC members in each category i.e. beam, column, slab and footing may be tested by UPV test method for establishing quality of concrete. It is suggested that test be conducted on RCC beam near joint with column, on RCC column near joint with beam, on RCC footings and rafts. On RCC rafts a suitable grid can be worked out for determining number of tests. In addition, doubtful areas such as honeycombed locations, locations, where continuous seepage is observed, construction joints and visible loose pockets will also be tested.

The test results are to be examined in view of the above acceptance criteria “Good” and “Excellent” and wherever concrete is found with less than required quality as per acceptance criteria, repairs to concrete will be made. Honeycombed areas and loose pockets will be repaired by grouting using Portland Cement Mortar/Polymer Modified Cement Mortar /Epoxy Mortar, etc. after chipping loose concrete in appropriate manner. In areas where concrete is found below acceptance criteria and defects are not apparently visible on surface,

injecting approved grout in appropriate proportion using epoxy grout /acrylic Polymer modified cements slurry made with shrinkage compensating cement / plain cement slurry etc will be resorted to for repairs (refer relevant chapters from CPWD Hand Book on Repairs and Rehabilitation of RCC Buildings). Repair to concrete will be done till satisfactory results are obtained as per the acceptance criteria by retesting of the repaired area. If satisfactory results are not obtained dismantling and relaying of concrete will be done at the cost of Contractor.

Standard of acceptance shall be same as specified in clause 16 of IS 456-2000. In case of rejection of concrete on account of unacceptable compressive strength, the work for which samples have failed shall be redone at the cost of Contractors. However, the The Engineer may order for additional tests (like cutting cores, ultrasonic pulse velocity test, load test on structure or part of structure etc) to be carried out at the cost of Contractor to ascertain if the portion of structure wherein concrete represented by the sample has been used, can be retained on the basis of results of individual or combination of these tests. The Contractor shall take remedial measures necessary to retain the structure as approved by the The Engineer without any extra cost.

Cover/Spacer Block- The Contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as called for cover in the drawings, spacer blocks of required shape and size. Chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. Only factory-made cover blocks shall be used. Pre-cast cement mortar/concrete blocks/blocks of polymer shall not be used as spacer blocks unless specially approved by the The Engineer. This shall be done as per approval of The Engineer without any extra cost.

### **Construction Joints**

Construction joints shall be provided as shown in the drawing and also at places where concreting is stopped due to unforeseen circumstances. The joints shall be straight and vertical through the full thickness of the slab. While concrete in adjacent bay is still green, flats of suitable size shall be drawn along the edge and a groove of size 10 mm × 25 mm deep shall be neatly formed and finished. The edges of the groove shall be full nosed. After curing of concrete is complete, this groove shall be thoroughly cleaned of all sand dust and shall be perfectly dried and filled with hot poured sealing compound conforming to grade B of IS 1834. Before filling with sealing compound the faces of concrete of the joint shall be coated with primer of approved brand to a depth of 25 mm at the rate of 2.6 liters per 10 square meters. Bitumen emulsion shall not be used as primer.

### **2.8. SHUTTERING / FORMWORK:**

The work shall be done in general as per CPWD Specifications 2019, Volume-I & II with date revisions/ amendments / correction slips issued upto last date of submission of bid.

Double steel scaffolding having two sets of vertical supports shall be provided for external wall finish, cladding etc. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding platform shall be fixed. Scaffolding shall have steel staircase for inspection of works at upper levels.

In order to keep the floor finish as per architectural drawings and to provide required thickness of the flooring as per specifications, the level of top surface of R.C.C. shall be accordingly adjusted at the time of its centering, shuttering and casting for which nothing extra shall be paid to the Contractor.

As per general engineering practice, level of floors in toilet / bath, balconies, shall be kept lower than general floors as required from waterproofing point of view. Shuttering should be adjusted accordingly. Nothing extra is payable on this account Dented, broken, cracked, twisted or rusted shuttering shall not be allowed to be used on the work. The shuttering shall be cleaned properly with electrically driven sanders to remove any cement slurry or cement mortar or rust. Proper shuttering oil or de-bonding compound shall be applied on the surface of the shuttering in the requisite quantity before assembly of steel reinforcement.

For the execution of centering and shuttering, the Contractor shall use propriety shuttering oil as approved by The Engineer and nothing extra shall be paid on this account.

All existing formwork that fail to meet the specifications mentioned above or do not qualify to meet the minimum standards in the view of The Engineer shall have to be removed and stacked.

### **2.9. REINFORCEMENT:**

The reinforcement work shall be done as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips upto last date of bid submission (including extensions if any).

Reinforcement work includes all operations including straightening, cutting, bending, welding, binding with annealed steel or welding and placing in position at all the floors with all leads and lift complete as per CPWD Specifications.

The Contractor shall provide approved type of support for maintaining the bars in position and ensuring required spacing and correct cover of concrete to reinforcement as mentioned in the drawings. Spacer blocks of required shape and size, chairs and spacer bars shall be used in order to ensure accurate positioning of reinforcement. To ensure proper cover, factory made round / rectangular type cover blocks will be used to avoid displacement of bars in any. Couplers shall be used for splicing of reinforcement bars.

Reinforcement TMT bars, to be used for the work, shall be corrosion resistance TMT bars of grade Fe 500D.

Bar Bending Schedule: The agency shall prepare bar bending schedule as per structural drawings and submit to The Engineer in advance for approval. The bar bending schedule shall

conform to Indian Standard IS 2502-Code of Practice for Bending and Fixing of bars for Concrete Reinforcement. Before execution of work, two copies of these bar bending schedules including revision, will be submitted to The Engineer for approval. Keeping in view the quantum of the work, the BBS shall preferably be prepared with software and one person acquainted with preparing BBS with software shall be deputed at site to speed up the work.

## **2.10. MASONRY WORK:**

The masonry work shall be done as per CPWD Specifications 2019, Volume-I & II with revisions / amendments / correction slips upto last date of bid submission (including extensions if any). In case of conflict or contradiction between detailing shown in drawings and specification mentioned herein under this subhead, the specification mentioned herein under this subhead will be followed.

Chicken mesh 24 gauge 19 mm size galvanised chicken wire mesh of approved make and design to be provided at junctions of RCC or CC members and brick work and other locations including necessary clips and "U" nails rawl plugs, screws etc. complete for all height as per specifications & direction of the The Engineer.

For masonry work above plinth level, RCC band at sill level and lintel level shall be provided. This thickness of the band shall be 100 mm or as per in drawing as approved by the The Engineer.

All opening on masonry wall shall be provided with RCC lintels, RCC bands / lintel over top of parapet wall at corridors, balconies etc. with specified grade of concrete as shown in the drawing or as approved by The Engineer.

AAC blocks masonry shall be of Grade I and of oven dry density 551-650 kg/cum with Cement Mortar 1:4 mix (1 cement : 4 coarse sand).

- a) Dimensions & Tolerances: Autoclave Aerated Concrete Block shall be made in sizes and shapes to fit different needs.
- b) The maximum variation in the length of the Autoclave Aerated Concrete Block shall not be more than plus/minus 5mm and maximum variation in the height and width of Autoclave Aerated Concrete Block, not more than plus/minus 3mm.
- c) The faces of Autoclave Aerated Concrete Block shall be flat & Rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angle to the face of the Blocks. The Autoclave Aerated Concrete Block with special faces shall be manufactured and supplied if so required.
- d) The autoclaved Autoclave Aerated Concrete Block shall be classified in two

grades according to their compressive strength as indicated in table below:

S.N.	Density in Oven dry Condition (Kg/m <sup>3</sup> )	Compressive Strength (N/mm <sup>2</sup> )		Thermal Conductivity in air dry condition (W/m.k)
		Grade I	Grade II	
1	451 to 550	2.00	1.50	0.21
2	551 to 650	4.00	3.00	0.24
3	651 to 750	5.00	4.00	0.30
4	751 to 850	6.00	5.00	0.37
5	851 to 1000	7.00	6.00	0.42

- e) All Autoclave Aerated Concrete Block shall be sound, free of cracks or other defects which interfere with the proper placing of block units impair the strength or performance of the construction. Where block units are to be used in exposed wall construction, the face or faces that are to be exposed shall be free of chips, cracks or other imperfections except that if not more than 5% of a consignment contains slight cracks or small chippings not larger than 25mm, this shall not be deemed grounds for rejection.
- f) Block Density – The Block density shall conform to the requirements specified in above table, when tested accordance with IS 6441 (Part-1) -1972.
- g) Compressive Strength – The min. compressive strength being the average of twelve block units shall be as prescribed in above table, when tested accordance with accordance with IS 6441 (Part-5) -1972.
- h) Thermal Conductivity – The thermal conductivity shall not exceed the values specified in above table when tested accordance with IS 3346 -1980.
- i) Drying Shrinkage – The drying shrinkage shall be not more than 0.05% for grade –1 block and 0.10% for grade-2 block when tested accordance with IS 6441 (Part-2) -1972.
- j) Number of tests: A sample of 24 blocks shall be selected at random. All the 24 Blocks shall be checked for dimensions and inspected for visual defects. Out of the 24 blocks, 12 blocks shall be subjected to the test for compressive strength, 3 blocks to the test for density, 3 blocks to the test for thermal conductivity and 3 blocks to the test for drying shrinkage. The remaining 3 blocks shall be reserved for re-test for drying shrinkage if a need arises.
- k) The samples of AAC blocks (each sample consisting of 6 specimen) shall be chosen randomly from the lot procured and tested for various parameters specified as above. One samples shall be tested for every 200 cum or part thereof. However, minimum one sample shall be tested from each lot received at site if the quantity procured in the lot is less than 200 cum. If required, The Engineer or his authorized representative shall inspect the factory during production of the

material for this work and also collect samples (of materials used for making AAC blocks and precast AAC blocks) from the factory itself. The Contractor shall consider this contingency also while placing the order with one of the approved firms. Nothing extra shall be payable on this account.

- l) Criteria for conformity: The number of blocks with dimensions outside the tolerance limit and or with visual defects, among those inspected, shall not be more than two. For density, the mean value shall be within the range as specified in above Table. For compressive strength, the mean value, say X shall be determined. The test results shall be grouped into groups of 4, individual values of ranges shall be determined, the average range a calculated from these values and shall satisfy the following condition:  $X - 0.6 R >$  minimum value specified in above Table. For thermal conductivity, the mean value shall be equal to or less than the value specified in above Table. For drying shrinkage, all the test specimens shall satisfy the requirements of the test. If one or more specimens fail to satisfy the requirements, the remaining 3 blocks shall be subjected to these tests. All these blocks shall satisfy the requirements.
- m) Manufacturer's Certificate: The manufacturer shall satisfy himself that the masonry units conform to the requirements of this specification and, if requested, shall supply a certificate to this effect to the purchaser or his representative.
- n) Marking: Each lot of concrete masonry units manufactured in accordance with this specification shall preferably be marked with information-
- ❖ The identification of the manufacture
  - ❖ The grade and block density of the unit
  - ❖ The month and year of manufacturing

### Measurements

Autoclave Aerated Concrete Block Masonry shall be measured in cubic metres unless otherwise specified. Any extra work over the specified dimensions shall be ignored. Dimensions shall be measured correct to the nearest 0.01 metre. ie. 1 cm. Areas shall be calculated to the nearest 0.01 sqm and the cubic contents shall be worked out to the nearest 0.01 cubic metres. Note : (i) Autoclave Aerated Concrete Block work in parapet walls, mummy, lift machine room and water tanks constructed on the roof upto 1.2 m height above roof shall be measured together with the corresponding work of the floor next below

### Rate

The rate shall include the cost of materials and labour required for all the operations described. The rate shall also include the following:

- (a) Raking out joints or finishing joints flush as the work proceeds;
- (b) Preparing tops of existing walls and the like for raising further new block work.
- (c) Rough cutting and waste for forming gables, splays at eaves and the like.



- (d) Leaving holes for pipes upto 150 mm dia. and encasing hold fasts etc.
- (e) Rough cutting and waste for block work curved in plan and for backing to stone or other types of facing.
- (f) Embedding in ends of beams, joists, slabs, lintels, sills, trusses etc.
- (g) Bedding wall plates, lintels, sills, roof tiles, corrugated sheets, etc. in or on walls if not covered in respective items
- (h) Leaving chases of section not exceeding 50 cm in girth or 350 sq cm in cross-section; and
- (i) Block on edge courses, cut brick corners, splayed reveals, cavity walls, brick work curved on plan to a mean radius exceeding six metres.

Brick masonry of class designation 7.5, with cement mortar 1:6 (1 cement: 6 coarse sand), shall be done in wet areas. FPS bricks of class designation 7.5 in cement mortar 1:6 (1 Cement : 6 Coarse Sand) shall be used in brick work in foundation upto plinth level and super structure or other masonry work shown in drawings.

#### **Dry Partition Wall:**

Glass Reinforced Gypsum (GRG) plaster board shall be conforming to IS 2095 (Pt.-3):1996 (Board with BIS Certification mark) The G.I. frame and board partitions shall be fixed as per nomenclature of the item and directions of The Engineer. Joints of the boards shall be finished with specially formulated Jointing compound and fibre tape to provide seamless finish. It is easy and simple to attach different fittings to wall panelling boards. Inclined nails can be fixed to the boards itself for light materials. For heavier materials the fastening should be centered on internal stud work or steel or wood frame behind the boards, fixed before boarding. Services should be incorporated before commencement of board fixing. Tolerance in dimensions shall be + 5 mm.

#### **Measurements**

The length and height shall be measured correct to a cm. Area shall be calculated in square meters correction two place of decimal. No deduction shall be made for ducts, opening made from the standard size of panel.

#### **Rate**

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

#### **2.11. WOOD & PVC WORK:**

The wood work in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). In case of conflict or contradiction between detailing shown in drawings and specification mentioned herein under this subhead, the specification mentioned herein under this subhead will be followed. The detailing shown in door and window drawings are suggestive only. Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of doors, showing all hardware's) shall be prepared (on the basis of specification laid herein) and submitted by Contractor for obtaining approval from

The Engineer and PMC.

The samples of species of timber to be used shall be deposited by the Contractor with the Engineer- in-Charge before commencement of the work. The Contractor shall produce cash vouchers and certificates from standard kiln seasoning plant operator about the timber to be used on the work having been kiln seasoned by them, failing which it would not be accepted as kiln seasoned. Specified timber shall be of good quality and well-seasoned. It shall have uniform colour, reasonably straight grains and shall be free from dead knots, cracks and sapwood.

Wood work shall not be painted, oiled or otherwise treated before it has been approved by the The Engineer and PMC. All portion of timber including architrave abutting against masonry concrete stone or embedded in ground shall be painted with approved wood preservative or with boiling coal tar.

Door/window schedules is provided with the tender document which shall be followed invariably. If any door type or tag is not mentioned in drawings or door & window schedule, decision shall be given by The Engineer and PMC based on door suggested in door & window schedule for similar functional area. Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of doors, showing all hardware) shall be prepared and submitted for obtaining approval from The Engineer and PMC.

Flush Door Shutters - Flush door shutters shall be of 35 mm thick or of thickness as specified/required/decided (in door & window schedule or in drawings) and conforming to IS: 2202 (Part I) Non decorative type, core of block board construction with frame of 1st class hard wood and well matched teak 3 ply veneering with vertical grains or cross bands and face veneers on both faces of shutters. Stainless Steel butt hinges with necessary screws shall be used for fixing. Lipping with 2nd class teak wood battens of 25 mm minimum depth on all edges of flush door shutters shall be provided. Rebate shall be cut (in frames/shutters) as specified and instructed by The Engineer and PMC. Vision panel of required and specified shape e.g. rectangular, square, circular etc. shall be provided.

Laminates- Flush doors shall be provided with 1.5 mm thick Decorative high pressure laminated sheet (on both side) of plain / wood grain in gloss / matt/ suede finish with high density protective surface layer and reverse side of adhesive bonding quality conforming to IS: 2046 Type S, including adhesive of approved quality. The laminates shall be resistant to fungal attack at the end of 28 days of incubation when tested as per ASTM: G 21 - 2015 test method.

Melamine Polish shall be done (in 3 or more coats to achieve superior finish) on all teak wood & decorative veneered surfaces.

### **Flush door hardware**

Door lock: Providing and fixing Stainless steel (SS 304) Mortice door lock with handles as

per CPWD specification and matching to LOM provided lever handles of approved quality with necessary screws etc. complete.

Door closer : Providing and fixing aluminium die cast body tubular type Concealed door closer/PA Bracket (having brand logo with ISI, IS : 3564, embossed on the body, door weight upto 35 kg and door width upto 700 mm), with necessary accessories and screws etc. complete.

Providing and fixing Stainless steel (SS 304) sliding door bolts, ISI marked in matt finish required colour or shade, with nuts and screws etc. complete : 250x16 mm dia 'Providing and fixing stainless steel (Grade 304) tower bolts approved equivalent with necessary screws etc. complete. Size 150 x 10mm & 250 x 10mm

Providing and fixing SS (304)hanging floor door stopper, ISI marked, matt finish with necessary screws etc. complete. Single rubber stopper

Metal Doors (Pressed Metal Doors): Unless specified otherwise, frame shall be single rebate profile made out of 1.20mm thick (minimum) galvanized steel sheet (18 gauge) and Door shutter shall be single leaf/double leaf fully flush double skin with or without vision panel manufactured from 1.2mm (18 gauge) minimum thick galvanized steel sheet. The profile of frame and thickness of shutter shall be as per manufacturer's specifications. Frames should be mitered, field assembled with self- tab. All provision should be mortised, drilled and tapped for receiving appropriate hardware. The frames shall have inbuilt grooved sealing system and site fitted with PVC seal as standard the frames shall be filled with puff. Frames should be provided with back plate for anchor fasteners for installation on a finished plastered wall opening. The internal construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core filled with mineral wool of density 96 kg/m<sup>3</sup>. For Double leaf doors astragal has to be provided on meeting stile for both active and inactive leaf. Doors should have passed minimum 500 hours of salt spray test. All doors should be finished with Powder coating (minimum 60 micron) in desired regular RAL Shades.

FRP Doors: - Fiber Glass Reinforced plastic (FRP) Door Frames shall have cross- section 90 mm x 45 mm with single rebate of 32 mm x 15mm to receive shutter of 30 mm thickness. Door frame laminate shall be 2 mm thick and shall be filled with suitable wooden block in all the three legs. The laminate shall be moulded with fire resistant grade unsaturated polyester resin and chopped mat. The frame shall be covered with fiber glass from all sides. M.S. stay shall be provided at the bottom to steady the frame. Fiberglass Reinforced Plastic (F.R.P.) flush door shutter of (30 mm thickness) should consist in different plain and wood finish made with fire retardant grade unsaturated polyester resin, moulded to 3mm thick FRP laminate all around, with suitable wooden blocks inside at required places for fixing of fittings and polyurethane foam (PUF)/ Polystyrene foam to be used as filler material throughout the hollow panel, casted monolithically with testing parameters of laminate conforming to table - 3 of IS: 14856, as per direction of Engineer- In-Charge and PMC.

High Pressure Compact Laminate: It shall be provided as per finishing schedule in 8 mm thick High Pressure interior compact Laminate (of) made out of thermo setting resin treated, Kraft as core material and design paper as a finish surface. The compact laminates should be resistant to water immersion through permissible increase on thickness and mass <0.60% and board should have density >1.35kg/cm<sup>3</sup>. compact laminates should be flame retardant and fulfill the criteria of classification of B-s1,d0 of EN 13501-1. It shall have Anti bacterial and anti-termite property as per JIS Z2801:2000, Chemical resistance, Scratch resistant, fire resistance, weather & climatic shock resistance. It should fulfill the criteria of FSC and Green Guard Gold certification and manufactured under EN438-2&3:2005 standard. Finish and colour of compact laminates should be finalized under direction of Engineer-in-charge. compact laminates should be installed on 25x50mm aluminum tube or approved tube size at 500mm c/c under desirable height and fixed through same compact colour rivets or compact adhesive as per recommended by manufacturer's specification/instructions. Finish and colour of Interior clade should be approved under The Engineer and PMC direction. The manufacturer should provide 10 years warranty certification on any manufacturing and moisture related defects.

**Wall Guard, Corner Guard:**

Wall guard, corner guard and hand rails shall be provided invariably in all corridors, Lobbies, internal ramps. Corner guards shall be provided at every corner. Wall guard and handrails shall be provided at 750 mm from FFL or at height specified in drawings or conforming to relevant standards.

- a) The wall guard should be superior impact resistance wall guard vinyl (Lead free) Snap on cover of 0.080'' (2mm) thickness extruded from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added (plasticizers may aid in bacterial growth). Surface shall have a Pebblette texture for scratch and stain resistance mounting on continuous aluminum retainer of 0.080''(2mm) thickness shall be fabricated from 6063-T5 aluminium, with a mill finish having dimensions of 6''(152mm) height x 1''(25mm) depth. Inner snap- on vinyl impact black bumper should be of 0.080'' (2mm) thickness x 3.930'' (100mm) width x 21mm height, which shall be extruded from chemical and stain resistant unplasticized polyvinyl chloride (uPVC). The system shall resist an impact of 45.5 ft-lbs/inch while producing no visual blemishes upon vinyl cover surface and no deformation in the aluminum retainers, as tested in accordance with applicable provision of ASTM F 476-84 for impact test and shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The system shall also confirm to class 'A' fire rating and ASTM D-543 for chemical and stain resistance. It shall include injection molded and end caps with black reveal strip.
- b) Handrail should be having rigid vinyl Snap-on cover (Lead Free) of 080'' (2mm)

thickness extruded from chemical and stain resistant Unplasticized Polyvinyl Chloride (uPVC) with the addition of impact modifiers. No plasticizers shall be added (Plasticizers may aid in bacterial growth). Surface shall have a Pebblette texture for scratch and stain resistance with rigid vinyl cover mounted on a sturdy continuous Aluminum Retainer of .080" (2mm) thickness that shall be fabricated from 6063-T5 Aluminum with a mill finish. Dimensions to be 4-5/16" (110mm) height x 1-5/8" (41mm) Gripping Diameter, extends 3-1/8" (79mm) from wall which has a oval gripping surface. The system shall resist an impact of 30.2 ft-lbs/inch of thickness as tested in accordance with the procedures specified in ASTM D-256- 90b, impact Resistance of Plastics. The rigid vinyl shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The system shall also conform to class 'A' fire rating and ASTM D-543 for chemical and stain resistance. It includes Molded end returns with black reveal strip and mounting brackets.

- c) Corner guard should be having Vinyl Snap on cover (Lead Free) of .080" (2mm) thickness extruded from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added (plasticizers may aid in bacterial growth). Surface shall have a Pebblette texture for scratch resistance and stain resistance and shall be mounted on continuous Aluminum Retainer of .070" thickness fabricated from 6063-T5 aluminum, with a mill finish. Dimensions to be of 3" (76mm) x 3" (76mm),90 degree. The rigid vinyl profile shall resist an impact Strength of 30.2 ftlbs/inch as per ASTM D-256-90b and shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The system shall also conform to class 'A' fire rating and ASTM D-543 for chemical and stain resistance. It includes Top caps and bottom caps which shall be made of injection molded thermoplastics.
- d) Stainless Steel (Grade 304) Braille Labels of size 170mm x 35mm X 0.5 mm having Braille dots raised 0.5mm above base plate with one SS rivet of same grade and adhesive of approved make shall be provided on handrails.

Glazed Doors: All the glazed doors (non-fire rated) be made in toughened glass with necessary fittings and fixtures of stainless steel (SS 304) required to make the door operational and function smoothly, complete as per directions of The Engineer (necessary shop drawings should be prepared by the Contractor and work shall be executed after obtaining approval from Engineer- in-charge in recommendation with PMC). The thickness of glazing should be 12 mm.

Roller Blinds shall be provided of approved make and approved shades having 0.40mm thickness in 100% polyester material with 100% Degree of opacity & having Weight of 375gm/Sqm to 450gm/Sqm in all sizes and for all Heights complete as per the direction of The Engineer.

Cubical track system: Providing and fixing /installation of hospital cubical track system with following specifications: Track material shall in general be aluminum alloy 6063-T-6 having tensile strength 195 MPA, shear strength 150 MPA. All materials shall be corrosion-resistant and shall have minimum 50- micron polyester powder coating of approved shade. Hospital cubical curtains shall consist of anti-microbial polyester blended fabric with 450 mm nylon mesh (net) on the top of curtain. The fabric shall be specially coated with anti- microbial coating and shall be wrinkle free, shrink-proof, anti-odour, anti- fungal and stain-repellent. Curtains shall be fitted with stainless steel grommets at 150 mm centers. Anti-microbial quality of fabric shall be tested by AATC- 147-2004 method (Qualitative method). The shade and design shall be decided by the The Engineer.

All fittings and fixtures shall be as per hardware schedule for doors / windows (mentioned in tender document) and got approved from the The Engineer before procurement well in advance and the approved samples shall be kept at site till completion of the work.

#### **Hardware For Doors / Windows:**

- a) BUTT HINGES: 5 Knuckle, 2 bearing butt hinges size 4" x 3" x 3mm, in SS 304 and in satin stainless steel as per EN 1935, CE Marked suitable for door weights upto 120kgs
- b) VISION PANEL: Unless otherwise specified, toughened glass of 6 mm thickness.
- c) GRAVITY COORDINATOR: Door coordinator /sequencer for the double leaf doors of make.
- d) DOOR LOCK: 55mm backset, 20mm square for end prepared for euro profile cylinder including strike plate. and EPC 70mm Length both side key operation & Escutcheons in SSS Finish
- e) FLUSH BOLT: DORMA lever action flush bolt with 19mm projecting bolt (LENGTH 172 mm OR 300 MM AS PER DIRECTION OF THE ENGINEER) in satin chrome.
- f) FLOOR SOCKET: Spring loaded dust excluding floor socket with fixing accessories, in satin Chrome finish.
- g) DOOR BOTTOM SEAL : Automatic Door Bottom Seal, Heavy Duty, Face Mounted Version, spring loaded to lift clear of the floor as soon as the door leaf is opened, suitable to be used on Fire and smoke check doors, Seal Material = Silicon, Finish = Anodized Satin Clear, Length = 48" IN SATIN CLEAR FINISH)
- h) DELTA SEAL : Delta Seal for acoustic, fire and smoke protection, suitable for wooden and steel frames, self-adhesive, Finish = Black, Length = 1 x 2000mm,

Height- 2 x 2750mm IN BLACK FINISH

- i) PA BRACKET: Parallel arm bracket suitable for surface mounted door closer for fixing of door closer in Silver finish.
- j) ARMOR PLATE: Armour plate with smoothed edges and rounded corners flush face fixing screws height 1000mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width.
- k) PUSH PLATE: Push plate with smoothed edges and rounded corners flush face fixing screws size 150 x 400 x 1.2 mm in SS 304 grade in satin stainless steel
- l) SIGN PLATES: Male/Female/Disable sign plate for WC application with fixing screws size 150x150x1.2 mm, rounded corners in SS 304 satin stainless steel finish with marking in black
- m) MOP PLATE: Mop plate with smoothed edges and rounded corners flush face fixing screws height 150mm and thickness 0.9mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width. Max door width =1200mm
- n) KICK PLATE: Kick plate with smoothed edges and rounded corners flush face fixing screws height 300mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width
- o) D type 300mm long CTC, 22mm Dia Pair of pull handle in SS 304 B/B fixing of.
- p) Offset type D handle of 450mm long CTC, 25mm Dia pair of handle in SS 304 B/B fixing.
- q) FLUSH PULL HANDLE: Stainless steel Flush Pull handle with fixing of screw at flush with surface of doors
- r) Door Stoppers: Stainless Steel (grade 304) wall mounted or hanging floor door stoppers in stainless steel satin finish with necessary SS screws etc.
- s) Door Closer: Aluminum die cast body tubular type universal hydraulic door closer (having brand logo with ISI mark, IS: 3564, embossed on the body, with necessary accessories and screws etc.
- t) Stainless Steel handles: Bright /matt finished Stainless Steel handles (Window) of approved quality & make with necessary screws etc.
- u) Pull Handle: 25mm dia, 300 mm long in cranked / square shape stainless steel (Grade 304) satin finish pull handle with necessary screws etc.
- v) Sliding Door Bolt: 250x16mm Stainless steel (Grade 304) satin finish sliding door

bolts of superior quality with necessary SS screws etc.

- w) Mortice Latch: Brushed finished 100mm mortice latch in stainless steel satin/polished finish with euro deadlock (Coin release) with rose rings and pair of stainless steel (grade 304 ) lever handles with necessary SS screws etc.
- x) Tower Bolt: Stainless steel (Grade 304) tower bolts with necessary SS screws etc. complete.

### **Fire Check / Rated Door:**

CPWD Specification 2019 Vol. I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions, if any), National Building Code (NBC) 2016 and manufacturer's specification will be followed. Fire Check doors shall be provided in buildings wherever necessary and required as per National Building Code 2016, as per door & window schedule and as per architectural drawing provided with tender document. Unless otherwise specified elsewhere in tender document, all fire doors should be fire rated for 120 minute and doors of fire exit corridor should meet the requirement of fire exit corridor specified in NBC 2016. In general all the services/electrical rooms/shafts shall be provided with Metal Fire Check/rated doors whereas all the lobbies, entry/exit to corridors shall be provided with the Glazed fire check/rated doors. Rooms opening in fire exit corridors may be provided with wooden fire check/rated doors. In case of any deviation is found between general principle mentioned herein and Fire check doors shown in architectural drawings (or mentioned door & window schedule), the former general principle (mentioned herein) will be followed. If any door type or tag is not mentioned in drawings or door & window schedule, decision shall be given by The Engineer based on principles mentioned herein. Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of doors, showing all hardware's) shall be prepared and submitted for obtaining approval from The Engineer.

The Fire check/rated Door should not collapse during the rated period of the fire under specified fire conditions. The fire door should not allow the passage of hot gases or the flames through the rebate or the gap between the door frame and shutter. The integrity or smoke sealing function is achieved by Fire Door by incorporating an "Intumescent Seal". This Intumescent Seal in the form of a strip, which under fire conditions expands many times its original size and forms a hard char which has high insulation properties and does not permit the smoke or flames to escape through the gap between the shutter and frame.

Observation, if any, made by the fire officer on the fire check/rated doors, shall be incorporated suitably. Nothing extra shall be paid on this account.

Execution of Fire Check Doors shall be carried out through the Specialized Agencies having sufficient work experience in the same field and shall be got approved from the The Engineer well in advance. Specialized firm shall furnish all materials, labour, accessories, equipment, tool and plant and incidentals required for providing and installing the fire check/rated doors.



Contractor has to select one specialized agency from list of preferred makes/brands and specialized agencies.

Fire resistance and smoke check doors shall be made of proper sizes and section as per the available opening at the site. The details shown on the drawings indicate generally the sizes of components parts and general standards. These may be varied slightly to suit the standard adopted by the manufactures. Before proceeding with manufacturing, the Contractor shall prepare and submit complete manufacture and installation drawing for approval of the The Engineer and no work shall be performed until the approval of these drawings is obtained.

The term “Fire Rating” referred in tender documents means fire rating of complete assembly of fire check door e.g. frames, shutter, Vision Panel, Glass, Hinges and other hardware’s. Doors will be approved only after door passes the required tests from fire testing lab approved by the Engineer-in- Charge. Cost of sample door and testing shall be borne by Contractor.

Doors shall be fabricated to size in factory. Fabricated material shall be protected against any damage during transportation. Loading and unloading shall be carried out with utmost care. On receipt of material at site it shall be carefully examined to detect any damaged units/members. Arrangements shall be made for expeditious replacement of damage units or members. Materials found acceptable on inspection shall be repacked in crates and stored safely.

Just prior to installation, the doors shall be uncartered and stacked on edge on level bars and supported evenly. The frame shall be fixed into position true to line and level using adequate number of fastener of approved size and manufacture and in an approved manner. The holes in concrete /masonry member for housing anchor bolts shall be drilled with an electric drilling machine only.

Stainless steel ball bearing hinges, panic bars, door trims, fire rated hydraulic door closers, handles, tower bolts, lock and other fittings shall be as per hardware schedule for doors & windows provided in tender document and shall be got approved from The Engineer. All Hardware’s should have a minimum 02 Years of manufacturer warrantee from the date of supply. Hardware’s should pass European certificate "CE" of conformity / UL certified with required fire ratings and relevant documents to this effect shall be produced at the time of approval of samples.

The design of fire check/rated doors and material to be used in their construction have to be such that the doors shall be capable of providing an effective barrier of desired rating.

**Glazed Fire Check / Rated Doors / Window / Partition –**

- a. Fire check/rated glazed door/window/fixed partition, shall be provided as per following specification.
- b. Non load bearing fixed frame for fire resistant glazed Partition for 120 min Fire

Rating, should be made out to a profile of dimension 60mm x 70 mm of 1.6 mm thick galvanized steel sheet as per test evidence suitable for fixing fire rated glass for 120 min of both integrity & radiation control (EW120) & minimum 20 min of insulation (EI20). The profile has to be fixed to the supporting construction by means of anchor fasteners of size M10 x 80, every 150 mm from the edges and every 500 mm (approx) c/c. The frame shall be filled with mineral wool insulation of density min 96kg/m<sup>3</sup> and finished with a approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer-in-charge.

- c. Fire resistant door frame of section 50 x 60 mm on horizontal side & 35 x 60 mm on vertical sides having built in rebate made out of 1.6 mm thick GI sheet (Zinc coating not less than 120gm/ m<sup>2</sup>) suitable for mounting 120 min Fire Rated Glazed Door Shutters. The frame shall be filled with Mineral wool Insulation having density min 96 Kg/m<sup>3</sup>. The frame will have a provision of G.I. Anchor fasteners 14 nos ( 5 each on vertical style & 4 on horizontal style of size M10 x 80 ) suitable for fixing in the opening along with Factory made Template for SS Ball Bearing Hinges of Size 100x89x3mm for fixing of fire rated glazed shutter . The frame shall be finished with an approved fire resistant primer or Powder coating of not less than 30 micron in desired shade as per the directions of Engineer-in-charge.
- d. Glazed fire resistant door shutters should be 60 mm thick with suitable mounting on door frame, consisting of vertical styles, top rail & side rail 60 mm x 60 mm wide and bottom rail of 110 mm x 60 mm made out of 1.6mm thick G.I. sheet (zinc coating not less than 120gm/m<sup>2</sup>) duly filled mineral wool insulation having density min 96 kg/ m<sup>3</sup> and fixing with necessary stainless steel ball bearing hinges of size 100x89x3mm of approved make, including applying a coat of approved fire resistant primer or powder coating not less than 30 micron etc. all complete as per direction of Engineer-in- charge. Glazed fire resistant door shutters should be having 120 min Fire Rating confirming to IS:3614 (Part II) or EN1634-1:1999, tested and certified as per laboratory approved by The Engineer.
- e. Providing and fixing glazing in fire resistant door shutters, fixed panels & partitions etc., with G.I. beading made out of 1.6 mm thick G.I. sheet (zinc coating not less than 120 gm/m<sup>2</sup>) of size 20 x 33 mm screwed with M4 x 38 mm SS screws at distance 75 mm from the edges and 150 mm c/c , including applying a coat of approved fire resistant primer/ powder coating of not less than 30 micron on G.I. beading, & special ceramic tape of 5 x 20 mm size etc. complete in all respect as per NBC 2016, IS 16231 (Part 3):2016 and as per direction of The Engineer with bidirectional inter layered glass of required thickness having 120 minutes of fire resistance both integrity & radiation control (EW120) and minimum 20 minutes of insulation (EI20). The manufacturer have to give test report/certification of fire glass and the glass should have the stamp showing the

value of E, EW & EI. The glass shall be tested in approved NABL accredited lab or by any other accreditation body which operates in accordance with ISO/IEC 17011 and accredits labs as per ISO/IEC 17025 for testing and calibration scopes shall be eligible.

### **Metal Fire Check / Rated Doors-**

- a. Metal Fire door shall be from ISO 9001:2015 certified manufacturers. The door must have been manufactured with galvanized - GI sheet of GPSP Grade as per IS 277. All Fire doors must satisfy the requirement of latest NBC 2016 Part 4 for Fire & Life Safety guidelines. The Prototype sample of the door must carry a prior test evidence as per IS 3614 part-2 / BS 476 Part 20 & 22. The manufacturer must submit the copy of test evidence prior to start of production. The offered test certificate should either carries it's Validity or certificate must not be older than 5 years from CBRI / NABL Accredited Lab. All doors should be finished with Powder coating (minimum 60 micron) in desired regular RAL Shades.
- b. Door frame shall be Single rebate profile of section 125 x 55 mm made out of minimum 1.20mm thick galvanized steel sheet with a factory pre-punched groove so as to accommodate fire seal size (minimum 10x4mm). Frames should be mitered, butt jointed and field assembled with bolting system for proper strength. Frames shall have in built grooved sealing system and shall be site fitted with fire rated EPDM gasket as standard. All provision should be mortised, drilled and tapped for receiving appropriate hardware. Frames should be provided with back plate for anchor fasteners for installation on a finished plastered wall opening.
- c. Door leaf should be minimum 46mm thick fully flush double skin door. Door leaf must be manufactured from minimum 1.2 mm (18 gauge) thick galvanized steel sheet. The internal Construction of the door should be rigid reinforcement pads for receiving appropriate hardware. The infill material shall be resin bonded honeycomb core. For Double leaf doors astragal has to be provided on meeting stile for both active and inactive leaf. Vision panels wherever required should be provided with specified shape and sizes of glass (bidirectional inter layered glass of required thickness).

### **Fire rated hardware for fire check doors:**

All hardware's for fire check/rated doors shall also be fire rated and shall have certification from UL/CE.

- a. DOOR CLOSER: Extruded aluminum body Heavy duty Fire Rated Door Closers with full body cover. The Door Closers should be spring adjustable type 2-6, Non handed with back check, and tested along with the fire doors from CBRI Roorkee

as per BS476 Part-22 and IS 3614 Part-2. The door closer shall have 10 years mechanical warranty from the manufacturer and complies with EN 1154- for 50000 cycles + A1: 2002 CE Certified

- b. BUTT HINGES: 5 Knuckle, 2 bearing butt hinges size 4" x 3" x 3mm, in SS 304 and in satin stainless steel as per EN 1935, CE Marked suitable for door weights upto 120kgs
- c. VISION PANEL: Unless otherwise specified, bidirectional inter layered glass of 15 mm thickness shall be used.
- d. GRAVITY COORDINATOR: Door coordinator /sequencer for the double leaf doors
- e. PANIC BAR-SINGLE POINT: Panic bar / latch (Single point) suitable for single / active leaf of door.
- f. PANIC BAR-TWO POINT OR DOUBLE POINT: Panic bar / latch (Two point or Double point) with vertical rod and top and bottom latch suitable for double doors or inactive leaf of door.
- g. EXTERNAL TRIM: External trim on back side of the Panic Latch ELECTROMAGNETIC HOLD OPEN-Electro Magnetic hold open device for holding the door in open condition EM with armature plate with 24v DC
- h. EM LOCK FOR HOLD OPEN DOOR- Holding force of 1200 lbs EM Lock with 1200 ALH and EM 1200 2ALH with armature receiving plate, surface mounted 12/24 VDC including armature plate holder.
- i. DOOR LOCK: 55mm backset, 20mm square forend prepared for euro profile cylinder including strike plate. and EPC 70mm Length both side key operation & Escutcheons in SSS Finish
- j. FLUSH BOLT: DORMA lever action flush bolt with 19mm projecting bolt (LENGTH 172 mm OR 300 MM AS PER DIRECTION OF THE ENGINEER) in satin chrome.
- k. FLOOR SOCKET: Spring loaded dust excluding floor socket with fixing accessories, in satinChrome finish.
- l. DOOR BOTTOM SEAL : Automatic Door Bottom Seal, Heavy Duty, Face Mounted Version, spring loaded to lift clear of the floor as soon as the door leaf is opened, suitable to be used on Fire and smoke check doors, Seal Material = Silicon, Finish = Anodized Satin Clear, Length = 48"IN SATIN CLEAR FINISH
- m. DELTA SEAL : Delta Seal for acoustic, fire and smoke protection, suitable for

wooden and steel frames, self-adhesive, Finish = Black, Length = 1 x 2000mm, Height- 2 x 2750mm IN BLACK FINISH .

- n. PA BRACKET: Parallel arm bracket suitable for surface mounted door closer for fixing of door closer in Silver finish.
- o. ARMOR PLATE: Armour plate with smoothed edges and rounded corners flush face fixing screws height 1000mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width.
- p. PUSH PLATE: Push plate with smoothed edges and rounded corners flush face fixing screws size 150 x 400 x 1.2 mm in SS 304 grade in satin stainless steel
- q. SIGN PLATES: Male/Female/Disable sign plate for WC application with fixing screws size 150x150x1.2 mm, rounded corners in SS 304 satin stainless steel finish with marking in black.
- r. MOP PLATE: Mop plate with smoothed edges and rounded corners flush face fixing screws height 150mm and thickness 0.9mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width. Max door width =1200mm.
- s. KICK PLATE: Kick plate with smoothed edges and rounded corners flush face fixing screws height 300mm and thickness 1.2 mm in SS 304 grade in satin stainless steel. Length=5mm short of the shutter width.
- t. Pull handle:
  - i. D type 300mm long CTC, 22mm dia pair of pull handle in SS 304 B/B fixing.
  - ii. Offset type D handle of 450mm long CTC, 25mm dia pair of handle in SS 304 B/B fixing.
  - iii. FLUSH PULL HANDLE: Stainless steel Flush Pull handle with fixing of screw at flush with surface of doors.
  - iv. Pull Handle: 25mm dia , 300 mm long in cranked / square shape stainless steel (Grade 304) satin finish pull handle with necessary screws etc.
- u. Door Stoppers: Stainless Steel (grade 304) wall mounted or hanging floor door stoppers in stainless steel satin finish with necessary SS screws etc.
- v. Sliding Door Bolt: 250x16mm Stainless steel (Grade 304) satin finish sliding door bolts of superior quality with necessary SS screws etc.

- w. Mortice Latch: Brushed finished 100mm mortice latch in stainless steel satin/polished finish with euro deadlock (Coin release) with rose rings and pair of stainless steel (grade 304) lever handles with necessary SS screws etc.
- x. Tower Bolt: Stainless steel (Grade 304) tower bolts with necessary SS screws etc. complete.

**uPVC:**

Factory made uPVC white colour sliding glazed window upto 1.50 m in height dimension comprising of uPVC multi-chambered frame with in-built roller track and sash extruded profiles duly reinforced with  $1.60 \pm 0.2$  mm thick galvanized mild steel section made from roll forming process of required length (shape & size according to uPVC profile), appropriate dimension of uPVC extruded glazing beads and uPVC extruded interlocks, EPDM gasket, wool pile, zinc alloy (white powder coated) touch locks with hook, zinc alloy body with single nylon rollers (weight bearing capacity to be 40 kg), G.I fasteners 100 x 8 mm size for fixing frame to finished wall and necessary stainless steel screws etc. Profile of frame & sash shall be mitred cut and fusion welded at all corners, including drilling of holes for fixing hardware's and drainage of water etc. After fixing frame the gap between frame and adjacent finished wall shall be filled with weather proof silicon sealant over backer rod of required size and of approved quality, all complete as per approved drawing & direction of The Engineer. (Single / double glass panes, wire mesh and silicon sealant shall be paid separately). Variation in profile dimension in higher side shall be accepted but no extra payment on this account shall be made.

For uPVC frame and sash extruded profiles minus 5% tolerance in dimension i.e. in depth & width of profile shall be acceptable.

Two track two panels sliding window made of (big series) frame 67 x 50 mm & sash 46 x 62 mm both having wall thickness of  $2.3 \pm 0.2$  mm and single glazing bead / double glazing bead of appropriate dimension . (Area of window above 1.75 sqm upto 2.50 sqm).

Window Accessories: 'Bright/matt finished Stainless Steel handles of approved quality & make with necessary screws etc all complete as per engineer incharge.

**Guarantee for uPVC Work:**

The Contractor shall guarantee about proper design and performance of uPVC work for a period of 10 years from the date of completion of work.

The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, thermal stresses, building movements and the like.

The 10 year guarantee, shall be furnished in non-judicial stamp paper of value Rs.100/- or more, in prescribed proforma for performance of glazed units, anodizing, EPDM/silicon gaskets

and sealants. The guarantees shall be submitted before final payment and shall not in any way limit any other rights to correct which the The Engineer may have under the Contract.

### **2.12. ALUMINUM WORK:**

- (a) Before taking up any procurement/construction activity, shop drawings (for fixing of all kind of Aluminum Works, showing all hardwares) shall be prepared and submitted for obtaining approval from The Engineer.
- (b) Minimum weight of aluminum section for door, windows and ventilators shall be as per relevant standards.
- (c) Kiln seasoned hard wood shall be filled inside door frames on hinged side and top of frames wherever hydraulic door closers are to be provided.
- (d) Frames shall be fixed with dash fastener of minimum size 10 x 100 mm as per approved shop drawings.
- (e) Gap between aluminum frame / aluminum window and adjacent RCC / masonry work shall be filled by providing weather silicon sealant over backer rod of approved quality as per direction of The Engineer.
- (f) The material for the work shall be procured from the approved manufacturer as per preferred make list for materials in this contract agreement. The Contractor shall procure and submit samples of various materials to be used in the work for the approval of The Engineer and no work shall commence before such samples are approved. Samples of un-anodized as well as polyester powder coated aluminum sections, microwave cured EPDM gaskets, glass, stainless steel screws, anchor fasteners, hardware and any other material or components requiring approval of samples, in opinion of The Engineer, shall be submitted for the approval as mentioned above. The above samples shall be retained as standards of materials and workmanship.
- (g) Aluminum sections to be used for various works shall be appropriate to meet technical, structural, functional and aesthetic considerations. Aluminum work for doors, windows, ventilators and partitions etc. shall be with extruded built up standard tubular sections/ appropriate Z sections and other sections of approved make conforming to IS: 733 and IS: 1285, fixing with dash fasteners of required dia and size, including necessary filling up the gaps at junctions, i.e. at top, bottom and sides with required EPDM rubber/ neoprene gasket 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 The Engineer. Polyester powder coated aluminum (minimum thickness of polyester powder coating 50 micron) section shall be used.

Hinges/ pivots, provision for fixing of fittings, EPDM rubber / neoprene gasket shall be provided wherever required. The polyester powder coating shall be carried out in a factory / workshop approved by the Engineer.

- (h) Glass in Windows/Ventilators: Glazing in windows, ventilators and partition etc. shall be Double glazed hermetically sealed with 6 mm thick toughened glass both side, having 12 mm air gap, including providing EPDM gasket, perforated aluminum spacers, desiccants, sealant (Both primary and secondary sealant) etc. as per specifications, drawings and direction of The Engineer complete. The DGU unit shall have visible Light transmittance (VLT) of minimum 65%, Light reflection internal - less than or equal to 23%, Light reflection external - less than or equal to 23 %, SHGC- less than or equal to 0.6 and U value - less than or equal to 2.5 W/m<sup>2</sup> degree K.
- (i) Frameless glass partition and doors: Frameless glass partition and doors shall be made out of 12 mm thick (minimum) toughened glass of approved brand and manufacture, including providing and fixing top & bottom pivot & double action hydraulic floor spring, fixing arrangement and making necessary holes etc. for fixing required fittings, all complete as per direction of Engineer-in- charge.
- (j) Hydraulic floor spring: It shall be double action hydraulic floor spring conforming to IS : 6315, having brand logo embossed on the body / plate with double spring mechanism and door weight up to 125 kg, for doors, cover plates with brass pivot and single piece M.S. sheet outer box with slide plate etc.
- (k) Mortice Latch & lock: It shall be of Brass 100 mm mortice latch and lock with 6 levers without pair of handles (best make of approved quality) for aluminum doors in partition.
- (l) Fabrication: The factory for fabrication and coating of aluminum partition frameworks shall be got approved from Engineer-charge. The fabrication unit should have experience of having done similar work of similar cost in 7 years prior to date of submission of proposal by Contractor.
- (m) All joints shall be accurately fabricated and be hairline in appearance. The finished surface shall be free from visible defects. All the aluminum partition shall be factory made and shall be brought to site for assembly and fixing.
- (n) All hardware used shall conform to the relevant specifications mentioned in door window hardware schedule and as per samples approved by the Engineer- in-Charge. Design, quality, type, number and fixing of hardware shall be generally in accordance with shop drawings and as approved by the Engineer- in-Charge before use.
- (o) All doors, windows, ventilators and glazing etc. shall be made water tight with



microwave cured EPDM gaskets and weather silicone sealants to the satisfaction of the Engineer-in-Charge.

- (p) The frames shall be strictly as per architectural drawings, the corners of the frame being fabricated to the true right angles. Both the fixed frames and openable shutter frames shall be fabricated out of sections cut to required length, mitered and mechanically jointed for satisfactory performance. All members shall be accurately machine milled and fitted to form hairline joints. The jointing accessories such as aluminum cleats, stainless steel screws etc. shall not to cause any bi-metallic reaction by providing separators, wherever required. Vertical members of the aluminum frame work shall be embedded in the floors, wherever required, by cutting and making good of the floor.

### **Fixing Of Aluminum Frame Work**

- a. The screws used for fixing fixed aluminum frames of the partition to masonry walls / RCC members and aluminum members to other aluminum members shall be of stainless steel of approved make and quality and of stainless steel grade 304. Threads of machine screws used shall conform to requirement of I.S. 4218.
- b. For the aluminum partition, the gap between the aluminum frames and the R.C.C / Masonry and also any gaps in the various sections shall be filled with weather silicone sealant DC 795 of Dow Corning or equivalent in the required bite size, to ensure water tightness including providing and fixing backer rod, wherever required. The weather silicone sealant shall be of such approved colour and composition that it would not stain or streak the masonry / R.C.C. work. It should not sag or flow and shall not set hard or dry out under any conditions of weather and shall be tooled properly. The weather silicone sealant shall be used as per the manufacturer's specifications and shall be of approved colour and shade. Any excess sealant shall be removed / cleared.
- c. Fixing of glass panes shall be designed in such a way that replacing damaged /broken glass panes is easily possible without having to remove or damage any members or interior finishing materials.

### **Protections and Cleaning**

- a. All glass panes shall be retained within aluminum framing by use of exterior grade microwave cured EPDM gaskets. Use of glazing or caulking compounds around the perimeter of glass will not be permitted. There shall be no whistling or rattling. Before installation of glass, Contractor shall ensure the following:
- b. All glazing rebates shall be square, to plumb, true to plane, dry and free from dust.

- c. Glass edge shall be clean and cut to exact size and grounded
- d. Glass of specified thickness in doors, windows, ventilators and fixed glazing etc. shall be of approved make and standard quality conforming to C.P.W.D. Specifications

### **Guarantee for Aluminium Work**

The Contractor shall guarantee about proper design and performance of aluminum work for a period of 10 years from the date of completion of work.

The design and installation shall be to the best international standards and shall specially take account of wind and seismic loads, storms, thermal stresses, building movements and the like.

The 10 year guarantee, shall be furnished in non-judicial stamp paper of value Rs.100/- or more, in prescribed proforma for performance of glazed units, anodizing, EPDM/silicon gaskets and sealants. The guarantees shall be submitted before final payment and shall not in any way limit any other rights to correct which the The Engineer may have under the Contract.

### **Measurements**

All the aluminium sections including snap beadings fixed in place shall be measured in running meter along the outer periphery of composite section correct to a millimeter. The weight calculated on the basis of actual average (average of five samples) weight of composite section in kilogram correct to the second place of decimal shall be taken for payment (weight shall be taken after anodizing). The weight of cleat shall be added for payment. Neither any deduction nor anything extra shall be paid for skew cuts.

### **Rate**

The rate shall include the cost of all the materials, labour involved in all the operations as described in nomenclature of item and particular specification.

### **2.13. FLOORING, MARBLE, CLADDING WORK:**

All flooring work and cladding work in Granite, Tile, Marble, Stones, Wooden, Carpet etc. in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips upto last date of bid submission (including extensions if any). The tiles / stones shall be as specified in the schedule of finishes and architectural drawings provided with tender document. The tiles / stones shall be of approved colours and shades and will be laid in pattern as per approved architectural drawings or shop drawings. Nothing extra shall be paid for laying tiles / different stones in specific design/pattern. The tiles shall be of first quality of approved make and nothing extra shall be paid for use of cut/saw tiles in the work. Schedule of finishes mentioned in tender documents shall be followed in case of deviation/different detailing is shown in Architectural Drawings. Before taking up any procurement/construction activity, shop drawings shall be prepared and submitted for obtaining approval from The Engineer.

Proper gradient shall be given to flooring for toilets, verandah, kitchen, courtyard, corridors etc. so that the wash water flows towards the direction of floor trap. Any reverse slope if found, these shall be made good by the Contractor by ripping open the floor/grading concrete and nothing shall be paid for such rectifications.

Samples of flooring material are to be deposited well in advance to the Engineer- in-Charge for approval. Approved samples should be kept at site with the The Engineer and the same shall not be removed except with the written permission of The Engineer.

**The samples shall be submitted along with the following details:**

- a. Three representative samples for each type of flooring/cladding specified.
- b. Details of physical characteristics such as dimensional tolerances (within the specified limits), water absorption, compressive strength, Mohs Hardness, Specific gravity with reference to IS or International standards.
- c. Source of supply and confirmation of availability in full quantity and uniformity of colour, tone and textures.
- d. Company profile of Suppliers.

The The Engineer or his representative may, if required, visit the source of supply of the various materials (Granite/Stones/Marble/Tiles/Cladding etc.) to assess the quality as well as availability of the material in the required quantities.

The entire supply for each type of granite/stone slabs shall be procured from one location (in one quarry), and supplied preferably, in one lot to keep variations to the minimum. The Contractor shall also segregate and sort the slabs according to colour, shade, texture and size of grains etc. to keep variation(s) in stones used at any one floor to the minimum. Any slab with variation in the colour, shade, texture and size of grains etc., not acceptable to the Engineer-in- Charge/PMC, shall not be used in the work and shall be removed and replaced by the Contractor. Nothing extra shall be payable on these accounts. Also, no claim of any kind shall be entertained from the Contractor on this account.

Based on the samples approved by the The Engineer for various flooring and dado / cladding materials as specified hereinafter, the Contractor shall prepare mock up(s) at site of work for approval of quality of workmanship and material specified. If the quality of the workmanship and the material is as per the required standards and approved by the Engineer-in- Charge, the mock up shall be allowed as part of the work. Otherwise, it shall be dismantled by the Contractor as directed by the The Engineer and taken away from the site of the work at his own cost. The mock up(s) so made shall be kept till completion of respective works for reference.

The (Granite/Stones/Marble/Tiles/Cladding etc.) shall be transported to site well packed in boxes or otherwise. These shall be handled carefully to prevent any damage. Granite stone slabs shall be individually packed in cardboard paper. The various types of stones and tiles, procured shall be free of any surface defect or any edge damage. The damaged

(Stones/Marble/Tiles/Cladding etc.) shall not be allowed to be used in the work. So, the Contractor shall procure additional quantity of the stone and tiles to cover such contingencies. The stone slabs shall not be waxed or touched up with dyes / colours

The following tolerances shall be allowed in the dimension of granite stone slab:

- a) Length  $\pm$  1mm
- b) Width  $\pm$  1mm
- c) Thickness - 1mm
- d) Angularity at corners  $\pm$  0.25%

The stone (slab and tiles) not meeting the above tolerance limits shall be rejected and not permitted to be used in the work. Nothing extra shall be payable on this account.

Stones slabs shall have uniform thicknesses within the tolerance limits and linear items like treads, sills and jambs, coping, risers, urinal partitions, kitchen / wash basin platforms, vanity counters, facias and other similar locations etc. shall have edge polished calibrated thickness i.e. exposed edges shall have edge polished uniform thickness throughout the length of the work.

The flooring work shall be carried out as per the architectural drawings in design and pattern (geometric, abstract etc.) and in linear and / or curve linear portions and in combination with stones of different colour and shade and ceramic tiles etc. For the flooring portions curved in plan, the stone slabs (at the edge) shall be cut to the required profile and shape as per the architectural drawings. Nothing extra shall be payable on this account and any consequent wastage and incidental charges on such accounts shall be deemed to be included in the cost.

The granite slabs used for providing and fixing in the sills, soffits and jambs of doors, windows, ventilators and similar locations shall be in single piece unless otherwise directed by the Engineer- in-Charge. Wherever stone slab other than in single piece is allowed to be fixed, the joints shall be provided as per the architectural drawings and as per the directions of the The Engineer. In the cabin areas, the joints in sills shall preferably be provided in line with the partition wall. Depending on the number of joints, as far as possible, the stone slabs shall be procured and fixed in slabs of equal lengths as per the architectural drawings and as directed by The Engineer.

The specifications for dressing, laying, curing, finishing etc. for the granite stone flooring shall be same as that of works for the Marble flooring, skirting and risers of steps under Flooring Sub Head of the CPWD Specifications. The wall lining / veneer work with granite stone shall be as per the CPWD Specifications for Marble work Sub Head.

All the tiles (flooring/wall lining/Skirting/dado) shall be fixed with quick set tile adhesive (of make Pidilite, Ardex endure, Weber) of minimum thickness of 6 mm. Also joints of flooring tiles having 3 mm width shall be grouted using epoxy grout (of Pidilite, Ardex Endure,

Weber) mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg).

Wet stone/granite wall cladding (in interior) shall be fixed in average 20 mm thick cement mortar in 1:3 (1 cement: 3 coarse sand), and proper adhesives with copper pins 7.5 cm long, 6 mm diameter for securing adjacent stones in stone wall lining. Dry stone cladding shall be fixed with proper adhesives as approved by the engineer incharge for the exterior cladding works

Unless specified otherwise, all stone/granite/marble in flooring shall be laid on 20 mm (average) thick base of cement mortar 1:4 (1 cement: 4 coarse sand) and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade.

Unless otherwise specified, all stone/granite/marble in skirting/wall lining/dado shall be fixed on 20 mm (average) thick base of cement mortar 1:3 (1 cement: 3 coarse sand) and jointed with cement slurry and pointing with white cement slurry admixed with pigment of matching shade.

For flooring work, the joints between the different types of flooring shall be located as per the architectural drawings. Also, the Contractor shall maintain the uniform level of the finished flooring of the different types unless specifically mentioned on the architectural drawings.

All the flooring works specified under this sub-head shall be adequately protected by a layer of Plaster of Paris which shall be laid over a 400- m i c r o n PVC film. The protective layer shall be maintained throughout the execution of works and removed just before handing over of the site.

One piece Granite stone for treads / risers in staircase shall be used including rounding of nose.

POP protection layer shall be laid on all finished floors for protection from damage during execution of other items of work in that area which shall be removed and cleaned just before handing over of the premises.

For the skirting in the enclosures with curvilinear profiles, the (Stones / Marble / Tiles / Cladding etc.) shall be cut to the required size and the shape to match the profile and/ or the joints as per the architectural drawings. Similarly, the skirting shall be fixed in a manner as to flush or project from the finished face of the wall as per the architectural drawings and as directed by the Engineer – in– Charge. Any chasing of the masonry works required for such fixing is deemed to be included in the cost of masonry.

Granite stone tiles and slabs shall be pre polished (mirror polished), eggshell polished, flame finished or given any other surface treatment as specified in finishing schedule or architectural drawings and as directed by the Engineer-in- Charge.

Machine polishing and cutting to required size shall be done with water (as lubricant) only. Sawing shall also be done preferably with water as lubricant but as a special case, the The Engineer may permit, at his discretion, oil or kerosene as lubricant subject to all kerosene or oil in the body and surface of tiles / slabs being thoroughly dried in ovens. Tiles / slabs with stains or patches due to the use of oil or otherwise, either before or after installation, shall be rejected and shall be replaced by the Contractor at his own cost.

The exposed cut edges of the Kota Stone slab in risers and treads along its width (sides of the risers and treads of the steps i.e. along the shorter dimensions of the Kota stone slab for the risers and treads) shall be polished in a workmanlike manner. The top exposed edge of the Kota stone skirting shall also be polished in a workmanlike manner.

Nosing / edge moulding shall be provided to the front edge of the Kota stone slab treads along its length i.e. along the longer dimensions of the Kota stone slab, as per the architectural drawings.

Tactile tile such as directional, warning or hazardous (for vision impaired persons as per standards) shall be of size 300x300x15 mm {10 mm base + (5mm ± 0.5mm) thick raised portion} having water absorption less than 0.5% and conforming to IS: 15622 of approved make in all colours (preferably yellow) and shades for indoor floors, should be laid on 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. as per harmonized guidelines and space standards for barrier free built environments for persons with disability and elderly persons issued by Ministry of Urban Development, Govt. of India.

50 mm wide Yellow colour, self-adhesive 'EDGE STRIPS' of approved make shall be provided on risers of staircase to help persons with visual disabilities and elderly. 25 mm wide high intensity Anti-Skid reflective tape of approved make on edges of treads of staircase shall be provided.

Wooden Flooring: Providing and laying 'Engineered wooden or Hard maple wood flooring 20mm thick,length varying from 230mm to 1800mm jointed together with the help of tongue and groove on all four sides of all boards. substructure of maple wood flooring shall consist of sleeper of spruce or pine having 63mm wide and cross section of 38 mm and laid perpendicular to the main flooring planks at a spacing 305mm centre to centre including 19 mm thick rubber shock pads at 305mm centre to centre spacing and polyethylene membrane installed over the concrete base beneath the flooring system as a vapour barrier between the concrete and wood floor. 0.20mm polyethylene membrane installed over the concrete base beneath the flooring system as a vapor barrier between the concrete and wood floor. approved by bwf complete satisfaction of the Engineer in-charge.

At the time of handing over, flooring & dado / cladding shall be free of any scratches, stains etc. The flooring & dado / cladding shall be properly cleaned before handing over. However, abrasive cleaners shall not be used to clean the marks and other scratches.

**2.14. ROOFING WORK:**

All roofing work in general shall be carried out as per CPWD Specifications 2019, Volume-I & II with revisions/ amendments / correction slips up to last date of bid submission (including extensions if any). Schedule of finishes mentioned in tender documents shall be followed in case of deviation/different detailing is shown in Drawings. Before taking up any procurement/construction activity, shop drawings shall be prepared and submitted for obtaining approval from The Engineer.

**Calcium Silicate False Ceiling Tiles :**

Providing and fixing tiled false ceiling of specified materials of size 595x595 mm in true horizontal level, suspended on interlocking metal grid of hot dipped galvanized steel sections ( galvanized @ 120 grams/ sqm, both side inclusive) consisting of main "T" runner with suitably spaced joints to get required length and of size 24x38 mm made from 0.30 mm thick (minimum) sheet, spaced at 1200 mm center to center and cross "T" of size 24x25 mm made of 0.30 mm thick (minimum) sheet, 1200 mm long spaced between main "T" at 600 mm center to center to form a grid of 1200x600 mm and secondary cross "T" of length 600 mm and size 24x25 mm made of 0.30 mm thick (minimum) sheet to be interlocked at middle of the 1200x600 mm panel to form grids of 600x600 mm and wall angle of size 24x24x0.3 mm and laying false ceiling tiles of approved texture in the grid including, required cutting/making, opening for services like diffusers, grills, light fittings, fixtures, smoke detectors etc. Main "T" runners to be suspended from ceiling using GI slotted cleats of size 27 x 37 x 25 x 1.6 mm fixed to ceiling with 12.5 mm dia and 50 mm long dash fasteners, 4 mm GI adjustable rods with galvanized butterfly level clips of size 85 x 30 x 0.8 mm spaced at 1200 mm center to center along main T, bottom exposed width of 24 mm of all T-sections shall be pre-painted with polyester paint, all complete for all heights as per specifications, drawings and as directed by The Engineer.

8 mm thick fully perforated calcium silicate board made with Calcareous & Siliceous materials reinforced with cellulose fiber manufactured through autoclaving process to give stable crystalline structure with minimum compressive strength 225 kg/ sq. cm, bending strength 100 kg/sq. cm, of size 595x595 mm, having perforation of dia. 10 mm with minimum perforated area 18 % with non woven tissue on the back side, having an NRC (Noise Reduction Coefficient) of 0.85, with 50 mm thick rock wool of 48 kg /cum backing.

**Metal False Ceiling Tile :**

Providing and fixing GI Clip in Metal Ceiling System of 600x600 mm module which includes providing and fixing 'C' wall angle of size 20x30x20 mm made of 0.5 mm thick pre painted steel along the perimeter of the room with help of nylon sleeves and wooden screws at 300 mm center to centre, suspending the main C carrier of size 10x38x10 mm made of G.I steel 0.7 mm thick from the soffit with help of soffit cleat 37x27x25x1.6 mm, rawl plugs of size 38x12 mm and C carrier suspension clip and main carrier bracket at 1000 mm c/c. Inverted

triangle shaped Spring Tee having height of 24 mm and width of 34 mm made of GI steel 0.45 mm thick is then fixed to the main C carrier and in direction perpendicular to it at 600 mm centers with help of suspension brackets. Wherever the main C carrier and spring T have to join, C carrier and spring T connectors have to be used. All sections to be galvanized @ 120 gms/sqm (both side inclusive), fixing with clip in tiles into spring T with. GI Metal Ceiling Clip in plain Beveled edge global white color tiles of size 600x600 and 0.5 mm thick with 25 mm height, made of G I sheet having galvanizing of 100 gms/ sqm (both sides inclusive) and 20% perforation area with 1.8 mm dia holes and having NRC of 0.5, electro statically polyester powder coated of thickness 60 microns (minimum), including factory painted after bending and perforation.

### **Mineral Fibre False Ceiling Tiles:**

It shall be 19 mm thick of size 595X595mm of approved texture, design and pattern. The tiles shall be confirming to ISO 4 according to norm ISO 14644- 1:2015, having Humidity Resistance (RH) of  $\geq 99\%$ , NRC $\geq 0.7$ , Light Reflectance 85-90%, thermal Conductivity  $k = 0.052- 0.057$  w/m K, Fire Performance A2- s1.d0 with Anti- Bacterial coating, adhering to Clean room requirement of Class 100 as per US Fed Standard 209 E and washability requirement of 500 wash cycles as per ASTM 4828 and with Recycled content of minimum 70%. Tiles shall be suspended in true horizontal level on interlocking T-Grid of hot dipped all round galvanized iron section of 0.38 mm thick (galvanized @120 gms ) comprising of main T runners of 15x38 mm of length 3000 mm, cross T of size 15x38mm of length 1200 mm and secondary intermediate cross T of size 15x38 mm of length 600 mm to form grid module of size 600x600 mm suspended from ceiling using galvanized mild steel item (galvanized @80gsm) 50 mm long 8mm outer diameter M-6 dash fasteners, 6 mm diameter fully threaded hanger rod up to 1000 mm length and L-shape level adjuster of size 80x30x0.6 mm, spaced at 1200 mm centre to centre along main 'T'. The system should rest on periphery walls /partitions with the help of GI perimeter wall angle of size 24x24X3000 mm made of 0.40 mm thick sheet, to be fixed to the wall with help of plastic Rawl plug at 450 mm centre to centre & 40 mm long dry wall S.S. crews. The exposed bottom portion of all T-sections used in false ceiling support system shall be pre-painted with polyester baked paint, for all heights.

### **Calcium Silicate Board:**

Providing and fixing false ceiling at all height including providing and fixing of frame work made of special sections, power pressed from M.S. sheets and galvanized with zinc coating of 120 gms/sqm (both side inclusive) as per IS : 277 and consisting of angle cleats of size 25 mm wide x 1.6 mm thick with flanges of 27 mm and 37mm, at 1200 mm centre to centre, one flange fixed to the ceiling with dash fastener 12.5 mm dia x 50mm long with 6mm dia bolts, other flange of cleat fixed to the angle hangers of 25x10x0.50 mm of required length with nuts & bolts of required size and other end of angle hanger fixed with intermediate G.I. channels 45x15x0.9 mm running at the spacing of 1200 mm centre to centre, to which the ceiling section 0.5 mm thick bottom wedge of 80 mm with tapered flanges of 26 mm each having lips



of 10.5 mm, at 450 mm centre to centre, shall be fixed in a direction perpendicular to G.I. intermediate channel with connecting clips made out of 2.64 mm dia x 230 mm long G.I. wire at every junction, including fixing perimeter channels 0.5 mm thick 27 mm high having flanges of 20 mm and 30 mm long, the perimeter of ceiling fixed to wall/partition with the help of rawl plugs at 450 mm centre, with 25mm long dry wall screws @ 230 mm interval, including fixing of gypsum board to ceiling section and perimeter channel with the help of dry wall screws of size 3.5 x 25 mm at 230 mm c/c, including jointing and finishing to a flush finish of tapered and square edges of the board with recommended jointing compound, jointing tapes, finishing with jointing compound in 3 layers covering upto 150 mm on both sides of joint and two coats of primer suitable for board, all as per manufacturer's specification and also including the cost of making openings for light fittings, grills, diffusers, cutouts made with frame of perimeter channels suitably fixed, all complete as per drawings, specification and direction of the The Engineer. 12.5 mm thick tapered edge gypsum moisture resistant board.

### **Polycarbonate Sheet Roofing**

Providing, Supplying & Installation of Microcell Polycarbonate 20mm thick (minimum.) UV protected panel system which shall be uniform in color with an integral Microcell core. They should be manufactured with Vertical Standing Seam with standing seam height of 10-20mm at both sides of the panel. Panels shall be fixed on MS /Trusses. purlins with continuous Structural Aluminum double wall I-profile Spacer together with snap-on connector. These connectors to interlock the panels shall have a 2-4 tooth grip-lock locking mechanism to ensure maximum uplift capability and shall pass a pullout load of min. 4000 N (4kN) when tested as per ISO 6892:1998 and IS 1608:2005. Panel shall be with additional End- cap/Aluminum U-Profile (mill finish) for ends. including glass wool 100 mm Above Panel System shall be fixed over structural steel trusses / MS purlin with 2 coats of Enamel paint etc. conforming to the detail technical specifications as per approved Architectural Drawings submitted by Vendor Items includes cost of 20mm thick Polycarbonate sheet roofing with all its elements(Louvers), accessories, fittings and fixtures, scaffolding, labour, all required machineries for fixing and all valid taxes i.e. sales tax, excise duty, custom duty etc. complete. The above work is to be carried out by a Specialized Agency, as approved by the The Engineer include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc complete for the finished as direction by the Engineer.

### **Galvalume Sheet Roofing :**

Precoated Galvanised iron profile sheets (size, shape and pitch of corrugation as approved by The Engineer) 0.50 mm (+ 0.05 %) total coated thickness with zinc coating 120 grams per sqm as per IS: 277, in 240 mpa steel grade, 5-7 microns epoxy primer on both side of the sheet and polyester top coat 15-18 microns. Sheet should have protective guard film of 25 microns minimum to avoid scratches during transportation and should be supplied in single length upto 12 metre or as desired by The Engineer. The sheet shall be fixed using self drilling /self

tapping screws of size (5.5x 55 mm) with EPDM seal, complete upto any pitch in horizontal/ vertical or curved surfaces, excluding the cost of purlins, rafters and trusses and including cutting to size and shape wherever required. Providing and fixing pre-coated galvanised steel sheet roofing accessories 0.50 mm (+0.05 %) total coated thickness, Zinc coating 120 grams per sqm as per IS: 277, in 240 mpa steel grade, 5-7 microns epoxy primer on both side of the sheet and polyester top coat 15- 18 microns using self drilling/ self tapping screws. Rate shall include roofing and wall cladding with necessary lappings, end crimp sheet, edge flashing, painted with regular modified polymer system/silicon modified polyester system and all lappings pasted with Buttyl tape including cost of screws and necessary scaffolding etc complete as per standard specifications. Rate including all material, all labour charges, all lead, lift, transportation, taxes etc complete and measured per unit of laid areas The quality of material, method of testing, installation etc as per IS codes, unless otherwise specified herein, shall be applicable. In all cases, the latest editions including all applicable official amendments and revisions shall be referred.

**Installation:** The installation shall be done by specialized agency or approved by the the Engineer. Manufacturer's recommended installation methodology shall be adopted for installation. The Contractor is to take approval of the sheet profile, design and installation methodology before installation of the sheets from the concern authorities. The installation includes profiled sheet, capping, trims, flashing and all type of accessories considered for the installation of items. The installation measurement shall be based on finished surface area.

**Test:** The sheet shall be tested before use to check the basic metal thickness, coating mass & tensile strength by appropriate testing method in the approved laboratory and cost for the testing shall be borne by the Contractor.

**Khur ra:** shall be of 45x45 cm with average minimum thickness of 5 cm cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) over P.V.C. sheet 1mx1mx400micron, finished with 12mm cement plaster 1:3 (1 cement : 3 coarse sand) and a coat of neat cement, rounding the edges.

At inlet mouth of rain water pipe, cast iron grating 15 cm diameter and weighing not less than 440 grams shall be provided.

**Rain Water Pipes -** All the RWP pipes shall be PVC Pipes (including with required fittings and clamps) exposed on walls / in the shafts to be executed as per CPWD specification 2009.

### **SHINGLES ROOF FINISHING**

Laying of roofing shingle including preparation of surface as required for treatment of roofing shingles, under laying membrane & nails consisting of following operations systems with nailing method:

Applying a Bitumen Prime Coating is intended for preparation of the surface before installation of self-adhesive sealant tape waterproofing material width 5cm. The primer

presents a mix of high-quality bitumen and specially selected organic solvents. It has an enhanced covering mass fraction of non-volatile substances 45-55% , relative viscosity 15-40s, consumption 0.25-0.35Lit per sqm bucket volume 3,10,30 and bitumen primer should be allowed to dry for a minimum of 6 to 8 hours to ensure proper adhesion of subsequent layers including cleaning the surface before treatment.

Laying of HIP and Ridge/Starter SBS modified, high-end, factory-made ridge called HIP and Ridge/Starter with the help of the nailing method and ensure the standard area assumption base layer fiber class 110, SBS bitumen type, Flow resistance at elevated temperature 100°C,  $3.4 \pm 0.2$  mm Thickness per layer, 5.5 kg per sqm weight, Installation method a/c and as directed and specified by the The Engineer .

Applying High Definition, Laminated Asphalt-based roofing shingles called "Country Series of Shingles Brand" (having 50 years warranty and weight of 12 kg per sqm) with the help of the nailing method. Shingles Brand's "Country Series" roofing shingles offer long durability with a significant weight. The shingles should be securely nailed to the surface for proper fixation. Roofing shingles for its strict requirements for the minimum mass of bitumen in products 1300 g/m<sup>2</sup> for laying roofing shingles and as directed and specified by the The Engineer.

#### **2.15. FINISHING WORK:**

All External AAC walls shall be finished with 18 mm cement plaster in two coats under layer 12 mm thick cement plaster 1:5 (1 cement : 5 coarse sand) and a top layer 6 mm thick cement plaster 1:3 (1 cement : 3 coarse sand) finished rough with sponge and all internal AAC walls shall be finished with 12 mm (average) finished (1:4) thick cement plaster. The Contractor is free to use ready-mix plaster of approved make in place of cement plaster and nothing extra shall be paid on this account at all floors and locations, finished in smooth line and level etc. complete.

All brick wall shall be finished with 12mm (1:6) thick cement plaster and 15mm (1:6) cement plaster on rough side. The Contractor is free to use ready-mix plaster of approved make in place of cement plaster and nothing extra shall be paid on this account. No plastering to be done at Ceiling.

Chicken mesh 24 gauge 19 mm size galvanised chicken wire mesh of approved make and design to be provided at junctions of RCC or CC members and brick work and other locations including necessary clips and "U" nails rawl plugs,screws etc. complete for all height as per specifications & direction of the The Engineer.

Necessary drip course shall be provided in Chajja, Balcony, Projecting Roof, Beams etc.

All the internal surfaces including exposed ceiling (non false ceiling areas) shall be finished with 1 mm thick cement based wall putty, one coat of cement primer and two or more coats

of paints specified in finishing schedule.

Application of paints shall be done with mechanical equipment's. Mechanical sanding machine (for scrubbing & preparation of surface) shall be used by the Contractor.

In case of painting over old work / new work, the Contractor shall give proper notice to the The Engineer after the surface is prepared & before applying of primer coat / paint. The The Engineer shall either approve the surface thus prepared or ask the Contractor to rectify the defects pointed. Only after approval by The Engineer, the priming / painting coat shall be applied.

### **Oil Emulsion (Oil Bound) Washable Distemper:**

Oil emulsion (Oil Bound) washable distemper (IS 428) of approved brand and manufacture shall be used. The primer where used as on new work shall be cement primer or distemper primer as described in the item. These shall be of the same manufacture as distemper. The distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer.

Only sufficient quantity of distemper required for day's work shall be prepared. The distemper and primer shall be brought by the Contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the Contractor and the The Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the The Engineer. Preparation of the Surface For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc. Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

### **Application:**

Priming Coat : The priming coat shall be with distemper primer or cement primer, as required in the description of the item.

Note : If the wall surface plaster has not dried completely, cement primer shall be applied before distemping the walls. But if distemping is done after the wall surface is dried completely, distemper primer shall be applied. Oil bound distemper is not recommended to be applied, within six months of the completion of wall plaster. However, newly plastered

surfaces if required to be distempered before a period of six months shall be given a coat of alkali resistant priming Paint conforming to IS 109 and allowed to dry for atleast 48 hours before distempering is commenced. For old work no primer coat is necessary. Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat.

The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat. For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be tho-roughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work.

#### **Water Proofing Cement Paint:**

Base coat of water proofing cement paint The solution shall be applied on the clean and wetted surface with brushes or spraying machine. The solution shall be kept well stirred during the period of application. It shall be applied on the surface which is on the shady side of the building so that the direct heat of the sun on the surface is avoided. The method of application of cement Paint shall be as per manufacturer's specification. The completed surface shall be watered after the day's work. The second coat shall be applied after the first coat has been set for at least 24 hours. Before application of the second or subsequent coats, the surface of the previous coat shall not be wetted.

For new work, the surface shall be treated with three or more coats of water proof cement Paint as found necessary to get a uniform shade. For old work, the treatment shall be with one or more coats as found necessary to get a uniform shade.

#### **Precaution:**

Water proof cement Paint shall not be applied on surfaces already treated with white wash, colour wash, distemper dry or oil bound, varnishes, Paints etc. It shall not be applied on gypsums, wood and metal surfaces. If water proofing cement is required to be applied on existing surface, previously treated with white wash, colour wash etc., the surface shall be thoroughly cleaned by scrapping off all the white wash, colour wash etc. completely. Thereafter, a coat of cement primer shall be applied followed by two or more coat of water proof cement.

Before pouring into smaller containers for use, the paint shall be stirred thoroughly in its container, when applying also the paint shall be continuously stirred in the smaller containers so that its consistency is kept uniform. Dilution ratio of paint with potable water can be altered taking into consideration the nature of surface climate and as per recommended dilution given by manufacturer. In all cases, the manufacturer's instructions & directions of the The Engineer shall be followed meticulously. The lids of paint drums shall be kept tightly closed when not in use as by exposure to atmosphere the paint may thicken and also be kept safe from dust. Paint shall be applied with a brush on the cleaned and smooth surface. Horizontal strokes shall be given, First and vertical strokes shall be applied immediately afterwards. This entire operation will constitute one coat. The surface shall be finished as uniformly as possible leaving no brush marks.

**Scaffolding:**

Wherever scaffolding is necessary, it shall be erected on double supports tied together by horizontal pieces, over which scaffolding planks shall be fixed. No ballies, bamboos or planks shall rest on or touch the surface which is being white washed. For all exposed brick work or tile work, double scaffolding having two sets of vertical supports shall be provided. The supports shall be sound and strong, tied together with horizontal pieces over which scaffolding planks shall be fixed.

Note: In case of special type of brick work, scaffolding shall be got approved from Engineer-in Charge in advance. Where ladders are used, pieces of old gunny bags shall be tied on their tops to avoid damage or scratches to walls.

**Exterior Painting On Wall: Textured & 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing**

Material: The paint shall be (Textured exterior paint/Acrylic smooth exterior paint/premium acrylic smooth exterior paint/100% premium 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing) of approved brand and manufacture. This paint shall be brought to the site of work by the Contractor in its original containers in sealed condition. The material shall be brought in at a time in adequate quantities to suffice for the whole work or at least a fortnight's work. The materials shall be kept in the joint custody of the Contractor and the Engineer-in- Charge. The empty containers shall not be removed from the site of work till the relevant item of work has been completed and permission obtained from the The Engineer.

**Preparation of Surface:**

For new work, the surface shall be thoroughly cleaned off all mortar dropping, dirt dust, algae, fungus or moth, grease and other foreign matter of brushing and washing, pitting in plaster shall make good, surface imperfections such as cracks, holes etc. should be repaired using white cement. The prepared surface shall have received the approval of the The Engineer after

inspection before painting is commenced.

**Putty:**

The surface shall be thoroughly cleaned. All unevenness shall be rubbed down smooth with sand paper and shall be well dusted. Knots, if any shall be covered with preparation of red lead made by grinding red lead in water and mixing with strong glue sized and used hot. Appropriate filler material conforming to IS 345 with same shade as Paint shall be used where specified. The surface treated for knotting shall be dry before Paint is applied. After obtaining approval of Engineer- in-Charge for wood work, the priming coat shall be applied before the wood work is fixed in position. After the priming coat is applied, the holes and indentation on the surface shall be stopped with glazier's putty or wood putty. Stopping shall not be done before the priming coat is applied as the wood will absorb the oil in stopping and the latter is therefore liable to crack.

**Acrylic Distemper:**

1st quality acrylic distemper having VOC content less than 50 gms/litre of approved brand and manufacture shall be used. The acrylic distemper shall be diluted with water or any other prescribed thinner in a manner recommended by the manufacturer. Only sufficient quantity of distemper required for day's work shall be prepared.

The distemper shall be brought by the Contractor in sealed tins in sufficient quantities at a time to suffice for a fortnight's work, and the same shall be kept in the joint custody of the Contractor and the The Engineer. The empty tins shall not be removed from the site of work, till this item of work has been completed and passed by the The Engineer.

Preparation of the Surface For new work the surface shall be thoroughly cleaned of dust, old white or colour wash by washing and scrubbing. The surface shall then be allowed to dry for at least 48 hours. It shall then be sand papered to give a smooth and even surface. Any unevenness shall be made good by applying putty, made of plaster of paris mixed with water on the entire surface including filling up the undulations and then sand papering the same after it is dry.

In the case of old work, all loose pieces and scales shall be removed by sand papering. The surface shall be cleaned of all grease, dirt etc.

Pitting in plaster shall be made good with plaster of paris mixed with the colour to be used. The surface shall then be rubbed down again with a fine grade sand paper and made smooth. A coat of the distemper shall be applied over the patches. The patched surface shall be allowed to dry thoroughly before the regular coat of distemper is applied.

**Application:**

In the case of new work, the treatment shall consist of a priming coat of whitening followed by

the application of two or more coats of distemper till the surface shows an even colour. For old work, the surface prepared as described shall be applied one or more coats of distemper till the surface attains an even colour.

The application of each coat shall be as follows:

The entire surface shall be coated with the mixture uniformly, with proper distemper brushes (ordinary white wash brushed shall not be allowed) in horizontal strokes followed immediately by vertical ones which together shall constitute one coat. The subsequent coats shall be applied only after the previous coat has dried.

The finished surface shall be even and uniform and shall show no brush marks. Enough distemper shall be mixed to finish one room at a time. The application of a coat in each room shall be finished in one operation and no work shall be started in any room, which cannot be completed the same day. After each day's work, the brushes shall be washed in hot water and hung down to dry. Old brushes which are dirty or caked with distemper shall not be used. Note : If the wall surface plaster has not dried completely, cement primer shall be applied before distemping the walls. But if distemping is done after the wall surface is dried completely, distemper primer shall be applied. For old work no primer coat is necessary.

Distemper Coat : For new work, after the primer coat has dried for at least 48 hours, the surface shall be lightly sand papered to make it smooth for receiving the distemper, taking care not to rub out the priming coat. All loose particles shall be dusted off after rubbing. One coat of distemper properly diluted with thinner (water or other liquid as stipulated by the manufacturer) shall be applied with brushes in horizontal strokes followed immediately by vertical ones which together constitutes one coat. The subsequent coats shall be applied in the same way. Two or more coats of distemper as are found necessary shall be applied over the primer coat to obtain an even shade. A time interval of at least 24 hours shall be allowed between successive coats to permit proper drying of the preceding coat. For old work the distemper shall be applied over the prepared surface in the same manner as in new work. One or more coats of distemper as are found necessary shall be applied to obtain an even and uniform shade. 15 cm double bristled distemper brushes shall be used. After each days work, brushes shall be tho-roughly washed in hot water with soap solution and hung down to dry. Old brushes which are dirty and caked with distemper shall not be used on the work

Synthetic Enamel Paint : All the steel work shall be applied two or more coats of synthetic enamel paint over a coat of suitable primer of approved brand and manufacture with ready mixed red oxide zinc chromatic on steel / iron works having VOC content less than 250 grams/litre.

Water repellent coat: 2 to 3 coats of Silicone based water repellent, anti-algal paint of approved shade, complete as per manufacturer's specifications, shall be applied on stone cladding.

Anti-Bacterial Paint: Low VOC, highly washable, water based, abrasion resistant (over 4000



cycles) sanitizing and anti-bacterial coating Ultra satin (D-11205) shall be applied as per finishing schedule to all kind of surface and enhancing protection against bacteria for Hygienic environment and conforming to JIS Z 2801:2100 test Protocols for Anti- Bacterial Coatings test. The material should be reactive curing acrylic resin water based coating. One coat of water based acrylic primer shall be applied before application of two coats of water based anti-bacterial coating. (Approved make: OIKOS/Liquid Plastic/Construction Specialty).

### **Gomusa Elevation finishing**

FR GRADE - FRP PANEL - Providing and Fixing of Pre Pigmented To Desired Colour - FRP (Fibre Reinforced polyester resin plastic composite )Panels in 5 mm thick finished , weight 8.5 Kg/Sqm, fire rating Class B as per ASTM E 84,size, pattern, design, and colour of approved make to be fixed on brick / RCC / Block work Column or structural steel work with Dry Fixing method with all appropriate , fasteners for fixing, and necessary hardware on Façade. The panel shall be made from materials UV Resistant, abrasion resistance . The panel shall be securely fixed to the available surface of required size at specified locations. This includes the cost of screen, , anchor fasteners, labour charges for fixing, for all heights in the elevation. - As Per Layer By Layer Technique Used By GFRC Facades - Panel

### **2.16. STAINLESS STEEL WORK:**

Unless otherwise specified, stainless steel generally shall be of Grade (SS 304) or 1.4401 (SS 316). Stainless Steel (SS) grade 316 shall be used for exposed / exterior work whereas grade SS 304 shall be used for interior works. Lower grades shall not be used. Before taking up any procurement/construction activity, shop drawings shall be prepared and submitted for obtaining approval from The Engineer.

Stainless steel railing shall be provided with SS 304 grade stainless steel of 50 mm dia. of 18 gauge handrail with adequate rods parallel to handrail, balusters, flanges, end caps, newel posts with caps etc. complete as per approved drawings and direction of Engineer-in-charge.

Surface finish of all the stainless steel materials will be in 240 grit satin finish / matt finish. All stainless steel material will have to be coated by a solution of Inox to avoid finger in prints and avoidance of settlement of environment / atmospheric dust. Stainless steel railing, both sides in staircase and external ramp with double handrail shall be used for barrier free accessibility requirements with adequate SS balusters, runners etc as per approved architectural drawing. Fixing shall be done by stainless steel expansion bolts of approved size and make as per Engineer-in- Charge and welding to be done by using organ welding rods and the surface being duly finished and cleaned by K2 passivation, which is nitric acid plus florice acid solution treatment by which the chances of corrosion will be eliminated and any burn out makes on the metal will also be eliminated.

### **2.17. Structural Steel Work :**

Scope of work for the Contractor in respect of structural steel work shall cover, but shall not be limited to the following:

- (i) Structural steel work shall cover all composite structural works consisting of structural steel and RCC in combination. It shall also cover steel trusses and misc structural steel frameworks.
- (ii) Preparation and submission of complete detailed shop fabrication drawings based on the architectural and structural design and drawings including revision in same as per directions of The Engineer.
- (iii) Submission of revised structural design, with calculations and detailed fabrication drawings, in case any substitution is required in the designed sections with prior approval of The Engineer. No shop fabrication will be executed without prior approval of the above from “ the Engineer”
- (iv) Submission of detailed erection plan/methodology for all structural members of structural steel structure, compatible with the details of fabrication. Also complete drawings & phase wise instructions for all the activities required to erect steel structure in final position, shall be submitted.
- (v) Submission of shuttering, staging and scaffolding details for casting of deck slab over the erected “Steel Plate Girders”.
- (vi) Submission of details of specialized agency for steel fabrication in workshop and erection at site of structural steel work, which the Contractor propose to associate for structural steel work. The agency for fabrication of steel members in workshop and agency for erection of these steel members at site should preferably be same. The specialized agency should satisfy the experience requirements as stipulated in bid document elsewhere. Details should include experience of specialized agency in similar structural steel works, financial capabilities, location of workshop, fabrication facilities available in fabrication workshop etc.
- (vii) Procurement and testing of all raw structural steel materials in lots for fabrication taking into account wastage margin etc., including storage and upkeep of the materials
- (viii) Providing all materials, labour, tools & plant and equipment’s and all types of consumables required for fabrication using Gas Metal Arc welding (MIG welding) or Submerged arc welding including all necessary bolts, nuts, washers with wastage margins.
- (ix) Fabrication of the steel works in accordance with the approved fabrication drawings, including all shop assembling, matching and marking. Design, manufacture/fabrication and provision of all jigs, fixings, manipulators etc. required for the fabrication.

- (x) Suitably marking, bundling and packing for transport of all fabricated materials.
- (xi) Preparing and furnishing detailed bill of materials, drawing Office dispatch lists, Bolts
- (xii) Lists and any other lists of bought out items required in connection with the fabrication of the structural steelwork.
- (xiii) Loading and transporting all fabricated steelwork and field connection materials including site unloading and erection of structure in final position with all bolts, nuts, insert plate etc.
- (xiv) The Contractor shall provide general assistance during complete erection for solving any problem related to fabrication or site assembling of the structural steelwork. The Contractor shall ensure the presence of the qualified and experienced Erection Engineer during complete erection work at site.
- (xv) All major/ minor modifications of the fabricated steel structures, as directed by the The Engineer, including but not limited to the following:
- (xvi) Removal of bends, kinks, twists etc. for parts damaged during transportation and handling.
- (xvii) Cutting, chipping, filling, grinding etc. if required or preparation and finishing of site connections.
- (xviii) Reaming of holes for use of higher size bolt if required.
- (xix) Re-fabrication of parts damaged beyond repair during transport and handling or re- fabrication of parts which are incorrectly fabricated.
- (xx) Fabrication of parts omitted during fabrications by error, or subsequently found necessary.
- (xxi) Drilling of hole, with prior approval of The Engineer, which are either not drilled at all or are drilled in incorrect location during fabrication. Drilling of holes for connections of all structural members shall otherwise be done in fabrication workshop only.
- (xxii) Carry out tests in accordance with the related Specification which will be inspected by The Engineer.
- (xxiii) Details of erection equipment machinery including capacity & specifications, tools, tackle etc. to be used for erection purpose.
- (xxiv) Necessary formwork & staging required for erection of structural members

including design of formwork for all the anticipated loads.

- (xxv) All procedures and tests on welds as per specifications and welded parts to ensure the strength requirements of joints.

Submittals: On commencement of the work pertaining to steel structure, the Contractor shall submit the following in two sets:

- a. Detailed baseline program, material procurement schedule, shop/working drawings, submission of samples, process/methodology of fabrication & delivery to site storage yard and erection at site for the approval of the The Engineer.
- b. Complete fabrication drawings, schedule of quantity, cutting lists, bolt lists, welding schedules.
- c. Results of any tests, as and when conducted and as required by the The Engineer.
- d. Manufacturer's mill test reports/certificates in respect of steel materials, bolts, nuts and electrodes etc. as may be applicable.
- e. A detailed list of all Plant & Equipment such as cranes, derricks, winches, welding sets, all consumables, grinding and hole drilling machine etc. their make, model, present condition and location, available to the Contractor and the ones he will employ on the job to maintain the progress of work in accordance with the contract.
- f. The total number of experienced personnel of each category like fitters, welders, riggers etc., which he intends to deploy on the project.

The The Engineer reserves the right to make changes in the design drawings even after release for preparation of shop drawings to reflect addition, omission & modifications in data/details and requirements. Contractor shall consider such changes as part of these Specifications and the contract and no extra claims shall be entertained on this account.

Design and drawings will show as appropriate the salient dimensions of structural members. Design loads, if needed shall be made available. Any other relevant information required for the preparation of fabrication drawings, designs and erection details shall be provided to Contractor by The Engineer.

It shall be clearly understood that the drawings provided to the Contractor will be design drawings. The typical details of connection, cuts, gusset plate shapes notches, bends, etc. wherever shown in the design drawings are only for general guidance of the Contractor. The Contractor shall develop all such details based on the design drawings.

In case of variations in design drawings and specifications, the decision of the The Engineer shall be final. Should the Contractor, find any discrepancy in the information furnished to him,

same shall be immediately brought to the notice of The Engineer for resolution. The Contractor shall obtain clarifications on discrepancies from The Engineer before proceeding with the work.

No detailed shop drawings will be accepted for examination by the The Engineer unless these have first been completely checked by the Contractor's qualified structural engineer and PMC's structural engineer. The Contractor shall check and ensure that detailing of connections is carefully planned to obtain ease in erection of structures, including field bolting or field connection of temporary structure to permanent structure. Any temporary structure which is used for erection or launching purpose and required to be welded to permanent structural works shall be accounted for in fabrication drawings. Permission shall be obtained before welding or holing is done in permanent structures other than as shown in design drawings or approved fabrication drawings. In case of field bolted connection between temporary structure and permanent structural works, all necessary holes provision shall be left during fabrication in shop.

No fabrication work shall be started by the Contractor without approval of The Engineer on the relevant drawings. Approval by the Engineer-in-charge of any of the drawings shall not relieve the Contractor of his responsibility of workmanship, fit of parts, details, materials and errors or omissions of any work.

The Contractor shall furnish three sets of prints of shop drawings as advance drawing (for approval) and four set of prints of all approved final shop drawings along with soft copy in CD/pen drive for field use and record purpose.

The Contractor shall specify the name of workshop where he intends to get the fabrication work carried out. The fabrication shop should have facility for at least Automatic continuous submerged arc H beam welding machine, Automatic paint conveyer system, Max Seam roofing System, shearing machine, CNC plasma machine, pug mill, edge beveling machine, flame cutting machine, grinders, sand blasting equipment's, facilities for lifting and handling of large span and heavy structural members etc.

The drawings prepared by the Contractor and all subsequent revisions thereof shall be at the cost of the Contractor and no separate payments shall be made for the same. Revisions shall incorporate all modifications, field changes, substitutions etc. effected.

The Contractor shall give due consideration to the need of trial assemblage at shop, weight and size limitation of elements for transportation from shop to site storage yard/Erection site, temperature variation of 25 degree centigrade between the fabrication shop and site, site measurements of as-built dimensions and position of pockets etc. for bolts and avoidance of site welding except for fixtures.

All the drawings shall be prepared in metric units. The drawings should preferably be of A-2 or A- 1 standard size, and the details shown therein shall be clear and legible. These drawings shall include but shall not be limited to the following:

- a. Assembly drawings, giving exact sizes of the sections to be used and identification marks of the various sections members.
- b. Dimensional drawings of base plans, anchorage detail of bearing bolts location etc.
- c. Complete quantity schedule of materials and detailed drawings of all sections.
- d. Detailed shop drawings for proper co-ordination with the concrete components to which the steel members shall be connected, as required.
- e. Any other drawings or calculations that may be required for proper completion of the works and clarification of the works or substituted parts thereof.
- f. All 'as-built' drawings in 4 prints and 1 plot on Garware film or equivalent and on CD.

**Applicable Codes of Practice:**

The following specifications, standards and codes of practice are included as part of this Specification-

1. IS: 226 Structural Steel (Standard Quality)
2. IS: 800 (1984) Code of Practice for General Construction in Steel.
3. IS: 808 (1989) Dimensions for Hot Rolled Steel Beam, Column, Channe and Angle Sections
4. IS: 813 Scheme of Symbols for Welding
5. IS: 814 (1991) Covered Electrodes for Manual Metal Arc Welding of Carbon & Carbon -Manganese Steel.
6. IS: 815 Classification Coding of Covered Electrodes for Metal Arc Welding of Structural Steel
7. IS: 816 (1969) Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel.
8. IS: 817 (1969) Code of Practice for Training and Testing of Metal Arc Welders.
9. IS: 822 Inspection of Welded Connection
10. IS: 823 Specification for Workmanship of Steel Structure
11. IS: 919 (1993) ISO System of Limits & Fits (Part 1 & Part 2)
12. IS: 961 Structural Steel (High Tensile)
13. IS: 1024 Code of Practice for use of Welding in Bridges and Structures subject to Dynamic Loading
14. IS: 1148 (1982) Hot Rolled Rivet Bars (upto 40mm) for Structural Purposes.
15. IS: 1161 Steel Tubes for Structural Purposes
16. IS: 1182 (1983) Recommended Practice for Radio Graphic Examination of Fusion Welded Butt Joints in Steel Plates.
17. IS: 1363 (1992) Hexagon Head Bolts, Screws and Nuts of Product grade C (Part 1 to Part

3)

18. IS: 1364 (1992) Hexagon Head Bolts, Screws and Nuts of Product Grades A & B (Part 1 to 5)
19. IS: 1367 (1991) Technical Supply Conditions for Threaded Steel Fasteners.
20. IS: 1852 (1985) Rolling & Cutting Tolerances for Hot-Rolled Steel Product.
21. IS: 1977 (1975) Structural Steel (Ordinary Quality).
22. IS: 2016 (1967) Plain Washers.
23. IS: 2062 (1992) Steel for General Structural Purposes.
24. IS: 2595 (1978) Code of Practice for Radio Graphic Testing.
25. IS: 3600 (1985) Methods of Testing Fusion Welded Joints (Part 1 to Part 9)
26. IS: 3613 (1974) Acceptance Tests for Wire Flux Combinations for Submerged Arc Welding.
27. IS: 3658 (1981) Code of Practice for Liquid Penetrant Flow Detection.
28. IS: 3757 (1985) High Strength Friction Grip Bolts
29. IS:4000 (1992) High Strength Friction Grip Bolts in Steel Structures-Code of Practice
30. IS:4353 (1967) Recommendations for Submerged Arc Welding of Mild Steel and Low Alloy Steel.
31. IS: 4923 Hollow Steel Sections for Structural Use
32. IS: 4943 (1968) Assessment of Butt and Fillet Fusion Welds in Steel Sheet, Plate and Pipe.
33. IS: 5334 (1981) Code of Practice for Magnetic Particle Flow Detection of Welds
34. IS: 5369, 5370 General Requirements for Plain Washers and Lock Washers(1975)
35. IS: 5372 (1975) Taper Washers for Channels
36. IS: 6610 Heavy Washers for Steel Structures
37. IS: 5374 (1975) Taper Washers for I Beams.
38. IS: 6227 Code of Practice for Use of Metal Arc Welding in Tabular Sections
39. IS: 6623 (1985) Specification for High Strength Structural nuts
40. IS:6649 (1985) Specifications for hardening and tempering washers for high strength structural nuts
41. IS: 6755 (1980) Double Coil Helical Spring Washers.
42. IS: 7215 (1974) Tolerances for Fabrication of Steel Structure.
43. IS: 7205, 7273, Safety Requirements for Steel Construction
44. IS: 7269, 7293 Handling of materials & Equipment's for Safe Working
45. IS: 7307 (Part I) Destructive & Non-Destructive Test of Welds
46. IS: 7318 (1974)(Part I) Approval Tests for Welders When Welding Procedure Approval is not required -fusion Welding of Steel.
47. IS:8500 (1991) Structural steel -Micro alloyed (Medium and High Strength Qualities)
48. IS: 8613 Wise Flux Combinations for Welded Joints
49. IS:8910 (1978) General requirements of Supply of Weldable Structural Steel.
50. 44. IS: 9595 (1980)Recommendations for Metal Arc Welding of Carbon & Carbon-Manganese Steels.
51. IS: 12843 Tolerances for Erection of Structural Steel Works
52. IRC: 24:Section V Standard Specifications and code of Practice for Road Bridges: Steel

## Road Bridges

53. 51 IRC:22-1986 Standard specification for road bridges

**Section VI – Composite construction****Materials**

- a. All materials to be supplied by the Contractor shall conform to relevant Indian Standards as approved by the The Engineer.
- b. Structural Steel materials required for the work shall be free from imperfections, mill scales, slag intrusions, laminations, pitting, rusts etc. that may im-pair strength, durability and appearance. All materials shall be of tested quality only. Test Certificates in respect of each consignment shall be submitted to The Engineer before use in work. Whenever the materials are permitted for procurement from identified stocks, a random sample shall be tested at an approved laboratory, as directed by the The Engineer.
- c. Structural steel encased column shall be in high tensile steel with a yield stress of 450 MPA conforming to IS: 2062. Structural steel beam shall be built up section in high tensile steel with yield stress of 450 MPA conforming to IS: 2062. UB/ UC sections shall be of yield stress of 350 MPA; for ISMB/ISMC/ ISA sections, the steel shall have yield stress of 250 MPA. Deck sheet shall be comflor-60, TR-60 or equivalent of 1mm thick with yield stress of 350 MPA with minimum 275 GSM galvanization of approved make. Shear studs shall have Ultimate stress of 450 MPA. Unless otherwise specified all anchor bolts shall be of property class of 8.8 (and size M40) and shall conform to IS: 1363 (1992), IS: 1364 (1992) and IS:1367, as applicable. Unless specified otherwise, head of bolts shall be hexagonal. All nuts shall conform to property class compatible with the property class of the bolt used. Unless specified otherwise, on drawings washer for HSFG/ High Strength bolts shall be conforming to IS:6649 (1985). Also plain washers shall be conforming to IS:5369 ( 1975).

**Storage of Materials:**

- a. All materials shall be so stored as to prevent deterioration, and to ensure the preservation of their quality and fitness for the work. If required by the The Engineer, the materials shall be stored under cover and suitably painted for the protection against weather condition. Any material, which has deteriorated or has been damaged shall be removed from site and replaced by new members, as directed by the The Engineer at no extra cost and time.
- b. The steel to be used in fabrication shall be stored in a separate stack clear of the ground section wise and lengthwise.



- c. The storage area shall be kept clean and properly drained. Structural steel shall be so stored and handled in such a manner that members are not subjected to excessive stresses and damage. Girders and beams shall be placed in upright position. Long members shall be supported on closely spaced skids to avoid unacceptable deflection.
- d. The Contractor shall have a suitable shop storage yard at his own premises for storing the fabricated steel structures and other materials. The yard shall have proper facilities such as drainage and lighting including access for cranes, trailers and other heavy equipment's.
- e. All Shop / field connection materials, shop paints etc. shall be stored on racks and platforms, off the ground in a properly covered building by the Contractor.
- f. The Contractor shall make proper arrangement for sand blasting of steel sections so that these sand blasted materials may be used for fabrication wherever required.

**Handling and Storing of Materials:**

- a. Suitable area for storage of structures and components shall be located near the site of work. The access road should be free from water logging during the working period and the storage area should be on leveled and firm ground.
- b. The store should be provided with adequate handling equipment's e.g. road mobile crane, gantries, derricks, chain pulley blocks, winch of capacity as required. Stacking area should be planned and have racks, stands sleeper, access tracks, etc., and properly lighted.
- c. Storage should be planned to suit erection work sequence and avoid damage or distortion. Excessively rusted, bent or damaged steel shall be rejected. Methods of storage and handling steel, whether fabricated or not shall be subject to the approval of the The Engineer.
- d. Fabricated materials are to be stored with erection marks visible, such as not to come into contact with earth surface or water and should be accessible to handling equipment.
- e. Small fitting hand tools are to be kept in containers in covered stores.
- f. All materials, consumables, including raw steel or fabricated material shall be stored specification-wise and size-wise above the ground upon platforms, skids or other supports. It shall be kept free from dirt and other foreign matter and shall be protected as far as possible from corrosion and

distortion. The electrodes shall be stored specification-wise and shall be kept in dry warm condition in properly designed racks. The bolts, nuts, washers and other fasteners shall be stored on racks above the ground with protective oil coating in gunny bags. The paint shall be stored under cover in air-tight containers.

- g. IS:7293 and IS:7969 dealing with handling of materials and equipment's for safe working should be followed. Safety nuts and bolts as directed are to be used while working. The Contractor shall be held responsible for loss or damage to any material provided by the Department while in his care or for any damage to such material resulting from his work.

**Shop Assembly:** The steelwork shall be temporarily shop assembled, as necessary, so that the accuracy of fit may be checked before dispatch. The parts shall be shop assembled with a sufficient number of parallel drifts to bring and keep the parts in place. Since parts drilled or punched, with templates having steel bushes shall be similar and, as such, interchangeable, such steelwork may be shop erected in part only, as agreed by the The Engineer.

**Erection Marking:** Each fabricated member, whether assembled prior to dispatch or not so assembled, shall bear an erection mark, which will help to identify the member and its position in respect of the whole structure, to facilitate re-erection at site. These erection marks shall be suitably incorporated in the shop detail and erection drawings.

**Formwork:** The formwork shall be properly designed, substantially built and maintained for all anticipated loads. The Contractor, if required, shall submit plans for approval to the The Engineer. Approval of the plans, however, shall not relieve the Contractor of his responsibility.

**Assembling :**

- a. The parts shall be accurately assembled as shown on the drawings and match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surface or surfaces to be in permanent contact shall be cleaned, before the members are assembled.
- b. The truss spans shall be erected on blocking, so placed as to give the proper camber. The blocking shall be left in place until the tendon chord splices are fully riveted and all other truss connections pinned and bolted. Bolts in splices of butt joints of compression members and bolts in railings shall not be driven until the span has been swung.
- c. All joint surface for bolted connections including bolts, nuts, washers shall be free from scale, dirt, burrs, other foreign materials and defects that would prevent solid seating of parts. The slope of surface of bolted parts in contact with bolt head and nut shall not exceed 1 in 20, plane normal to bolt

axis, otherwise suitable tapered washer shall be used.

- d. All fasteners shall have a washer under nut or bolt head whichever is turned in tightening.
- e. Any connection to be bolted shall be secured in close contact with service bolts or with a sufficient number of permanent bolts before the rivets are driven or before the connections are finally bolted. Joints shall normally be made by filling not less than 50 percent of holes with service bolts and barrel drifts in the ratio 4:1. The service bolts are to be fully tightened up as soon as the joint is assembled. Connections to be made by close tolerance bolts shall be completed as soon as practicable after assembly.

### **Transportation & Handling**

- a. Before the shop assembling is dismantled, all members and sections shall be appropriately marked with paint or grooved with their identification numbers as detailed in shop drawings.
- b. The Contractor shall transport the fabricated structural steel materials to work site, with all necessary field connection materials, in such sequence as will permit the most efficient and economical performance of the erection work. As per scheduled programme, the Engineer- in-charge may, at his discretion prescribe or control the sequence of delivery of materials.
- c. Fabricated parts shall be handled in such a way-that no damage is caused to the components. Measures shall be taken to minimize damage to the protective treatment on the steelwork. All work shall be protected from damage in transit. Particular care shall be taken to stiffen free ends, prevent permanent distortion and adequately protect all machined surfaces. All bolts, nuts, washers, screws, small plates and articles generally shall be suitably packed and identified.

### **Field Bolts:**

- a. Contractor shall supply the full number of bolts, nuts and washers and other necessary fittings required completing the work, together with the additional bolts, nuts and washers totaling to 10% of the requirement subject to minimum of 10Nos.
- b. At the time of assembly, the surfaces in contact shall be free of paint or any other applied finish, oil, dirt, loose rust, loose scale, burrs and other defects which would prevent solid seating of the parts or would interfere with the development of friction between them.

- c. If any other surface condition, including a machined surface, is specified, it shall be the responsibility of the Contractor to work within the slip factor specified for the particular case.
- d. Each bolt and nut shall be assembled with washers of appropriate shape, quality and number in cases where plane parallel surfaces are involved. Such washers shall be placed under the bolt head or the nut, whichever is to be rotated during the tightening operation. The rotated nut or bolt head shall be tightened against a surface normal to the bolt axis, and the appropriate tapered washer shall be, used when the surfaces are not parallel. The angle between the bolt axis and the surface under the non-rotating component (i.e. the bolt head or the nut) shall be  $90 + 3$  degree. For angles outside these limits, a tapered washer shall be placed under the non-rotating component. Tapered washers shall be correctly positioned.
- e. No gasket or other flexible material shall be placed between the holes. The holes in parts to be joined shall be sufficiently well aligned to permit bolts to be freely placed in position. Driving of bolts is not permitted. The nuts shall be placed so that the identification marks are clearly visible after tightening. Nut and bolts shall always be tightened in a staggered pattern and where there are more than four bolts in any one joint, they shall be tightened from the centre of the joint outwards.
- f. If, after final tightening, a nut or bolt is slackened off for any reason, the bolt, nut and washer or washers shall be discarded and not used again.

**Tightening of bolts:**

- a. Bolted connection joints with high strength friction grip bolts shall be inspected for compliance of codal requirements.
- b. The Engineer shall observe the installation and tightening of bolts to ensure that correct tightening procedure is used and shall determine that all bolts are tightened. Regardless of tightening method used, tightening of bolts in a joint should commence at the most rigidly fixed or stiffest point and progress towards the free edges, both in initial snugging and infinal tightening.
- c. The tightness of bolts in connection shall be checked by inspection wrench, which can be torque wrench, power wrench or calibrated wrench. Tightness of 10 per cent bolts, but not less than two bolts, selected at random in each connection shall be checked by applying inspection torque. If no nut or bolt head is turned by this application, connection can be accepted as properly tightened, but if any nut or head has turned all bolts shall be checked and, if necessary, re-tightened.

**Erection of Steel Structures:**

- a. The Contractor shall erect the structural steel, remove the temporary construction, and do all the work required to complete the, construction included in the contract in accordance with the drawings and the specifications and to the entire satisfaction of the Engineer.
- b. The Contractor shall submit erection plans prepared by the fabricator, showing a method and procedure of erection, compatible with the details of fabrication.
- c. A detailed scheme must be prepared showing stage-wise activities, with complete drawings and working phase-wise instructions. This should be based on detailed stagewise calculation and take into account specifications and capacity of erection equipment machinery, tools, tackles to be used and temporary working loads as per Codal provisions.
  - i. The scheme should be based on site conditions e.g. hydrology, rainfall intensity, soil and sub-soil conditions, temperature and climatic conditions and available working space, etc.
  - ii. The scheme should indicate precisely the type of temporary fasteners to be used as also the minimum percentage of permanent fasteners to be fitted during the stage erection. The working drawings should give clearly the temporary jigs, fixtures, clamps, spacer supports, etc.
  - iii. The Contractor shall supply and erect all necessary false work and staging and shall supply all labour, tools, erection plant and other materials necessary to carry out the work complete in all respects.
  - iv. Prior to actual commencement of erection all equipment, machinery, tools, tackles, ropes, etc. need to be tested to ensure their efficient working. Frequent visual inspection is essential in vulnerable areas to detect displacements, distress, drainages, etc.
  - v. Deflection and vibratory tests shall be conducted in respect of supporting structures, launching truss, cranes etc. as also the structure under erection and unusual observations reviewed, looseness of fittings are to be noted.
  - vi. For welded structures, welders' qualifications and skill are to be checked as per standard norms. Non-destructive tests of joints as per The Engineer's directives are to be carried out.
  - vii. Safety requirements should conform to IS: 7205, IS:7273 and IS:7269

as applicable and should be a consideration of safety, economy and rapidity.

- viii. Erection work should start with complete resources mobilized as per latest approved drawings and after a thorough survey of foundations and other related structural work. In case of work of magnitude, maximum mechanization is to be adopted.
- ix. The structure should be divided into erectable modules as per the scheme. This should be pre-assembled in a suitable yard/platform and its matching with members of the adjacent module checked by trial assembly before erection.
- x. The structure shall be set out to the required lines and levels. The stocks and masses are to be carefully preserved. The steelwork should be erected, adjusted and completed in the required position to the specified line and levels with sufficient drifts and bolts. Packing materials are to be available to maintain this condition. Organized "Quality Surveillance" checks need to be exercised frequently.
- xi. Before starting work, the Contractor shall obtain necessary approval of the Engineer as to the method adopted for erection, the number and character of tools and plants. The approval of the Engineer shall not relieve the Contractor of his responsibility for the safety of his method or equipment or from carrying out the work fully in accordance with the drawings and specifications.
- xii. During the progress of work, the Contractor shall have a competent Engineer or foreman in charge of the work, who shall be adequately experienced in steel erection and acceptable to the The Engineer.

#### **Painting at Site:**

- a. Surfaces which will be inaccessible after site assembly shall receive the full specified protective treatment before assembly. Surfaces which will be in contact after site assembly shall receive a coat of paint (in addition to any shop primer) and shall be brought together while the paint is still wet. Damaged or deteriorated paint surfaces shall be first made good with the same type of coat as the shop coat. Where steel has received a metal coating in the shop, this coating shall be completed on site so as to be continuous over any welds, bolts and site rivets. Specified protective final painting treatment shall be completed after erection.
- b. All the structural steel members (Beams/Columns/Slabs/Truss etc.) consist of members both of built up sections by steel plates as well as of

standard sections of various sizes shall be applied with single pack factory blended (free from asbestos & Glass fibers) vermiculite and Portland cement based, fire resistant material mixed with the required solvent/ water and designed for the fire protection of interior/exterior structural steel members as per manufacturer design & specification to required thickness sufficient to obtain minimum 3 Hour fire rating (as per NBC 2016). The exposed visible areas should be trowel finish. The plaster application shall be carried out through certified applicator / licensee of the manufacturer. The product shall adhere to the steel surface and should comply with latest provisions contained in UL-263 and BS-476 part 20/21 (for load bearing section). Before applying the material on surface of structural member, any metal mesh required to bond the material should be applied as per manufacturer specification. All lots / bags of blended material should have certification stamp from independent third party laboratories like Warrington Fire Research Lab (UK)/ UL (USA). (Approved make: NEWKEM / GRACE).

**Structural Steelwork Specification for Welded Structure:**

- a. The Steel structure should be made from Automatic continuous submerged arc H beam welding machine and shall be factory primer/ painted on Automatic paint conveyer system.
- b. This Specification covers the supply, fabrication transportation and erection at site of welded structural steelwork, including the supply of approved consumables, electrodes, wires and other materials required for fabrication and field connections of all structural steelwork covered under the scope of the Specification. The shear connectors' studs as specified in the drawing shall also be welded in the shop.
- c. Workmanship: All workmanship shall be in accordance with the best practices in modern structural steel works. Accuracy shall be maintained in the manufacture of every part of the work. The Contractor shall not proceed with any welding until the The Engineer has approved his welding plan, which shall include all information's on welding procedures, equipment, additives and preheating during welding operation, Details of non - destructive testing methods, Precautions with regard to welding shrinkage, Possible treatment of completed welds by grinding, Procedure and programme of welding sequence etc.
- d. Templates: Templates used throughout the work shall be of Steel. In cases where actual materials have been used as templates for drilling similar pieces, the The Engineer shall decide whether such materials are fit to be used as parts of the finished structure.

- e. Straightening: All materials shall be straight and free from twists, and if necessary, before being worked, shall be straightened and/or flattened by pressure, unless required to be of curvilinear form. Fusion faces and the surrounding surfaces within 50mm of the welds shall be free from all mill scale and free from oil, paint or any substance which might affect the quality of the welds or impede the quality/progress of welding. These shall be free from irregularities, which would interfere with the deposition of the specified size of weld or be the cause of defects. All mill scale within 50mm of welds shall be removed prior to welding, either by pickling followed by thorough power wire brushing, or by other approved methods. If preparation or cutting of the fusion faces is necessary, the same shall be carried out by shearing, chipping, gas cutting or flame gouging. Where hand gas cutting or hand gouging is employed, the blowpipe or gouging blowpipe shall be properly guided.
- f. Shearing, Cutting and Planning: Cutting shall be done automatically. Cutting by shearing machine may be used for plates not exceeding 10 mm in thickness provided that the plate edges be fully enclosed in a weld. For Plates above 10mm, CNC plasma cutting shall be used provided a smooth and regular surface free from cracks and notches is secured. Chipping of edges of plates, wherever necessary, shall be done without damaging the parent metal. Chipped edges shall be ground to a neat finish and sharp corners and hammered rough faces shall be rounded off. The edges and ends of all cut/sheared plates shall be plain/ground. Edge preparation for welding may be done by machine controlled flame cutting, with edges free from burrs should be clean and straight. The butting surfaces at all joints of girders shall be planed so as to butt in close contact throughout the finished joint. The edges shall be prepared, with an automatically controlled flame cutting torch, correctly to the shape, size and dimensions of the groove, prescribed in the design and fabrication drawings. In case of U-groove joints, the edges shall be prepared with an automatic false cutting torch in two phases, following a bevel out with a gouging pass or by machining. The welding surfaces shall be smooth, uniform and free from fins, tears, notches or any other defects, which may adversely affect welding, and shall be free of loose scale, slag, rust, grease, paint, moisture or any other foreign material. Assembly for Welding : Parts to be welded shall be properly assembled and held firmly in position by means of jigs and clamps prior to and during welding.
- g. Welding Procedure: All welding procedures shall be submitted to the The Engineer for approval, well before starting fabrication. The welding procedures shall be arranged by the Contractor to suit the details of the joints, as indicated in the drawings, and the position at which welding has to be carried out. Welding procedure shall cover the following:



- i. Type and size of electrodes
- ii. Current and (for automatic submerged arc welding) arc voltage
- iii. Length of run per electrode; or (for automatic welding) speed of travel
- iv. Number and arrangement of runs in multi run welds
- v. Position of welding
- vi. Preparation and set-up of parts
- vii. Welding sequence
- viii. Pre or post heating
- ix. Any other relevant information.
- x. Welding of 20 mm and more thick plates shall be done by beveling of edge to be welded.

The welding procedures shall be so arranged that distortion and shrinkage stresses are reduced to the minimum. Any weld found defective shall be removed, by using either chipping hammer or gouging torch, in such a manner that parent material is not injured in any way. Welding shall not be carried out when temperature is below 10 degrees Celsius or surface is wet or during periods of strong winds unless the work and the welder is adequately protected.

- a. Welding: The welding shall conform to code, IS: 816 (1969) and IS: 9595 (1980) and other applicable codes and standards, unless otherwise specified. As much work as possible shall be welded in shops and the layout and sequence of operations shall be so arranged as to eliminate distortion and shrinkage stresses. All electrodes/ wires / flux shall be kept under dry conditions. Any electrode / wires /flux damaged by moisture shall not be used unless it is guaranteed by the manufacturer that, when it is properly dried, there will be no detrimental effect. Any electrode, which has part of its flux coating broken away or is otherwise damaged, shall be rejected. Any electrode /wires/ flux older than six (6) months from the date of manufacture shall not be used. Batch certificates for electrodes/ wires /flux shall be submitted by the Contractor.
- b. Plate Construction : Automatic metal arc welding or sub merged arc welding shall be employed for fabrication of all members. Metal Inert gas welding may be done for short length where access to the location of the weld does not permit metal arc welding subject to approval of Engineer-in-charge.
- c. Accuracy of Fit-Up : Parts to be fillet welded shall be brought into as close contact as practicable, and the gap due to faulty workmanship or incorrect fit-up shall not exceed 1.5mm. If greater separation occurs at any position, the size of fillet weld shall be increased at such positions by the amount of the gap.
- d. Jigs and Manipulators : Jigs and manipulators shall be used, where

practicable, and shall be designed to facilitate welding and to ensure that all welds are easily accessible to the operators.

- e. Ends of Butt Welded Joints : The ends of butt joints shall be welded so as to provide full throat thickness. This may be done by the use of extension pieces, cross-runs or other approved means.
- f. Weld Face and Reinforcement of Butt welds : The weld face shall, at all places, be deposited projecting the surface of the parent metal. Where a flush surface is required, the surplus metal shall be dressed off.
- g. Testing of Butt Welds : Butt-welded joints are to be radio graphically tested (or Phased Array ultrasonic Testing) by the Contractor at his own cost in the presence of the the Engineer or his authorized representative, if desired by the the Engineer. If such tests indicate the joints to be defective, the cost of rectification of defective welds shall also be borne by the Contractor. The agency for testing of welds shall be specified for approval by the Engineer.
- h. Minimum Leg Length & Throat Thickness in Fillet Welds : The minimum leg length of a fillet weld as deposited shall be not less than the specified size as per codal provisions. In no case shall a concave weld be deposited, unless specifically permitted. Where permitted, the leg length shall be increased above that specified length, so that the resultant throat thickness is as great as would have been obtained by the deposition of a flat-faced weld of the specified leg length.
- i. Dislodging : After making each run of welding, all slag shall be thoroughly removed and the surface cleaned.
- j. Quality of Welds : The weld metal, as deposited (including tack welds), shall be free from- cracks, slag inclusions, porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without under cutting or overlapping at the toes of the weld. The surface of the weld shall have a uniform consistent contour and regular appearance.
- k. Weather Conditions : Welding shall not be done under weather conditions, which might adversely affect the efficiency of welding.
- l. Qualification and Testing of Welders : The Contractor shall satisfy the The Engineer that the welders are suitable for the work for which they will be employed, and shall produce evidence to the effect that welders, have satisfactorily completed appropriate tests, as described in IS:817 Part I (1992). The The Engineer may, at his own discretion, order periodic tests

of the welders and/or of the welds produced by them. Such tests shall be at the expense of the Contractor.

- m. Supervision : The Contractor shall employ competent welding supervisors to ensure that the standard of workmanship and the quality of the materials comply with the requirements laid down in this document.
- n. Machining of Butts and Bases : Splices and butt joints of compression members, depending on contact for stress transmission, shall be accurately machined over the whole section. In column bases, the ends of shafts together with the attached gussets, angles, channels etc., after bolting and/or welding together as the case may be, shall be accurately machined so that the parts connected butt over the entire surface of contact. Care shall be taken that connecting angles or channels are fixed with such accuracy that they are not reduced in thickness by machining by more than 0.8mm.

Requirement of Welded Joints: Apart from the requirements of welding specified under the above sub clauses, sections above, the Contractor shall ensure the following requirements in the welded joints.

- i) Strength-quality with parent metal.
- ii) Absence of defects
- iii) Corrosion resistance of the weld shall not be less than that of parent material in an aggressive environment.

Studs: Studs shall be used at interface of in-situ deck slab and plate girder to transfer the longitudinal shear. Unless otherwise specified the material used shall have characteristic yield strength of 385 MPA, minimum elongation of 18% and characteristic tensile strength of 495 MPA.

Welding of stud shear connectors: Unless otherwise provided the stud shear connectors shall be fusion welded to the plate girder using stud welding machine as per the manufacturer's instructions. No other type of welding shall be permitted. The stud and the surface to which studs are welded shall be free from scale, moisture, rust and other foreign material. The stud base shall not be painted, galvanized or cadmium plated prior to welding. Welding shall not be carried out when temperature is below 10 degrees Celsius or surface is wet or during periods of strong winds unless the work and the welder is adequately protected. The welds shall be visually free from cracks and shall be capable of developing at least the nominal ultimate strength of studs. The procedural trial for welding the stud shall be carried out when specified by the The Engineer.

#### Structural Steel Work - Quality Control & Testing Requirements

- a. The scope of work of these specifications is to establish the norms for ensuring the required Quality Control through established testing norms of

the welded structural steelwork by The Engineer.

- b. The Contractor shall himself inspect all materials and shop work to satisfy the specified tolerance limits and Quality norms before the same are inspected by The Engineer or his authorized representative.
- c. All materials, equipment and work of erection shall be subject to the inspection of the The Engineer who shall be provided with all facilities including labour and tools required at all reasonable times. Any work found defective is liable to be rejected.
- d. No protective treatment shall be applied to the work until the appropriate inspection and testing has been carried out. The stage inspection shall be carried out for all operations so as to ensure the correctness of fabrication and good quality. Plate Girder dimensions and camber, if any, shall not be finally checked until all welding and heating operations are completed and the member has cooled to a uniform temperature.
- e. Testing of material: All the materials shall be tested for mechanical and chemical properties as per various IS codes as may be applicable and shall conform to requirements specified. The cost of these tests shall be borne by the Contractor.
- f. Rivets, bolts, nuts, washers, welding consumables, steel forging, casting and stainless steel shall be tested for mechanical and chemical properties as per the appropriate IS Code.
- g. Rolling and cutting tolerance shall be as per relevant CPWD specifications or Indian Standards. The thickness check measurements for the plate and rolled sections shall be taken at not less than 15 mm from edge. For plates thicker than 25mm, Check for laminations in plates shall be carried out by ultra- sonic testing or any other specified methods.
- h. Steelwork shall be inspected for surface defects and exposed edge laminations during fabrication and blast cleaning. Significant edge laminations found shall be reported to the The Engineer for his decision. Chipping, grinding, machining or ultrasonic testing shall be used to determine depth of imperfection.
- i. Bolted connections: Bolts and bolted connection joints with high strength bolts shall be inspected and tested according to IS: 4000. The alignment of plates at all bolted splice joints and welded butt joints shall be checked for compliance with codal requirements.
- j. Welding and welding consumables: Welding procedure, welded

connection and testing shall be in compliance with codal requirements. All facilities necessary for stage inspection during welding and on completion shall be provided to the The Engineer or his authorized representatives. Adequate means of identification either by identification mark or other record shall be provided to enable each weld to be traced to the welder(s) by whom it was carried out.

- k. The Contractor shall through appropriate planning and continuous measurements in the workshop and the erection at site, ensure that the tolerance specified below are strictly adhered to. Tolerances in dimensions of components of fabricated structural steel work shall be specified on the drawings and shall be subject to the approval of the Engineer before fabrication.
- l. Dimensional & Weight Tolerance: The dimensional and weight tolerance for rolled shapes shall be in accordance with IS: 1852, 808 etc. The acceptable limits of straightness for rolled or fabricated members as per IS: 7215.
- m. The structural steel shall comply in all respects with the requirements of approved drawings and relevant codes and specifications and shall be procured from approved manufacturers only. It may be noted that quality of raw steel used for fabrication shall be essence of the contract & shall be strictly conforming to specified standard. Steel sections to be supplied by the manufacturers shall be tested as per codal provisions at the manufacturer's premises before dispatch. The Contractor on receipt of supply in his fabrication shop shall carry out necessary control tests including ultrasonic testing as per codal requirements and verify them with the list received from manufacturers. The rejected lot shall not be used and rejected lot shall be immediately removed from fabrication shop. Only steel passed in all tests shall be used for fabrication.
- n. The Contractor shall supply information in the technical package regarding source / manufacturers from where procurement of steel is proposed.
- o. Fabricator agency shall have in house facilities for all testing of weld, as detailed in this tender document.

#### **2.18. WATER PROOFING & INSULATION WORK :**

For waterproofing of works below plinth level, complete envelope/box shall be ensured with Pre- applied HDPE waterproofing membrane and Post-applied Self- Adhesive Modified Bituminous Waterproofing membrane.

Basically in all the buildings all the RCC works below plinth level (foundations, columns, slabs, shear walls, retaining walls, beams, lift well etc.), RCC work in Terrace slab (Columns above it, if any), retaining walls (with or without weep holes), reservoir, U.G. Tanks, water retaining/carrying structures, sewage & water treatment plant etc.) shall be given waterproofing treatment by adding the cementitious integral crystalline admixture of make KRYTONE, PENETRON, XYPEX or equivalent @0.80% (minimum) to the weight of cement content per cubic meter of concrete) or higher as recommended by the manufacturer's specification in reinforced cement concrete at site of work. The material shall meet the requirements as specified in ACI-212-3R-2010 i.e. by reducing permeability of concrete by more than 90%, compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure. The crystalline admixture shall be capable of self-healing of cracks up to a width of 0.50mm. The intension is to use integral cementitious crystalline admixture to all RCC works requiring the water proofing treatment. The product performance shall carry guarantee for 10 years against any leakage.

Pre-applied waterproofing membrane of 1.2 mm thick flexible sheets of make Pidilite, Grace, BASF or equivalent, consisting of HDPE carrier sheet coated with a pressure-sensitive adhesive and trafficable, weather and dirt resistant non-absorbent coating shall be used for waterproofing treatment below horizontal surface of foundations or underground structures exposed to soil (e.g. grade slab, raft, footing, lift pit base, UG tank, etc.). Sheet shall be durable and robust, manufactured using only virgin HDPE. The membrane shall form a continuous and permanent adhesive bond to poured concrete to prevent lateral water migration at the interface of the membrane and structural concrete. Continuity between adjacent sheets shall be assured using only adhesive to adhesive sealing, using either manufactured Zip Lap™ at side laps, or multiple adhesive layer tape at end laps or cut edges. Pre-applied membranes shall be smooth faced to avoid clogging or contamination and easy to clean prior to concreting to ensure intimate bonding to concrete. The membrane shall be capable of UV exposure without additional protection for a maximum of 45 days prior to concrete pouring. Third party test report from NABL accredited approved laboratory along with MTC of product should be submitted. Test report should not be older than 5 years. All detailing components of the system has to be compatible with the proposed waterproofing membrane and has to be manufactured and supplied by the manufacturer of waterproofing membrane. The Membrane shall confirm to following properties (minimum)- i) Pass for Lateral water migration resistance in both directions at 70 m (7 bar) of hydrostatic head pressure as per ASTM D 5385 modified. ii) Peel Strength to Poured-in-Place

Concrete after 7 days of water immersion should be >880N/m as per ASTM D 903.

Lap peel adhesion of 1408 N/m at 22°C as per ASTM D1876. iv) Peel Strength to Poured-in-Place Concrete of >880N/m – ASTM D 903. v) Elongation of at least 400 % as per ASTM D412. vi) Tensile strength of more than 27.6 MPA as ASTM D412. vii) Puncture Resistance of more than 890 N as per ASTM E154. All systems to be installed as per manufacturer's specification and executed by manufacturer's certified applicators (in house team) after successful mock-up at site etc.

Post-applied Self-Adhesive Modified Bituminous Waterproofing membrane of 1.5 mm thickness of make Pidilite, Grace, BASF or equivalent shall be used for waterproofing treatment on vertical sides of foundation system or underground structures exposed to soil (e.g. lift pit walls, retaining walls without weep holes, walls in continuation with the foundations, UG tank etc.). The water proofing treatment shall be as per manufacturer's specification and applications shall be by the manufacturer's certified applicators. The system shall be a self-adhesive, cold applied flexible water proofing membrane comprising of self-adhesive rubberized asphalt with cross laminated HDPE film with a unique solar reflective film on top surface. The membrane shall have pre-marked overlaps of 50mm and shall be applied on the uniform concrete surface and shall have expanded polystyrene protection including a load of bitumen solution primer on RCC surface. The membrane have following typical property values: i) Minimum thickness of 1.5 mm with HDPE thickness of minimum 0.2 mm as per ASTM D3767. ii) Hydrostatic Head Resistance of more than 70 m, as per ASTM D5385 test carried out on an overlap crossing a post formed crack. iii) Water Vapour Transmission Rate: 0.06 g/m<sup>2</sup>/day as per ASTM E96. iv) ) Elongation of at least 200 % as per ASTM D412. vi) Tensile strength of more than 482 psi as ASTM D412. vii) Puncture Resistance of more than 280 N as per ASTM E154.

Waterproofing cum insulation on terrace slabs shall be with an average 90 mm thick spray applied CFC & HCFC free polyurethane foam of Pidilite, BASF or equivalent, conforming to CPWD GHAR, IGBC, & GRIHA standards. The material shall have a core density of 50-60 kg /m<sup>3</sup> (as per ASTM 1622), thermal conductivity of 0.023 W/m.k at 25°C mean temperature (as per ASTM C518/91), U-value of 0.28 W/m<sup>2</sup>K as per ECBC standards for cold climate type, tensile strength of >400 kPa (as per ASTM D 1623/78), compressive strength >300 kPa (as per ASTM D 1621), closed cell content having apparent VOI of 96-98% (as per ASTM D 2856) and fire resistance property confirming to Class B2 as per DIN 4102. Before applying polyurethane foam, cracks shall be repaired by cutting V groove in 25x25 mm size and filling the same with polymer modified mortar( 1:3 Cement Mortar having polymer @10% by weight of cement). Base coat of highly elastomeric two component polyurethane based waterproofing coating (elongation of 600% and tensile strength of 6MPA) shall be applied at 1.5 kg/Sqm at the corners above the mother slab for a length of 150mm horizontally and 150mm vertically. Top of the polyurethane foam shall be applied with highly elastomeric two component polyurethane based waterproofing coating (elongation of 600%, tensile strength of 6MPA as per ASTM D 412) at 1.5 kg/Sqm. 150 gms Geo-textile (non-woven polyester) over the entire membrane maintaining proper overlaps shall be applied. A filler board of 10mm thickness for construction joints shall be placed vertically to form a rectangular bay not exceed 12sqm. The treatment should be followed by protective layer of average 75 mm thick concrete screed (grade M-15) including control joints of 3M X 4M size and making angle fillet of 50mmX50mm using concrete at the corners. Exposed filler boards shall be cut by mechanical means and groove shall be filled with Poly-sulphide Sealant. The width of sealant fill shall not exceed 10mm. All systems shall be installed by authorized applicators (in house team of manufacturer) as per manufacturer's recommendations and includes all lead and lift for all materials and labor.

Water proofing treatment to vertical and horizontal surfaces in all internal wet areas of building (e.g. Toilets/Kitchens/AHU/balconies etc.) shall consist application of water based, anti root, low VOC, single component, pure PU Polyurethane elastomer water proofing membrane of make PIDILITE, GRACE, BASF or equivalent with 1.5 mm DFT, having solid % value > 90, tensile strength > 2 MPA, Elongation > 550%, shore 'A' hardness  $60 \pm 5$  with a 150 gms polyester geotextile membrane. The system includes base preparation of cleaning, brushing and removal of flaky materials, grouting the porous area with cementitious grout, proper covering between slab and wall junctions and priming the surface as per manufacturer's specification. The coating shall be continued to the entire horizontal area and should be terminated at 300mm above the floor finish level complete as per manufacturer's specification. The treated horizontal surface shall be provided 40 mm (minimum) concrete screed (Grade M-15). The Vertical surface shall be provided with 15 mm thick Protective mortar of (1 Cement: 4 Coarse Sand) mixed with integral waterproofing compound of approved make as per manufacturer's specifications. All systems shall be installed by authorized applicators (In house team of manufacturer) as per manufacturer's recommendations and includes all lead and lift for all materials and labor.

Water proofing treatment to vertical and horizontal surfaces in all internal areas of building (ESS STP) shall consist application of integral crystalline slurry of hydrophilic in nature for waterproofing treatment to the RCC structures like retaining walls of the basement, water tanks, roof slabs, podiums, reservoir, sewage & water treatment plant, tunnels / subway and bridge deck etc., prepared by mixing in the ratio of 5 : 2 (5 parts integral crystalline slurry : 2 parts water) for vertical surfaces and 3 : 1 (3 parts integral crystalline slurry : 1 part water) for horizontal surfaces and applying the same from negative (internal) side with the help of synthetic fiber brush. The material shall meet the requirements as specified in ACI- 212-3R-2010 i.e by reducing permeability of concrete by more than 90% compared with control concrete as per DIN 1048 and resistant to 16 bar hydrostatic pressure on negative side. The crystalline slurry shall be capable of self-healing of cracks up to a width of 0.50mm. The work shall be carried out all complete as per specification and the direction of the the Engineer. The product performance shall carry guarantee for 10 years against any leakage.

#### **2.19. ROAD WORK:**

All roads will be Cement concrete Road & Paver Block pavement at car parking area roads (as per drawings), as per MORTH specifications (fifth edition), laid over sub grade duly prepared with power roller of required thickness as per design. Irrespective of whether shown in drawings or mentioned in tender document, all the drainage, signages (Informative, Mandatory, Regulatory etc.) other works associated with road works shall be provided as per relevant standards and specification. MORTH Specifications for Road and bridge work (Fifth Revision). The work shall be carried out using MORTH Specifications for Road and bridge work (Fifth Revision). The thickness of layers shall be followed as per tender drawings and get approval from The Engineer

As far as possible cross drainage should be taken under the road and at right angle to it.



Cement Concrete Road: Consisting the layer of C.C pavement M25 grade, Dry lean Concrete-(DLC) 125micron membrane Granular sub base (GSB) and sub grade. As per IRC code recommendation cement concrete road manual.

Sub grade: It shall be prepared and consolidated with power road roller of 8 to 12 tonne capacity after excavating earth to an average of 22.5 cm depth, dressing to camber and consolidating with road roller including making well the undulations etc. and re-rolling the sub grade and disposal of surplus earth.

Granular Sub-Base: Construction of granular sub-base shall be, by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of The Engineer. With material conforming to Grade-I (size range 75 mm to 0.075 mm) having CBR Value-30.

Dry lean cement concrete: Sub base over a prepared sub-grade with coarse and fine aggregate conforming to IS:383, the size of coarse aggregate not exceeding 25 mm, aggregate cement ratio not to exceed 15:1, aggregate gradation after blending to be as per specifications, cement content not to be less than 150 Kg/cum, optimum moisture content to be determined during trial length construction, concrete strength not to be less than 10 Mpa at 7 days, mixed in a batching plant, transported to site, for all leads & lifts, laid with a mechanical paver, compacting with 8-10 tonne vibratory roller, finishing and curing etc. complete as per direction of Engineer in- charge.

Cement Concrete Pavement: Design mix cement concrete of M-30 grade shall be laid as per drawings, in roads/ taxi tracks/ runways, using coarse sand and graded stone aggregate of 40 mm nominal size in appropriate proportions as per approved & specified design criteria, providing dowel bars with sleeve/ tie bars wherever required, laying at site, spreading and compacting mechanically by using needle and surface vibrators, leveling to required slope/ camber, finishing with required texture, including steel form work with sturdy M.S. channel sections, curing, making provision for contraction/ expansion, construction & longitudinal joints ( 10 mm wide x 50 mm deep) by groove cutting machine, providing and filling joints with approved joint filler and sealants.

#### **80mm Thick Paver Block Pavement:**

Consisting the layer of 80mm thick paver block M30 grade with sand bed 50mm thick, Wet Mix Macadam, Granular sub base (GSB) and sub grade. As per IRC code recommendation, Interlocking paver block manual.

80mm thick Factory made chamfered edge Cement Concrete paver blocks in drive ways or light traffic parking etc, of required strength, thickness & size/ shape, made by table vibratory method using PU mould, laid in required colour & pattern over 50mm thick compacted bed

of sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding layer through vibratory compaction by using plate vibrator, filling the joints with sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand. complete all as per direction of The Engineer.

**Wet Mix Macadam:** It shall consists providing, laying, spreading and compacting graded stone aggregate (size range 53 mm to 0.075 mm ) to wet mix macadam (WMM) specification including premixing the material with water at OMC in mechanical mix plant, carriage of mixed material by tipper to site, for all leads & lifts, laying in uniform layers with mechanical paver finisher in sub- base / base course on well prepared surface and compacting with vibratory roller of 8 to 10 tonne capacity to achieve the desired density.

**Granular Sub-Base:** Construction of granular sub-base shall be, by providing close graded Material conforming to specifications, mixing in a mechanical mix plant at OMC, carriage of mixed material by tippers to work site, for all leads & lifts, spreading in uniform layers of specified thickness with motor grader on prepared surface and compacting with vibratory power roller to achieve the desired density, complete as per specifications and directions of The Engineer. With material conforming to Grade-I (size range 75 mm to 0.075 mm) having CBR Value-30.

60mm Factory made chamfered edge Cement Concrete paver blocks in footpath, parks, lawns, etc, of required strength, thickness & size/ shape, made by table vibratory method using PU mould, laid in required colour & pattern over 50mm thick compacted bed of sand, compacting and proper embedding/laying of inter locking paver blocks into the sand bedding layer through vibratory compaction by using plate vibrator, filling the joints with sand and cutting of paver blocks as per required size and pattern, finishing and sweeping extra sand. complete all as per direction of The Engineer.

**Factory made kerb stone:** It shall be of M-25 grade cement (made by using ingredients from C & D waste) shall be provided at or near ground level in position to the required line, level and curvature jointed with cement mortar 1:3 (1cement: 3 coarse sand) as per drawings including making joints with or without grooves (thickness of joints except at Sharpe curve shall not to more than 5mm) including making drainage opening wherever required complete etc.

**Cement Concrete (M30 grade) tactile tile:** Such as directional, warning or hazardous (for vision impaired persons as per standards) of size 300x300x60 mm {60 mm base + (5mm ± 0.5mm) thick raised portion} having water absorption ≤ 6% and conforming to IS: 13801, of approved make in all color's (preferably yellow) and shades for footpath should be laid on 20mm thick base of cement mortar 1:4 (1cement : 4 coarse sand) in all shapes & patterns including grouting the joints with white cement mixed with matching pigments etc. (The thickness of wearing layer should not be less than 8mm) and as per harmonized guidelines and space standards for barrier free built environments for persons with disability and elderly persons issued by Ministry of Urban Development, Govt. of India.

Coloured, preferably yellow PU - Tactile Studs Warning/Positional) with 1 stem having stem dia of 6.0 mm & stem length between 20 - 25 mm, as ground surface indicators shall be provided for the visually impaired persons, on the pedestrian pathway as per manufacturers design / specification and as per harmonized guidelines.

Coloured, preferably yellow PU - Tactile strips (Guiding ) with 3 stems having stem dia of 6.0 mm & stem length between 20 - 25 mm, as ground surface indicators shall be provided for the visually im-paired persons on the pedestrian pathway as per manufacturers design / specification and as per harmonized guidelines.

Gang saw cut 30 mm thick or of thickness specified in drawings, mirror/Flamed polished pre moulded and pre polished machine cut granite stone of required size and shape of approved shade, colour and texture in footpath, flooring in road side plazas and similar locations as per landscape drawings, shall be laid over 20mm thick base of cement mortar 1:4 (1 cement: 4 coarse sand) including grouting the joints with white cement mixed with matching pigment, epoxy touch ups etc.

RCC Perforated Drain Covers: Factory made precast RCC perforated or non- perforated drain covers having concrete of strength not less than M-25, of required sizes for road side drains/underground utility shaft or duct, shall be provided. These should be properly reinforced to carry the desired load.

Drain Cell shall be of 20mm thickness (Weight Over 2Kg/sq. mt) consisting of High strength Polypropylene module having size of 500mm x 250mm and 20mm height with interlocking tabs. The Drain Cell to have compressive strength of over 120 tons/sqmt and weight of more than 2kg/sqmt. Drain Cell to be laid by interlocking individual modules their by covering the entire area. Drain Cell to be covered with Geo-textile 150 GSM with 200mm overlap before laying planting soil. Laying to be done as per manufacturer instructions.

Chain Link Fencing: G.I. chain link fabric fencing of required width in mesh size 50x50 mm including strengthening with 2 mm dia wire or nuts, bolts and washers as required complete as per the direction of The Engineer.

Made of G.I. wire of dia. 4 mm, PVC coated to achieve outer dia not less than 5 mm in required colour and shade. The length, height and position of foundation shall be followed as per in tender drawing and Engineers direction and in-charge

Road Surface marking: it shall be done with two or more coats to give uniform finish with ready mixed road marking paint conforming to IS: 164, on white/yellow shade, including cleaning the surface of all dirt, scales, oil, grease and foreign material etc.

Retro Reflective Signage Boards: It shall consist manufacturing, supplying and fixing made up of 2 mm thick aluminum sheet, face to be fully covered with high intensity and encapsulated lens type heat activated retro reflective sheeting conforming to type - III of ASTM-D- 4956-01 as approved by The Engineer, letters, borders etc. as per IRC : 67-2001 in

silver white with blue colour back ground and with high intensity grade, pasted on substrate by pressure sensitive adhesive backing which shall be activated by applying pressure conforming to class II of ASTM-D-4956-01 and fixing the same to the plate of structural frame work by means of suitable sized aluminum alloys, rivets or bolts & nuts @ 300 mm centre to centre all along the periphery as well as in two vertical rows along with theft resistant measures, including the cost of painting with two or more coats of epoxy paint in grey colour on the back side of aluminum sheet including appropriate priming coat. The process includes rounding off the corners, lowering down the structural frame work from the gantry, fixing and erecting the same in position all complete as per drawings, specification.

## **2.20. SIGNAGES:**

Signages inside/outside building shall be in English & Assamese language as per NBC 2016 guidelines and of approved design and make with LED backlit. Each rooms shall be provided with Name Boards, Numbering of rooms, Signages etc. The Contractor shall prepare the detailed shop drawing in compliance to the NBC 2016 guidelines and disable friendly building norms of MoHUA.

Name Boards for buildings shall be of approved design and make (like suitable gauge, 2 feet height SS 304 lettering) with LED backlit.

Signage works include providing and fixing Building Entrance signage / Tactile Layout / Emergency Evacuation Layout on the wall or with any other required structure, with provision of multilingual text integral with 4mm thick blue Acrylic base plate with min 0.5 mm Aluminium sheet at the back with Upper Case San Serif words made of white acrylic non glare cut out letters of height 15mm, raised above base plate by not less than 0.8mm and the equivalent word/s written in English & Assamese / any language as required with same specifications with Grade 1 Braille to be integral with the sign face and should be raised 0.5mm above Acrylic base plate. Each signboard to be fixed strictly as per the Harmonized Guidelines & Space Standards for Barrier Free Built Environment for persons with Disability, issued By MOUD, Govt. of India, and as per approved drawings and complete as per the directions of Engineer - In - Charge. Size of the Signboards shall be proportional to the layout plan of the particular building, Min Size of the above signboards shall not be less than 1200mm X 750 mm.

Identification signages (e.g. Room Names / Rooms Number / Toilet facility / Drinking Water / Staircase / Entry / Exit / Lift etc.) of the size 150 mm X 230 mm or 200 X 200 mm).

Floor Directories (Signboard Placed near the Lift / Staircase / Entry to the particular Floor indicating the facilities on that floor which are normally also called as Directional Signages) shall be of minimum size not be less that 450 mm X 450 mm.

Emergency Exit Sign Boards (Generally used Text as "In Case of Emergency, Do Not Use The Lift", "Emergency Exit" etc.)

**2.21. HORTICULTURE & LANDSCAPE WORK:**

GENERAL: Contractor to furnish all materials, labor and related terms necessary to complete the work indicated on drawing and specified here in. The quantities given herein for various plants/trees/shrubs/grass etc. are tentative. However, the Contractor shall provide the actual quantities as per the scope of work and requirement at site.

**Materials:**

- a) Plant materials:
  - (i) Plant materials shall be well formed and shaped true to type, and free from disease, insects and defects such as knots, windburn, injuries, abrasion or disfigurement.
  - (ii) All plant materials shall be healthy, sound, and vigorous, free from plant disease, insect pests or their eggs, and shall have healthy, well-developed root systems.
  - (iii) All plants shall be hardy under climatic conditions similar to those in the locality of the project. Plants supplied shall conform to the names listed on both the plan and the plant list. No plant material will be accepted if branches are damaged or broken. All material must be protected from the sun and weather until planted.
  - (iv) Any nursery stock shall have been inspected and approved by the The Engineer.
  - (v) All plants shall conform to the requirements specified in the plant list, except that plants larger than specified may be used if approved, but use of such plants shall not increase the contract price. If the use of the larger plant is approved, the spread of roots or ball of earth shall be increased in proportion to the size of the plant.
  - (vi) Plants shall be delivered with legible identification labels.
- b) Topsoil: Topsoil or good earth shall be a friable loam, typical of cultivated topsoil of the locality containing at least 2% of decayed organic matter (humus). It shall be taken from a well-drained arable site. It shall be free of subsoil, stones, earth clods, sticks, roots or other objectionable extraneous matter or debris. It shall contain no toxic material. No topsoil shall be delivered in a muddy condition. Good earth shall have PH range 6.5 to 7.5
- c) Manure (as locally available): Dry farm yard manure shall be used. It shall be free from extraneous matter, harmful bacteria insects or chemicals.

- d) Root System: The root system shall be conducive to successful transplantation. Where necessary, the root-ball shall be preserved by support with hessian or other suitable material. On soils where retention of a good ball is not possible, the roots should be suitably protected in some other way which should not cause any damage to roots.
- e) Condition: Trees and shrubs shall be substantially free from pests and diseases, and shall be materially undamaged. Torn or lacerated roots shall be pruned before dispatch. No roots shall be subjected to adverse conditions, such as prolonged exposure to drying winds or subjection to water-logging, between lifting and delivery.
- f) Supply and substitution: Upon submission of evidence that certain materials including plant materials are not available, the Contractor shall be permitted to substitute other material and plants, with an equitable adjustment of price. All substitutions shall be of the nearest equivalent species and variety to the original specified and shall be subject to the approval of the engineer-in-charge.
- g) Packaging: Packaging shall be adequate for the protection of the plants and such as to avoid heating or drying out.
- h) Marking: Each specimen of tree and shrub, or each bundle, shall be legibly labelled with the name of the supplier and the date of dispatch from the nursery, unless otherwise agreed.

#### **Trees, Ornamental Plants & Palms Planting:**

- a) Trees should be supplied with adequate protection as per drawing and as approved by the engineer in-charge. After delivery, if planting is not to be carried out immediately, balled plants should be placed cheek to cheek and the ball covered with sand to prevent drying out. Bare-rooted plants can be heeled in by placing the roots in a prepared trench and covering them with earth which should be watered into avoid airpockets round the roots.
- b) Digging of Pits: Tree pits shall be dug a minimum of three weeks prior to back filling. The pit sizes shall be as specified further herein. It shall be replaced with soil mixture as specified further herein. While digging the pits, the top soil up to a depth of 30 cm may be kept aside, if found good (depending upon site conditions) and mixed with the rest of the soil. If the soil is bad below, it shall be replaced with the soil mixture as specified further herein. The bottom of the pit shall be forked to break up the sub-soil.
- c) Back filling: If the excavated soil is normal, it shall be mixed with manure. River sand shall be added to the soil if it is heavy. However, if the soil is

bad, the pit shall be refilled with imported good garden soil mixed with manure 2:1 by volume (2 parts of stacked volume of earth after 20% reduction: 1 part of stacked volume of manure after 8% reduction). The soil back filled has to be watered through and gently pressed down a day previous to planting to make sure that it may not further settle down after planting. The rest 100mm shall be filled with manure. The soil shall be pressed down firmly by treading it down, leaving a shallow depression all around for watering.

- d) Planting: No tree pits shall be dug until final tree positions have been pegged out for approval. Care shall be taken that the plant sapling when planted is not buried deeper than in the nursery, or in the pot. Planting should not be carried out in water logged soil. Plant trees at the original soil depth; the soil marks on the stem is an indication of this and it should be maintained on the finished level, allowing for setting of the soil after planting. All plastic and other imperishable containers should be removed before planting. Any broken or damaged roots should be cut back to sound growth. The bottom of the planting pit should be covered with 50mm to 75mm of soil. Bare roots should be spread evenly in the planting pit; and small mound in the centre of the pits on which the roots are placed will aid an even spread. Soil should be placed around the roots, gently shaking the tree to allow the soil particles to sift into the root system to ensure close contact with all roots and to prevent air pockets. Backfill soil should be firmed as filling proceeds, layer by layer, care being taken to avoid damaging the roots, as follows:
  - e) Chlorpyrifos emulsifiable concentrate 0.2% shall be applied on walls of pit, and initially pit shall be filled to 200 depth with earth mixed Chlorpyrifos emulsifiable concentrate 0.2%. The balance earth shall be filled in with manure in proportion as specified further herein. Chlorpyrifos emulsifiable concentrate 0.2% shall be applied every 15 days.
  - f) Staking: Newly planted trees must be held firmly although not rigidly by staking to prevent a pocket forming around the stem and newly formed fibrous roots being broken by mechanical pulling as the tree rocks.
  - g) Methods: The main methods of staking shall be:
    - i. A single vertical stake, 900mm longer than the clear stem of the tree, driven 600mm to 900mm into the soil.
    - ii. Two stakes as above driven firmly on either side of the tree with a cross-bar to which the stem is attached. Suitable for bare-rooted or balled material.

- iii. A single stake driven in at an angle at 45° and leaning towards the prevailing wind, the stem just below the lowest branch being attached to the stake. Suitable for small bare-rooted or balled material.
- iv. For plant material 3m to 4.50 m high with a single stem a three-wire adjustable guy system may be used in exposed situations.
- v. The end of stake should be pointed and the lower 1m to 1.20m should be coated with a non-injurious wood preservative allowing at least 150mm above ground level.
- h) Tying: Each tree should be firmly secured to the stake so as to prevent excessive movement. Abrasion must be avoided by using a buffer, rubber or hessian, between the tree and stake. The tree should be secured at a point just below its lowest branch, and also just above ground level; normally two ties should be used for tree. These be adjusted or replaced to allow for growth.
- i) Watering: The Contractor should allow for the adequate watering in of all newly planted trees and shrubs immediately after planting and he shall during the growing seasons, keep the plant material well-watered.
- j) Fertilizing: Fertilizing shall be carried out by application in rotation of every 15 days from the beginning of the monsoon till the end of winter: - sludge of organic well-rotted dry farmyard manure or vermicomposting or approved organic manure as per directions of the Engineer.

### **Shrubs, Ground Covers, Creepers Planting In Planters And Beds**

- a) All areas to be planted with shrubs shall be excavated, trenched to a depth of 600 mm, refilling it with finely mixed good black garden soil and excavated earth (after breaking the clods and mixing with sludge in the ratio as specified further herein. Backfill soil should be firmed as filling proceeds, layer by layer, care being taken to avoid to avoid damaging the roots, as follows:
- b) o Chlorpyrifos emulsifiable concentrate 0.2% shall be applied on walls of pit. The balance earth shall be filled in a mixture with manure in proportion as specified further herein. Chlorpyrifos emulsifiable concentrate 0.2% concentration shall be applied every 15 days.
- c) Tall shrubs may need staking, which shall be provided if approved by the engineer-in- charge depending upon the conditions of individual plant specimen.
- d) For planting shrubs and ground cover shrubs in planters, good earth shall be



mixed with sludge in the proportion as above and filled in planters.

- e) Positions of shrubs to be planted should be marked out in accordance with the planting plan. When shrubs are set out, precautions should be taken to prevent roots drying. Planting holes (of sizes as specified further herein) should be excavated for longer shrubs. Polythene and other non-perishable containers should be removed and any badly damaged roots carefully pruned. The shrubs should then be set in holes so that the soil level, after settlement, will be at the original soil mark on the stem of the shrub. The hole should be backfilled to half pots depth and firmed by treading. The remainder of the soil can then be returned and again firmed by treading.
- f) Grass areas:
  - a. Mixing earth and manure in proportion 8:1 and spreading to a thickness of 200mm.
  - b. Fine dressing the ground (to levels specified).
  - c. Grassing with selection No. 1 grass including watering and maintenance of the lawn for 60 days or more till the grass forms a thick lawn, free from weeds and fit for mowing including supplying good earth, if needed.
  - d. In rows 5 cm apart in both directions
  - e. Flooding the ground with water including making kyries and dismantling the same.

### **Ground Cover And Herbal Plants**

- a) Pit Preparation: Preparing planting beds for ground covers planting by excavating and refilling the same with sweet earth mixed with manure 8:1 by volume (8 parts of stacked volume of earth after 20 % reduction: 1 part of stacked volume of manure after 8 % reduction), flooding with water, dressing including removal of rubbish and surplus earth if any with all leads and lifts; excluding cost of earth and manure. Unless otherwise specified, pit size shall be 0.15m x0.15m x 0.30 m.
- b) Supply and plantation: Planting best quality ground covers of species and height as specified. All ground covers to be planted should be best quality pot-grown healthy ground covers inclusive of preparation and cultivation of ground cover beds as specified. All plantsto be approved before planting.

**Creepers:**

- a) Pit Preparation: Preparing planting beds for creepers planting by excavating and refilling the same with sweet earth mixed with manure 8:1 by volume (8 parts of stacked volume of earth after 20 % reduction: 1 part of stacked volume of manure after 8 % reduction), flooding with water, dressing including removal of rubbish and surplus earth if any with all leads and lifts; excluding cost of earth and manure. Unless otherwise specified, the pit size shall be 0.6m x0.6m x 0.6m.
- b) Supply and plantation: Planting best quality creepers of species and height as specified. All ground covers to be planted should be best quality pot- grown healthy ground covers inclusive of preparation and cultivation of creeper beds as specified. All plants to be approved before planting.

The Contractor shall supply the sweet earth, cow dung manure, vermi compost manure, coco peats etc. as per requirement specified for horticulture works. Approximate volume would be around 2000 Cum.

**Mounds:**

Contractor shall prepare mounds of various size and shape by available excavated / supplied earth in layers not exceeding 20 cm in depth, breaking clods, watering of each layer, dressing etc., lead upto 50 meter and lift upto 1.5 m complete as per direction of the Engineer. Geocell is a three dimensional geocellular confinement system designed for steep slopes, river banks, ditches, spillways, and other exposed areas that are often prone to damage caused by erosion due to wind or water. Geocell system can help to prevent erosion by confining soils and aggregates within the cell structure. Varying degrees of protection can be afforded by selecting alternative in-fill materials. Seeded topsoil provides protection for less exposed areas. Protection may be increased by introducing vegetation such as small shrubs

**Miscellaneous:**

Anti- termite treatment: Providing and injecting chemical emulsion for post construction anti termite treatment along the external wall up to depth of 300mm as per CPWD specifications.

Anti-Termite Chemical Treatment: Post Constructional anti-termite treatment shall be with Chloropyriphos/ lindane emulsifiable concentrate 20% with 1% concentration as per CPWD specification.

Damp Proof Course: Damp proof course shall be with 40 mm thick cement concrete 1:2:4 (1cement:2 coarse sand :4 graded stone aggregate 12.5mm nominal size) mixed with water proofing compound painted at top with a coat of residual petroleum bitumen of grade VG-10 of approved quality at 1.7 kg/sqm.

Plinth Protection: Plinth Protection as per drawing (minimum 1000mm wide) shall be with 50mm thick cement concrete 1:3:6 (1cement : 3 coarse sand : 6 graded stone aggregate 20mm nominal size) over 75mm of brick ballast 40 mm nominal size with brick edging.

Barricading: 6 metre high temporary barricading at site as per drawing/ direction of The Engineer which includes writing and painting, arrangement for traffic diversion such as traffic signals during construction at site for day and night, glow lamps, reflective signs, marking, flags, caution tape as directed by the Engineer-in- Charge. The barricading provided shall be retained in position at site continuously. Rate include its maintenance for damages, painting, all incidentals, labour materials, equipments and works required to execute the job. The barricading shall not be removed without prior approval of The Engineer.

## 2.22. LIST OF PREFERRED MAKE / MANUFACTURERS FOR DIFFERENT MATERIALS TO BE USED FOR CIVIL WORKS:

- The followings brands are to be used for the Civil Works. However, Make(s) meeting the contract Technical Requirement/Specifications shall only be permitted to use in work.
- Items which are not mentioned in below list but required at site, can be taken from the approved list of Approved make of PWD Assam etc. Furthermore, the materials/equipment to be used which are not mentioned in any of the below list should have ISI or equivalent it shall be Certified from the engineer incharge during execution .

S.No	Material	approved Makes / Brands		
	Civil / Interior works			
1	Cement (OPC / PPC / White Cement)	ACC	Ultratech	J.K Cement
		Lafarge	Ambuja Cement	Ramco Cement
		Valley Strong	Amrit Cem	Shree Cement
		Star	Birla Soft	and Equivalent
2	A. Reinforcement Steel (TMT-Fe500/ Fe500D)	TATA	SAIL	RINL
		JSW	Shyam Steel	
3	Structural Steel/ M.S. Tube	TATA	RINL	SAIL
		BANSAL	NEZONE	UTKARSH
4	Anti.Termite Treatment	Tricel	Premis	or equivalent
5	Plasticizer, Super Admixtures, Other construction chemicals	CICO	FOSROC	MYK Arment
		SIKA	Chocksy	Brighton
		Firstchoice	Saint Globle	Penetron

S.No	Material	approved Makes / Brands		
		Ready Mix		
		Berger	Mapei	Asian paints
		and equivalent		
6	Roofing Sheet (PPGI Sheet/ PPGL Sheet)	Tata Bluescope	JSW	Durokolor
		Spectrum	Dyna Roof	Stellar
		Dura Roof	Taj Roofing	Magnum roofing
		Prestar	Indo roof	Mega roof
		Colour max	and equivalent	
	FINISHING PAINTS AND COATING			
7	Paint	Asian paints	Berqer	ICI
		J&N paint	Luxol	Nerolac
		Unicen	Duca paint	Briohtno
		ARIA paint	Flixopaint	Dulux
		and equivalent		
8	Texture Paint	Spectrum	BULWARK CONCHEM	or equivalent
9	Epoxy Paint	Pidilite	Beraer	FOSROC
		Slkka	Cico	Asian paints
		Nerolac	Shalimar	and equivalent
10	Wall Putty	Birla Wall Care	JK While	Asian Paints
		Berger	Dulux	Vinyl wall care
		Fosroc	Firstchoice Ready Mix	and equivalent
11	Polyster Powder Coating Paint	Nerolac	Berqer	Akzonobel
		and equivalent		
12	Water Based Melamine Polish	Asian paints	Pidilite	ICIDulux
		Berqer	and equivalent	
13	Fire Retradant Paint	Asian	Berger	Shalimar
		Viper FRS881	Nullifire	Brighton
		and equivalent		

S.No	Material	approved Makes / Brands		
14	Gypsum Plaster	Ferrous Crete	Elite(90)	Ultratech
		ArdexEndura	BULWARK CONCHEM	and equivalent
	FLOORINGS			
15	Floor/ Wall Tiles (Ceramic / Vitrified)	Somany	NITCO	Varmora
		Kajaria	AGL	Simonza
		Orient Bell	Johnson	Qutone
		Bonzer 7	Marbita	Oasis
		Sattvik Ceramik	Bajaj	NITCO
		VITERO by APARNA	RAK Ceramics	and equivalent
16	Parking Tiles	Johnson	NITCO	Marbita
		AGL	Somany	Varmora
		Sattvik Ceramik	RAK	and equivalent
17	Paver tiles	SUNROCK-Hi CTS	MULTIWYN	OMI's
		RAK	and equivalent	
18	Vinyl Flooring	Tarkett	Armstrong	Wonder floor
		Gerfloor	and equivalent	
19	Anti bacterial Tiles	Johnson	Orient Bell	NITCO
		AGL	Somany	and equivalent
20	Tac tiles	Durotect	AGL	Johnson
		and equivalent		
21	Wooden floor tiles / Carpet flooring	Armstrong American exotics	Welspun	and equivalent
22	Bamboo wood floor tiles	Epitome	Maisang	ESES
		and equivalent		
23	Broadloom carpet tiles	WELSPUN	and equivalent	
24	Dash / Anchoring Fasteners	Hilti	Fisher	Bosch
		Anchor	and equivalent	
25	Floor hardener	Ironite	Fosroc	Brighton
		Firstchoice	Mapei	Hardonite

S.No	Material	approved Makes / Brands		
		Ready Mix		
		and equivalent		
26	Composite Marble / Granite I Engineered Stone	Asian	Johnson	Kalinga
		and equivalent		
27	Heat Resistant Tiles	Swastik	Thermax	and equivalent
28	Facade Tiles	Clayton	Terreal	Hunter Douglus
		Faveton	and equivalent	
29	Venetian Blinds	Mac Decor	Vista	Hunter Douglas
		NITCO	Unitile	Ultra
		KKManholes	Unistone	and equivalent
31	Clamp System For Dry Stone Cladding	Hilti	Fischer	Bosch
		and equivalent		
32	Heat Resistant Tiles	Swastik	Thermax	Ardex Endura
		and equivalent		
	WATERPROOFING			
33	Integral Waterproofing Crystalline Admixture	Fosroc	Dr. fixit	Penetron
		Pidillte	Asian paints	Brighton
		Firstchoice Ready Mix	Berger	MYK Arment
		Mapei	and equivalent	
34	Polyurethane, Liquid Applied Waterproofing Membrane	Asian paints	BASF	SOPREMA
		MAPEI	Briqhton	BULWARK CONCHEM
		MYK .Arment	Berger	Penetron
		and equivalent		
35	Liquid Applied, Acrylic Elastomeric Membrane	MYK Arment	SIKA	FOSROC
		Chocksy	Dr. Fixit	BULWARK CONCHEM
		Brighton	Berger	Mapei
		Asian paints	and equivalent	
36	Water proofing Self	MYK Arment	STP	FOSROC

S.No	Material	approved Makes / Brands		
	Adhesive Membrane (HDPE )	Brighton	Berger	Mapei
		Asian paints	and equivalent	
37	SBS Membrane	MYK Arment	SIKA	FOSROC
		BULWARK CONCHEM	Beraer	Briahton
		Mapei	Asian naints	and eauivalent
38	PVC Water Stops	MYK Arment	Supreme	Oriplast
		Brighton	Mapei	and equivalent
	EPOXY COATING FLOORING			
39	Polyurethane Concrete Flooring	Pidilite	MYK Arment	MAPEI
		Brighton	Berger	Asian paints
		and equivalent		
40	Food Grade Epoxy Coating	MAPEI	STP	MYKArment
		BULWARK CONCHEM	Berger	Brighton
		Asian paints	and equivalent	
41	Anti Static Flooring	STP	FOSROC	MAPEI
		MYK Arment	Berger	Brighton
		Asian paints	and equivalent	
	GROUTS / CHEMICALS			
42	Grouting Admixture	FOSROC	ARDEXENDURA	MYK Arment
		SIKA	BULWARK CONCHEM	Berger
		Brighton	Firstchoice Ready Mix	Mapei
		Asian paints	and equivalent	
43	Zinc Panels	VM Zinc	Halcor	Leqsa
		Cinkarna	and equivalent	
44	Fibre Cement Panels	Equitone "Mineralis"	Swiss pearl	FibreC by Rieder
45	Rebarring Chemical	Hilti	3M India	and equivalent
46	Fire Sealant	Hilti	3M India	Fischer
		and equivalent		

S.No	Material	approved Makes / Brands		
47	Parallel Threaded Couplers (Compliant to IS:16172:2014)	Dextra	Halfen Moment	G-Tech
		and equivalent		
48	AAC Block	Superlite	Utralyte	Genex
		and equivalent		
49	Bricks	1st class clay bricks	Jhama Bricks	Solid 2 to 3 hole no 1 red bricks
50	Building Blocks	Plastic embedded light weight brick of Zerund Brand	Cellular Concrete Blocks	
		and equivalent		
51	Poly sulphide Sealant	Fosroc	Wacker	BASF
		Brignton	Berger	Dow Corning
		Asian Paints	and equivalent	
52	Adhesive for Wood Work	Dunlop	Fevicol	Vamicol
		Brighton	Pidillte	Araldite
		and equivalent		
	WOODEN WORK			
53	Moisture Resistant Board	Saint Gobin	Gyprox	USG Boral
		Anakon	and equivalent	
54	Veneered Particle Board	Duro	Action TESA	and Equivalent
55	Laminated Particle Board / Laminates	Merino	Greenlam	Century
		Ventura	KPI	Action Tesa
		Virgo	and equivalent	
56	MDF	Action Tesa	Greenply	Archidply
		Greenpanel	Ventura	KPI
		Jain Doors	and equivalent	
57	PRE Laminate MDF	Action Tesa	Green Ply	Archidply
		Greenpanel	Ventura	KPI
58	Metalic Laminates	Merino	century	Metlam
		Ventura	and equivalent	



S.No	Material	approved Makes / Brands		
59	Flush Door Shutters	Duro	Greenply	KPI
		Century	Archidply	Merino
		Jain Doors	and equivalent	
60	Plywood / Veneer / Laminate	Fiden	century	Austin Ply
		Green Ply	Archid Ply	BWR
		Jain Doors	and equivalent	
61	Extruded Polystyrene Board	STP	Supreme	Ownescorning
		Shalimar	and equivalent	
62	Glass Wool	Rockwool	UP Twiga	Lloyd Insulation
		and equivalent		
63	Glass Fibre Acoustical Ceiling Tile	Anutone	Decosonic	Armstrong
		Anakon	and equivalent	
64	Acoustic Wooden Perforated Slat	Anutone	Armstrong	Decosonic
		Anakon	and equivalent	
65	Acoustical Fabric (With Glasswood) Wall	Anutone	Armstrong	Decosonic
		Anakon	and equivalent	
	DOORHARDWARE'S / FITTING'S			
66	Hardware for Fire Check Door	Dorma	Becker Fire Solution	Dorset
		Bhawani Fire	and equivalent	
67	Stainless Steel	TATA	Jindal Alloys	SAIL
		and equivalent		
68	Stainless Steel Hardware	Dorma	Kich	Ozone
		Godrej	Dorset	and equivalent
69	UPVC Doors & Windows	Fenesta	Encraft	WINSTA-Koemmerling
		Futureview-AluPlast	Finesse-Prominace	Deceunik
		NCL VEKA	Duroplast	Okotech by APARNA
		and equivalent		
70	Door / Window Fittings	Godrej	Ozone	Doorset

S.No	Material	approved Makes / Brands		
		Dorma	and equivalent	
71	Door Closer	Godrej	Ozone	Doorset
		Dorma	and equivalent	
72	Die Cast Patch Fittings	Dorma	Geze	Ozone
		Hettich	Hardwyn	and equivalent
73	Fire Rated Doors & its hardware	Navair	Tata Parvez	Promat
		Shakti Hormann	Sukriti	Saint Gobain
		Jain Doors	Bhawani Fire	and Equivalent
73	Floor Springs	Godrej	Ozone	Doorset
		Dorma	and equivalent	
74	SS Mortise lock with one dead bolt and pair of SS handles steel grade - SS304	Godrej	Ozone	Doorset
		Dorma	and equivalent	
75	Grabbarsand Disabled Hardware	Dorma	Ozone	D-line
		and equivalent		
76	SS Mortise Latch & Lock with six levers and pair off SS handle Steel grade-SS304	Godrej	Ozone	Doorset
		Dorma	and equivalent	
77	SS Tower Bolt	Godrej	Ozone	Doorset
		Dorma	and equivalent	
78	SS Butt Hinges with ball bearing Grade-SS304	Godrej	Ozone	Doorset
		Dorma	and equivalent	
79	Magic Eye	Dorma	Godrej	Ingersoll rand
		and equivalent		
80	Stainless Steel Sliding door bolts	Godrej	Ozone	Doorset
		Dorma	and equivalent	
81	Pull handle back to back of length 150mm of steel Grade-SS304	Godrej	Ozone	Doorset
		Dorma	and equivalent	
82	Aluminium Level handles	Hardima	Godrej	Everite
		Classic	EBCO	and equivalent
83	Anodised Aluminium	Hardima	Godrej	Everite

S.No	Material	approved Makes / Brands		
	Hardware (Heavy Duty)	Classic	EBCO	and equivalent
84	Automation Systems for Windows	UCS	Window Master	Essmann
		Rivalu	Securistyle	and equivalent
85	Lever handle in SS 304 finish	Godrej	Ozone	Doorset
		Dorma	and equivalent	
86	Friction Stay Hinges	Dorma	LGSysmac	Dorset
		and equivalent		
87	Dash / Anchoring Fasteners	Hilti	Fisher	Bosch
		Anchor	and equivalent	
88	Welding Electrodes	Advani	Oerlikon	Modi
		L&T	ICI	and equivalent
89	Expansion Joint-Modular	C S	Herculus	Z-Tech
		Vexcolt	Fischer	Herrlich Alumin
		and equivalent		
90	Aluminium Bldg. Expansion Joint	Vexcolt	Z-Techindia	C/S Expansion Joint
		and equivalent		
	GLAZINGS / FAÇADE			
91	Anodised Aluminum Hardware (Heavy Duty)	Hardima	Alualpha	LGFSysmac
		Everite	Godrej	Halco
		Bhagwati Sai	Herrlich Alumin	and equivalent
92	Aluminum Structural Members- Windows, Glazing and Partitions	Jindal	Indalco	Hindalco
		Nalco	Bhoruka	Halco
		Bhagwati Sai	Herrlich Alumin	and equivalent
93	Aluminum Sheet roofing Top 0.9mm thick AA 3004 aluminium alloy and 2nd layer Bare Galvalume sheet 0.5mm TCT	KalZip	Tata Blue Scope	Kingspan Jindal Pvt. Ltd
		Virgo	and equivalent	
94	Pre-coated Galvanised Steel	Tata Bluescope	Dyna roof	Spectrum

S.No	Material	approved Makes / Brands		
	Sheet	and equivalent		
95	Glazing Structural/ Suspended/ Skylight	SaintGobain	Pilkington	Glaverbal
		Halco	Bhaqwati Sai	Herrlich Alumin
96	Clear/ Float/ FrostedGlass/ mirror	SaintGobain	AIS	Pilkington
		MODIGuard	Atul	Gold Plus
		and equivalent		
97	Fire-Rated Glass	Saint Gobin	Schott	Bhawani Fire
		and equivalent		
98	Glass Spider Fittings	Dorma	HAFALÉ	OZONE
		and equivalent		
99	Stainless Steel Railing, Accessories etc in Grade SS OR 316	Dorma	D-line	Geze
		Ozone	Q-railing	Halco
		Bhagwati Sai	and equivalent	
100	Firerate dvision Panels	Pilkington	SCHOTT	FERILITE
		Saint Gobain	Glaverbel	Bhawani Fire
		and equivalent		
101	G. I Steel door frame/Pressed Steel Door frame	Synergy Thrislington	Navair	Shakti
		TataParvez	and equivalent	
102	EPDM Gasket	Hanu	Anand	Osaka/ Alps
		Anand Reddiplex	EnviroSeals	and equivalent
103	Mirror Glass	Asahi India Safety Glass Ltd	ModiGuard	Saint Gobain
		Halco	Bhagwati Sai	Herrlich Alumin
		Gold Plus	and equivalent	
104	Aluminum Louvers	Lindner	Chicaao Metals	Harsons Green
		Hunte Doualas	Faveton	Wonder Alu Board
		Bhaawati Sai	Timexbond	Herrlich Alumin
		and equivalent		
105	Aluminium composite	Aludecor	Alstrong	Durabuild

S.No	Material	approved Makes / Brands		
	Panels	Wonder Alu Board	Virgo	Timexbond
		and equivalent		
106	Friction Stay Hinges	Dorma	LG Sysmac	Dorset
		and equivalent		
107	Ceramic panel Cladding	Hunter Douglas	Neolith	Terreal
		Anakon	and equivalent	
108	Pre-Cast GRC Jali	Unistone	Dalal Tiles Industries	Ecovision
		and equivalent		
	FALSECEILING			
109	False Ceiling-Gypsum	SaintGobain	USGBoral	Lindner
		IndiaGypsum	Lafarqe	Anakon
		and equivalent		
110	False Ceiling- Mineral fibre ceiling	Armstrong	AMF	USGBoral
		Saint Gobain	Hunter Douglas	Anakon
		and equivalent		
111	False Ceiling-Calcium Silicate Boards/ Tiles/Cement Fiber Board & Designer	Aerolite	Hilux	Saint Gobain (Gyproc)
		Anakon	Everest	and equivalent
112	False Ceiling-Metal	Amstrona	HunterDouglus	USG Baral
		Anakon	and equivalent	
113	Gyp Board	Saint Gobain	USG Boral	Lindner
		Boral Gypsum	Lafarae	India Gypsum
		Anakon	and equivalent	
114	False Ceiling-Aluminium	Armstrona	Durlum	Hunter Douglas
		Anakon	and equivalent	
115	Curtain Rod/ Drapery Rod	Vista work	Mac Decor	Hunter Douglas
		Anakon	and equivalent	
116	Fabric Blinds	Hunter Douglas	Mac	Vista
		Anakon	and equivalent	

S.No	Material	approved Makes / Brands		
117	Rolling Shutter	Rama	Prakash	Dura Ultrma
		and equivalent		
118	Tensile Fabric	Mehler	Verseidag	Heytex
		and equivalent		
119	Polycarbonate Sheet	Palram	Gallina	Danpalon
		DPI Daylighting	and equivalent	
120	Modular Furniture	Godrej	Durian	Wipro
		Featherlite	SOS	and equivalent

Note: - The articles / materials which are not mentioned in the above said list shall be approved by the The Engineer before execution of work.

### 2.23. FINISHING SCHEDULE

S. No.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
1.	Entrance Lobby	18mm Thick Polished Granite	1200 Mm Height Granite	1200 Mm Height Granite Above 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600 Tiles
2.	Doctor Room, Police Post, CCMO Room	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
3.	Stomach Wash	300x300mm Antiskid Ceramic Tiles Of 7-9mm Thick Laid Using Cement Mortar		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High Using Cement Mortar Shall Be Provided + Cement Paint Upto False	Calcium Silicate Board

S. No.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				Ceiling	
4.	Wash	20 Mm Thick Antis led		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
5.	Du (Dirty Utility)	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
6.	Cu (Clean Utility)	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar +2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Calcium Silicate Board
7.	Change (M & F)	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Calcium Silicate Board
8.	6 Beds Observation, 6 Beds Triage Area	Double Charged Vitrified Tile (600 X 600)	1200 Mm Height Vitrified Tile	1200 Mm Height Vitrified Tile Above 2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600 Tiles

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				plus100mm height + above false ceiling white washing	
9.	Nurse Lounge	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing & Oil Bound Distemper	Gypsum Plain Board
10.	Pharmacy Store, Linen Store & Linen	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Calcium Silicate Board
11.	Pharmacy Store	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	Oil Bound Distemper & Polyurethane Paint	Gypsum Plain Board
12.	Minor OT	ConDu (Dirty Utility)ctive Vinyl Flooring	Vinyl Coving	Polyurethane Paint	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
13.	Emergency Lab, Emergency ICU (Clean Utility)	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600 & Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600 Tiles
14.	Resuscitatio	Double Charged Vitrified Tile	Vitrified Tile	Anti Bacterial 2 coat putty + primer +	Gypsum Plain Board With



S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	n Room	(600 X 600)		Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Mineral Fibre False Ceiling Tiles 600 X 600
15.	AHU Room	IPS Flooring		Oil Bound Distemper	
16.	Equipment Store & Store	25 mm thick Polished Kota Stone	Kota Stone	Oil Bound Distemper & Polyurethane Paint	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600, Gypsum Plain Board & Calcium Silicate Board
17.	Sterile Store	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
18.	Lift Lobby	18mm Tk. Polished Granite		Granite Dado With Cement Mortar. Shall Be Provided. 2100mm High In Lift Facia Wall Only And Other Side Walls With Skirting + 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board
19.	Common Toilet (Male & Female) Staff Toilet (M&F)	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided +	

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	Phy- Toilet			Cement Paint Upto False Ceiling	
20.	Attached Toilet	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Gypsum Plain Board
21.	Pharmacy & Registration Counter	18mm Thick Polished Granite	Granite	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
22.	Back Office, Police Post	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
23.	Fire Command Control Room	IPS Flooring	-	Oil Bound Distemper	-
24.	Electrical	IPS Flooring	-	Oil Bound Distemper	-
25.	Ups Room,	IPS Flooring	-	Oil Bound Distemper	-
26.	Server Room & ELV Room	IPS Flooring	-	Oil Bound Distemper	
27.	Class 1v, House Keeping	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Metal & Gypsum Plain board
28.	Technician	Double Charged	Vitrified Tile	2 coat putty + primer +	Gypsum Plain

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	<b>Room, Radiologist Room</b>	Vitrified Tile (600 X 600)		Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Board
<b>29.</b>	<b>Recovery</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board
<b>30.</b>	<b>X-Ray, Fluoroscop y, Mobile X-Ray, Console Room of MRI &amp; CT Scan, Treatment/ Triage Room, Radiologist Waiting area</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
<b>31.</b>	<b>CT Scan, MRI Scan</b>	2mm ant laid	Vinyl Coving	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
<b>32.</b>	<b>Report Preparation Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
<b>33.</b>	<b>Cafeteria</b>	25 mm Thick Polished Kota	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint	Gypsum Plain Board Mineral

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
		Stone		up to false ceiling plus 100mm height + above false ceiling white washing	False
34.	<b>Cafeteria Preparation</b>	20mm Thick Polished Kota Stone	Kota Stone	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar+ Synthetic Enamel Paint	
35.	<b>Nutrition Manager</b>	20mm Thick Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
36.	<b>Corridor</b>	18mm Thick Polished Granite		Ceramic Tiles 300 X 450 Mm Dado Upto 2100mm Ht.	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600 Tiles
37.	<b>Staircase</b>	18 Mm Thick Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	-
38.	<b>MRI Chiller</b>	20 Mm Thick Polished Kota Stone	Kota Stone	Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
39.	<b>Service Entry Ramp,</b>	Chequered Tile ( 300 X 300)		-	-

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	<b>Morgue Ramp &amp; Cafeteria Ramp</b>				
40.	<b>Entrance Steps</b>	Granite		-	-
41.	<b>Hospital Ramp</b>	Cement Concrete Chequered Tiles		-	-
42.	<b>Emergency Exit Steps</b>	18 Mm Thick Polished Kota Stone		-	-
43.	<b>Entrance Covered Porch</b>	100 Mm Thick Concrete Tremix Flooring With Colored Epoxy Rein Paint (Fire Resistant, Chemical Resistant, Aniti Sked) As Per Specification			
44.	<b>Consultant Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
45.	<b>Injection Room(M&amp;F)</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
46.	<b>Hod/Visiting Faculty (Clean Utility)</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
47.	<b>Speech Therapy, Occupational (Clean Utility) Therapy, Physiotherapy</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
48.	<b>NCS Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
49.	<b>Attached Toilet</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Thick Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
50.	<b>Procedure Room &amp; Treatment Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
51.	<b>EEG, EMG, ECT</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
52.	<b>Staircase</b>	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height +	-

S. No.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				above false ceiling white washing	
53.	Sample Collection (F&M)	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
54.	Telemedicine	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
55.	Pantry	300x300mm Antiskid Ceramic Tiles Of 7-9mm Thick Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar+ Synthetic Enamel Paint	Gypsum Plain Board
56.	Store	18 Mm Thick Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
57.	Non Teaching Staff Room	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
58.	Class Iv/House Keeping	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
59.	<b>Demo Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
60.	<b>Clean Supply</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
61.	<b>Uro- Florometry</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
62.	<b>Procedure room/ Dressing</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
63.	<b>Uro- Dynamic Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar+ Synthetic Enamel Paint	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
64.	<b>Renal Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar+ Synthetic Enamel Paint	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600



S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
65.	TMT	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
66.	Holter Room	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
67.	Echo Room, ECG	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
68.	Intensive Care Unit Ward (10 Beds)	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	Poly Urethane Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
69.	Sluice	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	00x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
70.	Equipment Room	20 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
71.	Medication Room	Double Charged Vitrified Tile	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint	Gypsum Plain Board With

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
		(600 X 600)		up to false ceiling plus 100mm height + above false ceiling white washing	Metal False Ceiling Tiles 600 X 600
72.	Nurse's Lounge	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
73.	Isolation ICU (Clean Utility)	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	Poly Urethane Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
74.	Store	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
75.	UPS Room	IPS Flooring	-	Oil Bound Distemper	
76.	Ante	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
77.	Pantry	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height +	Gypsum Plain Board

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				above false ceiling white washing	
78.	<b>CSSD Manager</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
79.	<b>Trolley Exchange</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
80.	<b>CSSD</b>	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	Synthetic Enamel Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
81.	<b>Change (M &amp; F)</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
82.	<b>Staircase</b>	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	-
83.	<b>Central Blood Store Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
84.	<b>Prof. HOD</b>	Double Charged Vitrified Tile	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint	Gypsum Plain Board With

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
		(600 X 600)		up to false ceiling plus 100mm height + above false ceiling white washing	Mineral Fibre False Ceiling Tiles 600 X 600
85.	Department Office	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
86.	Asst. Prof	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
87.	Support Staff	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
88.	Ultrasound	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
89.	Upper GI	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
90.	Recovery	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
91.	<b>Sr.Resident s</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
92.	<b>Assoc. Prof</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
93.	<b>Disinfection</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
94.	<b>Utility</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
95.	<b>Lower GI</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
96.	Dialysis Equipment Room	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
97.	8 Beds Dialysis Complex	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
98.	Staff Lounge	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
99.	Ro Plant Room	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
100.	Isolation	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
101.	Clean Supply	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
102.	+Ve Wash	300x300mm Antiskid Ceramic Tiles	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado	Calcium Silicate Board

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
		Of 7-9mm Laid Using Cement Mortar		600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
103.	<b>General Wash</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
104.	<b>Corridor</b>	18mm Tk. Polished Granite		Ceramic Tiles 300 X 450 Mm Dado Upto 2100mm Ht.	Gypsum Plain Board With Metal False Ceiling Tiles
105.	<b>AHU Room</b>	IPS Flooring	-	Oil Bound Distemper	Not Provided
106.	<b>Equipment Room</b>	20 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
107.	<b>TSSU</b>	2mm Antistatic Vinyl Flooring	Vinyl Coving	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
108.	OT	ConDu (Dirty Utility)ctive Vinyl Flooring	Vinyl Coving	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Vendor Scope
109.	Resident Doctor	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
110.	Attached Toilet	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	-	300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Gypsum Plain Board
111.	Anesthesia	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
112.	OT Pharmacy	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board
113.	Patient Recovery	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600



S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
114.	<b>Linen</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board
115.	<b>Clean Supply</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board roof ceiling
116.	<b>Blood Storage</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board
117.	<b>Sterile Storage</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
118.	<b>OT Control Station</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
119.	<b>OT Record</b>	Double Charged	Vitrified Tile	2 coat putty + primer +	

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	<b>Room</b>	Vitrified Tile (600 X 600)		Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
120.	<b>Reception &amp; OT Complex Waiting</b>	18mm Tk. Polished Granite	-	Ceramic Tiles 300 X 450 Mm Dado Upto 2100mm Ht.	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
121.	<b>Flash Sterilization</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
122.	<b>BMW Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
123.	<b>OT Technician</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
124.	<b>Surgeons Lounge</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600
125.	<b>Nurses Change Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Calcium Silicate Board

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
126.	<b>Doctor's Change Room Female &amp; Male</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
127.	<b>St Aff Change Room Female &amp; Male</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
128.	<b>Pathology Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600
129.	<b>Utility</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
130.	<b>Micro Biology Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
131.	<b>Cyto Histology Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600
132.	<b>Cytology Lab</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600
133.	<b>Lab In charge</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling tiles 600 X 600
134.	<b>Staff Room</b>	Double Charged Vitrified Tile	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint	Gypsum Plain Board With

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
		(600 X 600)		up to false ceiling plus 100mm height + above false ceiling white washing	Metal False Ceiling Tiles 600x600
135.	<b>IPD Pharmacy</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600x600
136.	<b>Sluice</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
137.	<b>4 Beds Pre Operative Ward</b>	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	Poly Urethane Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
138.	<b>Demo Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling 600x600
139.	<b>8 Beds Post Operative Ward</b>	2mm Thick Vinyl Static Flooring	Vinyl Coving	Poly Urethane Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
140.	<b>Treatment Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
141.	<b>10 Beds Ward Male &amp; Female</b>	2mm Thick Anti Static Vinyl Flooring	Vinyl Coving	Poly Urethane Paint	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600
142.	<b>Attached Toilets</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Toilets Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	-
143.	<b>Nurse Lounge</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600 , Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
144.	<b>Medication Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
145.	<b>Doffing Change</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
146.	<b>Pg Students</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling	Gypsum Plain Board With Mineral Fibre

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				plus100mm height + above false ceiling white washing	False Ceiling Tiles 600 X 600
147.	Electrical Room	IPS Flooring	-	Oil Bound Distemper	-
148.	CATH Consultant	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Meteriale reserknce board
149.	CATH Examination	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Meteriale reserknce board
150.	Change (M & F)	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Calcium Silicate Board
151.	CATH Preparation	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
152.	CATH Wash Area	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling	Calcium Silicate Board, Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				plus100mm height + above false ceiling white washing	
153.	<b>Angiograph y Suite (Single- Plane-1) &amp; (By-Plane- 1)</b>	2mm Thk Anti Static Vinyl Flooring	Vinyl Coving	Poly Urathene Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
154.	<b>ICCU Beds (Clean Utility)</b>	2mm Thk Anti Static Vinyl Flooring	Vinyl Coving	Poly Urathene Paint	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
155.	<b>Sluice</b>	300x300mm Antiskid Ceramic Tiles Of 7-9mm Laid Using Cement Mortar	Ceramic Tile	00x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Calcium Silicate Board
156.	<b>Central Console</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
157.	<b>CATH Equip.</b>	20 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling white washing	Gypsum Plain Board
158.	<b>Recovery</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to fasle ceiling plus100mm height + above false ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600



S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
159.	AHU Room	IPS Flooring		Oil Bound Distemper	
160.	Corridor	18mm Tk. Polished Granite		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Corridor Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
161.	Staircase	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	-
162.	Refuge Terrace	Brick Bat Coba Heat Resistant Tiles (300 X 300)			
163.	Server Room	IPS Flooring	-	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
164.	Electrical Room	IPS Flooring	-	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	-
165.	Paying Cabin	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling	Gypsum Plain Board With Mineral Fibre False Ceiling Tiles 600 X 600

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				white washing	
166.	Ward Lab	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	300x450mm Ceramic Tile Of 6-8mm Thick Dado 600mm High For Above Counters Fixed Using Cement Mortar + Anti Bacterial 2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
167.	Medication Room	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
168.	Staircase	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
169.	Class Iv Room ,/House Keeping	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False
170.	House Keeping	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
171.	<b>Air Lock</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
172.	<b>Electrical Room</b>	IPS Flooring	-	Oil Bound Distemper	-
173.	<b>Chief Librarian, Assistant Librarian, Deputy Librarian</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
174.	<b>Office Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
175.	<b>Library</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
176.	<b>Digital Library</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
177.	<b>Ante</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
178.	<b>Nursing</b>	Double Charged	Vitrified Tile	2 coat putty + primer +	Gypsum Plain

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
	<b>Superintendent</b>	Vitrified Tile (600 X 600)		Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Board With Mineral Sibre False Ceiling Tiles 600 X 600
<b>179.</b>	<b>Deputy Superintendent</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
<b>180.</b>	<b>Record Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Calcium Silicate Board
<b>181.</b>	<b>PA Room</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
<b>182.</b>	<b>Staff Dining Area</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
<b>183.</b>	<b>Chief Superintendent</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
<b>184.</b>	<b>Seminar Hall</b>	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height +	Gypsum Plain Board With Mineral Sibre False Ceiling

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
				above false ceiling white washing	Tiles 600 X 600
185.	Waiting Area	Double Vitrified	Double Charged Vitrified	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
186.	MRD	Double Charged Vitrified Tile (600 X 600)	Vitrified Tile	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
187.	Conference Room	Wooden Plank Flooring	Vitrified Tile	Plaster , Pop & Paint Upto False Ceiling + White Wash Above False Ceiling Upto Bottom Of Slab	Gypsum Plain Board With Mineral Sibre False Ceiling Tiles 600 X 600
188.	Corridor	18mm Tk. Polished Granite		300x450mm Ceramic Tile Of 6-8mm Thick Dado Till 2100mm High For Corridor Fixed Using Cement Mortar Shall Be Provided + Cement Paint Upto False Ceiling	Gypsum Plain Board With Metal False Ceiling Tiles 600 X 600
189.	Staircase	18 Mm Tk. Polished Kota Stone	Kota Stone	2 coat putty + primer + Acrylic Emulsion Paint up to false ceiling plus 100mm height + above false ceiling white washing	
190.	Lift Machine Room	IPS Flooring		Oil Bound Distemper	-
191.	Store Room	IPS Flooring		Oil Bound Distemper	-

S. N O.	Room Name	FINISHES			
		FLOORING	SKIRTING (100MM)	WALL	CEILING
192.	<b>HVAC Panel Room</b>	IPS Flooring		Oil Bound Distemper	
193.	<b>Ups</b>	IPS Flooring	-	Oil Bound Distemper	-
194.	<b>Electrical Room</b>	IPS Flooring	-	Oil Bound Distemper	-
195.	<b>Terrace</b>	Brick Bat Coba Heat Resistant Tiles (300 X 300)	75x75mm Gola In Cement concrete	-	

**TECHNICAL SPECIFICATIONS FOR PLUMBING,  
WATER SUPPLY AND SANITARY INSTALLATION,  
SEWAGE TREATMENT PLANT & EFFLUENT  
TREATMENT PLANT INCLUDING SOLAR HOT,  
WATER SYSTEM PUMP WORKS**

### 3. TECHNICAL SPECIFICATION - PLUMBING WORKS

#### 3.1. SCOPE OF WORK

The work shall generally conform to the latest CPWD Specifications as mentioned in the GCC. Work under this contract shall consist of providing all labor, materials, equipment, and appliances necessary and required for the execution. The Contractor is required to fully furnish all plumbing and other specialized services as described below and as specified in the GFC plumbing drawings.

#### 3.2. GENERAL

The general scope of work to be carried out under this section includes the supply, installation, testing, commissioning, and successful handing over of a complete plumbing system, which includes:

- Internal and external water supply systems
- Internal and external soil/waste drainage systems
- Internal roof rainwater system
- Internal and external stormwater drainage systems
- Water treatment systems (e.g., RO systems)
- Hot water supply systems
- Water Treatment Plants (e.g., Iron Removal Plant)
- Sewage Treatment Plants and Effluent Treatment Plants

The work shall be carried out as mentioned in the Technical Specification, Bill of Quantities, and as detailed in the drawings. The Contractor shall execute and complete the work under this contract in full compliance with the rules and regulations of the local authority. The Contractor shall provide all necessary labor, materials, appliances, tools, and equipment required for the installation of plumbing services, including testing and commissioning, as specified herein and in accordance with the relevant Bureau of Indian standards (BIS), IS codes, and as shown in the drawings.

This also includes any materials, appliances, and equipment not specifically mentioned herein or noted on the drawings but which are necessary and customary to ensure a complete installation that is properly connected and in full working order.

Contractor shall provide documentary evidence supporting the equivalence of the brand(s) and make(s) and shall use such equivalent brand(s) and make(s) only after obtaining approval from the The Engineer.

Carry out all incidental works connected with the plumbing services installation, such as excavation of trenches and backfilling, cutting and chasing in concrete or brickwork, and making good. This includes cutting/drilling holes through walls and floors, as well as grouting for the embedding and fixing of fixtures/equipment, and other related activities.



Provide and install a complete and functional plumbing services system as shown in the drawings and described in this specification, in accordance with the latest Bureau of Indian Standards (BIS) specifications. This includes all work reasonably inferred, both internally and externally, for all buildings.

- a) Complete installation of the sewerage system and its appurtenances, both within and around the building.
- b) Complete installation of all sanitary and plumbing fixtures on all floors of the buildings.
- c) Coordination with other services, such as Electrical, Fire, HVAC, and MGPS, to ensure proper placement of the installation. Any work carried out without proper consideration or consultation with these services shall be removed by the Contractor, at no additional cost to the Employer, to allow for the correct installation of all other work as directed by the Engineer.
- d) Repair any damage caused to the premises as a result of this installation and remove all debris left by those engaged in the installation, to the satisfaction of the Engineer.
- e) Clean all plumbing and sanitary fixtures, test, and ensure the satisfactory performance of all fixtures at the time the buildings are handed over to the Employer. It is the Contractor's responsibility to maintain all fixtures until the time of handing over to the Employer.
- f) Paint all concealed and exposed pipes as specified. Wrap and coat all underground GI pipes as required.
- g) The Contractor shall take full responsibility for obtaining approval for all liaison work related to water supply, sewage drainage, and stormwater drainage, including any associated expenses. The Contractor is also responsible for obtaining and delivering to the Employer the certificates of final inspection and approval from the concerned authorities.

#### **Preparation of Shop Drawings**

- a. Manufacturer's or Contractor's fabrication drawings for any materials or equipment.
- b. The Contractor shall submit three copies of catalogues, manufacturer's drawings, equipment characteristic data or performance chart.
- c. The Contractor shall submit Technical Data Sheet and Material Approval Sheet.

#### **As Built Drawings**

Upon completion of the works, the Contractor shall submit three sets of “As-Built” drawings and provide all drawings and information in the latest version of AutoCAD. These drawings shall include the following information:

- a) The exact routes and sizes of all piping on all floors and vertical stacks.
- b) Ground and invert levels of all drainage pipes, along with the locations of all manholes and connections up to the outfall.
- c) The routes of all water supply lines, including diameters, and locations of control valves and access panels.
- d) The locations of all mechanical equipment, including layout and piping connections.
- e) The Contractor shall provide three sets of product catalogs, performance data, and a list of spare parts, along with the names and addresses of the manufacturers for all electrical and mechanical equipment provided.
- f) All “Warranty Cards” issued by the manufacturers shall be handed over to the Engineer.
- g) Three sets of operation and maintenance manuals in the required format shall be handed over to the Engineer.

### **Regulations and Standards**

The installation shall conform in all respects to the following standards in general:

IS 7558 – 1974	Code of practice for domestic hot water installation
IS 5329 – 1983	Code of practice for sanitary pipe work above ground for buildings.
IS 12251 – 1987	Code of practice for drainage of building basements
Is 2064 – 1973	Code of practice for selection, installation and maintenance of sanitary appliances
IS 1200 (Part 1)	Method of measurement of building earthwork
IS 1200 (Part 16)	Method of measurement of laying of water and sewer lines including appurtenant
IS 1200 (Part 19)	Method of measurement of Water supply, plumbing and drains.
IS 783 – 1959	Code of practice for laying of concrete pipes
IS 13592 – 1992	Specification for unplasticized PVC pipes for soil and waste discharge system inside building including ventilation and rainwater
IS 2527 – 1984	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS 2685 – 1971	Code of practice for selection, installation and maintenance of sluice valves.
IS 6784 – 1984	Method of performance testing of water meters (Domestic type).
IS 2692 – 1989	Specification of ferrules for water services
IS 12701 – 1989	Specification for rotational moulded polyethylene water

	storage tanks.
IS 771 – (Part 3 to 6)	Specific requirements for urinals.
IS 2548 (Part 1&2)	Specification for plastic seats and covers for water closets.
IS 3004 – 1979	Specification for plug cocks for water supply purposes.
IS 1711 – 1984	Specification for self closing taps for water supply
IS 1703 – 1977	Specification for ball valves (Horizontal plunger type) including floats for water supply purposes.
IS 4038 – 1979	Specification for foot valves for water works purposes.
IS 1172 – 1983	Code of basic requirements for water supply, drainage & sanitation (revised).
IS 1239 – 1990 (Part I)	Specifications for mild steel tube, tubular and other steel pipe fittings.
IS 1239 – 1992 (Part II)	Specifications for mild steel tube, tubular and other steel pipe fittings.
IS 1726 – 1991	Code for cast iron manhole frame and cover (third revision).
IS 1742 – 1983	Code of practice for building drainage. (Second revision)
IS 2064 – 1973	Code of practice for selection, installation and maintenance of sanitary appliances.
IS 2065 – 1983	Code of practice for water supply to buildings.
IS 4111 – 1986	Code of practice for Ancillary structures in sewerage system
BS 4515	Specification for unplasticized PVC pipefittings.
IS 4985 – 1988	Specification for unplasticized PVC pipes for portable water supplies (second revision)
IS 732 & IS 2274 – 1963	Indian Standard code of practice for electrical wiring & installation.
IS 780 – 1984	Specification for sluice valves for water works purposes.
IS 458 – 2003	Precast Concrete Pipes
ASTM –D2846	CPVC Hot and cold water distribution
ASTM – F493	CPVC Solvent cement specifications
ASTM – F402	Handling cement solvents
ASTM – F442	CPVC Plastic pipe (SDR-PR)
ASTM – F437	Threaded CPVC fittings Schedule 80
ASTM – F438	CPVC Schedule 40 CPVC fittings
ASTM – F439	CPVC Schedule 80 CPVC fittings
ASTM – F441	CPVC Schedule 40 & 80 pipe
ASTM – D1784	CPVC Compounds
ISO – 727	Dimensions of CPVC sockets
ASTM A182/A403, ASME SA182/SA 403	Stainless Steel Pipes & Fittings
IS 10446 – 1983	Glossary of terms relating to water supply and sanitation.
IS 11208 –1985	Guidelines for registration of Plumbers

IS 1701 – 1960	Specification for mixing valves for ablutionary and domestic purposes.
IS1711–1970	Specification for self closing taps.
IS 2963 – 1979	Specification for copper alloy waste fittings for wash basins and sinks.
IS 3004 – 1979	Specification for plug cocks for water supply purposes.
IS 3311 – 1979	Specification for waste plug and its accessories for sinks and wash basins.
IS775 – 1970	Specifications for CI brackets and supports for wash basins and sinks.
IS781 – 1977	Specifications cast copper alloy screw – down bib taps and stop valves for water supply.
IS 9758 – 1981	Specification for flush valves and fittings for water closets and urinals.
IS 9763 – 2000	Plastic Bib Taps, pillar taps, angle valves and stop valves for hot and cold water services.
IS 13983 – 1994	Stainless steel sinks for domestic purposes – Specification
IS 1700 – 1973	Specification for drinking fountains
IS 2064 – 1993	Code of Practice for selection, installation and maintenance of Sanitary appliances
IS 774 – 1984	Specification for – flushing cistern for water closets and urinals (Other than plastic cistern)
IS 2326 – 1987	Specification for automatic flushing cisterns for urinals
IS 2548 – part 1	Specification for plastic seats and covers for water closets (Part 1 Thermo-set seats and covers)
IS 2548 – part 1	Specification for plastic seats and covers for water closets (Part 2 Thermoplastic seats and covers)
IS 3489 – 1985	Specification for enameled steel bath tub
IS 6411 – 1985	Specification for gel coated glass fiber reinforced Polyester resin bath tub
IS 7231 –1984	Specification for plastic flushing cistern for water-Closets and urinals
IS 9110- 1979	Hand Operated Angers For Cleaning Water Closet & Pipes
IS 1795 – 1982	Specifications for Pillar taps for water supply purposes
IS 2556 – 1994	Specifications for the Vitreous Sanitary Appliances Part 1 - Part 14 (Vitreous china) (Part 1 general requirements)
IS 5961 – 1970	Specification for cast iron gratings for drainage Purposes
IS 779 -1978	Specifications for Water Meter s Domestic Type
IS 2104 – 1981	Specification for water meter boxes (Domestic type)
IS 2401–1973	Code of practice for selection, installation, and maintenance of domestic water meters.
IS 7413-1981	Insulation Material
IS 2065 –1983	Code of practice for Water Supply in Buildings (Second Revision)

IS 778- 1984	Specifications for copper alloy Gate, Globe and Check Valves for water supply purposes
IS 1703 – 1977	Specification for ball valves (horizontal plunger type) including floats for water supply purposes
IS 3004 – 1979	Specification for plug cocks for water supply purposes.
IS 3950 – 1979	Specifications for surface boxes for sluice valves.
IS 9338 – 1984	Specification for cast iron screw -down stop valves and stop and check valves for water works.
IS 4346 – 1982	Specification for washers for use with fittings for water services
IS 5219 – Part 1	Specification for cast copper alloy traps
IS 5312 – part 1	Specification for swing check type reflux (Non-return) Diaphragm type (plastic body) float operated valve for cold water services – specification
IS 13049 – 1919	Forged brass gate, globe and check valves for water works purposes – specification
IS 13114 – 1991	Code Of Practice for Water Supply
IS 310 –1965	Code of practice for selection, Installation and maintenance of domestic water meters
IS 2401 – 1973	Specification for Sluice valves for water works purposes (50 to 300mm size) (sixth revision)
IS 780-1984	Glossary of terms relating to water supply and sanitation.
IS 10446 – 1983	Guidelines for registration of Plumbers
IS 11208 –1985	Specification for rubber sealing rings for gas mains, water mains and sewers
IS 5382 – 1985	Code of Basic Requirement for Water Supply, drainage & sanitation third revision
IS 1172-1983	Method of Measurement Of Building And Civil Engg. Works (part- 1 earth work)
IS 1200 - 1992	Specification of colour code for the identification of pipes
IS 2379 –1963	Code of Practice for Building Drainage (Second Revision)
IS 1742 – 1983	Code of practice for Building Drainage
IS 301 – 1971	Code Of Practice For Drainage In Basement
IS12251- 1987	
BS 5572 -1978	
(Amendment No.2)	Sanitary pipe Works
BS 4660- 1973	
(Amendment No.1)	PVC Underground Drain Pipes & Fittings
IS 5329 – 1983	Code of practice for sanitary pipe work above ground for buildings First Revision)
IS 10446 – 1983	Glossary of terms relating to water supply and sanitation.
IS 11208 –1985	Guidelines for registration of Plumbers
IS 4111	Code of practice for Ancillary Structure In Sewerage System (part 1) 1986
IS 301 – 1971	Code of practice for Building Drainage

IS 651 1992	Specification for salt- glazed stoneware pipes and fittings
IS 1726 -1991	CI Manhole Covers and Frame
BS 5572 -1978	
(Amendment No.2)	Sanitary pipe Works
IS 4127 – 1983	Specification for testing of stone ware pipes and fittings
National building Code 2016	
CPHEEO Manuals	
SP-35	
SP-42, Uniform Plumbing Code	and International Plumbing Code.

The installation shall also be in conformity with the bye laws and requirements of the local authority in so far as these become applicable to the installation. Wherever this specification calls for, a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then this specification shall take precedence over the said regulations and standards.

Wherever drawings and specifications require something that may conflict with the regulations, the regulations shall govern. This shall be referred to the Engineer for arbitration.

### **3.3. EXECUTION OF WORK**

The work shall be carried out in conformity with the water supply and sanitary drawings and within the requirements of architectural, HVAC, Electrical, and other specialized services drawings.

The Contractor shall co-operate with all trades and agencies working on the site and make provision for hangers, sleeves, and structural openings and other requirements well in advance to prevent hold up or progress of the construction programme. Any work done without regard (or) consultation with other trades, shall be removed and rectified by the Contractor without additional cost to the Client.

The Contractor shall furnish and install a complete working, plumbing services installation as per approved drawings and as per the latest BIS codes of practice.

Execution of work by the Contractor includes complete installation of internal & external water supply system, sewerage and sewerage appurtenances internally as well as around the building, controllers, valves and power control wiring for controller etc. complete installation of all sanitary and plumbing fixtures.

It is the responsibility of the Contractor to protect all the installed fixtures and fittings until the time of handing over to the Client. The Contractor shall set out the drainage, soil, waste and water pipe lines and other fittings and fixtures in accordance with the Drawings and instructions of the The Engineer. The Contractor shall be responsible for the correctness of the above and any incorrectness shall be rectified at his own cost and also for taking levels at site before setting out and putting them on record without extra charge.

The Contractor shall provide at all times during the progress of the works and during maintenance period proper facilities and necessary attendance for inspection or measurement of the works by the Engineer or their representatives.

**3.4. FEES, PERMITS AND NOTICES**

Contractor shall comply with all bye-laws and regulations of local and other statutory authorities having jurisdiction over the works and shall be responsible for the payment of all fees and other charges and giving and receiving of all necessary notices. Contractor shall keep the Engineer timely informed about regulations and requirements of statutory authorities and shall obtain the final certificates of inspection and approval from the authorities.

**3.5. DRAWINGS AND SPECIFICATIONS**

The drawings and specifications shall be considered part of this contract, and any work or materials shown on the drawings but not mentioned in the specifications, or vice versa, shall be executed as if specifically included in both. The Contractor shall obtain the necessary approvals from the Engineer for shop drawings.

The tender drawings indicate the extent and general arrangement of the fixtures, Pipe routings and sanitary routing system etc., and are essentially diagrammatic. The tender drawings indicate the points of supply and termination of work and broadly suggest the routes to be followed. The works shall be executed as indicated on the drawings. However, any changes found essential to co-ordinate with this work and other trades shall be made without any additional cost. The drawings and specifications are meant for the assistance and guidance of the Contractor, and exact location, distance and levels will be governed by the building and site conditions. Therefore, approval of the Engineer shall be obtained before commencement of work.

**Plumbing Works Includes**

Overall Plumbing Works Internal & External:

- a) Plumbing Fixtures Chrome Plated Fittings & Accessories.
- b) Soil, Waste & Vent Pipes & Fittings
- c) Rainwater Pipes & Fittings
- d) Internal / External Water Supply System (Cold & Hot)
- e) External Sewerage & Drainage System
- f) External Rainwater System
- g) External Flushing Water System
- h) Drinking Water System

Samples of all materials should be approved before placing order and the approved samples shall be deposited with the The Engineer. If directed, materials shall be tested in an approved testing laboratory and the Contractor shall produce the test certificate in original to the The

Engineer and the entire charges for original as well as repeated tests shall be borne by the Contractor. If required by the The Engineer, the Contractor shall arrange to test portions of the work at his own cost in order to prove their soundness and efficiency. If after any such test the work or portions of work is found in the opinion of the The Engineer, to be defective or unsound, the Contractor shall pull down and re-do the same at his own cost. Defective materials shall be removed from site.

### **3.6. PLUMBING FIXTURES:**

#### **Scope of work**

- All sanitary fixtures like sanitary ware, CP fittings, bath room accessories, wall flanges, valves and all related to bath room, kitchen utility fittings (CP and sanitary fittings). And also supply small accessory piping and any specialties furnished for fixtures such as adopters, pipe fittings, cement, brick work supports for AWC, CP Extension pieces, Check nuts, screws, washers, gasket etc., waste connector, WC connector, PVC or CP connection pipe, connecting nipple, screws, clamps, white cement wall flanges, washers, sealant and other accessories of this type as required.

#### **Scope of installation to be performed by the Contractor is outlined below:**

- The Contractor is responsible for installing the fixtures and fittings in good condition; otherwise, any damages caused to the fittings and fixtures during transport or fitting by the contractor will be born by the contractor.
- The Contractor shall hydrostatically test all the sanitary appliances and CP fittings installation including accessories and specialties.
- Contractor shall supply all Jointing material as required for all joints. Like screws, washers, sealants, Installation tools, tackles, drilling machine as required to complete the work.
- Tile Sanitary fixtures and fittings shall be installed at the correct aligned position as shown on the drawings and as directed by the engineer, and shall fully meet with the aesthetic and symmetrical requirements as required
- All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Project Engineer requirements. Wherever necessary the fittings shall be centered to dimensions pattern as called for.
- Fixture shall be installed by skilled plumber with appropriate tools according to the best trade practice. Manufacturer's instruction shall be followed for the installation of fixtures. Fixtures in all toilets shall be standard height, mounting as called for on the drawings. Fixtures shall be mounted rigid, plumb and true to alignment
- All fixtures shall be fixed firmly to the floor / wall with accessories supplied by the manufacturer. Use chrome plated brass cap nuts for fixation screws.



- All ferrous accessories used for the installation of sanitary fixtures shall have anti-rust treatment given at the factory.
- Refer to interior architectural documents for details of toilet and bathroom accessories. These are part of the finishing works.
- Contractor shall do mock-up for each type of sanitary ware fittings & fixtures, before final installation.
- Care shall be taken in fixing all approved chromium plated (CP) fixtures and accessories so as not to leave any tool marks or damages on the finish. All such fixtures shall be tightened with fixed spanners.
- Use of 'Stilton' type pipe wrenches with toothed jaws shall not be allowed.
- All fixtures shall be thoroughly tested after connecting the drainage and water supply system. All fixtures shall be thoroughly finished and any leakage in piping valves and waste fittings corrected to the complete satisfaction of the Engineer.
- Upon completion of the work, all labels, stickers, plaster, etc. shall be removed from the fixtures and all fixtures shall be cleaned with soap and water so as to present a neat and clean toilet.

### **3.7. MOCK UP AND TRIAL ASSEMBLY**

The installation of the sanitary fixtures and shall be as per the GFC drawings approved by the The Engineer.

The Contractor shall assemble on trial basis at least one set of each type of sanitary fixture and fittings in order to determine precisely the required supply and disposal "connections. Relevant instructions from manufacturer shall be followed as applicable. This trial, assembly shall be developed to facilitate determining the location of punctures, holes, holding devices etc, which will be required for final installation In position of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the The Engineer.

The fixtures in the trial assembly can be reused for final installation without any additional payments for fixing or dismantling of the fixtures.

Operation & maintenance training to employer's staff, supply of basic minimum spares for equipments.

### **Indian Type W.C:**

Squatting pans shall be of white vitreous china conforming to IS 2556 Part-I for General Requirements and relevant IS codes for each pattern as described below:

- a) Long pattern-conforming to IS 2556 (Part-3).
- b) Orissa pattern-conforming to IS 2556 (Part-3).
- c) Integrated type conforming to IS 2556 (Part-14). Preferably Orissa type pan should be used. Each pan shall have an integral flushing rim of suitable type. It shall also have an inlet or supply horn for connecting the flush pipes. The flushing rim and inlet shall be of

the self draining type. It shall have weep hole at the flushing inlet to the pan. The flushing inlet shall be in the front, unless otherwise specified or ordered by the Engineer-in-Charge. The inside of the bottom of the pan shall have sufficient slope from the front towards the outlet and the surface shall be uniform and smooth to enable easy and quick disposal while flushing. The exterior surface of the outlet below the flange shall be an unglazed surface which shall have grooves at right angles to the axis of the outlet. In all cases a pan shall be provided with a (100 mm) S.C.I. trap 'P' or 'S' type with approximately 50 mm water seal and 50 mm dia vent horn, where required by the The Engineer.

#### **European Pedestal type Water Closet (Common Toilets)**

Providing and fixing white vitreous china pedestal type water closet (European type) with seat and lid, 10 litre low level white vitreous china flushing cistern & C.P. flush bend with fittings & C.I. brackets, 40 mm flush bend, overflow arrangement with specials of standard make and mosquito proof coupling of approved municipal design complete, including painting of fittings and brackets, cutting and making good the walls and floors wherever required.

#### **European Extended Wall Mounting Water Closet(Staffs Only).**

Providing and fixing white vitreous china extended wall mounting water closet of size 780x370x690 mm of approved shape including providing & fixing white vitreous china cistern with dual flush fitting, of flushing capacity 3 litre/ 6 litre (adjustable to 4 litre/ 8 litres),including seat cover, and cistern fittings, nuts, bolts and gasket etc complete.

For general requirement relating to terminology, materials, manufacture, glazing, defects, minimum thickness, tolerances, performance and methods of tests shall confirm to IS 2556 (Part 1). Wall mounted water closet shall be of one piece construction. Each wall mounted water closet shall be provided with fixing arrangement and shall have an integral flushing rim of suitable type. It shall have an inlet for connecting the flushing pipe of dimension confirming to IS 2556. The flushing rim may be box or open rim type or a combination of both. In case of box rim, adequate number of holes and slot be provided. The flushing rim and the inlet shall be of the self draining type and weep hole shall be provided at the flushing inlet of the wall mounted water closet.

The WC shall be provided with not less than two fixing holes to enable the WC to be securely installed to the wall using metallic corrosion resistant bolts and nuts and an independent concealed support frame. The support frame (metal hanger or carrier), depending on the design shall be securely attached to the building structural members so that no strain is transmitted to WC connector or any part of the plumbing system. Each wall mounted water closet shall have an integral trap and P type outlet confirming to IS 2556 (Part 16): 2002. Inside surface of water closet and trap shall be uniform and smooth in order to ensure an efficient flushing. The outlet if without serration, shall be glazed and if same is with serration, may not be glazed.

**European Syphonic Type Water Closet (Doctors Only)**

Providing and fixing floor mounted, white vitreous china single piece, double traps syphonic water closet of approved brand/make, shape, size and pattern including integrated white vitreous china cistern of capacity 10 litres with dual flushing system, including all fittings and fixtures with seat cover, cistern fittings, nuts, bolts and gasket etc including making connection with the existing P/S trap, complete in all respect as per directions of The Engineer.

**Installation of Water Closet**

Fixing chair bracket with bolts in concrete grout, bolts of 12mm Ø at a distance of 180mm ±5mm between two fixing bolts in the wall such that the height of front rim up to finished floor should be 400mm. Fix the rag bolt with the help of sleeves and the outlet hole in the wall should be made as 135 mm ± 5mm.

**Fit the seat cover on EWC**

Put the outlet rubber gasket in the outlet to fit in waste outlet hole. Put polysheet in between wall & EWC. Fit the EWC in the bolts (fitted inside wall) & tight the same & put chrome plated cap on the bolts.

**Installation of Concealed Cistern:**

- Drill two holes diameter of 8mm and depth of 40mm, and fill the bracket holes with wall plug and tighten the screws.
  - Install inlet valve, place inside cistern, with nut on outside and tighten nut. After installing the fixing bracket, put the cistern on the wall bracket.
  - Install the back nut, sealing ring and gasket on the flushpipe, then tighten the back nut.
  - Drill hole in required location. Install the button in the hole, with wall bracket underneath, adjust button and fix wall bracket on the button, then tighten the back nut.
  - Install the fixing block into the outlet.
  - Open the tank cover and fix the pneumatic pipes to the flush valve nozzle.
  - Install the small button and large button correctly.
    - Close the cistern lid.
    - Install the water pipe to the inlet pipe of cistern for water supply.
- ❖ Installation of Chrome Plated/Stainless Steel Flush Plates:
- Install two (2) threaded lock pins (part of actuator assembly).
  - Adjust lock pin length to be flush with finished wall, turn to lock in place.
  - Place actuator frame onto front of box with spring at the bottom facing outward.
  - Secure frame onto lock pins with two (2) self-tapping screws provided.

- Insert actuator push rod into rocker bushing so that taps are in contact with the actuator frame surface.
- Install rod and turn clockwise to lock it into the bushing.
- To complete the installation attach the actuator plate on to spring at lower side push up and snap the upper edge onto frame.
- Secure actuator plate to frame, test for function.
- Remove protective foil.

### **Method of Measurement and payment**

Payment for Extended wall mounting, Pedestal Type, Syphonic Type water closet shall be made on the basis of numbers by counting the number of EWC laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, scaffolding charges, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

### **Wash Basin :**

Providing and fixing White Vitreous China Surgeon type wash basin of size 660x460 mm with a pair of 15 mm C.P. brass pillar taps with elbow including operated levers.

### **Installation of Wash Basin:**

- a. The cutout is made on the slab according to the size of the fixing area of Wash Basin.
- b. If tap hole is required in Wash Basin, then fix the water tap in tap hole to connect the connection of Pillar tap with angle valve.
- c. Place the Wash Basin on the slab and put sealant at the bottom of rim of Wash Basin to fix Wash Basin. Fit the waste hole coupling in waste outlet of Wash Basin.
- d. Connect waste coupling to drain with beneath the marble/Slab through bottle trap.
- e. Connect Water tap with angle valve.

### **Washbasin Oval shape (T-2):**

Providing and fixing white vitreous china Table top wash basin size - 610\*460\*140mm, installed above granite / marble counter with 15 mm C.P. brass basin pillar tap, 32mm C.P brass waste coupling of standard pattern, including 2 nos. angle valve with riser pipes, connectors, adopters, all fittings etc. cutting and making good the walls/slabs wherever required.

### **Installation Of Wash Basin:**

Cut the marble / Slab for waste hole of Wash Basin to accommodate the outlet area at desired location where the Wash Basin is to be placed. Area of the hole should be made suitable for the bottle trap (100 mm Ø approx).

If tap hole is provided in Wash Basin, then fix the basin mixer tap in tap hole to connect the connection of tap with hot & cold connection angle valve

Fix the waste coupling and place Wash Basin on marble plate/slab. To fix put sealant between slab and Wash basin.

After fixing the Wash Basin on marble slab, connect to drain with bottle trap beneath the marble /slab. Connect cold & hot connection pipe of tap with cold & hot connection angle valve.

#### **Method of Measurement and payment**

Payment for Wash Basin shall be made on the basis of numbers arrived at by counting the number of Wash Basin laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, scaffolding, charges, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

#### **Flat Back Large Urinals (Type-1)**

Providing and fixing star white vitreous China flat back large urinals size - 375x390x590mm with self closing flush valve fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS : 2556, and other couplings in C.P. brass, including all necessary fixings and fittings complete with painting of fittings and cutting and making good the walls and floors wherever required.

#### **Installation of Urinals:**

Mark the screw fixing position at top and bottom end on the wall such that the height of front rim should be at a distance of 700 mm from finished floor.

Make holes with drill on wall at marked position with drill bit of 5 mm dia and insert PVC sleeve inside the holes.

Fix the urinal on wall with screws. Connect the incoming water line on top & connect waste pipe on outlet.

#### **Sinks:**

Laboratory sinks and Kitchen sinks shall be of white glazed fire clay confirming to IS 771 (Part-2) with up to date amendments. The kitchen sink shall be of one piece construction with or without rim but without overflow.

Stainless steel kitchen sink shall be of sizes as specified and shall be conforming to IS 13983.

#### **Bottle Trap:**

1. Providing and fixing CP Brass 32mm size Bottle Trap of approved quality & make and as per the direction of The Engineer.

**2. Providing and fixing PTMT Bottle Trap for Wash basin and sink.**

- Bottle trap 31mm single piece moulded with height of 270 mm, effective length of tail pipe 260 mm from the centre of the waste coupling, 77 mm breadth with 25 mm minimum water seal, weighing not less than 260 gms.
  
- Bottle trap 38 mm single piece moulded with height of 270 mm, effective length of tail pipe 260 mm from the centre of the waste coupling, 77 mm breadth with 25 mm minimum water seal, weighing not less than 263 gms.

**C.P. Brass Sink Cock**

Supplying, fixing testing and commissioning of C.P. Brass Sink cock With Extended Swivel Spout (Wall Mounted) type with all fixtures and fittings complete of approved quality conforming to IS standards.

A Sink Cock is a draw off tap with a horizontal inlet and free outlet with suitable means of connections for insertion in a pipe line for controlling or stopping the flow. They shall be of specified size and shall be of screw down type and shall conform to IS 781. The closing device shall work by means of disc carrying a renewable non-metallic washer which shuts against water pressure on a seating at right angles to the axis of the threaded spindle which operates it. The handle shall be crutch type securely fixed to the spindle.

**Installation of Sink Cock:**

- a. Place faucet and cover plate onto the wall mid of the sink and fix it with the screws.
- b. Adjust faucet position as necessary, then tighten all mounting hardware.
- c. Slip spray hose through flange and route hose up through faucet center mounting hole and slip washer supplied.
- d. Apply teflon tape to supply tube and attach hose to threaded adapter on faucet.
- e. Connect the supply hoses to the water supply.
- f. Turn on water supply and check for leaks

**Method of Measurement and payment**

Payment for Sink Cock shall be made on the basis of numbers arrived at by counting the number of Sink Cock laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

**Two Way Bib Cock**

Supplying, fixing testing and commissioning of C.P.Brass two way bib cock with wall flange and aerator type with all fittings and fixtures complete of approved quality conforming to IS standards.

**Method of Measurement and payment**

Payment for Two way Bib cock shall be made on the basis of numbers arrived at by counting the number of Two way Bib cock laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

**Health Faucet**

Supply, fixing, testing and commissioning of Hand Shower (Health Faucet) near EWC consisting of 15mm dia C.P. Angle stop cock and 1mtrs. Long C.P. flexible tube with wall hook includes all fittings and fixtures i.e connectors, adopters etc. conforming to IS standards.

**Method of Measurement and payment**

Payment for Health Faucet shall be made on the basis of numbers arrived at by counting the number of Health Faucet laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

**Wall Mixer**

Supply, fixing, testing and commissioning of Classic Wall Mixer 2 in 1 with Provision For Over Head Shower With 115mm Long Bend Pipe complete and wall flanges including shower arm, shower rose, bath spout, concealed body & exposed parts, connectors, adopters, fittings, fixtures, all complete of approved design etc.

**Installation of Wall Mixer:**

- Construct a suitable wall frame for the mounting plate.
- Make sure that the frame is level and correct.
- Fix the mounting plate to the valve body with the washers and the fixing screws.
- Fix the mounting plate and valve body to the wall frame.
- Make sure that the frame is level and correct.
- Connect hot and cold water supply to the inlet.
- During installation, the protectors remain on the valve body
- Ensure that all coupling nuts are tight.
- Turn on the main water supply.
- Check for leaks, and repair as needed.

**Method of Measurement and payment**

Payment for Wall Mixer shall be made on the basis of numbers arrived at by counting the number of Wall Mixer laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

#### **PTMT Brass Towel Ring**

Providing and fixing PTMT towel ring trapezoidal shape 215 mm long, 200 mm wide with minimum distances of 37 mm from wall face with concealed fittings arrangement of approved quality and colour, weighing not less than 88 gms

#### **Method of Measurement and payment**

Payment for PTMT Towel Ring shall be made on the basis of numbers arrived at by counting the number of PTMT Towel Ring laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

#### **PTMT Towel Rail**

Providing and fixing PTMT towel rail complete with brackets fixed to wooden cleats with PTMT brass screws with concealed fittings arrangement of approved quality and colour.

600 mm long towel rail with total length of 645 mm, width 78 mm and effective height of 88 mm, weighing not less than 190 gms.

#### **Method of Measurement and payment**

Payment for PTMT Brass Towel Rail shall be made on the basis of numbers arrived at by counting the number of PTMT Brass Towel Rail laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

#### **Toilets for Disabled Persons (Full sets)**

Providing and fixing of star white EWC and low level cistern of 6 litre capacity , angle valve with riser pipe with fittings and seat cover and including of wall hung compact washbasin of size 46x36cm fixed to wall with brackets, 1 nos.of angle valve with riser pipes, connectors, adopters, all fittings and one hinged rail of 76cm with one pair of mounting brackets and 5Nos grab rails of 60cm for support, faucet with spatula lever (without Bottle trap) with all fittings and fixtures complete, angle valve, riser / connector pipe, nuts, bolts, connector, adopter, check nuts etc including cutting and making good the walls and floors wherever required.

#### **Method of Measurement and payment**



Payment for Toilets for Disabled shall be made on the basis of numbers arrived at by counting the number of Toilets for Disabled laid in position. Rate shall include cost of all materials, labour charges, transportation, cost, scaffolding, charges, taxes, hire charges for tools and plants, finishing charges and curing etc. complete.

### **Floor Trap Grating**

Supplying and fixing of Square (125x125mm) & Round Stainless Steel grating of SS-304 including GI hopper for connection of wash basin/ urinal with fittings, connectors & adopters. and all fittings etc., complete.

### **Method of Measurement and payment**

Payment for floor trap grating can be made on the basis of number arrived at by counting the number of floor trap grating laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

### **Waste Fittings for Wash Basins and Sinks**

The waste fittings shall be of nickel chromium plated brass, with thickness of plating not less than service grade 2 of IS 4827 which is capable of receiving polish and will not easily scale off. The fitting shall conform in all respect to IS 2963 and shall be sound, free from laps, blow holes and fittings and other manufacturing defects. External and internal surfaces shall be clean and smooth. They shall be neatly dressed and be truly machined so that the nut smoothly moves on the body.

Waste fitting for wash basins shall be of nominal size of 32 mm. Waste fittings for sinks shall be of nominal size 50 mm.

### **Mirror**

The mirror shall be of superior glass with edges rounded off or beveled, as specified. It shall be free from flaws, specks or bubbles. The size of the mirror shall be 60 x 45 cm unless specified otherwise and its thickness shall not be less than 5.5 mm. It shall be uniformly silver plated at the back and shall be free from silvering defects. Silvering shall have a protective uniform covering of red lead paint. Where beveled edge mirrors of 5.5 mm thickness are not available, fancy looking mirrors with PVC beading/border or aluminium beading or stainless steel beading/border based on manufacture's specifications be provided nothing extra shall be paid on this account. Backing of mirrors shall be provided with environmentally friendly material other than asbestos cement sheet.

### **Floor Clean Out (FCO)**

Supplying and fixing of Square (125x125mm) & Round Stainless Steel – SS 304 clean out cover and include GI hopper for connection of CI pipe with fittings, connectors & adopters and all fittings etc., complete.

**Method of Measurement and payment**

Payment for FCO can be made on the basis of number arrived at by counting the number of FCO laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**Wall Mounted Double Coat Hook**

Providing and fixing wall mounted Double Coat hook on door complete.

**3.8. R.O. TREATMENT SYSTEM:**

Providing, fixing, testing and commissioning of R.O. plant 1000 ltrs. Per hour flow rate having capacity to treat the raw water having TDS 1200 ppm and not less than 40%. The treated water should have TDS less than 100 ppm and hardness less than 50 ppm. The operating voltage to 230 volt AC +/- 10% alongwith required capacity pump and solenoid valves, dry run protection of pump, automatic tank level control, inbuilt auto flush timer for periodic flushing of membranes, hydro pneumatic tank, over voltage and over current protection with switch mode power supply system complete in all respects.,

The Potable water is passed through high-pressure pump to the R.O. membranes where in concentration is reduced and then taken for further process.

The RO system comprises of R.O. membranes house in FRP pressure tubes. All interconnecting low-pressure pipe line and high pressure pipe line shall be SupremeUPVC SCH40/ SCH 80 pipelines. High-pressure pumps are provided for pumping of the water through the membranes. Necessary instrumentation is provided to monitor the operation of the system.

**PROCESS SCHEME:**

- Raw Water Storage Tank.
- Filter Feed Pump.
- Pressure Sand Filter.
- Activated Carbon Filter.
- Anti sealant Dose.
- Micron Cartridge Filters.
- High Pressure Pump.
- Reverse Osmosis Module.
- Product Water Storage Tank.

**Method of Measurement and payment**

Payment for RO Plant can be made on the basis of number arrived at by counting the number of RO Plant laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**3.9. WATER DISPENSER UNIT**

Supplying, fixing and commissioning of potable unit of approved make & suitable model for Water Dispenser with purified normal hot and cold water outlets including all fittings and accessories complete.,

### **Polyethylene Water Storage Tanks**

Material Polyethylene used for manufacture of tanks and manhole lids may be high density (HDPE), low density (LDPE) or linear low density (LLDPE) and shall conform to IS 10146. Polyethylene shall be compounded with carbon black so as to make the tank resistant to ultra violet rays from the sun. The percentage of carbon black content in polyethylene shall be  $2.5 \pm 0.5$  percent and it shall be uniformly distributed. The materials used for the manufacture of tank, manhole lid and fittings shall be such that they neither contaminate the water nor impart any taste, colour, odour or toxicity to water.

### **CP Brass Bib Cock**

The CP brass bib cock shall be conforming to IS: 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the bib cocks are normally fitted. The dimensions of body for Bib Cock shall be as per table given to IS: 8931. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

### **CP Brass Long Body Bib Cock**

The CP brass long body bib cock shall be conforming to IS standards. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the long body bib cocks are normally fitted. The weight of long body Bib Cock shall be less than 690 grams. Each bib cock shall be legibly marked with the Manufacture's name and trade mark.

### **CP Brass Angle Valve**

A valve with the inlet and outlet at right angles to each other and is intended to facilitate servicing of water fittings or appliances. The CP brass angle valve shall be conforming to IS: 8931. The body shall be of chromium plated copper alloy and external and internal surfaces shall be clean, smooth and free from sand. The 15mm nominal bore shall be designated by the nominal bore of the pipe outlet to which the angle valves are normally fitted. The dimensions of body for angle valve shall be as per table given to IS: 8931. Each angle valve shall be legibly marked with the Manufacture's name and trade mark.

### **M.S. Stays and Clamps**

The clamps shall be made from 1.5 mm thick M.S. flat of 32 mm width, bent to the required shape and size to fit tightly on the socket, when tightened with nuts & bolts. It shall be

formed of two semicircular pieces with flanged ends on both sides with holes to fit in the screws, bolts and nuts 40 mm long. The stay shall be minimum one metre long of 10 mm dia M.S. bar. One end of the stay shall be bent for embedding in the wall in cement concrete block of size 20 x 10 x 10 cm in 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size). The concrete shall be finished to match with the surrounding surface.

### **3.10. CUTTING CHASES IN MASONRY WALLS**

#### **Making Chases**

Chases are made in the walls for housing G.I. Pipes etc.

#### **I. Cutting of chases in one brick thick and above load bearing walls :**

- a) As far as possible services should be planned with the help of vertical chases. Horizontal chases should be avoided.
- b) The depths of vertical chases and horizontal chases shall not exceed one third and one sixth of the thickness of the masonry respectively.
- c) When narrow stretches of masonry (or short lengths of walls) such as between doors and windows, cannot be avoided, they should not be pierced with openings for soil pipes or waste pipes or timber joints, etc. Where there is a possibility of load concentration, such narrow lengths of walls shall be checked for stresses and high strength bricks mortar or concrete walls provided, if required.
- d) Horizontal chases when unavoidable should be located in the upper or lower one third of height of storey and not more than three chases should be permitted in any stretch of a wall. No continuous horizontal chase shall exceed one metre in length. Where unavoidable, stresses in the affected area should be checked and kept within the permissible limits.
- e) Vertical chases should not be closer than 2 m in any stretch of a wall. These shall be kept away from bearings of beams and lintels. If unavoidable, stresses in the affected area should be checked and kept within permissible limits.
- f) Masonry directly above a recess, if under than 30 cm (Horizontal dimension) should be supported on lintel. Holes in masonry may be provided up to 30 cm width x 30 cm height without any lintel. In the case of circular holes in masonry, no lintel should be provided up to 40 cm in diameter.

#### **Cutting of chases in half brick load bearing walls**

No chase shall be permitted in a half brick load bearing wall and as such no recessed conduits and concealed pipes shall be provided in half brick thick load bearing walls.

#### **Cutting of chases in half brick non-loading bearing walls**

In case of non load bearing half brick walls services should be planned with the help of vertical chases. Horizontal chases should be provided only when unavoidable.

#### **Cutting of chases in stone masonry walls**

The provision (i) to (vi) under Sl. No. I are equally applicable to stone masonry walls also.

**Note:**

1. No inclined chase shall be permitted in brick masonry or stone masonry walls. In case inclined chases are unavoidable these shall be cut with written approval of the The Engineer, and shall be repaired properly to his satisfaction. However, in half brick masonry wall, no inclined chase will be permitted.
2. Chases shall be made by chiseling out the masonry to proper line & depth. Any damage to the adjoining portion or to any other item shall be made good, as decided by the The Engineer, for which no extra payment shall be made. All dismantled material shall be removed from site. CPWD specifications 2019.

**CUTTING HOLES IN R.C.C. FLOORS (UPTO 15 × 15 CM)**

Square holes of size as specified shall be cut in R.C.C. floor and roofs for passing drain pipe etc. Any damage to the adjoining portion or to any other item shall be made good as directed by the The Engineer. All the dismantled material shall be removed from the site.

**Cement Concrete**

After insertion of drain pipe etc. the hole shall be repaired with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and the surface finished to match with the existing surface. The top and bottom shall be finished properly to make the joint leak proof. The specifications for cement concrete work and finishing etc. shall be the same as detailed under relevant sub-heads.

**POLYVINYL CHLORIDE (PVC) PIPES AND FITTINGS**

PVC (SWR) class pipes and fittings Type A and of Type B for soil and waste discharging system of pressure rating Max 6Kg/cm<sup>2</sup> and conforming to IS 13592: 1992, shall be used. The pipes shall be supplied in nominal lengths of 2, 3, and 4 or 6 meters as per IS 14735, tolerance on specified lengths shall be +/-10mm. Any physical test requirements shall be as per IS13592-1992.

**Handling**

Because of their lightweight, there may be a tendency for the PVC pipes to be thrown much more. Reasonable care should be taken in handling and storage to prevent damage to the pipes. Contractor should hold the fullest responsibility in this case. On no account the pipes should be dragged on the ground. Pipes should be given adequate supports at all times.

**Laying**

The PVC pipes shall be laid under the floors below slab or on walls either buried or exposed as the case may be, as per the specifications and instructions of the Engineer. The minimum thickness of fittings shall be of 3.2 mm. The fittings shall be of injection-moulded type with solvent cement joint. The pipes and fittings shall be capable of withstanding sun's rays. PVC pipes laid below slab or suspended in ceiling shall be supported by angle brackets / MS supports as detailed in the drawings and as per the instruction of the Engineer. The cost of drilling holes in RCC slab, floor, RCC/masonry retaining wall with the core cutting machine and making good the same with approved quality cement concrete etc. is at its own cost. If the pipes laid above the floor level (sunken level), it should be rigidly fixed with PCC bedding and levelled at every 1 meter intervals.

### **Jointing**

The jointing of pipes to fittings shall be done as per the manufacturer's instructions / recommendations and as per the Engineer instruction.

The PVC pipes and fittings shall be joined with Solvent Cement and jointing shall be carried out as follows:

1. Cut the spigot end of the pipe square.
2. All burrs from the internal and external surfaces should be removed.
3. The spigot should be marked with a pencil line and a distance equivalent to the socket depth. Clean the surface within the marked area.
4. Apply uniform coat of solvent cement on the external surface to the pipe and a lighter coat on the internal surface of the fitting.
5. Insert the pipe end into the socket of the fitting and push it in upto the mark.

Remove the excess solvent cement and hold the joint firmly in position for 30 seconds to dry. Gluing should be avoided in a rainy or foggy weather.

The other method of jointing shall be by rubber rings. The material of rubber ring should conform to IS 5382-1969. The ring is housed in groove formed in a plastic or metallic housing. The rubber is compressed and makes a seal between the pipe and housing. Lubricating paste should be applied before compressing the rubber. Where natural rubber 'O' rings are used, mineral oil or petrol or grease should be used.

### **Testing**

PVC pipes and fittings shall be tested in accordance with IS 13592 - 1992. The openings of the pipes shall be sealed for the section to be tested. These are of non pressure pipe and testing carried out by gravity water pressure or smoke test. The water pressure of 0.5Mpa (1.5m of H<sub>2</sub>O or 0.15 kg/cm<sup>2</sup>) shall be maintained for a minimum period of 15 minutes and

there should be no leakage at any joint. The Engineer shall examine carefully all the joints for leakage. The cost of equipments and accessories required for testing the system shall be supplied by the Contractor at his own cost.

### Mode of Measurement PVC Pipes

PVC Pipes shall be measured along pipeline including the specials in running meter (Rm.)

The quoted rate shall include the following:

- i) The cost of pipes, specials and other jointing materials.
- ii) Laying, jointing and curing.
- iii) Testing and making good the defects, if any.

### CHLORINATED POLYVINYL CHLORIDE (CPVC) Pipes & Fittings

CPVC pipes & fittings used in hot & cold potable water distribution system shall conform to requirement of IS 15778. The material from which the pipe is produced shall consist of chlorinated polyvinyl chlorides.

Diameter and wall thickness of CPVC pipes are as per given below.

Pipe selected i.e SDR 11 upto 50 mm & above 50 mm schedule 40 or 80 as per design.

Sl. No.	Nominal Size	Nominal Outside Diameter	Mean Outside Diameter		Outside Diameter at any point		Class	
			Min	Max	Min	Max	Avg.	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
(i)	15	15.9	15.8	16.0	15.8	16.0	2.2	
(ii)	20	22.2	22.1	22.3	22.0	22.4	2.5	
(iii)	25	28.6	28.5	28.7	28.4	28.8	3.1	
(iv)	32	34.9	34.8	35.0	34.7	35.1	3.7	
(v)	40	41.3	41.2	41.4	41.1	41.5	4.3	

### Notes

1. For CPVC pipes SDR is calculated by dividing the average outer diameter of the pipe in mm by the minimum wall thickness in mm. If the wall thickness calculated by this formula is less than 1.52 mm, it shall be increased to 1.52 mm. The SDR values shall be rounded to the nearest 0.5.

### Dimensions of Pipes

The outside diameter, outside diameter at any point and wall thickness shall be as given in above table.

### Diameter

The outside diameter and outside diameter at any point as given in above table shall be measured according to the method given in IS 12235 (part 1).

#### **Diameter at any point**

The difference between the measured maximum outside diameter and measured minimum outside diameter in the same cross-section of pipe (also called tolerance on ovality) shall not exceed the greater of the following two values:

- (a) 0.5 mm, and
- (b) 0.012 dn rounded off to the next higher 0.1 mm.

#### **Wall Thickness**

The wall thickness of the pipes shall be as given in above table. Wall thickness shall be measured by any of the three methods given in IS 12235 (part 1). To check the conformity of the wall thickness of the pipe throughout its entire length, it is necessary to measure the wall thickness of the pipe at any point along its length. This shall be done by cutting the pipe at any point along its length and measuring the wall thickness as above. Alternatively, to avoid destruction of the pipe, non destructive testing methods such as the use of ultrasonic wall thickness measurement gauges shall be used at any four points along the length of the pipe.

#### **Tolerance on Wall Thickness**

- a) For pipes of minimum wall thickness 6 mm or less, the permissible variation between the minimum wall thickness ( $e_{Min}$ ) and the wall thickness at any point ( $e$ ), ( $e - e_{Min}$ ) shall be positive in the form of  $+y$ , where  $y=0.1 e_{Min}+0.2$  mm.
- b) For pipes of minimum wall thickness greater than 6mm, the permissible variation of wall thickness shall again be positive in the form of  $+y$ , where  $y$  would be applied in two parts.
- c) The average wall thickness shall be determined by taking at least six measurements of wall thickness round the pipe and including both the absolute minimum and absolute maximum measured values. The tolerance applied to this average wall thickness from these measurements shall be within the range  $0.1 e_{Min}+0.2$  mm (see above table).
- d) The maximum wall thickness at any point shall be within the range  $0.15e_{Min}$  (above table).
- e) The results of these calculations for checking tolerance shall be rounded off to the next higher 0.1 mm.

#### **Effective Length ( $L_e$ )**

If the length of a pipe is specified, the effective length shall not be less than that specified. The preferred effective length of pipes shall be 3, 5 or 6 m. The pipes may be supplied in other lengths where so agreed upon between the manufacturer and the purchaser.



**Pipe Ends**

The ends of the pipes meant for solvent cementing shall be cleanly cut and shall be reasonably square to the axis of the pipe or may be chamfered at the plain end.

**3.11. PHYSICAL AND CHEMICAL CHARACTERISTICS****Visual Appearance:**

The colour of the pipes shall be off-white. Slight variations in the appearance of the colour are permitted. The internal and external surface of the pipe shall be smooth, clean and free from grooving and other defects.

**Capacity:**

The wall of the plain pipe shall not transmit more than 0.1 per cent of the visible light falling on it when tested in accordance with IS 12235 (Part 3).

**Effect on Water:**

The pipes shall not have any determinate effect on the composition of the water flowing through them, when tested as per 10.3 of IS 4985.

**Reversion Test:**

When tested by the method prescribed in IS 12235 (Part 5/ Sec 1 and Sec 2), a length of pipe 200 ±20 mm long shall not alter in length by more than 5 per cent.

**Vicat Softening Temperature:**

When tested by the method prescribed in IS 12235 (part 2), the Vicat softening temperature of the specimen shall not be less than 110°C.

**Density:**

When tested in accordance with IS 12235 (Part 14), the density of the pipes shall be between 1450kg/m<sup>3</sup> and 1650kg/m<sup>3</sup>.

**Hydrostatic Characteristics:**

When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (part 8/Sec 1), the pipe shall not fail during the prescribed test duration. The temperatures, duration and hydrostatic (hoop) stress for the test shall conform to the requirements given below table. The test shall be carried out not earlier than 24h after the pipes have been manufactured.

Sl. No.	Test	Test Temperature Min	Test Period
		°C	h
(1)	(2)	(3)	(4)
(i)	Acceptance	20	1
(ii)	Type	95	165

#### Thermal Stability by Hydrostatic Pressure Testing:

When subject to internal hydrostatic pressure test in accordance with the procedure given in IS 12235 (Part 8/Sec 1) and as per requirement given above table, Sl. No. (iv), the pipe shall not burst or leak during the prescribed test duration.

Resistance to External Blow at 0°C :

When tested by the method prescribed in IS 4985, with classified striker mass and drop height as given in below table, the pipe shall have a true impact rate of not more than 10 per cent.

Sl. No.	Nominal Pipe Size	Mass of Fall Weight
	mm	Kg
(1)	(2)	(3)
(i)	15	0.5±0.5%
(ii)	20	0.5±0.5%
(iii)	25	0.5±0.5%
(iv)	32	0.5±0.5%
(v)	40	0.5±0.5%
(vi)	50	0.5±0.5%

#### Flattening Test :

When tested by the method prescribed in IS 12235 (part 19), pipe shall show no signs of cracking, splitting and breaking.

#### Tensile Strength :

When tested by the method prescribed in IS 12235 (Part 19), the tensile strength at yield shall not be less than 50 MPa at  $27 \pm 2^\circ\text{C}$ .

Sampling and Criteria for Conformity

Each pipe shall be clearly and indelibly marked in ink/paint or hot embossed on white base at intervals of not more than 3 m. The marking shall show the following:

- (a) Manufacturer's name or trade-mark
- (b) Outside diameter,

(c) Class of pipe and pressure rating, and

(d) Bath or lot number

BIS Certification Marking: Each pipe may also be marked with the Standard Mark.

### Fittings

The fittings shall be as follows:

- a) Plain CPVC solvent cement fittings from size 15 mm to 160 mm.
- b) Brass threaded fittings.
- c) Valve from size 15 mm to 160 mm
- d) Brass Threaded Fittings: All types of one end brass threaded male/female adaptors in various fittings like coupler, socket, elbow, tee are available for transition to other plastic/metal piping and for fixing of CP fittings. Ball, Gate valves in CPVC are available in all dimensions.

All fittings shall carry the following information:

1. Manufacturer's name/trade mark.
2. Size of fitting

### Piping Installation Support and Spacing

**Concealed Piping:** Pipes can be concealed in chases. The pipes and fitting are to be pressure tested prior to concealing the chases. To maintain alignment of CP fittings while joining, all alignment of fittings and pipe shall be done correctly. Do not use nails for holding of pipes in the chases.

**External Installations:** For pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes. Pipes sleeves shall be fixed at a place the pipe is passing through a wall or floor so as to allow freedom for expansion and contraction. Clamping of the pipe is done to support it while allowing the freedom for movement.

All pipes exposed to sunlight shall be painted with a water based acrylic paint emulsion to enhance UV protection. Pipes in trenching shall be laid in accordance to the Good Plumbing practices followed for Metal piping.

Pipe Size	Horizontal Support (In meters)			
	Temperature			
	23°C	38°C	60°C	82°C
16mm	1.22	1.22	1.07	0.92
20mm	1.53	1.37	1.22	0.92
25mm	1.68	1.53	1.37	0.92
32mm	1.83	1.68	1.53	1.22
40mm	1.98	1.83	1.68	1.22
50mm	2.29	2.14	1.98	1.22
65mm	2.44	2.29	1.98	1.22

80mm	2.75	2.60	1.98	1.22
100mm	2.90	2.75	1.98	1.22

**Expansion LOOP:**

CPVC systems, like all piping materials, expand and contract with changes in temperatures. CPVC pipes shall expand 7.5 cm per 30 m length for a 400C temperature change.

Expansion does not vary with Pipe size. Thermal expansion can be generally be accommodated at changes in direction. On a long straight run, an offset or loop based on the following chart is required.

Nominal Pipe Size	Length of Run (Meter), Loop l		
	6 metre	12 metre	18 metre
15 mm	43	56	69
20 mm	48	66	81
25 mm	53	74	91
32 mm	59	81	102

**Testing**

All water supply systems shall be tested to hydrostatic pressure test. The pressure tests are similar to the test pressure used for other plastic/metal pipes. System may be tested in sections and such section shall be entirely checked on completion of connection to the overhead tank or pumping system or mains.

**Measurements**

The net length of pipes as laid or fixed shall be measured in running meters correct to a Rm(Running meter) for the finished work, which shall include CPVC pipe and fittings including plain and Brass threaded fittings and jointing solvent cement.

**3.12. VALVES****Ball Valve (BRASS) (Upto 50mm size)**

Supply and fixing in position the following lever operated, full flow, quarter turn, Ball Valves of Forged Brass body and chrome plated brass ball with chrome plated steel handle with PVC sleeve and PTFE seal tested to 25 Kg / Cm<sup>2</sup> pressure rating, conforming to BS : 5159 manufacturing standards, including all unions and effecting proper connections.

The ball valve shall be of Brass or Gunmetal as specified conforming to IS 1703. The ball valve shall be of following two classes:—

- a. High Pressure: High pressure float valves are indicated by the abbreviation 'HP' and are designed for use on mains having pressure of 0.175 MPa or above.
- b. Low Pressure: Low Pressure float valves are indicated by the abbreviation 'LP' and are designed for use on mains having a pressure up to. 0.175 MPa.

The ball valves shall be of following nominal sizes 15 mm, 20 mm, 25 mm, 32 mm, 40 mm and 50 mm.

### **Butterfly Valve (CI) (Above 50mm size)**

Supply and fixing in position the following lever operated, full flow, Butterfly Valves of Cast Iron body, Ductile Iron Disc, with Nitrile integrally moulded rubber and pressure rating of Body- 10 Kg / Cm<sup>2</sup> , Seat - 16 Kg / Cm<sup>2</sup> conforming to IS :13095 manufacturing standards, including all unions and effective proper connections.

Butterfly valves shall be slim seal, short wafer type with standard finish. The valves shall be suitable for mounting between flanges drilled to ANSI 125. The valve body shall be cast iron. The disc shall consist of disc pivot and driving stem shall be in one piece centrally located. The disc shall move in bearings on both ends with 'O' ring to prevent leakage. The seat shall be moulded with black nitrile rubber or nylon and shall line the whole body. The spindle shall be AISI 41 steel. The valve shall be suitable for a working pressure of 16.5 kg/sq.cm and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts. These valves conform to BS 5155 with electrosteel nickel coated SG Iron (N) and seat material EPDM3.

Also the following standard corresponds to their manufacture

Design	-	API609 / BS5155
Face to Face/ End to End	-	ANSI B 16.10
Flange		
Dimension	-	ANSI B 16.5
Butt Weld Ends	-	ANSI B 16.25
Pressure/Temperature		
Ratings	-	ANSI B 16.34
Seating	-	moulded in situ resilient lining of black Nitrile rubber
Body	-	Heavy duty CI to IS210 Gr FG220 & BS 1452 lining of black nitrile rubber.
Disk	-	Nylon coated SG iron of IS 1865 / SF400 / 127BS2729 Gr. 420 / 12

Shafts are to be made of SS AISI 431 Only, flanged valves to be used with Flanges drilled to BS10 table F, valves Shall be capable of being locked in open Position. Hand wheel shall be with Worm and worm wheel operated for Smooth opening and closing. Key rod with MS Coated extended spindle to be provided wherever the valves are not approachable from the ground surface.

### **Single Acting Air Valve W/ Ball Valve**

Supply and fixing in position the following Single Acting Air Valve of large orifice type Cast iron body pressure rating of 10 Kg / Cm<sup>2</sup> , 16 Kg / Cm<sup>2</sup> conforming to IS 14845 : 2000 with lever operated, full flow, quarter turn, Ball Valves of Forged Brass body and chrome plated brass ball with chrome plated steel handle with PVC sleeve and PTFE seal tested to 25 Kg / Cm<sup>2</sup> pressure rating, conforming to BS : 5159 manufacturing standards, and including all unions and effective proper connections.

#### **Double Acting Air Valve W/ Ball Valve**

Supply and fixing in position the following Double Acting Air Valve of large orifice type Cast iron body pressure rating of 10 Kg / Cm<sup>2</sup> , 16 Kg / Cm<sup>2</sup> conforming to IS 14845 : 2000 with lever operated, full flow, Butterfly Valves of Cast Iron body, Ductile Iron Disc, with Nitrile integrally moulded rubber and pressure rating of Body- 10 Kg / Cm<sup>2</sup> , Seat - 16 Kg / Cm<sup>2</sup> conforming to IS :13095 manufacturing standards, including fittings, GI flanges, connectors, adapters etc. all unions and effective proper connections.

#### **Solenoid Valve**

Supply and fixing in position the following Solenoid Valves with Brass body, SS-304 spring, pressure limit of 12 Kg / Cm<sup>2</sup> and assembled with NBR seal, Include power cable, control cable, level probe/sensor/ electrode with all fitting & accessories complete set.

Solenoid Valves are compact, general-service, two-way guide type. They are available in brass with a normally closed design and can be oriented in any position. The solenoid enclosure provides protection against dust, while also protecting against seepage of oil and noncorrosive coolants. The Series SBSV-B valves come assembled with an NBR (Nitrile butadiene rubber seal, having a maximum process temperature of 176°F (80°C). The series offers a wide range of valve sizes and flow ranges, with connection sizes from 1/8" to 2" NPT and orifices from 3 mm to 50 mm. The material and make should be submitted to the Client/PMC. After approval, the make and material will be procured by the contractor.

#### **Isolation Valve**

Supply and fixing in position the following shall be operated by screwed joints requiring only a quarter turn Isolation Valve 3 piece ball-type design with a bronze body and chrome plated brass ball and Seats shall be Teflon (TFE) and seals Viton for valves. A blow-out proof stem shall be used and the valve shall have a maximum pressure rating of 42 Kg / Cm<sup>2</sup> including all unions and effective proper connections.

#### **Installation Of Valves**

Valves should be installed in true tolerance of +/-5mm with respect to the center line of the pipe. Where threaded joints are encountered the threads should be initially sealed with PVC tape to avoid leakage due to improper tightening and leakage from threading.

Proper care has to be taken in welded installation so that the centerline of valve should not deviate from the pipe causing uneven load on the pipe and further stress during its operation. The welding should be done only after proper inspection of the joint by the Engineer in the tacked position of the joint.

Before putting the line in operative mode the valves should be checked for free and easy operation of the hand wheel. Any burrs or foreign materials should be removed by flushing before final operation so that no choking in the valves should occur which might damage the valve seat.

### **Method of Measurement and payment**

Payment for valves can be made on the basis of number arrived at by counting the number of valves laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

### **3.13. PRESSURE REDUCING STATION**

Supplying, fixing, testing & commissioning of Pressure reducing station includes brass Pressure reducing valve, 2 nos brass isolation valve, 1 nos strainer cast iron body with ss 304 basket strainer, 1 no cast iron non return valve, 15 mm SS 304 pressure gauge with ball valve 2 set complete with all fittings accessories, connectors, adopters etc complete. with pressure rating of 5 kg/sq.cm to 18 kg/sq.cm etc. the work shall also include accessories, etc, Complete..

### **Level Indicator**

Supply and fixing in position the following Water Level Indicator with Tube connected to the tank at the side, pressure limit of 28 Kg / Cm<sup>2</sup> and including all effective proper connections.

### **Water Meter (Electro Magnetic Type)**

Supply, fixing, testing and commissioning of Multi Jet Water meter with Brass Body, Couplings, and Flowage varies from 0.12 to 15 cu.m/hr with pressure limit of 16kg/sq.cm. The output is perfect for remote monitoring of flow rate or flow totalization, and to be interface with PLC's, counters, data loggers, and SCADA systems complete with bolts, nuts, rubber insertions etc.

Water meters shall be selected according to flow to be measured and not necessarily to suit a certain size of main. The following points shall govern the selection of meters:

- a) The maximum flow shall not exceed the nominal capacity of the meter.
- b) The continuous flow shall be not greater than the continuous running capacity rating.
- c) The minimum flow to be measured shall be within minimum starting flows.

Inferential water meter has the same accuracy as the semi-positive type at higher flows; it passes unfiltered water better than a semi-positive meter and is lower in cost.

Special care is necessary in selecting the most suitable meter where large rates of flow may exist for short periods. The normal working flow shall be well within the continuous running capacity specified in IS 779, as high rates of flow over short period may cause excessive wear if the meter chosen is too small for the duty.

Owing to the fine clearances in the working parts of meters, they are not suitable for measuring water containing sand or similar foreign matter, and in such cases a filter or dirt box of adequate effective area shall be fitted on the upstream side of the meter.

It shall be noted that the normal strainer fitted inside a meter is not a filter and does not prevent the entry of small particles, such as sand.

Water meters and their parts, especially parts coming in continuous contact with water shall be made of materials resistant to corrosion and shall be non-toxic and non-training. Use of dissimilar metals in contact under water shall be avoided as far as possible in order to minimize electrolytic corrosion.

**Body:**

The body of water meter shall be made either from Type A or Type B materials as specified below:—

Type A : The body of water meters shall be made from bronze, brass or any other corrosion resistant material e.g. Grey iron castings, blackheart malleable iron, periodical graphite iron casting.

Type B: The body of the water meters shall be made from suitable plastics.

**Note:** Plastics shall have following qualities:

- 1) It shall not affect the potability of water.
- 2) Elongation, 15 per cent, Min. on a specimen of length 150 mm (for procedure of determination of elongation).
- 3) Water absorption on immersion for 24 hours should not exceed 0.6 per cent by weight (for procedure of determination of water absorption).
- 4) It shall be capable of withstanding temperature up to 55°C without undergoing deformation or softening and becoming unsatisfactorily in performance.

**Registration Box:**

Registration box of water meters of Type A shall be made from bronze, brass, aluminium alloy or suitable plastics. Registration box of water meters of Type B shall be made from suitable plastics or aluminium alloys. The registration box of dry dial water meters shall be provided with one or two escape holes for minimizing the accumulation of condensed water.

**Cap:**



Cap of water meters of Type A shall be made from brass, bronze, aluminium alloy or suitable plastics. The cap of water meters of Type B shall be made of plastics or aluminium alloy. Where the cap and registration box are integral, the materials for cap may be the same as used for registration box. The cap shall be so designed and fixed to the registration box as to avoid entry of water and dirt. The transparent window which covers the dial shall be inserted from the inside into the cap. The protective lid shall be secured by a robust hinge or other suitable method of robust construction.

**Locking Arrangement:**

Provision shall also be made to lock the lid. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be of a diameter not less than 4 mm.

**Wiper:**

Where so required for dry-type water meters the transparent window covering the dial shall be provided with a wiper on the inner side for wiping off condensed water.

**Connecting Arrangements:**

The meter casing shall be fitted in the pipe line by means of two conical or cylindrical nipples or tail pieces with connecting nuts which shall be provided with each meter. The nipples of water meters of Type A shall be made of the same materials as specified for body.

Nipples of water meters of Type B shall be made of the same materials as specified for the body where they are integral with the body of the water meters; where they are separate, they shall be made of malleable iron, galvanized steel or suitable plastics. The nuts shall be of the same material as used for nipples. The internal diameter of the nipple where it connects the pipe line shall be equal to that corresponding to the nominal size of the meter. The threads on the connection shall conform to IS 779. The minimum length of the threads shall be as given below table.

**Overall Dimensions of Water Meters**

<i>Nominal size of Meter</i>	<i>Overall length including nipples</i>	<i>Overall width. (Max.)</i>
<i>1</i>	<i>2</i>	<i>3</i>
15	250	100
20	290	130
25	380	170
40	430	210
50	470	270

**Capacity on Short Period Rating or Nominal Capacity:**

The nominal capacity of the water meters shall be as specified in above table. The meters shall be capable of giving minimum discharges as stated in the table without the head loss exceeding 10 m within the meters.

### **Yarn (Spun)**

Spun yarn shall be of clean hemp and of good quality. It shall be soaked in hot coal tar or bitumen and cooled before use.

### **Method of Measurement and payment**

Payment for water meter can be made on the basis of number arrived at by counting the number of water meter laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

### **G.I.SLOTTED BRACKET**

Providing and fixing GI Slotted Brackets - upto 1500mm of approved design factory fabricated proprietary hot deep galvanized bracket supports including GI nut GI bolts, GI anchor fastener/bolt, GI washers etc complete to all pipe embedded and including cost of cutting holes and making good the walls etc.

### **Method of Measurement and payment**

Payment for GI Slotted Brackets can be made on the basis of weight of bracket laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

### **RUBBER SHEET**

Providing and laying Rubber Sheet of 6mm thick below polyethylene water storage tank

### **Method of Measurement and payment**

Payment for Rubber sheet can be made on the basis area of rubber sheet laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work

### **3.14. INSULATION FOR HOT WATER PIPES:**

Providing and fixing insulation for hot water piping with elastomeric Nitrile Rubber Tubular Insulation & the same insulation with aluminum cladding 22 gauge for hot water piping. Before applying insulation, all pipe work and fittings shall be brushed and cleaned. Dust, dirt, mortar and oil shall be removed.

Hot water pipes exposed in kitchen area must be provided with SS Jacket or Zinc aluminum jacket as per local code over the pipe insulation specified above.

The thickness of insulation to be applied shall be as follows:

Pipe Size	Insulation Thickness
15 mm, 20 mm	6 mm
25 mm, 32 mm	13 mm
40 mm & above	19 mm

### Measurements

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work.

### LAYING AND JOINTING G.I. PIPES (INTERNAL WORK)

For internal work the galvanised iron pipes and fittings shall run on the surface of the walls or ceiling (not in chase) unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 1.5 cm clear of the wall. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with the usual tools. The pipes shall not ordinarily be buried in walls or solid floors. Where unavoidable, pipes may be buried for short distances provided adequate protection is given against damage and where so required joints are not buried. Where directed by the The Engineer, a M.S. tube sleeve shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and to allow freedom for expansion and contraction and other movements. In case the pipe is embedded in walls or floors it should be painted with anticorrosive bitumastic paints of approved quality. The pipe shall not come in contact with lime mortar or lime concrete as the pipe is affected by time. Under the floors the pipes shall be laid in layer of sand filling as done under concrete floors.

All pipes and fittings shall be fixed truly vertical and horizontal unless unavoidable. The pipes shall be fixed to walls with standard pattern holder bat clamps of required shape and size so as to fit tightly on the pipes when tightened with screwed bolts, these clamps shall be embedded in brick work in cement mortar 1:3 (1 cement: 3 coarse sand), and shall be spaced at regular intervals in straight lengths as shown in the below table.

The clamps shall be fixed at shorter lengths near the fittings as directed by the The Engineer.

For G.I. pipes 15 mm diameter, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the The Engineer. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) and properly finished to match the adjacent surface

<b>Dia. of Pipe (mm)</b>	<b>Horizontal length (m)</b>	<b>Vertical length (m)</b>
15	2	2.5
20	2.5	3
25	2.5	3
32	2.5	3
40	3	3.5
50	3	3.5
65	3.5	5
80	3.5	5

Unions will be provided to facilitate connections additions and alterations as well as for maintenance and for change of pipes. The locations where unions are to be provided will be decided with prior written approval of the The Engineer.

### **3.15. MAKING CONNECTION OF G.I. DISTRIBUTION BRANCH WITH G.I. MAIN**

#### **Preliminary Work**

A pit of suitable dimensions shall be dug at the point where the connection is to be made with the main and earth removed up to 15 cm below the main. The flow of water in the water main shall also be disconnected by closing the sluice or wheel valves on the mains.

#### **Making Connection**

For cutting and jointing 18.6.2 and 18.6.3 of CPWD Sepcification-2019 (Vol-2) shall apply. The G.I. main shall first be cut. Water if any collected in the pit shall be bailed out and, ends of the G.I. pipes threaded. The connection of distribution pipe shall then be made after fixing G.I. tee of the required size to the G.I. main and fittings such as Jam nut, G.I. socket connecting piece etc.

#### **Testing of Joints**

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 payment.

The pipes & fittings after they are laid shall be tested to hydraulic pressure of 6 kg./sq.cm. (60 m) The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock of water hammer. The draw of laps 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 half an hour. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

#### **Finishing**

The portion of the pipe in the pit shall be painted with bitumastic paint and encased with sand 15 cm all-round. The pit shall be filled with earth in level with the original ground surface watered, rammed and the area dressed.

**Measurements**

The work of making connections shall be enumerated.

**Rate**

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

**S.W. Gully Trap:**

Gully traps shall conform to IS 651. These shall be sound, free from visible defects such as fire cracks, or hair cracks. The glaze of the traps shall be free from crazing. They shall give a sharp clear tone when struck with light hammer.

There shall be no broken blisters. Each gully trap shall have one C.I. grating of square size corresponding to the dimensions of inlet of gully trap. It will also have a water tight C.I. cover with frame inside dimensions 300 x 300 mm the cover weighing not less than 4.50 Kg and the frame not less than 2.70 Kg. The grating, cover and frame shall be of sound and good casting and shall have truly square machined seating faces.

**Fixing S.W. Gully Trap****(i) Excavation :**

The excavation for gully traps shall be done true to dimensions and levels as indicated on plans or as directed by the The Engineer.

**(ii) Fixing :**

The gully traps shall be fixed on cement concrete foundation 65 cm square and not less than 10 cm thick. The mix for the concrete will be 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The jointing of gully outlet to the branch drain shall be done similar to jointing of S.W. pipes described above.

**(iii) Brick Masonry Chamber :**

After fixing and testing gully and branch drain, a brick masonry chamber 300 x 300 mm (inside) in brick work of specified class in cement mortar 1:4 (1 cement: 4 fine sand) shall be built with a half brick thick brick work round the gully trap from the top of the bed concrete up to ground level. The space between the chamber walls and the trap shall be filled in with cement concrete 1:5:10

(1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size). The upper portion of the chamber i.e. above the top level of the trap shall be plastered inside with cement mortar 1:3 (1 cement: 3 coarse sand), finished with a floating coat of neat cement. The corners and bottom of the chamber shall be rounded off so as to slope towards the grating.

C.I. cover with frame 300 × 300 mm (inside) shall then be fixed on the top of the brick masonry with cement concrete 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size) and rendered smooth. The finished top of cover shall be left about 4 cm above the adjoining ground level so as to exclude the surface water from entering the gully trap.

(iv) **Measurements:** The work shall be enumerated. Excavation shall be measured separately under relevant item of earth work.

(v) **Rate:** The rate shall include the cost of materials and labour involved in all the operations described above, except earth work which shall be paid for separately.

### **DROP CONNECTION (Sewer line connection with Manhole existing)**

In cases where branch pipe sewer enters the manhole of main pipe sewer at a higher level than the main sewer, a drop connection shall be provided. The work shall be carried out as per Fig. 19.8. of CPWD Sepcification-2019 (Vol-2) S.C.I. pipes and special conforming to IS 1729 shall be of the same size as that of the branch pipe sewer.

For 150 and 250 mm main line, if the difference in level between the water line (peak flow level) and the invert level of the branch line is less than 60 cm, a drop connection may be provided with in the manhole by giving suitable ramp. If the difference in level is more than 60 cm, the drop shall be provided externally.

The main lines up to 350 mm dia, are designed for half depth of flow, from 350 mm to 900 mm for 2/3 depth of flow and beyond 900 mm for 3/4 depth of flow.

### **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 up to the bed concrete of the manhole and to the full width of the branch line.

### **Laying**

At the end of branch sewer line S.C.I. cross shall be fixed to the line which shall be extended through the wall of the manhole by a horizontal piece of S.C.I. pipe to form an inspection or cleaning eye. The open end shall be provided with chain and lid. The S.C.I. drop pipe shall be connected to the cross at the top and to the S.C.I. bend at the bottom.

The bend shall be extended through the wall of the manhole by a piece of C.I. 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 20 mm nominal size) and finished smooth to connect the main channel. The joint between CPWD specifications 2019 1032 S.C.I. pipe and fittings shall be lead caulked as described in 18.5.3 of CPWD Sepcification-2019 (Vol-2). The joint between S.C.I. cross and S.W. 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-around with minimum 15 cm thick concrete 1:5:10 (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) and cured.

For encasing the concrete around the drop connection, the necessary centering and shuttering

shall be provided. The holes made in the walls of the manhole shall be made good with brick work in cement mortar 1:4 (1 cement: 4 coarse 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.

**Measurements**

Drop connection shall be enumerated. The depths beyond 60 cm shall be measured in running metre correct to a cm under relevant items.

**Rate**

The rate shall include the cost of labour and materials involved in all the operations described above but excluding the cost of excavations and refilling.

**BOOSTER PUMP:**

Providing, fixing, testing and commissioning of Booster pump. The speed of the pump is 2900rpm & rated flow is 2.4m<sup>3</sup>/hr and the rated head is upto 53.1m. the impeller and motor are made in Stainless Steel & pump with maximum operating pressure of 10Kg/sq.cm and power requirement of 1.3kW including all necessary fittings, valves, piping, labour etc to complete in all respects.

**Method of Measurement and payment**

Payment for Booster pump can be made on the basis of number arrived at by counting the number of Booster pump laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**Stainless steel Floor Trap 125mm dia:**

Supplying and fixing of Square & Round (125x125mm) approximately Stainless Steel grating with centre hole 25mm dia including GI hopper for connection of wash basin/ urinal with fittings, connectors & adopters. and all fittings etc., complete.

**Method of Measurement and payment**

Payment for SS Floor trap 125mm dia can be made on the basis of number arrived at by counting the number of SS Floor trap laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**FLOOR GRATING:**

Providing & fixing 150 mm wide & 600 mm long & 25 mm in height SS 304 channel grating with angle frame, grating square opening of 30 mm from 4 mm thick SS 304 flat. Angle

frame shall be suitable for 25 mm thick channel grating in SS 304 with hold fast at 1 meter interval on either side complete.

**Measurements**

Payment for Floor Grating can be made on the basis of number arrived at by counting the number of Floor Grating laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**FLOOR CLEAN OUT:**

Floor Clean out : Providing and fixing of Stainless Steel floor clean out cover Square & Round (125x125mm) approximately plug with suitable for PVC pipes in Toilet areas including fittings, flanges, connector, GI rods GI coupling etc.

**INSTALLATION METHOD:**

The common toilet area should be connected to the soil and waste pipe using proper sealant or necessary solvent. Ensure the correct gradient of the soil pipe. In case of blockage, open the cover, insert the GI rod through the cleanout to clear the blockage.

**Measurements**

Payment for Floor cleanout can be made on the basis of number arrived at by counting the number of Floor clean out laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**Double Coat hook**

Providing, Fixing wall mounted Stainless steel Double Coat hook on door complete.

**Measurements**

Payment for Double Coat Hook can be made on the basis of number arrived at by counting the number of Hook out laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**3.16. UNPLASTICISED POLYVINYL CHLORIDE PIPES AND FITTINGS**

Providing and fixing PVC Pipes shall conform to Type A pipes of IS 14735. The internal and external surfaces of the pipes shall be smooth and clean and free from grooving and other defects. The end shall be clearly cut and shall be square with the axis of the pipe. The end may be chamfered on the plain sides. Slight shallow longitudinal grooves or irregularities in



the wall thickness shall be permissible provided the wall thickness remains within the permissible limit.

### **Colour of Pipe**

Surface colour of the pipes shall be dark shade of grey or as specified.

### **Marking**

Each pipe shall be clearly and indelibly marked with the following information at intervals not more than 3 meters.

- a) Manufacturer's name or trade mark.
- b) Nominal outside dia of pipe.
- c) Type 'A'
- d) Batch number.

### **Diameter and Wall Thickness:**

Mean outside diameter, outside diameter at any point and wall thickness for type –A manufactured plain or with socket shall be as given in Table- 1 of IS 14735. UPVC rain water pipes shall be of the dia, specified in the description of the item and shall be in nominal lengths of 2,3,4 or 6 metres either plain or with sliding/grooved socket unless shorter lengths are required at junctions with fittings. Tolerances on specified length shall be + 10 mm and – 0 mm.

### **Fixing and Jointing**

Pipes shall be either fixed on face of wall or embedded in masonry as required in the description of the item. Plain pipes shall be secured to the walls at all joints with PVC Pipes clips by means of 50 x 50 x 50 mm hard wood plugs, screwed with M.S. screws of required length i/c cutting brick work and fixing in cement mortar 1:4 (1 cement : 4 coarse sand ). The clips shall be kept about 25 mm clear off finished face of wall, so as to facilitate cleaning of pipes. Pipes shall be fixed perfectly vertical or to the lines as directed. The pipes shall be fitted to fittings with seal ring conforming to IS 5382 allowing 10 mm gap for thermal expansion.

### **Installation in Wall/Concrete**

The walls/concrete slots should allow for a stress free installation. Pipes and fittings to be inserted into the slots without a cement base have to be applied first with a thin coat of PVC solvent cement followed by sprinkling of dry sand (medium size). Allow it to dry. The process gives a sound base for cement fixation. This process is repeated while joining PVC material to CI/AC materials.

### **Fittings**

Fittings used shall be of the same make as that of the PVC pipes Injection moulded or fabricated by the manufacturer and shall have a minimum wall thickness of 3.2 mm. The fittings shall be supplied with grooved socketted ends with square grooves and provided with Rubber Gasket conforming to IS 5382. The plain ends of the fittings should be chamfered. The fittings shall be joined with the help of Rubber lubricant. The details of fittings refer IS 13592.

### Measurements

The fittings shall be measured by numbers. The pipes shall be measured net when fixed correct to a running metre. Including all fittings along its length.

### 3.17. HIGH DENSITY POLYETHYLENE PIPES

Providing and Laying HDPE pipes & fittings as per IS 14333: 1996 with pressure rating of 6kg/sq.cm. This includes jointing of pipes & fittings as per standard design, refilling & testing of joints complete as per direction of The Engineer.

	Test Results	Acceptance Norms	Reference
<b>1</b>	<b>Raw Material &amp; Test Results</b>		
1	Density Melt Flow	0.940 to 0.958G/CC	IS:4984:1995
2	Rate(MFI)	0.2 to 1.1Mins.	IS:14333:1996
<b>2</b>	<b>Visual Appearance</b>		
a)	Surface finish	Satisfactory. The internal & external surface of the pipes are smooth and free from grooving & other defects.	IS:4984:1995 IS:14333:1996
a.	Dimensions &	As per relevant BIS Standards	IS:4984:1995
b.	Tolerances		IS:14333:1996
c.	Outside Diameter		
d.	Wall Thickness,		
e.	of Pipe		
	Ovality Length:		
	Pipe/ Coil		
<b>3</b>	<b>Performance Requirement</b>		
a.	Heat Reversion	3% (Max.) Longitudinal Reversion	IS:4984:1995 IS:14333:1996
b.	Hydrostatic Pressure Resistance Test	No failure or leakage during the specified period Acceptance Test: Duration 48 Hr sat 80° Cat specified stress value. Type Test: Duration 165 Hr sat 80° Cat specified Stress value.	
c.	Overall Migration Test	10Mg/dm <sup>2</sup>	
d.	Carbon Black	2.5+0.5%	

	Test Results	Acceptance Norms	Reference
	Content		
e.	Carbon Black Dispersion	Satisfactory	
f.	Density	940.0 to 958.0KG/M3	
g.	Melt low Rate	0.2 to 1.1Gms/10Mins	
<b>4</b>	<b>Identification Marking &amp; Color</b>		
		Color: Black. A pipe is marked in white color by hot embossed or by indelible ink /paint by screening as mentioned below at every meter or on the either end of pipes. Each Pipe has three equi-spaced longitudinal stripes in Blue color a)Manufacturer's Name b)Designation of Pipe c) Batch Number.	IS:4984:1995 IS:14333:1996

**Wall Thickness of Pipe (All dimensions in mm)**

Nominal	PN 2.5		PN-4		PN-6		PN-10	
Diameter	Min	Max	Min	Max	Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
63	2.6	3.0	4.0	4.6	5.8	6.5	9.0	10.1
75	3.0	3.5	4.7	5.4	6.9	7.7	10.8	12.0
90	3.6	4.2	5.7	6.4	8.2	9.2	12.9	14.4
110	4.4	5.1	6.9	7.8	10.0	11.2	15.8	17.5
125	5.0	5.7	7.9	8.8	11.4	12.7	17.9	19.9
140	5.6	6.4	8.8	9.9	12.8	14.2	20.0	22.2
160	6.4	7.3	10.0	11.2	14.6	16.2	22.9	25.4
180	7.2	8.2	11.3	12.6	16.4	18.2	25.8	28.5
200	8.0	9.0	12.5	14.0	18.2	20.2	28.6	31.7
225	9.0	10.1	14.1	15.7	20.5	22.7	32.2	35.6
250	10.0	11.2	15.7	17.4	22.8	25.2	35.8	39.5
280	11.2	12.6	17.5	19.5	25.5	28.2	40.0	44.2
315	12.6	14.1	19.7	21.9	28.7	31.7	45.0	49.7
355	14.2	15.9	22.2	24.7	32.3	35.7	50.8	56.0
400	16.0	18.6	25.0	29.0	36.4	42.2		
450	18.0	20.9	28.2	32.6	41.0	47.3		
500	20.0	23.2	31.3	36.2	45.5	52.5		
560	22.4	26.0	35.0	40.5	51.0	58.8		
630	25.2	29.2	39.4	45.5				

**Measurements**

The net length of pipes as laid or fixed shall be measured in running meters correct to a cm for the finished work.

**GATE VALVE**

Providing and fixing bronze gate valve with C.I. wheel of approved quality (screwed end) with unbreakable sheet metal hand wheel and Standards as per IS778 Class I complete with GI flanges, bolts, nuts, washers & rubber gaskets etc.

The primary function of a gate valve is for starting and stopping of flow. It has a disc actuated by a stem screw and hand wheel, moves up and down at right angles to the path of flow of fluid and seats against two faces to shut of flow. As the disc of the gate valve presents a flat surface to the direction of flow, this valve is only for starting and shutting the flow in the pipe.

Supplying, fixing and testing shall correspond to IS 778-1984, Specifications for Copper Alloy Gate valve.

All valves should have manufacturer's test certificate indicating the date of shop test and other quality control tests with the material used for the same. Gate valves shall be of the size as specified in the BOQ.

**Method of Measurement and payment**

Payment for gate valve can be made on the basis of number arrived at by counting the number of gate valve laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**Non-Return Valve (Gun Metal)**

A non- return valve permits water to flow in one direction only and is provided on the ascending part of the main to check return flow. The non-return valve shall be of Gun metal and shall be of horizontal or vertical flow type as specified. The valve shall be of quality approved by the The Engineer and shall generally conform to IS 778.

**SLUICE VALVES**

Providing and fixing C.I. sluice valves as per IS 14846: 2000 (with cap) complete with GI flanges, bolts, nuts, washers & rubber gaskets etc.

The supply of sluice valve should confirm to IS 14846-2000.

The sluice valve are provided as locations of branches and for permitting / stopping flow in the pipe line with the pressure rating of PN 1.0 and 1.6.

The sluice valve is either wheel operated or hand operated with size ranging from 50mm – 1200 mm dia

For mains upto 250mm, the sluice solvers are provided as per the main size. But for higher mains, to have economy the valves sizes are reduced. The gear system arrangement is provided to make the valve operation easy. The sluice valves are manufactured in grey cast iron, FG 200, with spindle either made of bronze or stainless steel.

Proper gland packing, brushes, Nuts, Bolts etc are provided to prevent leakage through the sluice valve.

The flanged joints are made with rubber gasket 6mm thick, holes made all round for joining of bolts and Nuts. The bolts should be fully threaded made of carbon steel classes 4.6.

### **Valve chamber**

The sluice valve should be jointed to the pipe line with merged on either side and housed in an inspection chamber. The size of the inspection chamber is mentioned in DSR.

The chamber should be raised above the GL, at least 0.30m above and covered with precast RCC slab with suitable opening for fixing the surface box.

The size of the surface box should be made of cast iron, with angle frame around fixed with a lid.

### **Coating**

Coating material shall not impart any taste and odour to water. It neither shall contain any ingredients injurious to health, neither shall it be affected by water after drying nor shall it have any ill effects on the quality of water. Two coats of black jordan conforming to type B, of IS 341 or pair conforming to type 2 of IS 9862 shall be applied as specified by the purchaser.

### **Method of Measurement and payment**

Payment for Sluice valve can be made on the basis of number arrived at by counting the number of sluice valve laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

### **3.18. AIR VALVES**

Supply and fixing in position the following Single Acting Air Valve of large orifice type Cast iron body pressure rating of 10 Kg / Cm<sup>2</sup> , 16 Kg / Cm<sup>2</sup> conforming to IS 14845 : 2000 manufacturing standards, including all fittings, connectors, adapters, unions and effective proper connections etc. complete

The Indian standards covers requirement of single Air valve and Double air valve with or (without integral isolating valve) and kinetic air valves with or with our separate sluice valves for use on water mains.

- a. **I. Single Air valve** (small orifice) - for automatically releasing air which may be accumulated under pressure in a section of pipe line during normal working condition

**II. Single air valve** (large orifice) - for automatically releasing / admitting air that may accumulated under pressure is a section of pipe line of the time of initial charging or draining of mains.

**b. Double air valves:**

These valves are combination of small / large orifices air valves with common connection to the main. Large orifice serves for automatically exhausting air when a pipe is being filled with water or automatically ventilating the pipe when it is being emptied of water.

**End connection**

1. End connection of single air valve shall be either flanged according to IS 6418 or screwed. Screwed type shall have external pipe threads confirming to IS 554.
2. Double air valves shall have flange ends machined and drilled according to IS 1538 / Pr. IV & VI) of IS 6418.
3. For kinetic air valves, all flanges including that of the isolating sluice valves shall be machined and drilled in accordance with IS 1538 / pr IV & VI ) flanges shall be as right angles to the axis of the inlet bore and also concentric to the bore. Flanged bolts shall be drilled off the centre.

**Materials**

All the materials for the different components of the valves shall confirm to IS 14845 / 2000

**Hydraulic Testing**

Each valve shall be subjected to hydraulic tests to the test pressure and test duration as given below

PN Rating	test for / body / seat	Test pressure MPa
PN 1.0	Body	1.5
	Seat	1.0
PN 1.6	Body	2.4
	Seat	1.6

**Method of Measurement and payment**

Payment for Air valve can be made on the basis of number arrived at by counting the number of Air valve laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

**SCOUR VALVES**

Providing and fixing C.I. scour valves (with cap) complete with GI flanges, bolts, nuts, washers & rubber gaskets etc.

Scour valve is an arrangement made to drain off the water from the pipe line by providing a 'Scour Tee' and connected to the sluice valve with necessary flanged CI pipes, Duck flow bend and semi circular bend. The valves are manufactured in grey cast iron, FG 200, with spindle either made of bronze or stainless steel with the pressure rating of PN 1.0 and 1.6.

The scour valves are located at 120 lowest long profiles. So as to drain the water conveniently and also dispose the water away from the pipe line.

Scour valves are provided for attending repair / replacement of pipe, when the pipe is leaking or burst out.

The specifications stipulated for sluice valves shall be adhered for making scour arrangements.

The scour valve shall be designed or adopted as given below

Size of the scour - size of the main  $\frac{D}{2} + 25\text{mm}$

### **Method of Measurement and payment**

Payment for Scour valve can be made on the basis of number arrived at by counting the number of Scour valve laid in position. Rate shall include for all materials, labour charges, transportation, scaffolding, all taxes, hire of tools and plants etc. complete for the finished work.

## **3.19. EXTERNAL SEWERAGE / DRAINAGE SYSTEM / BOREWELLS / PUMPS**

### **Scope of Work**

Work under this section shall consist of furnishing all labour, materials, equipment's and appliances necessary and required to completely finish Sewerage/Drainage system as specified hereinafter or given in the approved drawings.

Without restricting to the generality of the foregoing, the sewerage system shall include:

- Internal/External sewer line.
- Excavations including refilling etc.
- Construction of Collection Chambers, Manholes and Drop Connections.
- Construction of Grease Trap etc.
- Connection to S.T.P and Disposal of treated effluent.
- Storm Water Drainage and Disposal.
- Construction of Desalting chamber & Rain water Harvesting tank
- Testing of pipe lines

### **General Requirements**

All materials shall be new and of the best quality conforming to specifications and subject to the approval of the The Engineer.

Drainage lines shall be laid to the required gradients and profiles.

All piping shall be installed at depth greater than 80cms below finished ground level.

The piping system shall be vented suitably at the starting point of all branch drains, main drains, and the highest/lowest point of drain and at intervals as shown. All venting arrangement shall be un-obstructive and concealed.

All drainage work shall be done in accordance with the local Municipal bye-laws.

Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the The Engineer.

Location of all manholes, catch basins etc., shall be got confirmed by the Contractor from the The Engineer before the actual execution of work at site.

All works shall be executed as directed by The Engineer.

### **Alignment and Grade**

The sewer pipes shall be laid to alignment and gradient shown on the approved drawings but subject to such modifications as shall be ordered by the The Engineer from time to time to meet the requirements of the works. No deviations from the lines, depths of cutting or gradients of sewers shown on the plans and sections shall be permitted except by the express direction in writing of the The Engineer.

### **STONEWARE PIPES**

For all drains Crossing and required places, glazed stoneware pipes shall be used as far as possible in preference to other types of pipes. These are suitable, particularly where acid effluents or acid sub-soil conditions are likely to be encountered.

- i) Trenches: Specifications described in 19.2.2.1 of CPWD Sepcification-2019 (Vol-2) shall apply, as far as possible. The trench shall be so dug that the pipe can be laid to the required alignment and at the required depth. When the pipe line is under a roadway, a minimum cover of 90 cm is recommended for adoption, but it may be modified to suit local conditions. The trench shall be excavated only so far in advance of pipe laying as specified by the The Engineer. The trench shall be so shored and drained that the workmen may work therein safely and efficiently. The discharge of the trench dewatering pumps shall be conveyed either to drainage channels or to natural drains.

The excavation shall be carried out with manual labour or with suitable mechanical equipment as approved by the The Engineer.

Unless otherwise specified by the The Engineer, the width at bottom of trenches for different diameters of pipes laid at different depths shall be as given below:—

- (a) For all diameters, up to an average depth of 120 cm, width of trench in cm = diameter of pipe + 30 cm.



- (b) For all diameters for depths above 120 cm, width of trench in cm = diameter of pipe + 40 cm.
- (c) Notwithstanding (a) and (b) the total width of trench shall not be less than 75 cm for depths exceeding 90 cm. The width of trench in the upper reaches shall be increased as described in sub-head 'Earthwork'.

### **CEMENT CONCRETE PIPES (with and without Reinforcement) (Light Duty, Non-Pressure)**

The pipes shall be with or without reinforcement as required and shall be of class not lesser than NP2. These shall conform to IS 458 and shall be capable of withstanding a test pressure of 0.07 MPa (7 m head). The reinforced cement concrete pipes shall be manufactured by centrifugal (or spun) process while un-reinforced cement concrete pipes by spun or pressure 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 moulding.

Concrete used for the manufacture of un-reinforced and reinforced concrete pipes and collars shall not be leaner than 1:2:4 (1 cement: 2 coarse sand: 4 graded stone aggregate). The maximum size of aggregate should not exceed one third of the thickness of the pipe or 20 mm whichever is smaller for pipes above 250 mm internal diameter. But for pipes of internal diameter 80 to 250 mm, the maximum size of aggregate should be 10mm. The reinforcement in the reinforced concrete pipes shall extend throughout the length of the pipe. The circumferential and longitudinal reinforcements shall be adequate to withstand the specified hydrostatic pressure and further bending stresses due to the weight of water when running full across a span equal to the length of pipe plus three times its own weight.

The minimum clear cover for reinforcement in pipes and collars shall be as given in Table 19.3.

TABLE 19.3

Sl. No.	Precast concrete pipe/collar	Minimum clear cover, mm
(i)	Barrel wall thickness	
(a)	Upto and including 75 mm	8
(b)	Over 75 mm	15
(ii)	At spigot steps	5
(iii)	At end of longitudinal	5

Note: An effective means shall be provided for maintaining the reinforcement in position and for ensuring correct cover during manufacture of the unit. Spacers for this purpose shall be of rust proof material or of steel protected against corrosion.

### **MANHOLES**

At every change of alignment, gradient or diameter of a drain, there shall be a manhole or inspection chamber. Bends and junctions in the drains shall be grouped together in manhole as far as possible. The maximum distance between manholes shall be 30 m.

Manholes of different types and sizes as specified shall be constructed in the sewer line at such places and to such levels and dimensions as shown in the drawings or as directed by the Engineer - in-Charge. The size specified shall indicate the inside dimensions between brick faces of the manholes.

Where the diameter of the drain is increased, the crown of the pipe shall be fixed at the same level and necessary slope given in the invert of the manhole chamber. In exceptional cases and where unavoidable, the crown of the branch sewer may be fixed at lower level but in such cases the peak flow level of the two sewers shall be kept the same.

Sewers of unequal sectional area shall not be joined at the same invert in a manhole. The invert of the smaller sewer at its junction with main shall be at least  $\frac{2}{3}$  the diameter of the main above the invert of the main. The branch sewers shall deliver sewage in the manhole in the direction of main flow and the junction must be made with care so that flow in main is not impeded.

No drain from house fittings, e.g. gully trap or soil pipe, etc. to manhole shall normally exceed a length of 6 m unless it is unavoidable.

Manholes  $90 \times 80$  cm are generally constructed within compound for house drainage only and near the buildings for house drainage. Manholes  $1.2 \text{ m} \times 90$  cm are generally constructed for main drainage work for depths less than 1.5 m. Manhole  $1.4 \text{ m} \times 90$  cm is of the arched type and is generally constructed for main drainage works where depth is 1.50 m or more. The width of manholes shall be increased more than 90 cm on bends or junctions or pipes with diameter greater than 450 mm and that the benching width on either side of the channel is minimum 20 cm.

Manholes 1.4 m internal diameter are generally constructed for main drainage works where depth is 2.45 m or more as an alternative to manholes of arch type. The diameter shall be increased suitably, for pipes with diameter greater than 450 mm in the same manner as in the case of rectangular manholes.

Before deciding size of manholes, Local Municipal Bye Laws shall be consulted. As a general guide some typical type designs of manholes followed in Delhi have been shown in Fig. 19.4 to 19.7. When manholes are constructed on foot path, these shall be provided with cover of medium duty casting and when built within the width of the road under vehicular traffic, these shall be provided with cover of heavy duty casting.

All Manholes, Chambers, etc., shall be supported on base of cement concrete of such

thickness and mix or shown on the approved shop drawings.

Where not specified, Manholes will be constructed as follows: -

**(All dimensions internal clear in cms)**

Size of Manhole Type	90x80 Rect.	120x90 Rect.	910 dia. Circular	1220 dia. Circular	1520 dia. Circular
Maximum depth	100	245	170	230	Any depth beyond 230
Average thickness of R.C.C slab	15	15	--	--	--
Size of cover and frame (Internal dia.)	61x45.5	50 dia.	56 dia.	56 dia.	56 dia.
Weight of cover and frame	38 Kg.	116 Kg.	116 Kg.	116 Kg.	116 Kg.
Type of Cover & Frame	SFRC	SFRC	SFRC	SFRC	SFRC

### FOOT RESTS

All manholes deeper than 0.8 m shall be provided with M.S. foot rests. These shall be embedded 20 cm deep in 20 x 20 x 10 cm blocks of cement concrete 1:3:6 (1 cement: 3 coarse sand 6 graded stone aggregate 20 mm nominal size). The concrete block with M.S. foot rest placed in its centre shall be cast in situ along with the masonry and surface finished with 12 mm thick cement plaster 1:3 (1 cement: 3 coarse sand) finished smooth.

TABLE 19.5

Sizes of drain (mm)	Top of channel at the centre above bed concrete (cm)	Depth of benching at side walls above bed concrete (cm)
100	15	20
150	20	30
200	25	35
250	30	40
300	35	45
350	40	50
400	45	55
450	50	60

Foot rests which shall be of 20 × 20 Sq. M.S. bars as shown in Fig. 19.8 shall be fixed 40 cm apart vertically and staggered laterally and shall project 10 cm beyond the surface of the wall. The top foot rest shall be 45 cm below the manhole cover.

Foot rests shall be painted with coal tar, the portion embedded in the cement concrete block

being painted with thick cement slurry before fixing.

### **Commissioning**

After successful testing of the different sewerage and drainage pipes in parts, the Contractor shall provide all facilities including necessary piping's, labours, tools and equipment etc. for carrying out testing and commissioning of the entire external sewerage and drainage system complete as per requirement in the presence of Client representative/Consultant, wherever and as may be required. Generally, the following test/inspection has to be carried out:-

- For any Leakages/seepages in the external sewerage and drainage pipes.
- For checking the functioning of the entire external sewerage and drainage system including rainwater harvesting system and to ensure that the waste water is continuously flowing towards outfall without any intermediate stagnation.
- For the functioning of the valves and accessories etc. by putting ON/OFF the controlling valves of the various diversions in the sewerage and drainage and rain water harvesting system.

### **UN PLASTICIZED RIGID PVC RAIN WATER PIPES FOR RAIN WATER HARVESTING SYSTEM**

#### **Rainwater Pipes**

- a) All terraces shall be drained by providing down-takes rainwater pipes.
- b) A separate piped drainage system for slopping roof with ladders shall be provided.
- c) Rainwater pipes are separate and independent connected to the external storm water drainage system.
- d) Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.
- e) Any dry weather flow from waste appliances, AHU's pump rooms, shall be connected to the sewerage system only.

#### **Low level terrace / Planter drainage**

Low level terrace, terraces, planters and formal landscape areas will be drained by a separate pipe connected to external storm water drainage system.

#### **Pipes**

- All pipes shall be straight and smooth and inside free from cracks and other manufacturing defects. Pipes shall be conforming to I.S. 4985 class 3(6kg/cm<sup>2</sup>) for rain water.
- Pipes shall be joined by approved type of socket and 'O' rubber ring (conforms to I.S. 5382) joints with rubber lubricant.

**Fittings**

- Fittings shall conform to the Indian Standard recommended for the pipes. Pipes and fittings must be of matching I.S. Specification. Interchange of pipes of one standard with fittings on the other standard will not be permitted.
- Fittings shall be of the required degree of curvature with or without access door.
- Connection from a vertical stack or position to a horizontal line shall be made only by a “Y” junction.

**Fixing**

- All vertical pipes shall be fixed truly vertical to walls with approved type of uPVC saddle clamp. 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). However in shaft where more vertical pipes run, the pipes may be fixed to the slotted angle/channel supports fixed to walls at intervals specified here under:-
- Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps (Clevis clamps) of special design or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully rest on them.
- Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the The Engineer for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces at no extra cost.

**Clamps**

- Holder bat clamps shall be of standard design and fabricated from galvanized M.S. standard flats 40x3 mm thick and 12 mm dia. M.S. Rod and 6 mm nuts and bolts. Holder bat clamps shall be fixed in cement concrete 1:2:4 mix blocks 10x10x10 cms deep.
- Where holder bat clamps are to be fixed in RCC column or slotted angles, walls or beam they shall be fixed with galvanized 40x3 mm flat iron "U" type clamps with anchor fasteners of approved design or 6 mm nuts and bolts.
- Structural clamps shall be fabricated by electro-welding from M.S. structural members e.g. rods, angles, channels flats. Contractor shall provide all nuts & bolts, welding material. All fabricated clamps, nuts, bolts and washers shall be not dipped galvanized.
- Galvanized slotted angle/channel supports on walls shall be provided wherever shown on drawings. Angles/channels shall be of sizes as required. Angles /channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with suitable anchor fasteners. The spacing of support bolts horizontally shall not exceed 1 m.

- Wherever M.S. clamps are required to be anchored directly to brick walls, concrete slabs, beams or columns, nothing extra shall be payable for clamping arrangement and making good with cement concrete 1:2:4 mix (1 cement :2 coarse sand :4 mm stone aggregate 20 mm nominal size) as directed by the The Engineer.
- Providing and fixing to the inlet mouth of rain water pipe cast iron grating 15 cm diameter and weighing not less than 440 grams.
- For sleeves, anchor fasteners and clamp spacing chart shall be as follows:

**Clamp and Pipe Support Spacing**

S.No	Type of Pipes & Position	< -----Commercial Pipe Dia (Spacing in m)----->						
		15/20	20/25	32/40	50	75/80	100/110	150/160
<b>1</b>	<b>Vertical Pipes</b>							
1.1	GI / MS Pipes	2.4	2.4	3		3.6	4.5	5.4
1.2	uPVC Pipes Soil & Waste CI Pipes	x	x	<-----1 m----->				
1.3	uPVC/cPVC Pipes IS 4985 for Water Supply	x	x	x	<-----1 m----->			
	IS 13585 for SWR	x	x	0.5		0.7	0.9	0.9
<b>2</b>	<b>Horizontal Pipes</b>							
2.1	GI/MS Pipes			2.4m	3	3.6	4	4.5
2.2	uPVC Pipes Soil & Waste Pipes IS Water Supply Pipes uPVC IS 4985	<----2.0m---->		<-----1.0 m----->			<-----1 m----->	
2.3	Fittings	All traps and tees and fittings running below ceiling shall be supported on both sides						

**KHURRAS:**

The khurras shall be constructed before the brick masonry work in parapet wall is taken up and it shall be of size 45 cm x 45 cm unless otherwise specified in the description of the item and shall be made of cement concrete 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) or other mix as stipulated in the description of the item.

**LAYING:**

A PVC sheet of size 1 m x 1 m x 400 micron (alternatively, aluminium foil of 32 SWG) shall be laid under the khurra and then cement concrete shall be laid over it to average thickness of 50 mm with its top surface lower than the level of adjoining roof surface by not less than 50 mm.

The concrete shall be laid to a size greater than the stipulated size of the khurra in such a way

that the adjoining terracing shall overlap the concrete on its three edges by not less than 7.5 cm. The concrete will slope uniformly from the edges to the outlet, the slope being as much as possible and in no case less than 20 mm cement concrete at the outlet. The concrete shall be continued at the same slope through the width of the wall into the outlet opening to ensure a water tight joint.

The khurras and the sides of the outlet shall then be rendered with 12 mm coat of cement plaster 1:3 mix (1 cement : 3 coarse sand) or other mix as stipulated in the description of the item. This shall be done when the concrete is still green and shall be finished. The sides of the khurras and sides of the outlet opening shall be well rounded. The size of the finished outlet opening shall be 10 cm wide and by 20 cm high or as directed by the The Engineer.

In cases where rain water is to be disposed off through rain water pipes, iron grating shall be provided at the outlet as a safeguard against choking, if so directed by the The Engineer. Iron gratings, shall be of overall size 20 × 25 cm. with an outer frame of 15 × 3 mm M.S. flat to which 4 Nos M.S. bars of 10 mm dia shall be welded in a vertical direction keeping equal clear spacing of 2.5 cm. or as directed by the The Engineer.

### **Desalting Chamber & Rain Water Harvesting Tank**

Rainwater harvesting is the collection of rainfall. In most cases, a roof is used for this purpose. The rainwater then flows through the Spouts / gutters, into a collection tank. The collected water can be used for small scale irrigation (of vegetable gardens etc.), clothes washing, bathing and after treatment also for drinking and food preparation.

A rooftop rainwater harvesting system consists the following elements:

- (a) Collection area
- (b) Conveyance/piping system,
- (c) Filtration /treatment
- (d) Storage
- (e) Usage/ Recharge

The various components of systems for Rain Water Harvesting are covered in the CPWD Rain Water Harvesting and conservation Manual.

All Rainwater Collection Chamber shall be of the size 450cm, 300x100x450cm (internal) complete as per approved shop drawing or as instructions of The Engineer.

Rain water harvesting pit is constructed preferably 5 to 10m from the permanent structure. The bore will be excavated manually or drilled by reverse direct rotary method up to the water level or as per instruction of The Engineer.

The dia. of Rain water harvesting pit shall be 3000mm / 4500mm. Pit shall be filled with boulders, gravel and coarse sand.

Constructing brick masonry manhole (silt chamber type) inside size 1.20X0.90m, and 1.20m deep with FPS brick class designation 75 in cement mortar 1:4 (1 Cement: 4 coarse sand )

15mm thick RCC top slab with 500mm dia opening in cement concrete 1:2:4 (1 cement: 2 C/sand: 4 graded stone aggregate, n/size reinforced with 18.92 kg cold twisted steel bars 20cm foundation concrete 1:4:8 (1 cement: 4 C/sand: 8 graded stone aggregate 40mm size) inside plastering 12 mm thick with cement mortar 1:3 (1 cement: 3 C/sand) finished with a floating coat of neat cement and providing 75 mm thick bed concrete in 1:2:4 mix (1 cement: 2 C/sand: 4 graded stone aggregate. 20mm n/size) including neat cement punning inside the manhole etc. all complete as per direction of The Engineer.

Extra for depth for manhole size (120cmx90cm) with common burnt clay F.P.S (nonmodular) bricks of class designation 7.5

Bore shall be 450mm dia. and pipe shall be 250 mm uPVC (10 Kg/cm<sup>2</sup>) pipe. The pipe placed in the centre of the shaft touching the lowest portion of the pit. The overflow pipe from the desalting chamber is directly connected to the rain water harvesting pit so that the rain water freely enters the pit for recharging. In addition to the inlet pipe from desalting chamber an overflow pipe at the ground level so that any excess water that enters the pit is automatically drained away without damaging the pit.

The Specifications for Storage tanks/Underground sumps shall be followed as per IS 2470: 1986 (Part I & II).

### **3.20. TUBE WELL (BORE WELL)**

#### **General Conditions**

All work shall be done in a systematic manner in accordance with a programmer prepared in consultation with the The Engineer.

Expected quantity of water required is in the order of 10,000 LPH on 10-12 hours continuous pumping, but lower flow will be acceptable if the strata yield is such.

#### **Water Supply & Power**

Contractor shall make his own arrangement for water at site required for his work. He may obtain the water by boring a trial bore or by obtaining in water tankers at his own cost.

Contractor shall also make his own arrangements for power required for his work.

#### **Site Clearance**

The Contractor shall clear the site for any trees, growth, grass and rubbish to enable him to execute the work properly at his own cost.

On successful completion of the work the Contractor shall clear up the site of all his surplus material equipment and accessories and hand over the same to the The Engineer.

#### **Type of Well**

Tube well shall be bored by a reverse circulation rotary rig with 600 mm dia. (24") blind and slotted pipe. Annular space between pipe and bore shall be gravel packed.



**Boring**

Boring shall be 600-650 mm dia. to an approximate depth of 90-120 m. The depth may be increased or decreased as per actual site conditions. The depth at which the tube well boring is to be terminated shall be as agreed upon by the The Engineer Sub-soil water shall not be tapped.

**Well and Housing Pipes**

Pipes shall be uPVC pressure pipe with couplings.

**Slotted Pipes**

Slotted pipes shall be 250 mm dia. with slots. Slot size shall be as per soil conditions and shall be approved by the The Engineer. No variation in rate shall be permissible due to size and dimension of slots.

**Special Fittings**

Provide all special fittings e.g. blank pipes, socket rings, bail plug, centring guides, pipe slips and top cap suitable for housing pipe.

**Verticality**

Well assembly shall be truly vertical as per latest Indian Standard and verticality certificate shall be furnished by the Contractor.

**Gravel Packing**

Space between boring and well assembly shall be packed with washed pea gravel 3 to 6 mm size.

**Development**

The well shall be developed by an air compressor of 450 cfm capacity and pressure of 10.5 kg/cm<sup>2</sup> for a period of at least twenty hours. This period may however be extended in case the development is not satisfactory.

**Water Tests**

The Contractor shall get the water tested for its quality from approved Water Testing laboratory as per The Engineer. Tests shall be for drinking water quality as per IS: 10500 for Physical, Chemical & bacteriological parameters. (Tests shall be performed after development of the well and clear water is available in the discharge).

**Sanitary Sealing**

The annular space between the bore and its housing pipe shall be grouted with cement concrete 1:2:4 to a depth of 5 m below the ground level. Four 50 mm dia. gravel feeding shall be provided with caps at top. Pipes shall be G.I. to I.S. 1239, medium class.

### **Bore Log**

A bore log in a standard format form shall be maintained at the site and shall give the following information.

- Description and depth of strata
- Spring level below ground.
- Aquifer opposite which slotted pipes have been placed.
- Rate of progress of drilling
- Full particulars of final test
- Four copies of strata sheets yield and water quality tests shall be handed over on completion of the well.
- Suggested depth for the tube well submersible pump.

### **3.21. GARDEN HYDRANT SYSTEM**

#### **Scope of Work**

The scope of this section comprise of the supply, installation testing and commissioning of piping network for garden hydrant & irrigation system.

Work under this section consists of furnishing all labour, materials equipment and appliances necessary and required to completely install the garden irrigation system as required by the approved drawings, specified hereinafter and given in the approved drawing.

Without restricting to the generality of the foregoing, the garden hydrant system shall include the following: -

- All irrigation lines to different parts of site and making connection from source i.e. from STP Treated water Tank etc.
- Pumps & Pipe protection.
- Control valves, masonry chambers and other appurtenances.
- Connections to all hydrant point.
- Excavation and refilling of pipe trenches, wherever necessary.
- Trenches for taking pipe lines for these services if required.

#### **General Requirements**

All materials shall be new and of the best quality conforming to specifications. All works executed shall be to the satisfaction of the The Engineer.

Pipes and Fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workmanlike manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

As far as possible pipes shall be installed at-least 60cms below finished grade.

Valves and other appurtenances shall be so located as to provide easy accessibility for operations, maintenance and repairs.

### **HDPE Pipes & Fittings**

All pipes used in Garden Hydrant System shall be HDPE (High density Poly Ethylene pipe and conforming to I.S. 4984 of class IV (10 kg/cmsq)

Fittings shall be HDPE fittings, of approved make.

Pipes and fittings shall be jointed with butt welding joint.

### **Flanges**

Flanged connections shall be provided on pipes where ever required or as directed by The Engineer. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

### **Trenches**

The HDPE pipes and fittings shall be laid in trenches. The width and depth of the trenches for the different diameters of the pipes shall be as follows:

<b>Dia. of Pipe</b>	<b>Width of Trench</b>	<b>Depth of Trench</b>
15mm to 50mm	30 cms	60 cms
65mm to 100mm	45 cms	75 cms

At joints the trench width shall be widened where necessary. The work of excavation and refilling shall be done true to line and gradient in accordance with general specifications for earth work in trenches.

When excavation is done in rock, it shall be cut deep enough to permit the pipes to be laid on a cushion of sand minimum 7.5 cm deep.

### **Pipe Protection**

Where specified in the approved drawing all pipes below ground shall be in trenches and protected with fine sand 150 mm all around before filling in the trenches.

**Lawn Hydrants:**

Lawn hydrants shall be of 25mm size unless otherwise indicated. All hydrants shall be provided with gate valves and threaded nipple to receive hose pipes. Lawn hydrant valves shall be of approved make and design. Where called for lawn hydrants shall be located in masonry chambers of appropriate size.

**Irrigation System (Pop up & Gun Sprinkler Irrigation System):**

Gardens and lawns shall be irrigated in combination of Garden Hydrant System, Sprinkler Irrigation System & Rain Gun for Large Area. The Main Distribution grid shall be HDPE pipes PE-100 (10kg/cm<sup>2</sup>) conforming to IS: 4984 and branch distribution system be with uPVC pressure pipes (10 kg/cm<sup>2</sup>) confirming to IS: 4985. Irrigation water from STP shall be pumped to Irrigation Grid by a variable speed hydro pneumatic pumping system located at STP pump room.

**¾" Gear Driven Pop Up Sprinkler:**

**SOLENOID ELECTRONIC CONTROL VALVE:** The valve shall have an operating pressure range of 1.0 -13.6 bars (15-200 psi). The valve body shall be manufactured of 33% glass reinforced nylon and be unaffected by climatic temperature variations within its full operating pressure range. The valve shall incorporate a straight through flow path design and be full ported to provide very high flow capacities at minimal friction loss. The valve shall meet / exceed the following flow characteristics at pressure losses not exceeding 0.5 bar (7.5psi): Size 2" Valve – 756 LPM [200 (US) GPM] with a minimum flow capability of 7.6 LPM (2.0 (US) GPM). The Valve shall be slow closing to avoid the potential for pressure surge/water hammer. The valve shall be normally closed and be either electrically or manually activated to open. The valve diaphragm shall be spherical, reversible and manufactured of durable reinforced Rubber. The valve diaphragm shall have a double seating surface for leak free closure. The valve manual operator shall be of an internal bleed design so as to provide no discharge of water to atmosphere. The valve manual operator shall be captive to the valve body assembly.

The valve flow control stem shall be constructed of stainless steel. All internal components, including the diaphragm shall be captive within the valve bonnet assembly. The valve shall utilize stainless steel screws and integrally molded brass inserts as body to bonnet fasteners. All valve control water shall be filtered through a conical stainless steel mesh screen. The valve shall incorporate not more than three internal components to minimize servicing. The valve shall have no hidden cavities so as to avoid potential for clogging. The valve should have pressure regulator to provide constant outlet pressure from 5 to 125 psi.

**DISC FILTER: The disc filter shall conform to following specification:****2" T TYPE DISC FILTER:**

Available Connection: 2" (BSPT)

Closing system:	Stainless Steel Clamp
Max. Pressure :	8 kg/cm <sup>2</sup>
Range of Flow Rate:	22-35 m <sup>3</sup> /hr
Nominal Flow Rate:	30 m <sup>3</sup> /hr
Clean Pressure Drop:	Max 0.32 kg/cm <sup>2</sup> at Nominal flow
Filtration Surface Area:	1193 cm <sup>2</sup>
Filtering Cartridge :	PP Disc (130 micron)
Cartridge Diameter:	117 mm
Cartridge length:	394 mm
Weight:	6.100 kg

**PRO-Ex CONTROLLER:**

PRO-Ex (6 Station) Controller shall be having multiple wire technology having 6 program with 6 starts time program. It has 6 available stations and run time per stations will be 0-10 hrs. 59 minutes max., and irrigation water budget by program 0-250% it has programmable rain of days 0-31 days max. and pause time between station will be 0-59 sec. It can run two valves plus master valve simultaneously. The controller should be capable to rain sensor and operate 100-230 VAC 50/60 Hz input power.

**3.22. AIR RELEASE CUM VACCUM RELIEF VALVE:**

It shall be of inlet size 2" of cast aluminum with synthetic rubber seal. It shall meet the requirement at working pressure 10 bar and testing pressure 16 bar.

**PRESSURE RELIEF VALVE:**

It shall be of inlet size 2" of cast aluminum with BSP female threaded connection. It shall meet the requirement at working pressure 10 bar and testing pressure 16 bar.

**Handing Over Procedure****Documents Submission**

The Contractor before finally handing over the completed work in his scope to the owner, shall submit the documents as per the Contract and as directed by the The Engineer. Given

below the checklist for the reference of the The Engineer.

<b>Packages/</b>	<b>Sanitary Fixtures</b>	<b>Soil, waste &amp; vent pipes</b>	<b>Water supply system</b>	<b>Sewerage/ drainage system</b>	<b>Water tanks</b>
Final cleaning					
List of inventory					
Training Conducted on					
Operation Manual					
Maine. Manual					
As built P&I Dwg / SLD					
Defects Liability Period/ Warranty					
Commissioning report					
Test reports/ Certificates					
List of essential spares					
Address/ Contact nos. of Vendors					
Remarks					

### **3.23. PUMP/WTP/STP/ETP/SOLAR HOT WATER SYSTEM**

#### **PUMPING SYSTEM**

#### **SCOPE OF WORK**

The scope of work in this subhead shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely do all work relating to the supply, installation, testing & commissioning of Pumping System as described herein after and shown on the drawings and Bill of quantities.

The scope of work in general shall included the following.

- i. Water supply Pumps.
- ii. Drainage Pumps
- iii. Sewage Pumps
- iv. Solar Booster Pumps

v. The WTP - Pumps.

vi. The STP Pumps

### **EXECUTION OF WORK**

The Contractor shall cooperate with all services and agencies working on the site. Provisions for hangers, sleeves, structural openings, and other necessary requirements shall be made well in advance to avoid any delays in the construction schedule. All supports to the civil structure shall be provided using dash fasteners.

### **PREPARATION OF SHOP DRAWINGS**

- The tender drawings and schematics of the WTP, RO, ETP, STP, and Solar Hot Water System are provided to the Contractor. Based on these, all detailed shop drawings shall be prepared and submitted to the The Engineer for approval. The execution of the work shall be carried out in accordance with the approved shop drawings.
- The Contractor shall verify all dimensions at site and bring to the notice of the The Engineer all discrepancies or deviations noticed. Decision of the The Engineer shall be final.
- All corrections, deviations and changes made on the site shall be shown on the GFC (Good for Construction) drawings issued by the PMC for final incorporation in the completion drawings to be submitted by the Contractor in fulfilment of the conditions of this contract.
- Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.
- Two sets of manufacturer's equipment drawings, roughing in and wiring diagrams shall be submitted.
- Contractor shall submit shop drawings furnishing all details of MCC panels, cable routes, wiring diagrams and connection details as required.
- Each submission shall be accompanied by Contractor's certificate stating that the shop drawings meet all the contract requirements and that the piping and equipment can be satisfactorily installed without any obstructions in the space available.
- On approval of the above the Contractor shall furnish three sets of the approved shop drawings for execution of the work.

**INSPECTION AND TESTING OF MATERIALS**

- Contractor shall be required, if requested, to produce manufacturers test certificate for the particular batch of materials supplied to him. The tests carried out shall be as per the relevant Bureau of Indian Standards.
- For examination and testing of materials and works at the site Contractor shall provide all testing and gauging equipment necessary but not limited to the following: a) Steel tapes b) Weighing machine c) Plumb bobs, spirit levels, hammer d) Micrometers e) Hydraulic machine
- All such equipment shall be tested for calibration at any approved laboratory, if required by the The Engineer. All testing equipment shall be preferably located in special room meant for the purpose.
- Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the The Engineer.

**COMPLETION DRAWINGS**

- On completion of work, Contractor shall submit one complete set of original tracings and four prints of "as built" drawings to the The Engineer. These drawings shall have the following information.
  - a) Run of all piping, diameters on all floors, vertical stacks and location of external services.
  - b) Ground and invert levels of all drainage pipes together with location of all manholes and connections up to outfall.
  - c) Run of all water supply lines with diameters, locations of control valves, access panels.
  - d) Location of all mechanical equipment with layout and piping connections and mechanical equipment.
  - e) All shop drawings shall be updated from time to time for the purpose of making completion drawings. No completion certificate shall be issued unless the above drawings are submitted.
- Contractor shall provide four sets of catalogues, service/operation & maintenance manuals, manufacturer's drawings, performance data and list of spare parts together with the name and address of the manufacturer for all electrical and mechanical equipment provided by him.
- All "warranty cards" given by the manufacturers shall be handed over to the The Engineer.



**Testing**

- Piping and drainage works shall be tested as specified under the relevant clauses of the specifications.
- Tests shall be performed in presence of the The Engineer and test records for the tests shall be duly signed by Contractor and the The Engineer.
- All materials and equipment found defective shall be replaced and whole work tested to meet the requirements of the specifications.
- Contractor shall perform all such tests as may be necessary and required by the local authorities to meet municipal or other bye-laws in force.
- Contractor shall provide all labour, equipment and materials for the performance of the tests

**3.24. WATER SUPPLY PUMPS (Silchar, Barpeta & Lakhimpur)****Hydro pneumatic System for Multiple Overhead tanks filling**

The scope shall cover the supply, installation, testing, commissioning of the Variable Speed Hydro pneumatic system (Individual VFD for Each Pump). Booster should minimum consist of the components as per the below specifications. Complete system shall be tested at the manufacturer's factory, in accordance to the provisions of the appropriate standard before delivery. Manufacturer should have facility of witness test with proper test bed.

**System Descriptions**

The variable speed booster system shall be supplied and installed as designed.

The system shall comprise of number of pumps as mentioned in BOQ, in parallel and it shall be a package system manufactured by the manufacturer of the pumps at their factory. System assembled by the dealers locally will not be accepted. System should come with CED coated base frame & Manifolds to reduce the rust formation. The system shall consist of:

Vertical In Line Multistage Centrifugal pumps with IE5 efficiency class Motor as per IEC 60034-30-2 standard. Pump should come with integrated VFD & Control panel with each pump.

The quantity shall be as per BOQ.

Integrated Frequency Drives with each pump (IP 55 Protected) Quantity shall be as per BOQ.

Low Carbon steel Pre-pressurized bladder or diaphragm type pressure vessel complete with pre-charged nitrogen gas/Air to the design pressure settings.

Each pump shall have individual PI controller & integrated VFD and with IE5 efficiency

class motor as per IEC standard.

Pipe work and valves, pressure transmitter, pressure gauge, check valve, gate valve and all necessary fittings etc to the satisfactory operation of the system and to make system as complete. Only supply & delivery line will be connected to start the system

### **Components of Variable Speed Booster - Pumps and Motors**

The pump shall be of approved make of vertical-in-line multistage centrifugal type pump with IE5 efficiency class motor, integrated VFD & controller with each pump with IP 55 protection.

The suction and discharge port shall be in line with each other. The maximum operating liquid temperature for the pump shall be up to 120 deg C.

The motors shall be vertically stool mounted on top of the pump casing and the pump casing shall be designed to take the dynamic load of the motor. The motor shall be provided with thrust bearing to cater for the downward thrust of the pump.

The manufacturer of the pump should have a local factory with at least 20 years of experience and able to provide after sales service. The factory must have a pump testing facilities with approved test bed to carry out pump as well as complete booster performance witness testing.

### **Pump Selection**

Each pump shall have the stable characteristics and the operating point shall fall within the acceptable range on the pump curve. Duty point should not be selected at extreme right or left side of the curve.

The pump performance curve shall be complying with the tolerance according to ISO 9906:2012, 3B. Per Pump

### **Pump Head and Base**

Pump head and base should be made of CED (Cathodic Electro deposit) coated Cast Iron, SS-316 or better -Shaft, SS-304 Impeller, Mechanical Seal (SiC vs SiC face combination).

The motor terminal housing shall be of a completely watertight design with tight cable glands to prevent ingress of water. For bigger motor, the housing shall have provision for the lubrication of the motor bearing to enable the pump to run effectively with only periodic withdrawal for maintenance and lubrications, if required.

### **Shaft, Impeller and Guide Vanes**

All the inter stage components (impeller, intermediate chambers, diffusers) as well as sleeves and guide vanes shall be made of stainless steel 304 material, Shaft-SS 316 or Better.

**Mechanical Seal**

The mechanical shaft seal shall be of cartridges type with seal faces of Silicon Carbide/silicon carbide material or C vs SiC. It should be possible to change mechanical seal without opening the pump to reduce downtime.

**Motor**

The electric motor shall be of total enclosed fan cooled (TEFC) squirrel cage induction type suitable for operation on a 380-500V / 3 ph/ 50 Hz voltage supply. The motor shall be designed based on 50 deg C ambient temperature with IE5 Efficiency Class and integrated VFD & Controller (IP 55 Protection). The motor shall be of class F insulation and a minimum of IP 55 enclosure with a maximum surface temperature of 120 deg C.

The motor shall comply with the Efficiency Class IE5 requirement as per IEC standard.

All motors shall be sized for pump operation based on non-overloading conditions for the full QH curve. The motor shall also be suitable for at least 40 start/stop per hour. All motor should be of IE5 efficiency class.

**Variable Frequency Drives**

Integrated AC variable (IP 55 Protection) drive with in-built Harmonics IEC/EN 61000-3-12. Up to 7.5 kW (5.5 kW low speed): Category C1 according to EN 61800-3, corresponding to CISPR11, class B (residential area) Above 7.5 kW (5.5 kW low speed): Category C3 according to EN 61800-3, corresponding to CISPR 11, class.

**Pump Controller**

Each Pump shall be having PI controller with HMI Graphical display. Controller should be of the same make, as of pump i.e. Pump manufacturer should provide dedicated PI integrated controller with each pump for this application. General purpose PLC programmed for boosting application will not be accepted.

The controller should have the following features as minimum:

- Built-in PI-controller.
- External input signal both digital and analog. Alarm output.
- Soft pressure buildup.
- Colour Graphical Display.
- Suitable for Modbus (RS 485). External BUS communication port. Automatic pump changeover.
- Upgradeable software program.
- Back light for specific button to be light up only when applicable. Adjustable contrast for display.
- Selectable service language. Selectable units between SI and US. Manual

entry of pumps data.

- Primary sensors.
- Clock Program.

The controller should be able to perform the following functions as minimum: Selectable auto/manual mode for both system and individual pump from Controller

- Set point influence
- Friction loss compensation at lower flows.
- Adjustable number of start/stop
- Adjustable system time and error correction value
- Adjustable ON/OFF band (stop function)
- Pump test function
- Security setting with pass word for operation and setting
- External fault input
- Selectable dry running protection for either digital or analog signal
- Selectable auto/manual reset for dry running protection
- Selectable open/close loop operation
- The controller should be able to display the following alarms, whenever it occurs:
  - Alarm log up to 24 event

### **Pump Selector Mode**

Selection should be provided to enable any pump to be the lead pump, first duty pump, second duty pump and standby pump as desired. There shall be alternating mode selection too, where all pumps are operated cyclically upon each call for pumping.

### **Liquid Level Control**

To prevent dry running, electrode liquid level or float level control shall be provided in the suction tank to shut down the system in the event of low water level.

### **Pump Isolation**

It shall be possible to isolate any pump for maintenance without affecting the performance of the system in the automatic mode.

### **Alarm**

Alarm should be displayed in case of any problem. Alarms should be as per details given in Panel section.

All panels/controllers shall be tested at the factory according to the procedures stipulated,

before dispatch. The manufacturer shall carry all spare-parts for the controllers. All spares of the controllers shall be readily available for a minimum period of 10 years after the production of the particular model of controller has been discontinued.

### **Hydro Pneumatic Pressure Tank**

The hydro-pneumatic tank shall be of butyl bladder diaphragm type with pre-pressurized air/nitrogen. It shall be capable of handling the designed effective system protection (ESP) Volume to protect pump and operating controls by ensuring that the actual pump operation conform to the manufacturer's specified minimum running time and maintaining the designed pressure range.

The shell shall be constructed with deep-drawn low carbon steel.

The diaphragm/membrane shall be of heavy-duty type. This diaphragm/membrane should be the only component in contact with the liquid.

The tank should have an air valve for the introduction of compressed air.

The tank shall have a maximum operating pressure of 10 bars/16 Bar depending on the pump shutoff head and shall be able to handle a maximum liquid temperature of 90 DegC/70 DegC respectively.

### **Pressure Transmitter**

Pressure transmitters shall be field mounted and shall transmit an isolated 4-20mA signal indicative of process variable to the pump logic controller via standard two wire 24 DC system. Unit shall have stainless steel wetted parts and it should be installed at the discharge header. It should have watertight, electrical enclosure capable of withstanding minimum 10/16 bar static pressure.

### **Headers, Skid & Accessories**

The suction and discharge manifolds & skid shall be fabricated steel with Cathodic Electrode Deposit Coated. Both manifolds shall be designed to attach to the system piping at either end of the manifold (Completely Factory Assembled set, locally manufactured/assembled set is not acceptable). Delivery manifold shall include a pressure gauge along with 2 Nos of pressure transmitter. The discharge manifold shall include a socket to install a pressure transducer with a 4-20mA output. The pressure transducer shall be factory installed and wired.

Isolation valves shall be installed on the suction and discharge of each pump. A check valve shall be installed on the discharge of each pump (optional on the suction side for suction lift applications). Base frame should also be made of galvanized sheet.

### **Hydro pneumatic System Working**

The system shall be under the control of PI based pump logic controller with graphical colour display. 2 Nos. of pressure transmitter shall be incorporated into the system to detect the pressure at the discharge manifold and feedback to the Microprocessor based controller.

The system shall maintain a constant pressure at all times regardless of the system demand. The activation of the next duty pump in a high demand situation shall not base on a different set point. However, the microprocessor based controller should have a flow test function to determine the numbers of pumps in operation and a stop function into the controller to stop all pumps from operation, whenever there is no demand, which prevent and reduce wear and tear of the system as well as reduce energy consumption. The controller shall also ensure alternation of all pumps for even running hours.

The lead pump shall operate when the system pressure reduces to the preset point. If demand escalates, the lag pumps shall commence operation as required. During next operation lead pump to become lag and lag pump to become lead pump automatically. The system shall vary the frequency of each pump (in case of multi VFD system) and it will be equalized to ensure smooth operation to meet the specific demand. Under decreasing hydraulic demand, the reverse to the above description shall apply

### **Operations**

- The control circuit shall enable automatic and manual operations of the system.
- Automatic Operation
- Everything will be controlled by controller in this case.
- Manual Operation
- Either one or all pumps shall be capable of being started and stopped by their respective push buttons or MCB's.
- The control panel should have starters for this purpose

### **3.25. WASTE WATER PUMP**

#### **Drainage Pump**

Supply installation & Commissioning of submersible drainage pump (1W+1S) for each sump with 3 Ph 380-415V 2 Pole Motor with CI or SS 304-Casing, SS 304 or DI/CI -Impeller, SS 304/SS 410- Shaft, Mechanical Seal suitable for handling 10-12mm soft solid.

#### **Sewage Pump**

Supply installation & Commissioning of submersible drainage pump (1W+1S) for each sump with 3 Ph 380-415V 2 Pole Motor with CI -Casing, DI/CI -Impeller, SS 304/SS 410- Shaft, Mechanical Seal suitable for handling 65mm soft solid or pump shall be with grinder system as per the requirement given in the BOQ.

**Drainage/Sewage Pump Control Panel**

Pump controller shall be having with screen displays, phase loss protection (incoming as well as for outgoing), Individual pump overload protection, individual pump under voltage protection, dry Running protection without installing any float switch, memory function when power off and during

Recovery, visual and audio alarm for fault prompt, auto manual switch, suitable for RS 485 Communication (ModBUS) depending on the site requirement and pump should operate based on The sump water level and both pump should run together for high level in case of more than one Pump. Panel should come with 3 Nos Float switch to work as per the sump water level.

**Submersible Bore Well Pump**

The submersible bore well pump with SS 304-Casing/Impeller/Shaft & Mechanical seal coupled with a 380-415V, 50Hz 2 Pole, Insulation Class-F, IP 68 Protected Electric Motor. Pump hydraulic efficiency should not be less than 75%. Flow Rare-18 m<sup>3</sup>/hr, Head-100m

**Pump Control Panel**

Pump controller suitable for 1 Pump with LCD screen displays, phase loss protection (incoming as well as for outgoing), Individual pump overload protection, individual pump under voltage protection, dry running protection without installing any float switch, memory function when power off and during recovery, visual and audio alarm for fault prompt, auto manual switch, and pump should operate based on the UGT water level.

**Pipe & Fittings (for Headers and Connections)**

Pump suction and delivery headers shall be Galvanized iron pipes/MS heavy class with matching fittings. The pipe joints shall be threaded as per manufacturer's instructions.

Vibration Eliminators All suction and delivery lines as shown on the drawings shall be provided with double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connectors shall be as per site requirements in accordance with manufacturer details.

**3.26. VALVES****Sluice valves**

- i. Full way Sluice Valves shall be used on the suction connection to pumps and headers.
- ii. Sluice valves (80 mm dia. and above) shall be C.I. double flanged sluice valves with rising stem. Each sluice valve shall be provided with wheel in exposed

positions and cap top for underground valves. Contractor shall provide suitable operating keys for sluice valves with cap tops.

iii. Sluice valves shall be of approved makes conforming to I.S.780 PN1.6 class.

#### **Butterfly Valves (PN 1.6 rating)**

- i. Butterfly Valves shall be used in all other locations as required conforming to IS 13095.PN 1.6
- ii. They shall have a cast iron body.
- iii. Disc shall be CI heavy duty electrolyses nickel plated abrasion resistant.
- iv. The shaft to be EN-8 Carbon Steel with low friction nylon bearings.
- v. The seat shall be drop tight constructed by bonding resilient elastomer inside a rigid backing.
- vi. Built in flanged rubber seals. vii. Actuator to level operated for valves above ground and T Key operated for valves below Ground. viii. Built in flanges for screwed on flanged connections. Manufacturer's details on fixing and Installation will be followed.

#### **Non Return Valves (NRV PN 1.6 rating)**

- i. Non return valves will be used at location to allow flow only in one direction and prevent flow in the opposite direction.
- ii. NRV shall be cast iron slim type with cast iron body and gunmetal internal parts and accompanying flanges. Valves shall conform relevant IS or match the butterfly valves.PN 1.6
- iii. Built in flanges for screwed on flanged connections.

#### **Ball Valves**

Ball Valves up to 40 mm dia. shall be screwed type ball valves with stainless steel balls, spindle, Teflon seating and gland packing tested to a hydraulic pressure of 20 kg/cm<sup>2</sup> and accompanying coupling and steel handles to B.S. 5351.

'Y' Strainers (PN 1.6 rating) Provide cast iron 'Y' type strainers with gunmetal internal strainers, CI screwed plug to be provided on all water tank suction connections to pump.

#### **Painting and Cleanup**

- a) On completion of the installation Contractor shall scrub clean all pumps, piping, filters and equipment and apply one coat of primer.



- b) Apply two or more coats of synthetic enamel paint of approved make and shade on steel pipes.
- c) Provide painted identification legend and direction arrows on all equipment and piping as directed by The Engineer.
- d) On final completion of the work, Contractor should cleanup the site, filter room of all surplus materials rubbish and leave the place in a broom-clean condition.

### **3.27. CABLES**

- Contractor shall provide all power and control cables from the motor control centre to various motors, level controllers and other control devices.
- XLPE Cables shall be provided conforming to I.S. 7098.
- Wiring cables shall conform to IS 694.
- All power and wiring cables shall be aluminum conductor PVC insulated armoured and XLPE sheathed of 1100 volts grade.
- All control cables shall be copper conductor PVC insulated armoured and XLPE sheathed 1100 volts grade.
- All cables shall have stranded conductors. The cables shall be in drums as far as possible and bear manufacturer's name.
- All cable joints shall be made in an approved manner as per standard practice.

### **Earthing**

All equipment installed by the Contractor shall be suitably earthed by making proper connection by means of G.I. Wires to the main earthing system laid by the electrical Contractors.

### **3.28. WATER SUPPLY, FLUSHING / IRRIGATION SUPPLY PUMPS & EQUIPMENT**

#### **General Requirements**

- All materials shall be new of the best quality conforming to specifications and subject to the approval of The Engineer.
- All equipment shall be of the best available make manufactured by reputed firms.
- All equipment shall be installed on suitable foundations true to level and in a neat workmanlike manner.

- Equipment shall be so installed as to provide sufficient clearance between the end walls and between equipment to equipment.
- Piping within the pump house shall be so done as to prevent any obstruction in the movement within the pump house.
- Each pumping set shall be provided with a butterfly valve on the suction and delivery side and a flap type non return valve on the delivery side
- All pump couplings and belt guards for air compressors shall be totally enclosed with 5 mm mesh.

### **3.29. SYSTEM OF WATER SUPPLY**

- The water supplied by the authorities will be stored in the domestic U.G. tank.
- Water from this U.G. tank shall be pumped to O.H. Tanks at terrace of each building by separate pumps/sump.
- Each toilet, bath, wash basin, sink and labs shall be fed with water from terrace tanks by gravity. Top three floors of the Hospital Building will be fed by Hydro pneumatic System.

#### **Rising Mains & Level Control System.**

- Water from the pumps described above will fill each tank by a rising main to each tower.
- To control the level in each tank and enable it to fill as the water demand so requires, each tank will be provided with a ball cock to shut off the water supply when the tank is full.
- A set of electronic level sensing probes will be installed in each tank The probes installed in each pumping system will be wired to a central electronic panel which will activate the pump when any one of the tank probe signals low water conditions and top up all tanks. No excess flow will occur due to the ball cock in the tank.

#### **Level Controllers**

- Level controllers shall be electronic magnetic type using required number of stainless steel type probes, shrouded in PVC sheath or encapsulated in a stainless steel pipe. The level controller will be used for following applications:-
- Provide a audible high water alarm when water level in the sump reaches a pre-determined high level in the sump location at MCC panel installed in wall near sump location

**Overhead tank level controller cum indicators**

- Each OHT to be provided with required number of stainless steel electronically operated probes (housed in a stainless steel protective housing) and connected by a control cable to a central junction box connected to MCC panel located in the pump house at basement. A common multi-core cable from each group of buildings will be laid to the pump room in basement. The probes will function as follows:
- To cut off the water supply pumps when all the OHT is full and to start the pump if any OHT level reaches at pre-determined low level.
- Provision shall be made to enable the operation of the second duty pump in case the water level does not rise above a pre-determined level in the tank due to water demand which is higher than capacity of duty pump no.1 to meet.
- Indicate the water level in each OHT in the level indicating panel installed in the pump room.
- Each OHT are also provided with a float valve to stop the supply in individual OHT when level reaches a cut off high level.

**Control & Indicating Panel ( For overhead and underground water tanks)**

- A centralized indicating stand-alone wall mounted panel fabricated from 14 g. with seven tank process MS sheet and painted inside and outside with stove enameled finish with clear vertical panels for each group of buildings & tanks shall indicate water level in each tank by means of digital display unit to indicate water level in each tank in four levels ( $\frac{1}{4}$ th,  $\frac{1}{2}$ ,  $\frac{3}{4}$  and full). The panel shall be installed on the control console panel located in the pump room or as directed by the Project Engineer. The panel shall have:
  - Digital level indicator panel meter for each water tank.
  - Etched plate identification plates.
  - Control cabling from MCC to the panel installed in the control room as directed by the Project Manager.
  - Cabling from PHT sensing probes to the panel.

**3.30. WATER TREATMENT PLANT (WTP – IRON REMOVAL PLANT)  
(Barpeta & Lakhimpur – 12000LPH / Silchar -5000LPH)****Scope of Work**

The scope of work in this subhead shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely do all work relating to the supply, installation, testing & commissioning of Pumping System as described herein after and shown on the drawings and Bill of quantities.

Prepare and submit detailed shop drawings, schematics, and layouts based on the tender drawings and as per site requirements. Ensure compliance with relevant codes, standards, and local regulations.

Shop drawings shall be furnished for detailed layout of all equipment, foundation, bolting and vibration elimination details along with information on dead and dynamic load, vibration etc.

Technical Specification:

- 1) The proposed WTP is primarily designed for filtration followed by a water softening process. The system offered is manually operated, with individual manual valves. No reduction / removal of TDS, Chlorides, Sulphates, Total alkalinity, BOD, COD & Reactive Silica, etc.,
- 3) The proposed pH dosing system (230 V) should be looped with existing source motor starter and dosing discharge should be connected with pump outlet suitable provision for fixing near the source pump room starter
- 4) Since the feed water contains Iron Content, it is suggested to have suitable retention time in the raw water sump - for better treatment cum settlement.
- 5) Softener exchanges Ca & Mg for equivalent amount of sodium ions (Prevents Ca & mg scaling in pipe lines & fittings, provides soft water for bathing & washing and prevents scaling in heating elements).
- 6) Though the total Hardness as CaCO<sub>3</sub> output of softener is expected to be < 50 ppm. The required blending piping along with valve control – fittings – etc.,

PH Correction Dosing System

FILTER FEED PUMP

MULTIGRADE FILTER

ACTIVATED CARBON FILTER

IRON REMOVAL FILTER

WATER SOFTNER

NAOCL DOSING SYSTEM

WATER METER

### MCC PANEL WITH CABLES

One No. MCC Panel of Non-compartmental Wall mountable indoor - type with suitable incomer, voltmeter, Ammeter with energy meter & outgoing starters & MCB's for the following electrical drives:

- i) Feed Pump : 2 Nos. (1W + 1S)
- ii) Naocl Dosing System : 1 No.
- iii) Level Switch : 2 Nos. (1 RWL, 1 TWL & TWH with 5 meters cable each)

The above capacity and materials must comply with the guidelines provided by the The Engineer and the specifications outlined in the approved Bill of Quantities.

### **3.31. SEWAGE TREATMENT PLANT (CAMUS –SBT TECHNOLOGY) (Silchar & Lakhimpur)**

#### **General**

The enclosed tender drawings. Based on these, the Contractor shall prepare and submit the shop drawings for civil works, plant, and machinery to the The Engineer. After receiving the final approval, the Contractor may proceed with the execution of the work.

The proposed capacity for the Camus SBT technology sewage treatment plant is as follows:

- 1. Barpeta – 100KLD the Existing STP to be used.**
- 2. Silchar – 100 KLD**
- 3. Lakhimpur – 100 KLD**

The specifications for the above capacities are as per the BOQ.

The Technical requirement given below shall be read in conjunction with the other documents forming part of the contract. In case of any variance, these Technical requirements shall supersede any other conditions mentioned in any contract document.

The materials and workmanship shall satisfy the specifications contained herein and codes referred to. Where the technical specifications stipulate the requirement in addition to those contained in the Standard Codes and specifications those additional requirements shall also be satisfied. In the absence of any Standard / Specifications covering any part of the work covered in this tender document, the instructions / directions of the Engineer will be binding on the Contractor.

The work shall be carried out strictly as per latest CPWD specifications.

#### **The Work Includes**

- Civil, Mechanical & Electrical works
- Piping as specified.

- Testing, commissioning and operation of plant with water and under load conditions.
- Incoming power connection, electrification of pump house.
- Incoming sewer / rising main connection to the plant.
- Connection from final sewage tank / pump to point of use for reuse for flushing of toilets and urinals after that used to irrigation system or for disposal in accordance with approval of the State Board for Prevention and Control of Pollution.

### **Contractor's Experience**

Contractor quoting for the work shall be an experienced specialize Contractor engaged in the design, manufacture and execution of STP of similar types and must have completed at least 5 plants of similar or larger size in the last 5 years.

- Each offer must be accompanied by a list of plants that have been planned, constructed, executed, and in operation for at least 12 months, as follows:
- Owner's name, address, telephones and faxes nos.
- Architects/Consultants name, Address, Telephone & fax nos.
- Type of load (Domestic)
- Average daily flow, BOD and other information of plant.

### **Shop Drawings**

The Contractor shall submit shop drawings as follows:

- On award of the work, Contractor shall submit shop drawing, PIB diagrams, plant layout with basic dimensions, flow diagram with levels of elements.
- Fabrication and equipment layout piping, valves and all other information required for installation.
- Electrical layouts, detail of all MCC, cable sizing and system diagrams and earthing system.
- Piping layout with pipe dia. slopes, fixing arrangements.
- Three copies of the shop drawings shall be submitted for initial scrutiny. On approval of the same Contractor shall submit six copies of the same incorporating corrections etc. Two sets will be stamped "GOOD FOR CONSTRUCTION" by the Consultant and returned to the Contractor.

### **Other Submittals**

Contractor shall furnish four sets of folders giving:

- Catalogues and technical information sheets of equipment to be installed.

- Performance curves, foundation details and fixing arrangements.

Contractor's proposal for testing procedures for individual equipment and for overall testing of the plant.

**Submittals shall be separate for:**

- Mechanical and Piping works
- Electrical Works

All shop drawings and submittals mentioned above shall be approved by Architect and two sets duly stamped shall be returned to the Contractor for execution of the works.

**Execution of Work**

All work shall be executed only in accordance with the approved shop drawings and other submittals. Contractor shall ensure that all inserts, support plates, puddle flanges and other items required to be incorporated during execution shall be placed in position as per his own requirements during execution of the works.

All special tools and tackle required for erection and assembly of the equipment covered by the contract shall be obtained by the Contractor himself. All other materials such as foundation bolt nuts, etc. required for the installation of the plant and equipment shall be supplied by the Contractor and are part of the contract.

**Testing & Handing Over**

The Contractor shall carryout tests on different equipment as required in the presence of the Consultant or his representative in order to enable him to determine whether the plant, equipment and installation comply with the specifications, local codes and in accordance with the letter and intents of the specifications.

The installation shall be handed over to the The Engineer only on successful completion, operational tests and acceptance of the effluent quality by the municipal / pollution control and statutory authorities.

**Statutory Permissions**

Contractor shall submit a write-up of process of the plant, drawings, design parameters flow and PIB diagrams as necessary and required for submission to the State pollution control authority.

Contractor shall furnish at his own cost, analysis of influent at source (for evaluation) as well as that of influent at the holding tank of the STP and the effluents from the STP for submitting to State Pollution Control Board and any other statutory authority whose approval is required.

Contractor shall perform all testing and operation of the plant in presence of the Pollution Control Board if so stipulated by them.

Contractor to obtain all statutory approval as required for PCB or any other approval. Only official fee will be reimbursed to Contractor by the Owner.

### **Completion Documents**

On successful completion of the entire work, the Contractor shall submit 4 sets of following documents to Engineer – In-charge. A brief write-up of process, day to day operating and maintenance instructions.

List of approved chemicals and procedure for storage and safety norms.

Completion drawing and data, catalogues, performance charts, technical data sheets and equipments installed.

Manufacturer's maintenance and operating instructions for mechanical and electrical equipment.

Laminated and framed "As Built" drawings with plans, section, process flow diagrams, pipe runs, levels and final disposal point schedule of equipment installed with all their model Nos. plate data and date of installation.

Test readings of Influent & Effluent parameters taken at final handing over time

NOC (No Objection Certificate) from State Pollution Control Board and any other statutory authority whose approval is required.

### **Performance Guarantee**

Equipment supplied and installed shall be guaranteed to yield the specified effluent standards which must meet and accepted with the requirements of Pollution Control Board.

The guarantee implicitly includes replacement of the entire plant on failure to meet desired effluent parameters, replacement of individual equipment or repairs as warranted. Decision on each and every aspect on this matter shall rest with the Consultant and shall be final and binding on the Contractor.

### **Defects Liability**

All equipment and the entire installation shall be guaranteed against defective materials and workmanship for a period of 24 months reckoned after taking over of system by client along with the documentation. During the defects liability period, the Contractor shall replace defective parts and components free of cost. Rectification or repair may be permitted in case the defect is of minor nature.

### **General**

Supplying, assembly, installation, testing and commissioning of the main treatment units in RCC tanks, mechanical equipment for the Sewage Treatment Plant (STP) of capacity and design parameters for 150KLD and 50KLD respectively specifications broadly comprising of



: -

- No external aeration
- Low power consumption
- All green process
- No moving parts
- No bio-sludge formation
- Efficient removal of pollution
- One time media installation ,Long life, Unskilled personnel sufficient to operate
- **Capacity: 100KLD - Two Locations**
- Recovery: More than 98%
- Peak factor: 3
- Bio Mound Area: as per Approved drawings
- GL / IL Level :- As per site
- Other Features: Green Structure, No Secondary Bio-Sludge, Low Energy Requirement, Robust System, Recalcitrant COD Handling, No Odour, Less Start-Up Time.

#### **TECHNICAL SPECIFICATION OF CAMUS STP TECHNOLOGY**

The Fabricating, Supplying, Installation & Commissioning 100 KLD STP, Supply of mechanical, electrical and instrumentation including

- Fine Screen Chamber SS304, 5mmx5mm,
- Tube Settler,
- Collection /Equilisation Tank,
- Bio Mound 1 & Bio Mound 2
- Collection Tank 1 & 2,
- Treated Water Tank
- Submersible Sewage pump to transfer fluid between EQT-BM1
- Submersible Slurry Pump to transfer slurry between TS-VCB
- Submersible sewage Pump to transfer fluid between CT1-BM2
- Submersible clear water pump to transfer fluid between CT2-TWT
- Bio Mound Media (lateratite/Basaltic/red clay origin media with technology provider specified aggregate sizing),
- Jute 250gsm @every 0.5m inside BM media, Plantation/Saplings @2sqm each

etc.,

The above capacities of Pumps and details are as per BOQ

### **Bio Mound (BM) Media**

- Bio Mound Media :- As per the BOQ and Approved Drawings
- Jute 250gsm @every 0.5m inside BM media :- As per the BOQ and Approved Drawings
- Plantation/Saplings @2sqm each :- As per the BOQ and Approved Drawings

### **Electromechanical Specifications**

Slurry Pump TS-VCB; Submersible Slurry Pump; (1W) with Piping , NRVs, Cabling & Other Instrumentation as Applicable Sewage Pump

EQT-BM1; Submersible Sewage Pump capacity and Pipings, NRVs, Cabling & Other Instrumentation as Applicable Sewage Pump based on the BOQ.

CT1-BM2; Submersible Sewage Pump capacity and Pipings, NRVs, Cabling & Other Instrumentation as Applicable Sewage Pump based on the BOQ.

CT2-TWT; Submersible Sewage Pump capacity and Pipings, NRVs, Cabling & Other Instrumentation as Applicable Sewage Pump based on the BOQ.

- Distributor System in UPVC inclusive fittings; MOC:- UPVC
- Tube Settler Packing; MOC:- PVC
- Fine Screen; MOC:- SS 304; Slot Size:- 5 mm
- Mechanical Flow Meter; Line Size :-2 inch
- Control Panel: - 1 JOB.

### **The Garden Soils and Garden work for STP plant top level:**

Supplying on site fresh Garden soil (free from stones rubbish like dried grass roots, other such materials) for excavation area of depth of 30 cms.( consolidated thickness).(As per P&G DSR 2022-23 Items of garden work, Sr No.36a),Fresh garden soil is required for growing plants using the treated water on STP. Supplying on site well decomposed Farmyard Manure for excavation area of depth of 30 cms. (Consolidate thickness). (As per P&G DSR 2022-23 Items of garden work, Sr No.36b), providing on site required variety of lawn (free from weeds /disease etc.) Cynadon/ paspalum/ selection for 1 sqm. area dibbling distance 5 cms. apart c/c. (As per P&G DSR 2022-23 Items of garden work, Sr No.46), Excavation for planting lawn/ shrub/ flower bed/ hedges/ edges/ canna bed in earth, soil of all types, soft murum, including removing the excavated material up to a distance of 50 mtrs. for a depth of 30 cms.(As per P&G DSR 2022-23 Items of garden work, Sr No.3), Filling fresh garden soil / silt & manure in excavated area of depth 30cms. (As per P&G DSR 2022-23 Items of

garden work, Sr No.13), Mixing garden soil/silt & manure thoroughly well, watering previous night. Planting required plant species, lawn grass as directed etc. complete for required depth 30 cms. for planting lawn/ shrub/ flower bed/ hedges/ edges/ canna bed/ ground cover. (1/10 of semiskilled labour)(As per P&G DSR 2022- 23 Items of garden work,Sr No.23), Maintenance of Newly Developed lawn Area. For First 30 days Only (Paspallum/ selection)(As per P&G DSR 2022-23 Items of garden work,Sr No.28)

After the commissioning of the STP plant, garden soil must be laid on top of the plant in BM 1 & 2 to support plantation growth. Therefore, laying garden soil over the STP is essential for this purpose.

**CAMUS-Cultures** and Catalyst; Patent No 414339 METROL Process (Mite Ecology for Treatment of Organic Liquids)

- Process Design (Sizing and Specifications)
- GA Drawings as per site
- Bio Media Identification, Testing and Certification
- Routine Supervision during Civil, Media Filling and Installation of Electromechanical Items
- Commissioning
- Operation and Maintenance During DLP period ( 1 year)

1. Operators:- 2 Nos

2. Quarterly Site Visit:- 4 Nos

3. Compliance Water Test Reports (quarterly) for raw water and treated water for parameter COD, BOD, TSS, pH:- 8 Nos

Note: GRIHA norms & relevant IS standards (output water for irrigation/ flushing/ sewer/ portable) for output water parameters should be complied with standard norms.

Si.No	Parameter	Units	Treated Outlet (Less than)
1	PH		6.5-7.5
2	Biological oxygen Demand	mg/L	10
3	Chemical oxygen Demand	mg/L	50
4	Total Suspended Solids	mg/L	10

After treatment of STP treated water should be adhere to the Standard.

### 3.32. EFFLUENT TREATMENT PLANT:-

Supply, Installation, and Testing & Commissioning of ETP shall be carried out by the Contractor. The specifications for ETP (Capacity 25 KLD) shall be as defined in Design Basis Report, meeting functional requirements & as per directions of the Engineer.

The Contractor shall submit shop drawing illustrating the detailed piping & instrumentation details of entire ETP system, which shall be approved by PMC prior to start of execution work at site.

### DESIGN METHOD

PLANT CAPACITY		25KLD Effluent Treatment Plant
OPERATION		Semi-automatic, PLC-based
Hours of Operation		20 Hours X 365 days (Except time for general preventive maintenance)
AREA CLASSIFICATION		Non-Hazardous
POWER (V/PH/HZ)		400V/3Ph/50-60Hz as per BOQ
DESIGN TEMPERATURE		Mechanical design: 40°C Process design: 25-30°C

### WATER ANALYSIS

For output water parameters should be complied with standard norms.

Si.No	Parameter	Unit	Treated Water Characteristics (Outlet)
1	PH		6.5-7.5
2	TSS	ppm	100
3	BOD	ppm	30
4	COD	ppm	250
5	Oder		Absent
6	Colour		Clear
7	Oil & Grease	ppm	10
8	TDS	ppm	<2100

### CIVIL COMPONENTS:

#### SCREENING CHAMBER

The untreated effluent contains bigger suspended solids and floatable matter which contributes organic and inert matter that needs to be removed from the effluent. Also, there are chances that these particles may clog the pump causing breakdown. The untreated industrial effluent is first passed through the fixed bar screens where all the bigger suspended solids and floatable matter get separated and removed. The screened effluent is then taken to the oil and grease removal tank by gravity.

## EQUILIZATION AND NEUTRALIZATION TANK

The raw effluent is let into the collection tank and continually mixed with a floating aerator or air-diffused device to homogenize the combined effluent from the hospitals' various sources and maintain similar effluent characteristics. The pH is generally low. As a result, the effluent is fully mixed by dosing lime, caustic soda, or soda ash in the Collection tank to neutralize the pH of the raw effluent before it is discharged into the subsequent units. The equalization tank will balance out fluctuations in the flow and quality of raw effluent and maintain a consistent and uniform supply of composite effluent to the succeeding treatment units in terms of flow and quality. Agitation will be run as needed and will regulate itself based on the liquid level in the tank.

## COAGULATION AND FLOCCULATION

Treatment of industrial and municipal wastewater that may contain colloidal solids, i.e., particles that are too small or light to filter out, requires flash mixing, coagulation, and flocculation. To encourage sedimentation and agglomeration in bigger particles, flash mixing, coagulation, and flocculation are essential. After the coagulation and flash mixing phases, flocculation occurs. The particles that have been removed from the water are transported to larger clumps, or flocs, during this phase. They might do this so that they may settle in the sedimentation chamber and be divided by the water that was directed to the drain. The reaction with a polymeric solution that functions as a flocculent agent, such as poly electrolytes or polyamines, makes this process possible.

## PRIMARY TUBE SETTLER

The effluent from the Flash Mixing Tank is pumped to the primary tube settler. TS is used to remove suspended solids which are treated with coagulants and flocculants. The supernatant from the TS enters the Anaerobic Baffle Reactor. Sludge from the clarifier is sent to the sludge holding tank/s. The supernatant from the Tube Settler will be sent to the Equalization Tank of the Sewage Treatment Plant for further Treatment. While Sludge will be sent to the Sludge Collection Tank of the Sewage Treatment Plant.

### **3.33. SOLAR WATER HEATING SYSTEM – 5000LPD**

Design, Supply, Installation, Testing & Commissioning of Solar Water Heating system shall be carried out by the Contractor & as directed by The Engineer. Solar water heating (SWH) is the conversion of sunlight into renewable energy for water heating using a solar thermal collector. For Hospital Building Close Coupled Solar Hot Water System coupled with Heat Pumps shall be used. In a "close-coupled" SWH system the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermo siphon flow. Solar water heating system produces hot water at a temperature of 60 Deg. C and In accordance with the IS-12976:1990 and IS12933:1990 (Part 1 to part 5).

Solar hot water system may be with recirculation pump & heat exchanger system, pump to supply water from raw water storage tank to solar storage tank if height of storage tank is

higher than raw water storage tank.

System to ensure that the solar hot water generated during the sunshine hours of the day is stored in a Solar Insulated tank (Heat Bank) & then the Heat is transferred to the Mixing tank as & when required (HTC application), so that the Hot Water is made available at the Controlled Temperature for final usage. In other buidings, conventional Solar Hot Water System shall be used without any recirculation pumps. It supplies the hot water by gravity as a preheated water to the electric geysers at all user points Testing: All G.I pipes of Primary Circuit (Collector Circuits) shall be tested to hydrostatically for a period of 30 minutes to a pressure of 2 kg/Sq.cm without drop in pressure and all other G.I pipes for a pressure of 6 Kg/Sq.cm.

### **3.34. HOT WATER STORAGE TANK**

SS-304 horizontal/vertical hot water storage tank with the required thickness (as Required) to withstand working pressure of 5 kg/sqcm. The hot water storage tank is provided with a manhole, cover, drain, vent, overflow, inlet and outlet connections etc as required and as per direction of The Engineer. Each hot water storage tank shall be provided with the following:

- Thermostatic control valve
- Safety valve
- One AIR Release valve
- Pressure and temperature relief valve
- High limit Temperature sensor
- Primary flow connection
- Hot water supply connection
- Hot water return connection
- Drain connection
- Thermometer fitted (inserted) in thermo well
- Pressure gauge
- Make up tank
- Ball valve
- The hot water storage tank shall be hydrostatically tested to one and half times the working pressure of a system for a period of 24 hours without any leak. Field tests are to be performed at site to satisfy the capacity and operation of the unit by the CLIENT/ project in-charge.

### **3.35. HOT WATER PIPING**

Supply and return pipes of the hot water system complete with necessary pipes, bends, flanges, fittings, gaskets and valves are to be provided to connect Solar water heating system , hot water storage tank.

The hot water supply and return pipes are insulated with Rock wool and cladded with aluminium sheets of 24SWG.

### **3.36. HOT WATER SOLAR PIPING**

GI/CPVC/UPVC solar hot water piping complete with bends, flanges, fittings, gaskets and valves to connect the solar panels to the hot water storage tank with necessary valves and fittings. This also includes the solar circulation pumps as per requirement to circulate the hot water to the tank from the solar panels. The hot water piping insulated with Rock wool and clad with aluminium sheets.

### **Pipe Insulation**

Pipe insulation shall be as required under “HOT INSULATION”.

### **Installation**

Pipe installation shall be carried out with proper workmanship in accordance with approved drawings/ The Engineer. Pipe shall be aligned parallel to walls and ceiling and not across the room. Change of direction shall be through hydraulically formed welding fittings as specified. Alignment shall follow the approved drawings/ The Engineer and wherever necessary pipe shall be rerouted under the instructions of The Engineer in order to meet the site conditions and or interference from other services.

### **Solar Collector Panels**

The scope of work covers supply, erection, testing and commissioning of the Solar Collector Panels meeting the requirements and the intent of this specifications and Capacity.

Manufacturer’s catalogues and guaranteed performance details to be submitted for Approvals before ordering the supply of the equipment.

a. Collector: Type: copper type with minimum size of 2 sqm of each type.

i) Collector Frame Extruded -

ii) Gasket for Glass (Beading) - iii) Glazing (Cover) - iv) Collector Body v) Bottom Insulation - vi) Side Insulation vii) Absorber Plate - ix) Riser Copper - x) Inlet Header Copper - xi) Reflective Foil xii) Grommet xiii) Collector Back sheet

### **Collector Support Frame**

The structure should be in a position to withstand a wind velocity of 100 Kms/hr. It shall be made of angle iron 40mm x40mmx5mm and shall have vertical support at top and bottom edge of the inclined plane of the collector at a distance of 2.5 m or less. The vertical support shall be firmly grouted to the roof in the ground in case of ground mounted system. The grouting blocks shall be of minimum equal to 250 mm x 250 mm x 150 mm and finished properly. In case the grouting is carried out on roof already water proofed with asphalt the back support of the collectors may be anchored to the parapet or the size of the grouting block shall be increased to provide for a dead weight anchoring of 75 kg per leg of the vertical support.

Items which are not mentioned in below list but required at site, can be taken from the approved

list of Approved make of PWD Assam etc. Furthermore, the materials/equipment to be used which are not mentioned in any of the below list should have ISI or equivalent it shall be Certified from the engineer incharge during execution.

### 3.37. LIST OF APPROVED MAKE

SNo.	Descriptions	PWD Approved Make
	<b>Sanitary Fixtures and CP Brass Fittings</b>	
1.	European Wall mounted water closet	Hind ware/Parry ware/Jaguar /Cera /Kerovit by Kajaria/ Kingston/ Midas or Approved Equivalent
2.	Washbasin	Hind ware/Parry ware/Jaguar /Cera /Kerovit by Kajaria / Kingston/ Midas or Approved Equivalent
3.	Urinals	Hind ware/Parry ware/Jaguar /Cera /Kerovit by Kajaria / Kingston/ Midas or Approved Equivalent
4.	Bib cocks	Hind ware/Parry ware/Jaguar /Cera /Kerovit by Kajaria / Kingston/ Midas or Approved Equivalent
5.	CP Brass Fittings and Accessories	Jaquar/ Roca/ Kohler/ Kingston/ Rak or Approved Equivalent
6.	PVC Water Stops	BASF/ Supreme/ Oriplast or Approved Equivalent
7.	Kitchen Sinks	Neelkanth/ Jayna/ Hindware/ Nirali/ Kingston/ RAK or Approved Equivalent
8.	RO Purifier Units	Kent/ ION Exchange/ Eureka Forbes/ Blue star or Approved Equivalent
	<b>Soil, Waste, Vent, and Rain water Pipes</b>	
9.	UPVC,PVC pipes with fittings	PRINCE/Finolex/Astral /Ashirvad /Supreme /AKG or Approved Equivalent
10	GI Pipes	Jindal Hissar/ Prakash Surya/ Tata or Approved Equivalent
11	GI Pipe Fittings	Zoloto M/ DRP/ New/ Unik or Approved Equivalent
12	GI clamps with EPD M rubber	Intellotech/ Indotech/ Hilti/ CAMRY or Approved Equivalent
	Stainless Steel Gratings	Chilly/ Camry/ Kamal or Approved Equivalent
	<b>Water Supply System</b>	
13	CPVC pipes with fittings	PRINCE/Ashirvad/Astral /Finolex /Supreme /AKG or Approved Equivalent
14	Water Meter	Kranti/ Toshaniwal/ Capstan/ Anand or Approved Equivalent
15	Hotwater Insulation	Arma Flex/ Superlon/A Flex/ K- Flex/ Therma flex/ Kaiflex or Approved Equivalent
16	HDPE Pipes	PRINCE/ Jain Irrigation/Hasti/Oriplast or



SNo.	Descriptions	PWD Approved Make
		Approved Equivalent
17	All types of Valves	Zolato/Apollo/Leader/Audco /Sant /DRP/ Giacomini or Approved Equivalent
18	Solenoid valves,	Dwyer/Taylor/Audco or Approved Equivalent
19	Central RO Plant	Ion Exchange/ Thermax/ Pentair/ Eureka Forbes or Approved Equivalent
20	Polyethylene Storage Tank	Sintex/ Supreme/ Sheetal/ Prince or Approved Equivalent
	<b>Hot Water System (Heat Pump)</b>	
21	Heat Pumps	AO Smith/ Cristopia/ Bluebox/ Climaveneta/ Klima or Approved Equivalent
22	Hot water Recirculation and Return Pumps	Grundfoss/Kirloskar/KSB Pump /Willo /Xylem/DP or Approved Equivalent
	<b>Sewerage and Drainage System</b>	
23	HDPE Double Wall Corrugated (DWC)	Finolex/ Astral/ Ashirvad/ Supreme or Approved Equivalent
24	SFRC Manhole Cover and Frame	KK Manholes/ SK Precast Concrete/ Advent Concreteovision/RPMF or Approved Equivalent
25	Foot Rests	KJM/ Deesawala/ Surya/ Sinecos or Approved Equivalent
26	RCC Pipes	Jain Spun Pipes/ KK Concrete Products/ Usha Spun Pipes/ Indian Hume Pipe/ Pragati/ Daya/ Dewan spun/ Concrete Udyog or Approved Equivalent
	<b>Water Supply, Bore well, Drainage Pumps and Water Treatment Equipment</b>	
27	Level Indicator	Dwyer/Taylor/Audco or Approved Equivalent
28	Pumps	Grundfoss/Kirloskar/KSB Pump /Willo /Xylem/DP or Approved Equivalent
29	Hydro pneumatic System	Grundfoss/Kirloskar/KSB Pump /Willo /Xylem/DP or Approved Equivalent
30	Water Filters	Ion Exchange/ Thermax/ Pentair or Approved Equivalent
31	Water Softeners	Ion Exchange/ Thermax/ Pentair or Approved Equivalent
32	Chemical Doser (Cholorinators)	AsiaLMI/ Toshcon/ Chloromax or Approved Equivalent
33	Electrical Panels	As per Electrical Make List
34	GI Pipes	Jindal Hissar/ Prakash Surya/ Tata or Approved Equivalent
35	GI Fittings	Zoloto M/ DRP/ New/ Unik or Approved

<b>SNo.</b>	<b>Descriptions</b>	<b>PWD Approved Make</b>
		Equivalent
36	CI Butterfly Valves	Zoloto/ Audco/ Sant/ DRP or Approved Equivalent
37	CI Dual Plate check Valves	Zoloto/ Audco/ Sant/ DRP or Approved Equivalent
38	CI Strainers	Zoloto/ Audco/ Sant/ DRP or Approved Equivalent
39	Vibration Eliminators	Resistoflex/ D'wren/ Kanwalor Approved Equivalent
	<b>Sewage Treatment Plant</b>	
40	STP - UPVC Pipes and Fittings, Ball valves	PRINCE/Finolex/Astral /Ashirvad /Supreme /AKG or Approved Equivalent

**FIRE FIGHTING SYSTEM**  
**&**  
**FIRE ALARM DEDUCTION SYSTEM**

#### **4. TECHNICAL SPECIFICATIONS FOR FIRE FIGHTING SYSTEM**

##### **4.1. SCOPE OF WORK**

The scope of work includes the supply, erection, and painting, testing, commissioning, and handing over of a complete Fire Protection System, as envisaged for all buildings in accordance with the stipulations of the National Building Code – 2016.

The work under this section consists of providing all labor, materials, equipment, and accessories necessary to fully install the firefighting equipment, as specified hereinafter.

##### **4.2. DRAWINGS & TECHNICAL SUBMITTAL**

a) After the award of the work, the Contractor shall submit shop drawings for the entire pumping installations covered under this contract, along with supporting documents and general arrangement drawings for major equipment related to the Fire Hydrant and Sprinkler Systems. The Contractor shall also promptly provide any clarifications or explanations as requested by the The Engineer to ensure the timely finalization of the design. All work shall be executed in accordance with the approved shop drawings and technical submittals provided by the Contractor.

b) On Completion of Work The Contractor shall submit O&M manuals for Hydrant and Sprinkler System including pumps, motors, diesel engines, MCC panels, Circuit Diagram, Manufacturers technical catalogues, detailed specification of items provided along with as built drawings and copies of Test Certificates of all major equipment's duly bound in neat and presentable booklet forms.

##### **4.3. APPROVAL BY LOCAL FIRE SERVICE**

The Contractor shall be fully responsible and shall carry out following activities:-

- a. Obtaining the approval of Entire Fire Fighting System drawings
- b. Arranging inspection of site by officials of the Authority
- c. Obtaining the final no objection/ completion certificate after submitting required documents.
- d. Any other statutory approvals require.

- e. The Contractor to get the approval in stages from the Local fire Service as required. This shall be without any liability to the The Engineer.
- f. On successful completion of work, the Contractor shall prepare as built drawings which have been so approved by the Fire Service incorporating all changes that might have been effected during execution of the work.
- g. The Contractor shall also bring to the notice of the The Engineer any deviations from Local Fire Service/Building Bye Laws Norms and requirements in the systems that he shall install as well as architectural features that will affect approval from the Fire Service.

#### **4.4. MANUFACTURING**

The responsibility for ensuring the manufacture of the equipment as per the specifications shall be solely that of the contractor. The contractor shall be responsible for selection of materials as per agreed specifications.

#### **4.5. MAKE OF MATERIALS**

Only approved makes as mentioned in our approved make list of tender documents that material shall be used. The contractor shall get the samples of required items approved from the PMC or project in charge engineer before commencing the supply.

#### **4.6. TRAINING OF DEPARTMENT PERSONNEL**

- a. The Contractor shall train the CLIENT personnel to become proficient in operating the equipment installed. Training shall be done before the expiry of the defects liability period (one year after completion & handing over).
- b. The period of training shall be adequate and mutually agreed upon by the Engineer and Contractor.
- c. The CLIENT personnel shall also be trained for routine maintenance work and lubrication, overhauling, adjustments, testing, minor repairs and replacement.
- d. Nothing extra shall be paid to the Contractor for training CLIENT personnel.

#### **4.7. COORDINATION**

The contractor shall co-ordinate with all other agencies involved at the site of work so that the work of other agencies is not hampered due to delay in his work. Piping,

cabling or any other work, which directly affect the progress of work of other agencies, shall be given priority.

#### **4.8. WORKS TO BE DONE BY THE CONTRACTOR**

Unless otherwise mentioned in the tender documents, the following works shall

Be done by the contractor.

- (i) Foundations for equipment including foundation bolts and vibration isolation spring/pads,
- (ii) Suspenders, brackets and floor/wall supports for suspending/supporting pipes.
- (iii) Suspenders and/or cable trays for laying the cables,
- (iv) Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports.
- (v) Sealing of all floor slab/wall openings provided by the Department or made by the contractor for pipes and cables, from fire safety point of view, after laying of the same.
- (vi) Painting of all exposed metal surfaces of equipment and components with appropriate colour as per following standard.
  1. The entire metal work above ground level shall be painted with red color shade No. 536 of IS: 5.
  2. Pump, motor and engine shall be painted with red color shade No. 536 of IS: 5.
- (vii) Making openings in the walls/floors/slabs or modification in the existing openings wherever provided for carrying pipe line, cables etc.
- (viii) All electrical works including cable/wires, earthing etc. beyond power supply made available by the department.
- (ix) Making good all damages caused to the structure during installation and restoring the same to their original finish.
- (x) Approval from local fire authorities as may be required as per local bye-laws. (The contractor's responsibility shall be limited to the work executed by him.)

**4.9. COMPLETION / AS BUILT DRAWINGS**

Three sets of the following laminated drawings shall be submitted by the contractor while handing over the installation to the Department. Out of this one of the sets shall be laminated on a hard base for display in the fire control room. In addition, one set will be given on compact disc.

- (a) Installation drawings giving complete details of all the equipment, including their foundations,
- (b) Plumbing layout drawings giving sizes and lengths of all the pipes and the 9 sizes and locations of all types of valves, and including isometric drawings for the entire piping including the pipe connections to the various equipment,
- (c) Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout,
- (d) Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits.
- (e) Location of External Hydrants, 2-way/4-way fire brigade inlet connection, Earth pipes, route of earthing conductors etc. f. Route of all cables and pipes run along with detail sizes and mode of installation.

**4.10. DOCUMENTS**

Three sets of the following documents shall be furnished to the department by the contractor on completion of work:-

- (a) Completion drawings as per Para 4.5
- (b) 3 sets of manufacturer's technical catalogues of all equipment and Accessories.
- (c) Operation and maintenance manual of all major equipment, detailing all Adjustments, operation and maintenance procedure.
- (d) Name plate details of all equipment.
- (e) NOC from Fire authority before commencement of execution & after completion of entire work etc.

**4.11. TECHNICAL SPECIFICATION OF FIRE FIGHTING WORKS**

The Work under this sub-head consists of furnishing all labour, materials, equipment and accessories necessary and required to completely install the Fire Fighting equipment etc., specified hereinafter and given in the Without restricting to the generality of the foregoing the work of Fire Fighting System shall include the followings:

- Providing M.S. black steel (Class C) pressure pipe line main including Valves, Fire Hydrants, Excavation for Pipe, Laying of pipe, Painting of pipe and Making Connection to supply system.
- Black Steel Pipe, Mains Laterals, Branches, Valves, Hangers and Appurtenances.
- Hose Reels, Rubberized fabric lined hose pipes, Hose cabinets, Sprinkler heads and Landing Valves.
- Portable Fire Extinguishers.
- Fire Fighting Pumps, diesel operated pumps, and water curtain pump, panels and all connected accessories including suction & delivery pipes.
- Testing Commissioning and giving live demonstrations to the various Inspection Authorities and Obtain their “No Objection Certificate” (NOC) for occupation of the building.

**4.12. General Requirements**

All materials shall be of the best quality conforming to the specifications and subject to the approval of the The Engineer.

Pipes and Fittings shall be fixed truly Vertical, Horizontal or in slopes as required in a neat workman like manner.

Pipes shall be fixed in a manner so as to provide easy accessibility for repair and maintenance and shall not cause any obstruction in shaft, passage etc.

Pipes shall be securely fixed to walls and ceiling by suitable clamps at intervals specified. Only approved type of anchor fasteners shall be used for RCC ceilings.

Valves and other appurtenance shall be so located that they are easily accessible for operation, repairs and maintenance.



#### **4.13. PIPES FOR WET RISER SYSTEM**

##### **Scope Of Work**

This section covers the details of requirement of piping used in wet riser system, including the associated auxiliary equipment.

All pipes within and outside the building in exposed locations and shafts including connections buried under floor shall be M.S. Pipes as follows:

- Pipes 150 mm dia and below IS: 1239 (Class C) Heavy Class
- Pipe 200 mm dia and above IS 3589 of thickness specified.

##### **Pipe Fittings**

Pipes and fittings means tees, elbows, couplings, 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 pipe diameters 50 mm and below.

When used, they shall be fabricated, welded and inspected in workshops under supervision of The Engineer whose welding procedures have been approved by the TAC as per TAC rule 4102 for sprinkler system and applicable to hydrant and sprinkler system. For "T" connections, pipes shall be drilled and reamed. Cutting by gas or electrical welding will not be accepted.

##### **Jointing**

###### **Screwed (50 mm dia. pipes and below)**

Joint for black steel pipes and fittings shall be metal-to-metal thread joints. A small amount of red lead may be used for lubrication and rust prevention. Joints shall not be welded or caulked. (With screwed MS forged fittings).

###### **Welding (65 mm dia. and above)**

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. Buried pipes will be subject to x ray test from an approved agency as per the TAC norms at the cost of

Contractor. (With welded M.S. fittings heavy class with V-Groove). The welding machine shall be 3 Phase rectifier of required current and capacity. The vendor for welding will be approved by The Engineer.

### **Flanges**

Flanged joints shall be provided on:

- Straight runs not exceeding 30 m on pipelines 80 mm dia. and above.
- Both ends of any fabricated fittings e.g. bend tees etc. of 65 mm dia. or larger diameter.
- For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and required as good for engineering practice.
- Flanges shall be as per IS 6392-1971, Table 17/18 with appropriate number of G.I. nuts and bolts, half threaded of with 3 mm insertion neoprene gasket complete.

### **Unions**

Provide Approved type of dismantable unions on pipes lines 65 mm and below in similar places as specified for flanges shall be provided.

### **Dia Of Flange And Hole Conforming Is:**

Size of pipe - 80 mm 100 mm 150 mm 200 mm

Dia of flange - 200 mm 220 mm 285 mm 340 mm

Flange thickness - 20mm 20mm 22mm 24mm

Dia of bolt - 16 mm 16 mm 16 mm 16 mm

No. of hole - 4 mm 4 mm 8 mm 8 mm

### **Pipe Protection**

All pipes above ground and in exposed locations shall be painted with one coat of Red Oxide Primer and two or more coats of Synthetic Enamel Paint of approved shade.

All black steel pipes under floors or below ground shall be provided with protection against corrosion by application of 100mm wide and 4mm thick layer of PYPKOTE/MAKPOLYKOTE over the pipe, as per manufacturers specifications.

### **Pipe Supports**

All pipes shall be adequately supported from ceiling or walls from existing/new inserts by structural clamps fabricated from M.S. Structural e.g. Rods, Channels, Angles and Flats as per details given in approved shop drawings and specifications. All clamps shall be painted with one coat of red lead and two coats of black Enamel paint.

Where inserts are not provided, the Contractor shall provide anchor fasteners. Anchor fastener shall be fixed to walls and ceilings by drilling holes with Electrical drill in an approved manner as recommended by the manufacturer of the fasteners.

### **Testing**

All pipes in the system shall be tested to a hydraulic pressure of 1.5 times of the working pressure or minimum of 15 kg/cm<sup>2</sup> without drop in the pressure for at least 2 hours.

Rectify all leakages, make adjustment and retest as required.

### **Anchor Block**

Contractor shall provide suitable cement concrete, anchor blocks of ample dimensions at all bends, tee connection and other places required and necessary for overcoming pressure thrusts in pipes. Anchor blocks shall be of cement concrete 1:2:4 mix (1 cement: 2 coarse sand: 4 stone aggregate 20 mm nominal size).

### **Valves, Gauge and Orifice Plates**

Sluice Valves above 65 mm shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to type PN 1.6 of IS:780-1984, valves up to 65mm shall be of Gunmetal Full Way Valve with wheel tested to 20 kg/cm<sup>2</sup> class-II as per I.S: 778-1984. Valve wheels shall be of right hand type and have an arrow head engraved or cast thereon showing the direction for turning open and closing.

Non-return valves shall be of Cast Iron body and Bronze/Gunmetal seat. They shall conform to class of IS: 5312 and have flanged ends. They shall be swing check type in horizontal runs and lift check type in vertical runs of piping. They shall not be spring-loaded type.

#### **4.14. EXTERNAL YARD HYDRANTS**

The Contractor shall provide Single headed External Fire Hydrant in the Ring or on External Fire Line, as per specifications as specified in Indicative Items. The spacing of the hydrants and the distance from the building shall be maintained as per relevant requirements of latest relevant codes, unless specified herewith.

Each External Fire Hydrant shall be provided with an External Fire Hose Cabinet size 76.8 x 61.44 x 25.80 cm, of 2 hrs fire rating as specified in Indicative Items as approved by the The Engineer to equip 2 nos. of 63 mm dia, 15 mtr long non percolating reinforced rubber line (RRL) hoses, one no. branch pipe and accessories as required. The cabinet shall be installed near the Hydrant as per details, approved by the The Engineer. The fire hose cabinet shall have with glass fronted double door with lock and keys and break glass recess for keys all complete. The glazed glass shall be of minimum 6mm thickness or as specified in the Indicative Items.

The FHC shall be red painted. The words “yard hydrant”, “hydrant” etc. shall be painted in white (or red on the glass) in 75mm high letters. The hose box shall be lockable with socket spanner. Top surfaces shall be slopped for water discharge. Vents shall also be located on sides of the Hose Box.

A brick pedestal with brick wall complex with plaster shall also be constructed for supporting the hose box. All surfaces shall be plastered with 1:4 ratios (1 cement: 4 fine sand) mortar.

Sample of one installation to be approved before proceeding with execution

#### **4.15. ANTI-CORROSIVE PROTECTION ON UNDER GROUND MS PIPE**

Corrosion protection tape shall be wrapped on MS pipes to be buried in ground. This corrosion protection tape shall comprise of coal tar/asphalt component supported on fabric of organic or inorganic fiber and minimum 4 mm thick and conform to requirement of IS : 10221-Code of practice for coating and wrapping of underground mild steel pipe line. Before application of corrosion protection tape all foreign matter on pipe shall be removed with the help of wire brush and suitable primer shall be applied over the pipe thereafter. The primer shall be allowed to dry until the solvent evaporates and the surface becomes tacky. Both

primer and tape shall be furnished by the same manufacturer. Corrosion protection tape shall then be wound around the pipe in spiral fashion and bounded completely to the pipe. There shall be no air pocket or bubble beneath the tape. The overlaps shall be 15 mm and 250 mm shall be left uncoated on either end of pipe to permit installation and welding. This area shall be coated in situ after the pipe line is installed. The tapes shall be wrapped in accordance with the manufacturer's recommendations. If application is done in cold weather, the surface of the pipe shall be pre- heated until it is warm to touch and traces of moisture are removed and then primer shall be applied and allowed to dry. Holiday Testing for wrapping and coating is essential. Holiday testing may preferably be carried by flexible and detachable ring probe, which will enable the entire 360 Deg. of the surface of the pipe to be scanned. At least 10 percent of all the welded joints shall be radio graphically tested and half of the joints radio graphed shall be the 'field joints'.

#### **4.16. INTERNAL HYDRANTS**

The Single headed Internal Hydrant outlet shall be as per IS: 5290 (Type-A), and as specified in the Indicative Items.

- a) A cap with chain is provided on the head of the outlet. The hydrant will have an instantaneous pattern female coupling for connecting to Hose Pipe.
- b) The Landing Valve shall be fitted to a Tee connection on the wet riser at the landing.
- c) The Hydrant shall be constructed from gun metal and finished to a smooth polish on screwed ends. The Hydrant shall have screwed inlet of 80mm dia. flanged type with 4 nos. holes. The Hydrant shall have a PVC plug with chain fixed to the main body of the Hydrant. The Hydrant shall be tested to minimum 20 kg / cm<sup>2</sup> test pressure. The Hydrant shall not leak at any screwed joint.

#### **4.17. FIRST-AID HOSE REEL EQUIPMENT**

First aid hose reel equipment shall comprise reel, drum which can swing up to 170 degrees, with hose, guide fixing wall bracket, hose tubing, globe valve, stopcock and nozzle. This shall conform to IS: 884 - 1969. The hose tubing shall confirm to IS: 444- 1980 or IS: 12585 (Thermoplastic). The drum shall be fabricated from GI sheet of minimum 18-gauge thickness or as specified in the Indicative Items.

- a) The hose tubing shall be 20 mm dia and 36.50 m long, or as specified in the Indicative Items. The G.M. nozzle 5mm and shutoff valve shall be of 25 mm size to shut off the water supply to the Hose Reel, or as specified in the Indicative Items.
- b) The fixing bracket shall be of swinging type. Operating instructions shall be engraved on the assembly. This heavy duty mild steel and cast iron brackets shall be conforming to IS: 884 - 1969. The first-aid hose reel shall be connected directly to the M.S. pipe riser through a 25mm dia pipe.
- c) MS bracket shall be fixed on the wall to which the first aid hose reel shall be bolted. The bracket shall be of 40x40x5mm thick MS angle to form a square of 400x400 mm approx. This shall be fixed on the wall. After approval of sample by Engineer-In Charge further units shall be fabricated in factory and all joints shall be finished with grinder and shall be spray painted after single coat of primer paint.

#### **4.18. HOSE PIPES, BRANCH PIPES & NOZZLES**

##### **HOSE PIPES**

- a) Two numbers Hose Pipes shall be rubber lined woven jacketed and 63mm in dia. 15m long. They shall conform to type A (Reinforced rubber lined) of IS: 636 - 2018. The hose shall be sufficiently flexible and capable of being rolled.
- b) Each run of hose shall be complete with necessary coupling at the ends to match with the landing valve or with another run of hose pipe or with branch pipe. The couplings shall be of instantaneous spring lock type. This shall be conforming to IS: 903.

##### **BRANCH PIPES**

Branch pipe shall be of Gunmetal 63 mm dia. and be complete with male instantaneous spring lock type coupling for connection to the hose pipe. The branch pipe shall be externally threaded to receive the nozzle.

##### **NOZZLE**

The nozzle shall be of Gunmetal 20 mm in (internal) diameter. The screw threads at the inlet connection shall match with the threading on the branch pipe. The inlet end shall have a hexagonal head to facilitate screwing of the nozzle on to the branch pipe with nozzle spanner.

End Couplings, Branch pipe, and Nozzles shall conform to IS: 903 - 1985.

### **ORIFICE PLATE**

The pressure in a Fire Fighting system varies from point to point. The pressure will be maximum in the pump house and minimum at the farthest hydrant at top level. To reduce pressure to operating pressure at every internal/external hydrant, orifice plates are provided before connection of landing valve between the flanges of landing valve and pipe flange

### **HOSE CABINET**

The internal hose cabinet shall accommodate the Hose pipes, branch pipe, Nozzle First Aid Hose Reel and Hydrant Outlets and shall be fabricated from 2 mm thick or 14 mm gauge MS/aluminium sheet. The overall size shall be minimum requirement 2100x900x800 mm, or as specified in the Architectural details. This shall have lockable centre opening glazed doors as per the requirement and as per Architectural details. Where the niche for wet riser is provided with shutters, separate hose cabinet as above may be dispensed with.

The hose cabinet shall be painted red and stove enamelled and words FIRE written in front glazed portion.

Two C.P hoses of 15m length with couplings shall be provided with each External (Yard) Hydrant. Two RRL hoses of 15m length, as specified, with couplings shall be provided with each Internal Hydrant. One nozzle and one branch pipe with coupling shall be provided with each Yard Hydrant and Internal Hydrant.

#### **4.19. FIRE BRIGADE INLET CONNECTIONS**

One set of 2/4 ways collector head Fire Brigade connection shall be provided at underground tank, Ring Main, Sprinkler system and individual wet risers as specified conforming to IS 904.

The inlet to the wet riser sprinkler header shall be with 150 mm dia butterfly or sluice valve and non-return valve. The scope shall include necessary reducers, tees bends and special fittings as required.

It should be provided with M.S. enclosure fabricated from 1.5 mm thick M.S. sheet, front glass locking arrangement supported on M.S. structural members, painting with two coats of postal red enamel.

Fire Brigade Inlet connection shall be provided near the pump house and to the wet riser system as specified, for the following purposes:

Fire Brigade suction connection for fire static tank with provision of foot valve.

Fire brigade inlet connection to fire static tank.

The locations of this Fire brigade connection shall be suitably decided with the approval of Consultant/Landscape Architect and with a view that these are easily accessible to the fire brigade, without any possible Hindrance.

### **HYDRAULIC SIREN**

A siren shall be provided in the system, to indicate the flow of water in the wet riser system. Alternative arrangements may also be adopted. This shall be turbine type.

### **VALVE CHAMBERS**

Contractor shall provide suitable Brick Masonry Chamber in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick in 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 40 mm nominal size) 15 mm thick plaster inside and outside finished with a floating coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back filling complete.

Valve chambers shall be of following size:

- For depths 100 cm and beyond 90x90x100 cm

### **SPRINKLER HEADS**

a. Sprinkler heads shall be quick response type of quartzoid bulb type with bulb, valve assembly yoke and the deflector, rosette plate & complete with all accessories & shall be UL listed & FM approved . The sprinklers shall be as per IS: 9972of approved make and according to type of discharge.

#### **b. Types**

I. Conventional Pattern

ii. The sprinklers shall be designed to produce a spherical type of discharge with a



portion of water being thrown . The sprinklers shall be suitable for erection in upright position or pendant position. The designing of installation will be as per IS 15105.

iii. Spray Pattern

iv. The spray type sprinkler shall produce a hemispherical discharge below the plane of the deflector.

v. Ceiling (flush) Pattern vi. These shall be designed for use with concealed pipe work. These shall be installed pendant with plate or base flush to the ceiling with below the ceiling.

**C. Side Wall Sprinklers**

i. These shall be designed for installation along with the walls of room close to the ceiling. The discharge pattern shall be similar to one quarter of sphere with a small proportion discharging on the wall behind the sprinklers.

**d. Constructions**

i. Bulb:- Bulb shall be made of corrosion free material strong enough to with stand any water pressure likely to occur in the system. The bulb shall shatter when the temperature of the surrounding air reaches a predetermined level.

ii. Valve Assembly: - Water passage of the sprinkler shall be closed by a valve assembly of flexible construction. The valve assembly shall be held in position by the quartzoid bulb. The assembly be stable and shall withstand pressure surges or external vibration without displacement.

iii. Yoke: - The yoke shall be made of high quality gun metal. The arms of yoke shall be so designed as to avoid interference with discharge of water from the deflector. The sprinkler body shall be coated with an approved anti-corrosive treatment if the same is housed in corrosive conditions.

iv. Deflector: - The deflector shall be suitable for either upright or pendent erection. The deflector shall be designed to give an even distribution of water over the area protected by each sprinkler

## e. Colour Code

The following color code shall be adopted for classification of sprinkler according to nominal temperature ratings:

Sprinkler Temperature Rating	Color of the Bulb
68 deg. C	Red

f. Size of Sprinklers Orifices The following sizes of sprinklers shall be selected for various classes or hazards.

Light hazard - 15 mm nominal bore

g. All measures to be considered so that sprinkler bulb is cleaned & free from any blemishes.

h. Sprinkler type (pendant/upright/sidewall) shall be conforming to requirements & relevant IS codes.

#### 4.20. PIPES AND FITTINGS

##### a. Pipes

- i. Pipes less than 25mm dia shall not be used and shall be Black Steel conforming to IS: 1239 (Heavy Class) up to 150mm.
- ii. Welded Black Steel Pipe, Heavy Class conforming to IS:3589 for size greater than 150mm.
- iii. Fittings for black steel pipes shall be malleable iron suitable for welding or approved type cast iron fittings with tapered screwed threads.

##### b. Jointing

Joint for black steel pipes and fittings shall be metal to metal tapered thread or welded joints. A small amount of red lead may be used for lubrication and rust prevention in threaded joints. For Pipe size up to 50mm, Thread Joints are to be considered and for Pipe size above 50mm, Welded joints are to be considered.

Joints between MS pipes, valves and other appurtenances, pumps etc. shall be made with M.S. flanges with appropriate number of bolts. Flanged joints shall be made with 3mm thick insertion rubber gasket.

#### **c. Pipe Protection**

- i. All pipes above ground and in exposed locations shall be painted with one coat of red oxide primer and two or more coats of synthetic enamel paint of approved shade.
- ii. Pipes in chase or buried underground shall be painted with two coats of hot bitumen, wrapped with bituminous Hessian cloth and finished with one coat of hot bitumen paint.

#### **d. Pipe Supports**

All pipes shall be adequately supported from ceiling or walls from existing inserts by structural clamps fabricated from M.S. structural e.g. rods, channels, angles and flats. All clamps shall be painted with one coat of red and two coats of black enamel paint. Where inserts are not provided, the Contractor shall provide anchor fasteners.

#### **e. Orifice Flanges**

Contractor shall provide orifice flanges fabricated from 6mm thick Brass plates on the branch lines feeding different zones/ floors so as allow required flow of water at 3.5 kg/ sq.mm pressure. The Contractor shall furnish design for these orifice flanges.

- f. Valves Butterfly or Sluice valves of size 80mm and above shall be double flanged cast iron conforming to IS: 780. Check valve shall be of cast iron double flanged conforming to IS: 5312. Valves on pipes 65mm and below shall be heavy pattern gunmetal valves with cast iron wheel seat tested to 20 kg/ sq.mm pressure. Valves shall conform to IS: 778.
- g. Air Valves 25mm dia screwed inlet cast iron single acting air valves on all high points in the system or as shown on drawings.
- h. Drain Valves 50 mm dia black steel pipe conforming to IS: 1239 heavy class

with 50 mm gunmetal full way valve for draining water in the system in low pockets

Automatic sprinkler system shall be provided in the building as per requirement with permitted exceptions e.g. electrical switch rooms, power transformers and D.G. rooms, Panel rooms, Electrical rooms as identified

Sprinkler heads shall be provided at approximate spacing to cover 9 to 12 m<sup>2</sup> per Sprinkler head. The spacing shall however, be in conformity with the approved drawings and properly coordinated with Electrical Fixtures, Ventilation Ducts and Grills and other services along the ceiling.

Sprinkler heads shall be chrome finished Brass/Gunmetal with quartz bulb with a temperature rating of 68°C. Sprinkler heads shall be of type and quality approved by the local fire brigade authority. The inlet shall be screwed. Sprinkler heads shall be pendent, recessed or special application side wall Sprinkler types as shown in approved shop drawings. All Sprinklers should have the Specifications.

Contractor shall supply spare Sprinkler Heads of each type as per requirement and one Spanner for each type of sprinkler neatly installed in a steel box with glass shutters at locations approved by the The Engineer.

#### **4.21. ALARM VALVE & AUTOMATIC WATER MOTOR GONG VALVE**

The alarm valve & water motor gong valve UL approved shall be provided on the Sprinkler main delivery pipe complete in all respects.

- a) The alarm valve & water motor gong valve is to be provided on all the Sprinkler main delivery pipes or Installation Control Valves as per approval of authority having jurisdiction.
- b) The Installation Control valve shall be double seated clapper type check valve. The Body and cover shall be made from Cast Iron to IS: 210 Grade FG 200. The seat and seat clamp shall be made from bronze to IS: 318, LTB II grade. The sealing to the seat shall be neoprene gasket. The hinges pin and ball shall be from stainless steel.

- c) It shall be vertically mounted and the direction of water travel shall be indicated on the surface. It shall be rated to 12 kg / cm<sup>2</sup> and tested to 25 kg / cm<sup>2</sup> pressure.
- d) A By-pass check valve shall be fitted to adjust minor and slow variations in water pressure for balancing so as to avoid any false alarm.
- e) The valve shall also be provided with a Test Control Box. The Box shall house a lever to test and operate the ICV. A brass strainer shall also be provided at the point of water supply to the Alarm gong. A Retarding Chamber shall also be provided. The Chamber shall be able to balance the water pressure in case of water line surges.
- f) Each Installation Control Valve shall have two sets of pressure Gauges with brass ball valve type shut off.
- g) A Water Motor Alarm shall also be provided. This shall be mechanically operated by discharge of water through an impeller. The drive bearing shall be weather resistant. A strainer shall be provided on line before the nozzle. The Gong piece shall be constructed from bronze to IS 318, 2 TB II Grade, and base of cast iron. The motor Housing, Rotor and Housing Cover shall be pressure die cast aluminium.
- h) A brass automatic ball drop valve with the retard chamber shall also be provided.

#### **INSPECTOR TEST VALVES**

The Inspectors Test Valve assembly is to be provided on the Sprinkler System pipes in location as per approval of authority having jurisdiction.

#### **FLOW SWITCHES**

The Flow Switches are to be provided on the Sprinkler System pipes for each zone, complete with all necessary wiring up to monitor modules as per instructions of the The Engineer.

#### **4.22. INTELLIGENT TYPE SPRINKLER ANNUNCIATION PANEL & MONITOR MODULES**

For detailed specification kindly refer Package of Addressable Type Fire Alarm and detection system

**Voice Evacuation System**

Multi storied building shall be provided with Voice evacuation system at all floors as per NBC 2016 standard. This system is an electronic sound amplification and distribution system with a microphone, amplifier and loudspeakers used to allow a person to address an occupant at all floor level of the building. The term is also used for systems which may additionally have a mixing console, and amplifiers and loudspeakers suitable for broadcasting any message, distributing throughout the building.

The system shall include the following.

Speakers with Sufficient capacity, ceiling / wall mounted type shall be provided in corridor and common areas, large rooms, parking areas etc.

Control Console should be Integrated 8 channel Digital Voice Evacuation System Controller capable of broadcasting Evacuation Messages on same peer-to-peer Network with the fire detection Control Panel as per The Cause & effect matrix

Console with microphone for Voice evacuation system shall be located in the main of the building at ground floor for easy accessible.

System should be capable of supervising all the speaker circuits with adequate zone control and accessories.

Failure of Fire Panel CPU shall not result in failure of DVC operation.

Each floor shall be considered as a separate zone. Speakers in each zone are connected to the console using fire retardant cable.

Announcement from the main control Centre in ground floor to upper floor levels shall be done in case of Emergency by individual zone or collectively to all zones.

If there is any other Announcement system is there, it has to override with Voice evacuation announcement in case of emergency.

Wiring to speakers and between floors 2Cx1.5 mm<sup>2</sup> armored FRLS, PVC insulated copper conductor cable.

**Water Curtain Nozzle (Tezpur & Jorhat Basement)**

Water Curtain Nozzle distributes water in the form of a flat curtain extending all the way to the ground for fire compartment segregation. The fire water curtain system is designed to

prevent the fire from propagating into adjacent areas in case of a fire incident. The system has encapsulated the fire between the water curtain sections in order to make the evaluation of people who may be trapped inside basements. The present system is designed as a fire controlling system where the water curtains have effectively stopped the fire from propagation.

Water curtains, on the other hand, are specialized protective barriers designed to control and suppress fire by utilizing a continuous flow of water. The basement car parking area has been compartmented by the use of open head curtain nozzle fed from run/stand by curtain nozzle pumps.

The water supply to each compartmented area has been held back by a deluge valve with PRV for pressure control in case of emergency fire pump operation. The valve has been actuated by fire alarm system.

#### **System Description:**

The Water Curtain system consists of Pipe network, Water Curtain nozzles and Deluge Valve with trims.

Pipe network has been laid at the ceiling level of basements. Water curtain nozzles have been fixed on the pipe network at regular intervals. The pipe network has been connected to the Deluge Valve located outside the hazard.

#### **System operation – Automatic:**

In case of fire, the flow switch at the basement ceiling level has detected the pressure difference and sends the signal to the Fire alarm panel. The Fire Alarm Panel shall send the signal to the solenoid valve of the deluge valve of the respective zone. The Deluge Valve shall open to spray water through water curtain nozzles.

For basement car parking, - compartmentation can be achieved, with fire barrier or with water curtain nozzle (K-23) or with combination thereof.

Automatic deluge system comprising deluge valve, piping, nozzles, etc has been used to zone the compartment in case of water curtain system.

In case of water curtain, existing water storage has been supplemented by water demand for water curtain nozzles for 60 min considering the largest compartment's perimeter out of all compartments of car parking in any of the basements.

The water supply for the water curtain nozzles is provided through an independent electric pump of adequate capacity (both flow and head), along with piping and risers to ensure a

reliable water supply to the nozzles.

The water curtain have been operated by the actuation of flow switch actuating sprinkler system.

System operation – Local manual

Deluge Valve Control Panel has been provided near each Deluge Valve. When the push button of the Deluge valve control panel is pressed, it has send the signal to the solenoid valve of the Deluge Valve to open it.

In addition, each Deluge valve has been provided with emergency release valve. When the lever of the emergency release valve is pushed down, the Deluge valve has open.

Water curtain system to be installed in basement (where there is parking facilities) as per NBC-2016 (Part-IV).

### **Fire Command Centre**

As per NBC 3.2.1 Fire command Centre shall be on the entrance floor of the building having direct access. The control room shall have the main fire alarm panel with communication system (suitable public address system) to aid floors and facilities for receiving the message from different floors.

Fire command Centre shall be constructed with 120 min rating walls with a fire door and shall be provided with emergency lighting. Interior finishes shall not use any flammable materials. All controls and monitoring of fire alarm systems, pressurization systems, smoke management systems shall happen from this room. Monitoring of integrated building management systems, CCTVs or any other critical parameters in building may also be from the same room.

Details of all floor plans along with the details of firefighting equipment and installations (2 sets laminated and bound) shall be maintained in fire command Centre.

### **Fire Fighters Telephone System**

All the exit doors to Fire escape staircases has to be provided with Addressable Fire Fighter's Telephone Jack with suitable supervised module along with Portable Type Fire Telephone Handset for two-way communication between Remote Fire Fighter & Fire Command Centre.

The Fire Detection panel integrated with Digital Voice Evacuation System Controller Should has an inbuilt 2 ways Communication Fire Fighters System. The Fire Fighters Telephone



System shall be capable of having minimum 30 Telephones in conference in multiple FFT Risers.

#### **4.23. PORTABLE FIRE EXTINGUISHER**

The Extinguisher shall be filled with ABC Grade 40, Mono Ammonium Phosphate (MAP base) from approved manufacturer.

The Capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS 15683, part II 8/ IS 2171, shall be 4.0 kg +/-2 % or 10 kg +/-3 %.

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety city, fitted with a pin, to prevent accidental discharge. It shall be pressurized with Dry Nitrogen, as expelling. The Nitrogen to be charged at a pressure of 15 kg / cm<sup>2</sup>. 25

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 of 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 meters, 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 labeled 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<sup>2</sup> for a minimum period of 2 minutes. The pressure Gauge shall be imported and suited for the purpose.

Portable fire extinguishers shall confirm to IS:15683.

- Two 9 lit. water CO2 type for every 600 m2 area with minimum of 1 extinguisher per floor as per I.S: 15683

- Dry Chemical powder type of 6 Kg. Capacity as per (IS:15683)
- CO2 type of 4.5 kg capacity as per (IS:15683)

#### **4.24. Carbon Dioxide Extinguisher**

- The Carbon Dioxide Extinguisher shall be as per IS: 15683.
- 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 overlay height shall not exceed 720 mm.
- The discharge mechanism shall be through a control valve conforming to IS: 3224. The internal siphon tube shall be of copper or aluminum conforming to relevant specifications. Hose pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 kg/cm<sup>2</sup>, and shall be approximately 1.0 meters 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 handgrip 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/cm<sup>2</sup>. The expansion ratio between stored liquid carbon dioxide to expanded gas shall be 1:9 times and total discharge time shall be minimum 10 sec. and Maximum 25 sec.
- The extinguisher shall fulfill the following test pressures: a) Cylinder: 236 kg/cm<sup>2</sup> b) Control Valve: 125 kg/cm<sup>2</sup> c) Burst pressure of Hose: 140 kg/cm<sup>2</sup> minimum. 26
- 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 ISI Mark.

#### **4.25. GAS BASED FIRE SUPPRESSION SYSTEM**

##### **For UPS / ELV Rooms**

The Total Room Flooding system of fire detection and quenching is proposed in all Low Voltage Equipment rooms where Water sprinklers cannot be used. The Gas cylinder assembly should be UL Listed approved with seamless CCOE approved cylinder and will be connected to discharge nozzles through metal Piping. The master cylinder Kit fitted on Gas cylinder will be operated through separate Fire Detection Panel, Cross zoning Option with

Aspiration system & Spot detectors can be used to avoid any False alarm and up on receiving the signal, Gas release panel will release F-K5-1-12 gas through the nozzles in case of fire.

The system shall be designed with minimum design concentration of 4.2 % as applicable to Class-A & C fire. The cylinders shall be super-pressurized with dry Nitrogen to 25 bars / 34.5 bars / 42 Bar. The FK-5-1-12 gas shall be complying with the following. UL listed.

120 liters. Seamless Cylinder CCOE Approved, complete with a safety burst disc & Safety cap. C.S seamless piping and Fittings All piping shall be Schedule 40 seamless pipes complying with grade B and all fitting shall be of ASTM A-105.

2 Zone CONVENTIONAL Gas release panel with batteries to connect Manual abort/Release switches, multi sensor detector, Hooter cum strobe.

#### **For Electrical panels:**

As per NBC Part IV, 3.4.6.3 Electrical MV Main Distribution Panel & lift panels shall be protected with Gas flooding system. All Panel compartments should be equipped with a cylinder Located beside the panel. Suitable detection mechanism shall be provided for triggering the system automatically.

Tube based Fire protection system is used in the Electrical Panels to be installed in substations. (LV & HT panels). in case of fire the tube shall rupture at a point.

The rupture Tube (UL Listed) shall result in formation of discharge point and release Gas Agent in Uniform pattern.

#### **Fire Signage**

Various types of signage are proposed in the building block as per NBC 2016 Part -4. Material of signage shall be of acrylic / aluminium of required dimensions. At every floor near Lift landing diagram showing stairways shall be provided mentioning instruction- 'IN CASE OF FIRE, USE STAIRS UNLESS INSTRUCTED OTHERWISE'.

The signage shall be above call push button in Lift Lobby. Floor Signage will be provided in each floor within the staircase & should easily readable. Each corridor of every floor will have directional signage indicating Fire Escape Proposed route.

These Signage may be LED lit with UPS power backup or of photo Luminescent paint so that they can be visible even in dark in case of power failure.

**Response indicator:**

- (i) The response indicator shall be used to locate a fire alarm if the detector's LED cannot be seen (i.e. it is hidden by false floors, false ceilings etc.). When a detector is set off, as well as the alarm message being sent, unit response indicator is also activated and flashes red.
- (ii) The response indicator shall loop powered and separate power supply shall not be required.
- (iii) Remote response indicator shall be installed outside the areas normally kept closed to identify the detector response even if the room is locked. These indicators shall be able to indicate the status of the corresponding detectors in these areas. 4.7.1 Installation of Response Indicator:-
  - (i) Response indicator shall be installed on wall such that its top is at door level and by the side of the entrance to the respective premises.
  - (ii) Response indicators for detectors installed over a false ceiling in a corridor shall be installed directly under the false ceiling.
  - (iii) Response indicators for detectors under a false floor shall be installed at a height of 1 mtr above false floor level. Additionally, a marking of an arrow pointing downwards shall be made by the side of the response indicator.
  - (iv) The installation shall be such that visual indications from the response indicators are conspicuous and the affected area is spotted without difficulty.

**4.26. ELECTRICAL WORKS RELATED TO FIRE FIGHTING SYSTEM**

Firefighting panel of suitable size incomer & sufficient numbers of outgoing feeders for all pumps along with spares/spaces shall be provided.

Power cabling of suitable size to be laid from LT panel to firefighting panel. Power cabling of suitable size from firefighting panel to fire pumps to be laid. Control cabling from fire pumps to firefighting panel & firefighting panel to pressure switch to be done.

Suspenders and/or cable trays for laying cables to be used for sprinkler system, fire annunciation panel needs to be considered. Motor shall be TEFC squirrel cage AC induction type. The motor shall be suitable for continuous duty & rating necessary to drive the pump at 150% of its rated discharge with at least 65% rated head. Motor shall be with class F

insulation & 1E-2 class efficiency. DOL/star delta starter shall be provided as per H.P rating of motors.

Adequate no. of NO/NC contacts for interlocks, indicating lamps, remote operation etc. shall be provided on starter/contactors.

Metallic body of all motors, medium voltage equipment etc. shall be connected by 2 separate & distinct earth conductors to the earth stations of the installations. Looping of such body earth conductors is acceptable from one equipment to other equipment.

#### **4.27. FIRE ALARM AND DETECTION SYSTEM (FAS)**

##### **Scope of Work:**

The scope of FAS / AFAS installation work shall generally comprise the supply, installation, testing and commissioning of the following. The scope shall also include the engineering design of the system, using the equipment offered.

- (i) Trigger devices viz. automatic fire detector of the required types and/or manual call boxes.
- (ii) Sounders of low intensity and high intensity types.
- (iii) Control and indicating panels including repeater panels, if any.
- (iv) Standby battery and charging unit.
- (v) Mimic diagram (s)
- (vi) P.A. System.
- (vii) System wiring.

##### **General**

- a. The specifications includes furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Network Fire Alarm Control Panels (FACP), Network Reporting Terminals (NRT), Network Liquid Crystal Display (NLCD), auxiliary control devices, annunciators, and wiring as specified herein.
- b. The fire alarm system shall comply with requirements of IS:2189:1999 & 1996 NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification, or the stringent one of the

two specification in case of any discrepancy. The system shall be electrically supervised and monitor the integrity of all conductors.

- c. Fire Alarm System shall be integrated with P.A. system. A digitized pre-recorded voice message shall notify occupants that a fire condition has been reported. The message shall instruct the occupants with emergency instructions. Emergency manual voice override shall be provided.
- d. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing for equivalent European standard EN54.
- e. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Alarm Control Room and designated personnel.
- f. The FACP's shall be active/interrogative-type systems where each transponder is repetitively scanned, causing a signal to be transmitted to the fire alarm control panel node indicating that the transponder and its associated initiating device and notification appliance circuit wiring is functional. Loss of this signal at the FACP shall result in a trouble indication on both the FACP display and at the network display, as specified hereinafter for the particular input.
- g. The system shall be arranged such that not less than 20 percent additional transponders may be inserted into any network communication loop.
- h. The installing company shall employ technicians on site to guide the labours and to ensure the systems integrity.

### **Submittals**

- A. General:** All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the Contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment. Two copies of all submittals shall be submitted to the The Engineer/Engineer for review.

**B. Shop Drawings:** 1. sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications. 2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to point diagrams, and conduit layouts. 3. Show equipment layout and main control panel, module layout, configurations and terminations.

**C. Approvals:**

- The system must have proper listing and/or approval from the following nationally recognized agencies: UL Underwriters Laboratories Inc FM Factory Manual ULC Underwriters Laboratories Canada CPWD Central Public Work Department BIS Bureau of Indian Standards EN 54 or Equivalent European Standards
- The fire alarm control panel, network interface and all transponders shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels, which may require return to the manufacturer for system upgrades, and are not acceptable.

**4.28. FIRE ALARM CONTROL PANELS AND FIRE CONTROL ROOM:**

The Fire Alarm Control Panel shall be as per Section 7.33 of IS: 2189. Each network FACP shall contain a microprocessor-based central processing unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable detectors, addressable modules, Panel modules including initiating circuit, control circuits, transponders, local and remote operator terminals, printers, annunciators, emergency voice communication systems, and other system controlled devices. Each FACP on the network shall perform the following functions:

- a. It shall Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
- b. It shall supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.
- c. It shall detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as

programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

- d. It shall visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
- e. When a any of the following condition is detected and reported by one of the system initiating devices or appliances:
  - i. Fire Alarm Conduits
  - ii. Trouble Confirmation.
  - iii. Supervisory Card
  - iv. Security Alarm
  - v. Pre Alarm Then the following functions shall immediately occur:
    - a. The FACP alarm LED on the FACP shall flash.
    - b. A local piezo-electric indication for the event signal for the event in the FACP shall sound a distinctive Signal.
    - c. The 640-character LCD display on the local FACP node and on the network displays shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
    - d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
    - e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.



#### **4.29. SYSTEM COMPONENTS - ADDRESSABLE DEVICES DETECTORS & ADDRESSABLE DEVICES**

The addressable detector and devices shall comply to the below mentioned specifications. The addressing of detectors and devices shall be of rotary type electronic addressing shall not be acceptable. Intelligent Laser Photo Smoke Detector

- a) The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
- b) The laser detector shall have conductive plastic so that dust accumulation is reduced significantly. c) The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.03 percent per foot.
- d) The laser detector shall not require expensive conduit, special fittings or PVC pipe.
- e) The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases. f) The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required. g) The laser photo detector shall include two bi-color LEDs that flash green in normal operation and turn on steady red in alarm.

Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.

- If a wire-to-wire short occurs, the isolator module shall automatically open circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

- The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- The isolator module shall not consume any detector or device address from the loop capacity.
- **Intelligent Multi Criteria Acclimating Detector.**
- a) The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine its environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
- b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
- c) The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

Intelligent Thermal Detectors Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.

- Intelligent Photoelectric Smoke Detector The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Intelligent Multi Sensor intelligent Detector (CO, IR, Smoke & Heat)
- a) The intelligent multi sensor intelligent detector shall be an addressable device that is designed to monitor a minimum of photoelectric, thermal technologies, carbon monoxide & infrared in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built-in microprocessor to determine it's environment and choose the appropriate sensing settings. The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smoldering fires and thermal properties all within a single sensing device.
- b) The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, parking etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes) The intelligent multi sensor detection device shall include the ability to combine the all of four signals in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

- Intelligent Duct Smoke Detector a) The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel. b) When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
- a) Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
- b) If a wire-to-wire short occurs, the isolator module shall automatically opencircuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
- c) The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
- d) The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.
- e) The isolator module shall not consume any detector or device address from the loop capacity.

**Talk Back System/Fire Fighters Telephone Systems:-**

- (i) Fire Fighters Telephone System Panel:- Fire Fighters Telephone System Panel shall be microprocessor based with its own microcontroller, memory, communication modules, intelligent initiating and indicating devices and suitable SMPS. The

panel shall be suitable for required number talk back unit connections. The fire fighters telephone system will have integral talk back system to provide a 2 way voice communication between the fire fighters telephone. The talk back system shall include fire fighter master control console with a backlit LCD display for status display and a fire fighters telephone handset, standby battery for 24 hours in operation and half an hour alarm condition. The Fire Fighter Telephone System shall also include the following: A red colored master telephone handset with flexible coiled self winding five feet cord placed within the fire fighters telephone system panel housing:-

- (ii) The Fire Fighters Telephone Systems Panel shall include:- - Indicating High power LEDs - Input power supply : 230 volts AC 50Hz single phase supply 17-28V DC through rectifier, sealed maintenance free battery including trickle/Booster battery charger. Fire fighters telephone system panel housing shall be Dust and vermin proof cold rolled steel sheet 16 gauge powder coated with see through glass 0 0 front Fire fighters Telephone system shall be able to withstand 10 to 490 C and up to 93 % RH non condensing type. Fire fighter Telephone system shall be able to be integrated with building and control system and Public Address System.

#### **Addressable Control Relay Module.**

Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires. Addressable Control Module

- a) Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
- b) The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
- c) Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised UL listed remote power supply.

- d) The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

### **Manual Pull Stations**

The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. Programmable Electronic Exit Point Directional Sounders with Strobe Light

- a) Shall follow NFPA 72 2007 edition recommendation.
- b) Electronic sounders shall operate on 24 VDC nominal.
- c) Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dBA measured at 10 feet from the device.
- d) Shall be capable to broadcast pre programmed Voice Message also
- e) Shall be flush or surface mounted as shown on plans.
- f) Shall produce broad band directional sound with 20 Hz to 20 KHz frequency band to guide occupants to safe exists even in complete darkness.
- g) Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
  - h) The maximum pulse duration shall be 2/10 of one second.
  - i) Strobe intensity shall meet the requirements of UL 1971.
  - j) The flash rate shall meet the requirements of UL 1971.
- k) Field Wiring Terminal Blocks 1) For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for #18 to #12 AWG wire. Terminal blocks that are permanently fixed are not acceptable.

### **Test**

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system.

- a. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- b. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

- c. Verify activation of all flow switches.
- d. Open initiating device circuits and verify that the trouble signal actuates.
- e. Open signaling line circuits and verify that the trouble signal actuates.

#### Intelligent Addressable Relay / Control Module

- Relay module may contain up to four relays each with a potential free changeover contact.
- Each relay contact should be FAIL/ SAFE programmable, means it should be possible to program each contact to operate in three conditions viz. NO FIRE CONDITION, FIRE CONDITION AND LOOP POWER FAILURE CONDITION.
- Both the addressing of the module and setting of parameters to be carried out using PC software via the fire alarm control panel.
- The module contains a short circuit isolator, which ensures that the fault is localized and that the loop continues to function fully in the event of a wire break or a short circuit.
- The module should be minimum with IP 40 protection category when housed in a case or as per manufacture design.
- It should have integrated buzzer for signaling maintenance alarms.

#### **4.30. FIRE, SPRINKLER AND JOCKEY PUMPS ELECTRIC DRIVE AND DIESEL ENGINE**

##### **PUMP HOUSE: -**

For installation of firefighting pumps (Main Electrical Pump, Diesel Engine Driven and Pressurization Pump) along with Electrical & Control Panel, valves, diesel tank etc., pump house is required. Following factors are considered:

- In order to provide positive (flooded) suction to fire pumps, the pump house shall be at a level below or equal to that of static water storage tank.
- The pump house at ground level shall be easily accessible for firefighting operations and at least 6 meters away from all surrounding buildings and

overhead structures. In case, the 6m spacing of pump room from surrounding buildings is not feasible, the provisions of Para 5.1.12 of IS 13039:2014 shall be followed.

- General water supply pumps can be installed in the same pump house.
- Suitable ramp with proper slope and/or cutout in roof shall be provided for lowering the equipment in to the pump house. Stair case with entry door at ground level and locking arrangement shall be provided.
- In order to ensure that there is no leakage of water in the pump house, no pipe/ cable shall cross the pump house below ground level. Suitable opening in wall above ground level shall be provided for crossing of pipes/cables.
- Installation of negative suction arrangement and submersible pumps shall not be allowed.
- Pump house shall be separated by fire walls all around and doors shall be protected by fire doors (120 min rating).
- The pump house shall be clearly marked by luminous sign.

#### **PUMPING SETS**

- a) All pumps (main sprinkler & hydrant pumps, jockey pumps, diesel driven pump) shall be of suitable capacity & head to meet the requirements of NBC 2016 .
- b) Pumping sets shall be multi stage horizontal split casing centrifugal Pump having single outlet with cast iron body and bronze dynamically balanced impellers. Connecting shaft shall be stainless steel with bronze sleeve and grease- lubricated bearings. The centrifugal pumps shall conforming to IS 1520.
- c) Pumps shall be connected to the drive by means of spacer type love joy couplings, which shall be individually balanced.
- d) The coupling joining the prime movers with the pump shall be provided with a sheet metal guard. Pump and motor engine shall be mounted on a common base plate fabricated from MS section.



- e) Pumps shall be provided with approved type of mechanical seals.
- f) Pumps shall be capable of delivering not less than 150% of the rated capacity of water at a head of not less than 65% of the rated head. The shut off head shall not exceed 120% of the rated head.
- g) The pump shall meet the requirements of N.B.C. 2016 and N.F.P.A. and the unit shall be design proven in fire protection services.
- h) Suction and delivery pipes of pumps shall not be less than following.

Pump Discharge	Suction dia (mm)	Delivery dia (mm)
(a) 2280 lpm	200	150
(b) 2850 lpm	200	150

#### **ELECTRIC DRIVE PUMP**

- Electrically driven pumps shall be provided with totally enclosed fan ventilated induction motors of efficiency rating IE-3. For fire pumps the motors should be rated not to draw starting current more than 3 times normal running current
- The fire pump shall be horizontal end suction centrifugal type. It shall have a capacity to deliver 2280 LPM as specified in the BOQ, developing adequate head so as to ensure a minimum pressure of 3 kg. per sq.cm at the highest and the farthest outlet. The delivery pressure at pump outlet shall be not less than 6 kg. per sq.cm. in any case
- Motors for fire protection pumps shall be at least equivalent to the horse power required to drive the pump at 150% of its rated discharge and shall be designed for continuous full load duty and shall be design proven in similar service.
- Motors shall be wound for class F insulation and winding shall be vacuum impregnated with heat and moisture resistant varnish glass fiber insulated.
- Motors for fire pumps shall meet all requirements and specifications of N.B.C.-2016 and N.F.P.A.
- Motors shall be suitable for 415 volts, 3 phase 50 cycles A/c supply and shall be designed for 38 deg. C ambient temperature. Motors shall conform to I.S. 325.
- Motors shall be designed for two-start system.

- Motors shall be capable of handling the required starting torque of the pumps.
- Contractor shall provide inbuilt heating arrangements for the motors for main pumps to ensure that motor windings shall remain dry.
- Speed of the motors shall be compatible with the speed of the pump.

### **ACCESSORIES**

Each pump shall be provided with the following accessories: -

- (a) Sluice valves on suction and delivery.
- (b) Reducers, as may be required to match the sizes of the connected pipe work.
- (c) Non-return valve at the delivery.
- (d) Pressure gauge at delivery side between pump and the non-return valve.
- (e) Flexible coupling/connections shall be provided between Pump sets and Valves on suction and delivery sides of all the pump sets.

Note: 1) No butterfly valves shall be installed inside the pump room.

- 2) The size of the non-return valve and cut off (Sluice valve) shall not be less than the size of the initial delivery pipe.

### **INSTALLATION**

- Pumps shall be installed true to level on suitable concrete foundations. Base plate shall be firmly fixed by foundation bolts properly grouted in the concrete foundations. Angle iron frame of size 35mmx35mmx3mm shall be provided on the edge of foundation.
- Pumps and motors shall be truly aligned by suitable instruments.
- All pumps connections shall be standard flanged type with appropriate number of bolts. In case of non-standard flanges companion flanges shall be provided with the pumps.
- Manufacturer's instructions regarding installation, connections and commissioning shall be followed with respect to all pumps and accessories.
- Contractor shall provide necessary test certificates and performance charts with NPSH requirement of the pumps from the manufacturer.
- The Contractor shall provide facilities to the The Engineer or their authorized representative for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the HITES.
- Each pump shall be provided with a 150 mm dia pressure gauge, isolation cock and connecting piping, bleed and block valve.
- Provide vibration eliminating pad and connectors for each pump.
- A minimum clearance of 1M around the pumps shall be provided.

**VIBRATION ELIMINATORS**

- Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors (double arch of min. PN 16 rating).
- Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

**DIESEL ENGINE PUMP**

- a) Diesel engine shall be of multi cylinders (4/6 cylinder AS PER REQUIREMENTS) with individual head assemblies. The engine shall be water-cooled and shall include heat exchanger/radiator cooled and connecting piping, strainer, isolating and pressure reducing valves, bypass line complete in all respects.
- b) Engine shall be direct injection type with low noise and exhaust emission levels and shall conform to BS649/IS 1601/IS10002 as amended up to date.
- c) The speed of the engine shall match the pump speed for direct drive.
- d) The engine shall be capable of being started without the use of wicks, cartridge heater, plugs or either at engine room temperature of 7 deg. C and shall take full load within 15 seconds from the receipt of the signal to start.
- e) Noise level of the engine shall not exceed 105 DBA (free field sound pressure) at 3 m distance.
- f) The engine shall be self starting type up to 4 deg. C and shall be provided with one 24 V heavy duty DC battery, starter, cut-out, battery leads complete in all respects. One additional spare battery shall be provided.

The battery shall have a capacity of 180 to 200 ampere hours and 640 amps cold cranking amperage.

- Provided a battery recharger of 10 to 15 amperes capacity with trickle and booster charging facility and regulator.
- Annunciation panel shall be suitable for working on 24 volts D.C.

Arrangement for starting shall be automatic on receiving the signal but shutting off shall be manual.

- The engine shall be provided with an oil bath or dry type air cleaner as per manufacturer's design.
- Engine shall be suitable for running on high speed diesel oil.

- The system shall be provided with a control panel with push button starting arrangement also and wired to operate the engine on a differential pressure gauge.
- The entire system shall be mounted on a common structural base plate with ant vibration mountings and flexible connections on the suction and delivery piping.
- Provide one fully mounted and supported day oil tank fabricated from 5mm thick M.S. sheet electrically welded Provide level indicating gauge glass on the day oil tank and low fuel indication of the control panel. The capacity of tank should be sufficient to allow engine to run on full load for at least 2 hours. The fuel pipe from diesel tank to pump should be of robust construction, preferably of hard rubber.
- Provide one exhaust pipe with suitable muffler (residential type) to discharge the engine gases to outside open air as per site conditions. The piping shall be duly insulated with 50mm thick glass wool and 1.0mm thick aluminium sheet cladding.
- Provide all accessories fittings and fixtures necessary and required for a complete operating engine set.

### **Cooling System**

The engine shall be radiator water cooled. The radiator assembly shall be mounted on the engine. The radiator fan shall be driven by the engine as its auxiliary with multiple fan belts. When half the belts are broken, the remaining belts shall be capable of driving the fan. Cooling water shall be circulated by means of an auxiliary pump of suitable capacity driven by the engine in a closed circuit.

### **Fuel System**

The fuel system shall be gravity fed from the fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either adjacent to the engine or suitably wall mounted on brackets. The fuel filter shall be suitably located to permit easy servicing.

The fuel tank shall be of welded steel construction (3mm thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary floor mounted supports, level indicator (protected against mechanical injury) inlet,

outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet should be so located as to avoid entry of any sediment into the fuel line to Appendix 36 the engine.

Any valve in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and it shall be locked in the open position.

All fuel tubing to the engine shall be with M.S.'C' class pipe with flexible hose connections where required. Pipe joints shall not be soldered and plastic tubing shall not be used.

The following shall be provided:

- i) A sludge and sediment trap shall be provided.
- ii) An inspection and cleaning hole
- iii) Means to enable the entire fuel system to be bled of air (Air relief cocks are not allowed; screwed plugs are permitted)

### **Lubricating Oil System**

Forced feed lubricating Oil system shall be employed for positive lubrication. Necessary lubricating oil filters shall be provided, located suitably for convenient servicing.

### **Starting System**

The starting system shall comprise of necessary batteries 12 Volts/ 24 Volts, starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Suitable protection to protect starting motor from excessively long cranking runs shall be suitably integrated with engine protection system.

### **Exhaust System**

The exhaust system shall be complete with residential grade silencer suitable for outdoor installation and silencer piping shall be extended up to 1 m, outside pump house duly insulated with 50 mm thick glass wool and 1.0 mm thick aluminum sheet cladding.

### **Engine shut down mechanism**

This shall be manually operated and shall return automatically to the starting position after use.

**Governing System**

The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

An over speed shutdown device to shutdown the engine at a speed approximately 20% above rated engine speed with manual reset, so that the automatic engine controller will indicate an over speed signal until the device is manually reset to normal operating position.

**Battery Charger**

Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery under trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

**The following spare parts shall be supplied with the engine and kept on hand:**

- a) Two sets of fuel filters, elements and seals;
- b) Two sets of lubricating oil filters, elements and seals;
- c) Two sets of belts (where used);
- d) One complete set of engine-joints, gaskets and hoses;
- e) Two injector nozzles;
- f) One complete set of piston rings for each cylinder; and g) One inlet valve and one exhaust valve).

**Pipe work**

All pipe lines with fittings and accessories required shall be provided for fuel oil, lub. oil and exhaust systems. The fuel tubing to the engine shall be MS C – class pipe with flexible hose connections wherever required.

**4.31. OPERATING CONDITIONS FOR JOCKEY ,ELECTRIC& DIESEL PUMPS**

- Jockey pump shall start automatically when the Water Pressure in the System falls to a pre-set value and shut down when the system pressure reaches the set value. Both Limits shall be adjustable. The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.
- Main Electric Fire Pump shall operate on account of sudden pressure loss. So,

long as Main Electric Fire Pump is working, other Fire Pumps will not operate. The Pump shall start when the water pressure falls to a pre-set value in the system. The Pressure switch settings for Jockey Pump shall be determined as per relevant codes and Site Conditions.

- The Diesel Fire Pump will start on sudden pressure loss, only in case supply to main electric Fire Pump is not available or within a pre-set time the main Electric Fire Pump fails to start or fails during operation. No other pump will be working when Diesel Engine fire Pump is in operation. Audio-Visual Alarm shall be available to indicate failure of Main Electric Fire Pump.
- A three attempts starting facility will be provided for diesel Pump.
- If within a pre-set time, the pump also fails to start or fails to develop pressure, the diesel pump shall also be shut down and locked out. An audio visual alarm indication shall be given at the Control Panel.
- The Terrace Pump will start on sudden pressure loss of pressure only when both the Fire Pumps have either failed to start or exhausted water.
- Only one pump will be working at a time. In manual mode, more than one Pump can be started.
- Water Level in UG and Terrace Tanks shall be monitored and in case of low water level, pumps connected with the tank shall not operate (even on manual mode) or stop operation as the case may be. An audio-visual alarm shall be given at the Control Panel. The Terrace Fire Tank shall be provided with Baffles to ensure proper circulation of water before overflow/discharge into domestic tank.

### **VIBRATION ELIMINATORS**

Provide on all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors. Connectors should be suitable for a working pressure of each pump and tested to the test pressure given in the relevant head. Length of the connector shall be as per manufacturer's details.

Pump channels shall be provided with min. one coat of black paint.

### **AIR VESSEL FOR FIRE PUMPS**

Air vessel shall be fabricated out of 8 mm thick MS sheet & the end shall be dished and suitable supporting legs, air vessel shall be provided with a 100mm dia flanged connection from pump, one 40mm dia drain with valve, one gunmetal water level gauge and 25mm sockets for pressure switches. The vessel shall be 250mmx1200mm dia high and tested at 25 Kg/cm<sup>2</sup> pressure before installation. The fire pumps shall operate on drop pressure in the mains automatically or manually. (The ratings will be adjusted finally at the time of commissioning as per site requirement and final setting shall be kept as per approval of The Engineer).

### **4.32. ELECTRICAL INSTALLATIONS**

#### **Power And Control Panel And Other Control Components**

For Fire Fighting Panel & Control Panel, specifications under Technical Specifications for LT Panel under Electrification shall be followed.

#### **Cable Laying:**

Cable shall be laid generally in accordance with CPWD Specifications (Electrical) External & Internal amended up to date. Cables shall be laid on 14 gauge perforated MS sheet cable trays and cable drops/risers shall be fixed to ladder type cable trays fabricated out of steel angle. Access to all cables shall be provided to allow cable withdrawal/ replacement in the future.

Where more than one cable is running, proper spacing shall be provided to minimize 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 1.1 KV cable shall be buried 600 mm below ground level. For additional details pertaining to Cable Laying, Refer the Electrical Works Specifications under the relevant Head.



**Wire Sizes:**

For all Single phase/ Three phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated aluminum conductor wires of adequate size. 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 single strand aluminum 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 in control wiring.

The minimum size of control wiring shall be IS marked 2.5 mm<sup>2</sup> 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:

- e. Up to 5 HP motors: - 3 x 4 mm<sup>2</sup> Cu conductor wires.
- f. Above 5HP up to 15 HP motors: - 2 Nos. 3 x 6 mm<sup>2</sup> Cu conductor wires.
- g. From 20 HP to 25 HP motors :- 2 Nos. 3 x 10 mm<sup>2</sup> Al conductor armoured cables.
- h. From 60 HP to 75 HP motors. :- 2 Nos.3 x 50 mm<sup>2</sup> Al conductor armoured cables.
- i. 100 HP motors. :- 1 No. 3 x 150 mm<sup>2</sup> Al conductor armoured cables.

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.

The motor starter shall conform to IS 1822 as amended up to date.

**Earthing:**

For Earthing details, Refer the CPWD Electrical Works Specifications 2013 and electrical specification.

**Drawings:**

Shop drawings for control panels and wiring of equipment showing the route of conduit/ cable shall be submitted by the Contractor for approval of The Engineer 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.

**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 authorized person. The entire electrical installation shall be got approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Supervisor.

**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 backed in an oven. The finishing treatment shall be by application of synthetic enamel paint of approved shade.

**Label and Tags**

Engraved PVC labels shall be provided on all incoming and outgoing feeders' switches. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel and covered with transparent plastic sheet. All cables terminations at panels and at equipments shall be provided with tags as approved by Project Manager.

1. All panels to have provision for padlocking and all MCCB's/ MCB are to have provision for locking in off position.

**4.33. ELECTRIC FIRE PUMP PANEL :-**

The main switch board shall be floor mounted/ wall mounted fabricated from 2mm thick CRCA sheet powder coated with IP 42 protection 3Ph 415V Normal supply for fire pumps

near UG tank and Essential supply for terrace pump and jockey pumps

The panel shall incorporate the following facilities.

- j. TP &N Moulded case circuit breaker of appropriate fault level
- k. Control system components and equipment such as relays, Contractors, and timers etc. for automatic operation.
- l. Starter unit, current transformer and ammeter
- m. Indication lamps, their fuses, terminal block, push button, control and selector switches etc. as required.
- n. Pump lock out devices due to faults or abnormalities as specified.
- o. Visual/ audio alarms, indications and communications facility as specified.
- p. Necessary inter-connection control and power cable work, cable glands, lungs and internal wiring and connections.

**Engine Section: -**

The engine section shall incorporate the following facilities.

- a) Control system components and equipment such as relays, Contractors, and timers etc. for automatic operation.
- b) Instruments, indicator lamps, fuses, terminal blocks, push buttons, control and selector switches etc. as are required.
- c) Engine shut down and block out devices due to faults or abnormalities as specified.
- d) Visual/ audio alarm indication and enunciator facility as specified.
- e) Inter- connection control and power cable work, cable glands, lungs, all internal wiring and connection etc.

**Auxiliary Pump Section: -**

Each of the auxiliary pump section for priming pump shall incorporate the following:

- a) TP&N Molded case circuit breaker
- b) Control system components such as relays, timers, Contractors etc. as are necessary for functional requirements.
- c) Starter unit, current transformer and ammeter
- d) Indication lamps, fuses, terminal blocks, push buttons selector, switch etc. as required.
- e) Inter-connections, power and control cable work, cable plants lugs, internal wiring and connections.

- f) Low water level alarm for terrace tank, where provided.

**System Controller: -**

The system controller shall consist of relay timer, contactor etc for interlocking of fire pump and fault isolation and incorporate the following:

- a) Control components integrating the various sections, so as to satisfy the functional requirements.
- b) Battery charger unit with boost/ float charge facility with voltmeter, capable of independently charging 1 set of battery at a time.
- c) Visual/ audio alarms not covered in individual sections.
- d) Lamps healthy test facility.
- e) Instruments, indicating lamps, push buttons, fuse terminal blocks etc. as are required.
- f) Test facility to stimulate operation of hydrants.

**Other Control Components****Pressure Switches:**

Pressure switches shall be provided for switching on and off the jockey pump at present pressures and also for switching of the fire pump at present pressure. Being the main component for initiating the signal for the operation of the pumps, the pressure switches shall be totally reliable, sturdy in construction and of long life. The pressure settings shall be adjustable.

**Low water level indication and switch:**

To prevent the dry running of the fire pumps due emptying of the static tank, water level indication and switch shall be provided. This shall trip the electric motor or stop the diesel engine, as the case may be when the water level goes below a present level. This shall also furnish a distinct low water level audiovisual alarm. This should indicate the level of water at different stages is the power and control panel.

**Power Supply for Controls:**

In order ensure that the control systems remains operational at all times, the control system shall be designed for 24V DC operation, fed from 24 V wet battery. This shall be

independent of the starting battery for the engine i.e., battery shall remain trickle charged at the times from the common battery, charges at the control section.

**Operating Conditions For The Fire Pumps :**

Fire Service Pump	Nos	Cut in Pressure	Cut out pressure	Remarks
Jockey Pump	Two	Automatic	Automatic	To auto start and stop
Main Pump (Hydrant)	One	Automatic	Push button Manual	To auto start on pressure switch on air vessel and manual off
Sprinkler Pump	One	Automatic	Push button Manual	To auto start on pressure switch on air vessel and manual off
Diesel Fire Pump	One	Automatic	Push button Manual	To auto start on pressure switch on air vessel and manual off

**4.34. GAS FLOODING SYSTEM**

**SCOPE OF WORK:**

Scope of work includes Design, supply, erection, testing and commissioning of Gas flooding fire suppression system

**System Design**

Supply Installation testing and commissioning of FK-5-1-12 based fire suppression system. The fire suppression system shall include and not be limited to gas release control panel, CCOE approved seamless cylinders, discharge valve (with solenoid or pneumatic actuator) as the case may be, discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 or ISO standards and installed in compliance with all applicable requirements of the local codes and standards. The system shall be VdS or FM/UL listed. The system shall be designed with minimum design concentration of 4.2 % as applicable to Class-A & C fire. The cylinders shall be super-pressurized with dry Nitrogen to 25 bars / 34.5 bar / 42 Bar.. The FK-5-1-12 gas shall be complying with the following. UL listed.

120 liters. Seamless Cylinder CCOE Approved, complete with a safety burst disc & Safety cap.

EXTINGUISHING Gas agent to be filled in above Gas cylinders,

Cylinders shall be seamless construction in order to have UL listing. Cylinder neck shall be threaded to suit the type of valves.

Electrical CUM Manual Actuator

Local manual actuator

Electrical, Pneumatic actuators, manual actuators, all actuators shall be as per NFPA. and UL/ VDS/FM/LPCB listed & marked.

2" Flexible discharge hose.

Discharge pressure switch, WP(2-3/4" outlet), Lat.

Brass nozzle degree NPT – India

Cylinder bracket assembly for each cylinder as per above capacity.

Supply installation, testing and commissioning of C.S seamless piping and Fittings All piping shall be Schedule 40 seamless pipes complying with grade B and all fitting shall be of ASTM A-105.

Supply installation, testing and commissioning of 2 Zone CONVENTIONAL Gas release panel with batteries to connect Manual abort/Release switches, multisensory detector, Hooter cum strobe.

Supplying, installation, testing & commissioning of intelligent analog addressable photo thermal detector complete with mounting base complete as required.

Supply installation, testing and commissioning of 2C x 1.5 sq.mm PVC sheathe armored FRLS cable with suitable clamps.

Supply installation, testing and commissioning of Manual release switch.

Supplying, installation, testing & commissioning of addressable horn cum strobe complete as required.

Supplying, installation, testing & commissioning of response indicator on surface/recessed MS Box having two LED, metallic cover complete with all connections etc as required.

Modules for integrating with Fire Detection system

#### **4.35. ELECTRICAL PANEL FIRE SUPPRESSION SYSTEM:**

The Electrical Panel of Cylinder Valve Assembly (2.5 lb / 1 Kg - capacity), Cylinder with Single Outlet Valve, F -K-5-1-12 Fire Suppression Fluid (2.5 lbs) 1 Kg, Cylinder bracket (1), Rubber Grommets - 6mm, Plastic Loop Clamps with accessories, EOL Adapter with Pressure Gauge with Accessories etc.,

The capacity of 5 lb capacity/ 2 kgs Capacity , Cylinder with Single Outlet Valve, F-K-5-1-12, Fire Suppression Fluid (2.5 lbs) / 2 kgs Cylinder bracket (1), Rubber Grommets - 6mm, Plastic Loop Clamps with accessories, EOL Adapter with Pressure Gauge with Accessories, etc.,

The Capacity of 10 lb capacity/ 4 kgs Capacity ), Cylinder with Single Outlet Valve, F-K-5-1-12, Fire Suppression Fluid (10 lbs) / 4 kgs Cylinder bracket (1), Rubber Grommets - 6mm, Plastic Loop Clamps with accessories, EOL Adapter with Pressure Gauge with Accessories. etc.,

The internal Panel inside provided the Heat detection tube (UL approved) for S type top to bottom of the Panel area, whenever heat accrue limitedly spread the dry powered

The Audio Visual Alarm of fixing external wall of Electrical room the immediately sensed the Fire symptoms

#### **4.36. TECHNICAL SPECIFICATION OF PASSIVE FIRE PROTECION SYSTEM**

##### **SCOPE OF WORK**

This method statement describes a proper work procedure that shall be followed for fire stopping applications as per site requirement, specification(s) and contract drawing(s). The scope of work covers:

- (a) Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical bus ways and raceways through fire-rated vertical barriers (walls and partitions),

horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions

(b) Gap between edge-of-floor slabs and curtain walls

(c) Openings/joints between structurally separate sections of fire rated wall or floors

## **GENERAL**

Fire stop assembly are used to restore integrity of breached fire stop walls/floors. These breaches may be created due to passage of service utilities, joints etc.

Fire stop is a fire-resistant material, or construction, having a fire resistance rating of not less than the fire separating elements, installed in concealed spaces or between structural elements of a building to prevent the spread/ propagation of fire and smoke through walls, ceilings.

Fire stop assembly for through penetrations is a combination of fire stop compatible for use with the penetrate, penetration items such as cables, cable trays, conduits, ducts, pipes etc, and their means of support through the wall or opening that together restores the fire resistance rating of the fire separating elements in terms of its integrity and/or insulation properties. The selected system should can accommodate anticipated movement (if any) in service.

## **FIRE SHAFT / ELECTRICAL ROOF CUT OUT**

Providing Fire stop mortar system CP 636 , with minimum 2 hours fire rating when tested in accordance with UL 1479/ASTM-E 814 standards, for horizontal openings in floors or slabs after passing service lines like cables/cable bundles, cable trays etc. The mortar shall be a light weight cementitious product and shall carry test certificate in accordance with IEC 60068-2-57:1999-11 (Environmental Testing) as per Part 2-57: Test for Vibration-Time-history method and VERTEQII for seismic zone 4. The product shall be age tested as per Dafstb and DIBT standards. The product shall carry test certificate for mold resistance rating of 0 as determined by ASTM G21-96. The product shall be age tested as per Dafstb and DIBT standards. The system shall be UL listed & classified and product shall bear the UL and FM approval logo on the packing. If none of UL test certificate comply with actual application, an EJ document prepared by a qualified personnel and based on nearest third party tested & approved systems like UL test certificates.



**WALL OPENIGN FOR ELECTRICAL TRAY / HVAC DUCT CROSSING**

Provide rodent and termite proof Fire Barriers CFS COS ( Composite Sheet) system for 2 hours fire rating when tested in accordance with ASTM E 814/UL 1479 standards. The Composite Sheet 3.81 mm thick, bonded with organic/inorganic fire-resistive elastomeric #SS 304 (Stainless steel) sheet. One side it should be bonded with 26 gauge #SS 304 (Stainless steel) sheet and the other side it should be reinforced with hexagonal shaped #SS 304 (Stainless steel) wire mesh and covered with aluminum foil for the penetrates and the big opening. The small gaps left around the penetrates should be closed with In tumescent sealant FS One max, or with Fire rated Moldable Putty CP 619T, which should be soft & moldable to any shape, to give complete L Rating. This system is to seal all fire rated horizontal in Floor made of concrete, masonry, metal, gypsum partition, after passing service lines like cables/cable bundles, cable trays etc. The system shall be UL listed & classified and product shall bear the UL & FM approval logo on the packing

**FIRE STOP SEALENT FOR CABLE / PIPES/DUCT**

Providing Pre-formed block CFS BL made from in tumescent polyurethane material for temporary or permanent fire stop sealing around cables, cable bundles and conduits. Surface burning characteristics according UL 723 (ASTM E84-01): Flame spread index 10 and smoke development index 15. The sound transmission classification for this product according ASTM E 90 is 52 (STC Rating). The density is 0.27 g/cm<sup>3</sup> and the expansion temperature (intumescent activation) is around 392, °F (200°C). Seismic tested on mechanical.

**Submittal by contractor / fire stops applicator**

The fire stop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project.

The Documentation form for through penetrations is to include:

1. A sequential location number
2. The project name
3. Date of installation
4. Detailed description of the penetration's location
5. Tested system or engineered judgment number

6. Type of assembly penetrated
7. A detailed description of the size and type of penetrating item
8. Size of opening
9. Number of sides of assemblies addressed
10. Hourly rating to be achieved

Items which are not mentioned in below list but required at site, can be taken from the approved list of Approved make of PWD Assam etc. Furthermore, the materials/equipment to be used which are not mentioned in any of the below list should have ISI or equivalent it shall be Certified from the engineer incharge during execution.

#### List of Approved Make

S.No	Fire Fighting System	Approved make / Brands
1.	Gas Based Fire Suppression System	Honeywell/ Fike/Nohmi/ Firetrax or Approved Equivalent
2.	Deluge valve/ Solenoid Valve/ Spray nozzle/ Installation Control Valve	Victaulic/ Smithcooper/ Anvilor Approved Equivalent
3.	Fire Pumps	Mather & Platt (WILO), Grundfos/ Kirloskar/ KSB or Approved Equivalent
4.	Fire Buckets	Safeguard/ Lifeguard/ Swastik/ Minimax or Approved Equivalent
5.	Fire Extinguishers	Safeguard/ Lifeguard/ Swastik/ Minimax/ EEC or Approved Equivalent
6.	Fire Hydrant Valves/ Fire RRL Hose Pipes/ Fire Hose Reels/ Fire Man's Axe/ Short branch pipe/ 2,3,4 FB Inlet/ draw out connection/ Hose Box/ Hose reel drum/ Nozzle/ blank caps and chains/ Coupling	Minimax/ Safex/ Newage (Surendrangar)/ EEC or Approved Equivalent
7.	Flow switch	Potter/ Rapid flow/ Danfoss/ Viking/ Honeywell or Approved Equivalent
8.	Pipe coat material (Pipe Protection)	PypCoat/ Makphalt or Approved Equivalent
9.	Pipe Hangers/ Clamps/ Supports	Chilly/ GMGR/ CAMRY/ Hilti or Approved Equivalent
10.	Mild steel Pipes	Jindal Hissar/ Prakash Surya/ Tata/ SAIL or Approved Equivalent
11.	Weld Electrodes	Advani/ ESAB/ L & T/ Victor or Approved Equivalent

12.	Pressure Gauge	Fiebig/ H GURU/ HD/ BRC or Approved Equivalent
13.	Push Buttons/ Indicating Lamps LED	As per list of Electrical make or Approved Equivalent
14.	Single Phase Preventer	As per list of Electrical make or Approved Equivalent
15.	Solenoid valve/ Spray nozzle	HD/ Tyco/ Danfoss/ Honeywell or Approved Equivalent
16.	Sprinkler Heads (Sidewall/ Upright/ Pendant)	Grinnel -Tyco/Viking/HD or Approved Equivalent
17.	Sprinkler Flexible Drops	Victaulic/ Smith Copper/ Anvil or Approved Equivalent
18.	MS Forged Fittings	New/ DRP/ VS/ SS or Approved Equivalent
19.	Popup Connecting Assembly	Rain Bird/ Dura/ Lasco or Approved Equivalent
20.	Popup Spray Head	Rain Bird/ Toro, USA/ Nelson or Approved Equivalent
21.	Powder coating Material pure Polyester	Jotun/ Berger/ Goodlass Nerolac or Approved Equivalent
22.	RQRC Hydrant	Harvel/ Alprene/ RainBird, USA or Approved Equivalent
23.	RQRC Key	Harvel/ Aqua/ Drip & Drip or Approved Equivalent
24.	CI Butterfly Valves/ Sluice Valves	Zolato/ Audco/ Sant/ DRP or Approved Equivalent
25.	CI Dual Plate check Valves	Zolato/ Audco/ Sant/ DRP or Approved Equivalent
26.	CI Strainers	Zolato/ Audco/ Sant/ DRP or Approved Equivalent
27.	Vibration Eliminators/ Rubber Bellow	Resistoflex/ D'wren/ Kanwal or Approved Equivalent
28.	Electric wires and Cables	As per list of Electrical make or Approved Equivalent

**ELECTRICAL WORK**

**TECHNICAL SPECIFICATION FOR ELECTRICAL SYSTEM****ELECTRICAL SYSTEM****5.1. GENERAL**

The electrical Installation work shall be carried out in accordance with Indian Standard Code of Practice. It shall also be in conformity with the current Indian Electricity rules and regulations and requirements of the Local Electricity Supply Authority and Fire Insurance regulations, so far as these become applicable to the installation. Electrical work in general shall be carried out as per following CPWD General Specifications amended up to date.

Part-I - Internal Work - 2023.

Part-IV - Substation Work- 2013.

Part-VII - DG Set Work - 2013.

Wherever these specifications calls for a higher standard of material and or workmanship than those required by any of the above mentions regulations and specification then the specification here under shall take precedence over the said regulations and standards.

The details of scope of work subhead wise are given in the subsequent phrase.

The Contractor should note that the specifications furnished general nature only and it is the responsibility of the Contractor to submit GAD/shop drawing, supply, install and commission the equipment and services required for the satisfactory performance of the installation. All the items of equipment required for the safe and satisfactory operation of the installation shall be supplied and installed by the Contractor.

**5.2. Scope**

- a) These General Specifications indicate the requirements and precautions to be taken during the execution of Electrical Installation works to ensure efficient, safe, economical and practical use of materials and equipment including prevention of risks and fire hazards.
- b) This Section also covers the general requirements applicable to this works contracts for Electrical Installation works.

**5.3. Related Documents**

These General Specifications shall be read in conjunction with the standard conditions of contract contained in other parts of the document and their correction slips, the specifications, Indicative Items, drawings and other documents.

**5.4. Drawings**

The Shop drawings shall be submitted by the Contractor and got approved from the Engineer. Architectural drawings shall take precedence over other services drawings as to all dimensions. Any deviations in drawings will be brought to the notice of the The Engineer before work is executed. Contractor shall verify all dimensions at site and bring to the notice of the Engineer- In Charge any or all discrepancy or deviations noticed.

**5.5. Approvals**

- a) The Contractor shall obtain all information relating to local regulations, Bye-Laws, sanction and release of electrical connection, application of any and all laws relating to his work or profession and need to execute the work as required. All statutory certificates shall be provided by the Contractor.
- b) Contractor shall obtain sanction of electrical load, approval of the complete installation including D.G. Set and release/ enhance of electrical connection from the relevant inspection/ sanctioning Authorities at all stages and on completion of the installation work. The Contractor shall pass on these approvals to the The Engineer.
- c) All the materials sample before procurement needs to be approved by “ the Engineer”.

**5.6. Code Requirements**

All work shall be done in accordance with the IS Code amended up to date/ Indian Electricity Rules.

**5.7. Codes & Standards**

The manufacturing and the installation shall be in accordance with established codes, sound engineering, practices, and specifications and shall conform to the statutory regulations

applicable in the country. Contractor shall obtain all approvals from statutory authorities' e.g. Electrical inspector & CEIG, pollution control boards, SEB as applicable before commissioning of electrical / DGs, Indian Electricity Act, Indian Electricity Rules, Factory Act, Pollution Control Act. latest amended.

IS-732	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-3043	Earthing.
IS-7689	Guide for control of undesirable static electricity.
IS-3716	Insulation co-ordination application guide.
IS-8130	Conductors for insulated electrical cables and flexible cords
IS-5831	PVC insulation and sheath of electric cables.
IS-3975	Mild steel wire, strips & tapes for armour cable.
IS-3961	Current rating of cables.
IS-694	PVC insulated (heavy duty) electric cables for working Voltage up to including 1100 volts.
IS-424-1475 (F-3)	Power cable flexibility test.
IEC-439/IS-7098	Specification for cross linked polyethylene insulated PVC sheathed cable for working voltage up to 1.1 KV.
IS-1554	PVC insulated cables up to 1100 volts.
IS-10810	Test procedures for cables.
IS-6121	Cable glands.
IS-10418	Cable drums.
IEC-754(1)	FRLS PVC insulated cable.
ASTM-D-2863	Standard method for measuring minimum oxygen concentration to support candle like combustion of plastic (oxygen index).
ASTM-D-2843	Standard test method for measuring the density of smoke from burning or decomposition.
IS/IEC-62305	Code of practice for the protection of buildings and allied structure against Lightning.
IEEE-383	Standard for type test class-IE, electric cables, field splicers and connections for power generation station.
IS 13947/IEC 947	Air circuit breaker/moulded case circuit breaker.
IS-8623	Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000vac/1200vdc.
IS 1018	Switch gear and control gear selection/installation and maintenance.
IS-1248	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS-13779	Digital measuring instruments and testing accessories.
IS-3156	Voltage transformer.

IS-2705	Current transformer for metering and protection with classification burden and insulation.
IS -2147	Degree of protection provided by enclosures for low voltage. Part I,II,III Switch gear and control gear
IS-3427	Metal enclosed switch gear and control gear
BS-162	Safety clearance.
IS-3202	Code of practice for climate proofing of electrical equipment.
IS-375	Marking and arrangement for switch gear, bus bars, main connections and auxiliary wiring.
IS-722	Ac electric meters.
IS-3231	Electrical relays for power system protection.
IEC-255	Electrical Relays.
IS-5082	Electrolytic copper/aluminium bus bars
IS-2834	Capacitors.
IS-2713	Steel tubular pole.
IS-335	Specification for insulating oil.
IS-3837	Specifications for accessories for rigid steel conduit for electrical wiring.
IS-1180 &335	Distribution transformer
(PART I,II,III) GI/STEEL/PVC conduit pipe for electrical wiring.	
IS-2274	Code of practice for electrical wiring installation system voltage not exceeding 650V.
IS-6665	Code of practice for industrial lighting
IS-3646	Interior insulation part 1&2
	a) Supply Voltage 11 KV as applicable
	b) Neutral Earthing Solid Earthing
	c) Voltage Regulation + 10%
	d) Frequency Regulations + 3%
IS-1944	Code of practice for lighting of public through fares.
IS-7752	Guide for improvement of power factor consumers installation.
IS-13346	General requirement for electrical for explosive gas atmosphere.
IS-13408	Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmosphere.
IS-12360	Voltage and frequency for ac transmission & distribution system.
IS-5572	Classification of hazardous area for electrical installations.
IS-5571	Guide for selection of electrical equipment for hazardous area.
IS-4201	Application guide for Current Transformer.
IS-4146	Application guide for Voltage Transformer.
IS-10028	Code of practice for installation and maintenance of transformer.
IS-8478	Application guide for on load tap changer.
IS-10561	Application guide for power transformer.
IS-1646	Code of practice for fire safety of buildings electrical installation.



IS-3034	Code of practice for fire safety of industrial building-electrical generating and distribution station.
IP-30	National electrical code (NEC) BIS publication.
IS-4722	Rotating electrical machines.
IS-4889	Method of determination of efficiency of rotating electrical machines.
IS-325	Three phase induction motors.
IS-4729	Measurement and evaluation of vibration of rotating electrical machines.
IS-900	Installation and maintenance of induction motors.
IS-4029	Air break switches.
IS-2208-9224	HRC cartridge fuses.
IS-2959	Contractors.
IS-9537	Rigid steel conduit.
IS-1030-1982	Specification for carbon steel castings for general engineering purpose.
IS-1601/ BS-649	Performance & testing of Internal Combustion (IC) engines for general purpose.
AIEE-606(1959)	Recommended specification for speed governing of I.C. engine generator units.
BS-5514/IS-3046 8528(Part-2)	Reciprocating IC engine driven A.C. generators.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above. In case of any deviation /conflict of this specification with the codes & standards, the following order of precedence shall govern. Specification, particular specification if any and drawings. Indian regulations/codes and standards.

- Two separate Load Break Switches.
- A mechanism to operate and mechanically interlock the switches.
- An actuator made of a motorized unit or a double solenoid mechanism (both momentarily energized).
- A 3 phases monitoring device and control module (MDCM) for monitoring supply circuits and for transferring the load circuit from one supply to another.

The ATSE shall be fully integrated in one device. No additional wiring other than the power connection shall be allowed to facilitate the proper functioning of the ATSE with the MDCM. All the elements of the transfer switch equipment and control module shall be of the same manufacturer.

## **5.8. A EXTERNAL ELECTRIFICATION**

### **11KV SUBSTATION WORK**

#### **11KV H.T. Metering Panel (Outdoor Type)**

The Outdoor type floor mounted, dust, damp and vermin proof, cubicle HT. Metering Panel made out of 14 gauge CRCA sheet steel complete with conforming to relevant IS Standards and complete as required. H.T. Metering cubicle along with meter (Trivector meter shall be Electricity Supply Authority) be got tested and approved from local electricity supply authority. The GA drawing shall be got approved by ELECTRICITY SUPPLY AUTHORITY before fabrication. The primary function of a metering panel in an HT panel is to measure various electrical parameters such as voltage, current, power factor, active power (kW), reactive power (kVAR), and apparent power (kVA). These measurements are essential for billing purposes, load management, and monitoring the health of the electrical system.

#### **11 KV VCB Panel (Indoor Type)**

##### **General**

Vacuum Circuit Breaker shall be incorporated in H.T. Panel wherever specified. VCB's shall be suitable for operation on 11KV, 3 phase, 50Hz, AC supply.

##### **Codes and Standards**

The 11KV VCB Panel shall comply with the following standards as amended up to date.

IS: 2516 (Part I – Set 3): Indian Electricity Supply & regulations

IEC 60298& IEC 60694

IS: 3427 & IS 12729: Vacuum Circuit Breakers

IEC: 298 (1987) (Annex. AA): Testing for Internal Arc

IEC: 529: Degree of Protection – IP 55

IS: 2544: Bus Bar Supports

IS: 2705 / IEC – 185: Current Transformer

IS: 3516 / IEC – 186: Potential Transformer

##### **Rating**

The rating of the vacuum circuit breaker shall be as per the drawings and schedule of

quantities. The rated/breaking capacity of the breaker shall be 350 MVA at 11KV. The rated making capacity shall be as per the relevant standards.

### **Accessories**

Circuit Breakers shall be provided with the following accessories.

- i. Auxiliary Switch with minimum 6 NO+ 6 NC auxiliary contacts.
- ii. Shunt Trip & Closing coil
- iii. Mechanical Operation Counter
- iv. Spring Charging motor and handle for manual charging.

### **Submittals**

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- d) Type test certificates along with oscillograms for breakers of identical design.
- e) All GAD / Shop drawings and data shall be in English.

### **Type and Construction**

The metal clad panel shall be made out of 2.0 mm thick CRCA sheet steel. The steel work should have undergone a rigorous rust proofing process comprising alkaline degreasing, descaling in dilute sulphuric acid and recognized phosphating process and shall then be given powder coating (Electrostatic) paint of manufacturer's standard shade. The Switch Board Shall be fully extensible with following compartment.

- a. Circuit Breaker Compartment
- b. Bus bar Compartment
- c. CT and Cable Termination Compartment

The compartments shall be dust & vermin proof and safe to touch. A separate metering

chamber for fixing the necessary instrumentation metering and protective equipment shall be mounted on the top / bottom of the panel at the front. The VCB shall consist of three air insulated poles incorporating mechanism of interrupters and suitable clearance between phases. The body of interrupters shall be made of nickel chromium steel supported on insulators made out of metalized aluminum oxide. The contacts shall be of chromium copper and butt shaped. Vacuum circuit breaker shall be mounted on truck or a carriage mechanism. The draw out carriage shall have two position for the circuit breaker viz isolated/test & service position.

Bus bars shall be insulated type made of high conductivity copper supported on cast epoxy mono block designed to withstand full short circuit currents and shall be provided all along the length of the H.T. board.

It shall be horizontal draw out & isolation type, fully interlocked, with dust and vermin proof construction, suitable for indoor installation. The panel shall be supplied with the manufacturer's test certificates. Certificates with date of manufacture and shall be complete in all respects as per details given in the bill of quantities. The switchgear constructions shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panel shall be specially designed to withstand these. Pressure relief flaps shall be provided for safely venting out gases produced inside the high voltage compartment, bus bar compartment and termination compartment. These flaps shall be vented upwards and cannot be opened from outside. These relief flaps shall be of such construction as not to permit ingress of dust/water in harmful quantities under normal working conditions. Enclosure shall be constructed with sheet steel of at least 2.0mm thickness. It shall have a rigid, smooth, leveled, flawless finish.

Total height of the H.T. Panel board shall be 2750mm approximately and width 1000mm (approx.). On the incoming breaker panel, a 100VA burden and Class I accuracy potential transformer  $11KV/\sqrt{3}$  /  $110V/\sqrt{3}$  with LT fuses shall be provided. These shall be three single phase PTs cast resin insulated type. Adequate space at the rear of the panel shall be provided for termination of power & control cables. The panel shall be provided with suitable terminating arrangement for termination of cables. The making contact arms (upper & lower) of the circuit breaker shall be encased in polypropylene tubes. Penetration type bushings shall be provided in the bus bars & cable compartment for the fixed contacts. Safety shutters shall be provided to cover up the fixed high voltage contacts on bus bar and cable sides when the carriage is moved to Isolated/Disconnected position. The shutters shall move automatically

with the movement of the draw out carriage. It shall, however, be possible to open the shutters of bus bars side and cable side individually.

Mechanically operated circuit breaker auxiliary switches of minimum 6 NO + 6 NC ways, shall be provided for control and indication purposes. Control wiring shall be done by using 1.5 sq. mm, 1.1KV grade stranded copper PVC insulated cable. All control fuses shall be HRC link type.

L.T. Terminal blocks for control wiring shall be clamp type suitable for connection of only 2 wires per terminal and shall be 650 V grade. The L.T. control circuit shall be routine tested to withstand 2.0 KV for one minute. Bus bar compartment shall be provided at the rear. Electrolytic copper bus bars shall be of rectangular cross section and insulated. Bus bars shall be supported properly by cast epoxy resin insulators so as to withstand thermal and dynamic stresses during system short circuits. Bus bars shall be provided with necessary colour coding for phases indication. The bus bars shall be designed to withstand a temperature rise of 60 deg. C above and ambient temperature of 50 deg.C. The standard clearance between phase bus bars to be maintained.

### **Bus Bar and Insulators**

The bus bars shall made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-9IE of IS-5082 and air insulated. They shall be adequately supported on epoxy insulators to withstand electrical and mechanical stresses due to specified short circuit currents. Bus bar cross section shall be uniform throughout the length of switch board. Contact surface at all joints shall be properly cleaned and No-oxide grease applied to ensure an efficient and trouble free connections. All bolted joints shall have necessary washers for maintaining adequate contact pressure. All connection hardware shall have high corrosion resistance. Bus bar insulators shall be of track-resistance, high strength, non-hygroscopic, non-combustible type & shall be suitable to withstand stresses due to over voltages and short circuit current. Bus bar shall be supported on the insulator such that the conductor expansion and contraction are allowed without straining the insulators. The temperatures of the bus bars and all other equipments, when carrying the rated of relevant Indian Standards, duly considering the specified ambient temperature.

### **Earthing and Protective Earthing**

Copper earthing bus shall be provided. It shall be bolted/ welded to the frame work of each

panel. The earth bus shall have sufficient cross time fault currents to earth without exceeding the allowable temperature rise. Suitable arrangement shall be provided at each end of the earth for bolting Owner's earthing conductors and earth bus shall run inside at the back of the panel for entire length. Facilities shall be provided for integral earthing of bus bars & feeder circuit-IS 3043

### **Metering and Protection**

The VCB Panel Board shall be provided with cast resin current transformers for metering and protection. The CT's shall conform in all respects to IS 2705-1992Part-I, II and III. These shall have accuracy class of 1.0 for metering of 5P10 for protection. Potential transformers shall be epoxy cast resin type & conform to specifications of IS: 3156-1965 Part-I, II & III and shall be class-1. Electronic digital type Ammeter and voltmeter to be installed on panel. Electronic type digital energy analyzer having parameter of KW, KWH power factor, frequency etc. with 30 days memory shall be provided. All meters shall be tested for 2000V for 1 minute and shall be 96mm square pattern, flush mounting type with necessary selector switches. Necessary indicating lamps of low voltage type with built in resistors shall be provided (maximum wattage 2.5W). The electronic digital types IDMT relay (2 O/C + 1 E/F) to be provided as per B.O.Q. description.

### **Interlocking, Safety and Operating Mechanism**

Vacuum Circuit Breaker shall have electrically operated mechanism for spring charging. These operating mechanisms shall be of the stored energy type. In the closed state of the breaker, the energy stored in the springs shall be suitable for O-C-O duty. The draw out carriage cannot be moved from either test/disconnected to service position or vice versa, when the circuit breaker is 'On'. The circuit breaker cannot be switched 'ON' when the carriage is in any position between test & service position. The front door of the panel cannot be opened when the breaker is in service position or in an intermediate position. The low voltage plug & socket cannot be disconnected in any position except test/isolated position. The door cannot be closed unless the LV plug has been fitted. It shall be possible to mechanically close and trip the circuit breaker through push buttons with the circuit breaker in service position and the door closed. Individual explosion vents shall be provided for breaker, bus bar, cable chambers on the top of the panel to let out the gases under pressure generated during an unlikely event of a fault inside the panel. Circuit Breaker & sheet metal enclosure shall be fully earthed. Self locking shutters shall be provided which close

automatically and shall be interlocked with the movement of the draw out carriage mechanism.

### **Additional Accessories**

The loose items to be supplied with the 11KV VCB Panel Board shall comprise of the following:

- a. Maintenance Manual.
- b. Racking in/out handle.
- c. Foundation bolts.
- d. One number Earthing Trolley for cable side.

### **Control Supply**

The tripping circuit shall be at 24 Volt D.C. through a power pack unit.

### **Installation**

11 KV switch board shall be installed and levelled on the foundation as per manufacturer's drawing. Bus bar connections shall be checked after installation. Cable end boxes shall be sealed after the cable work is completed to prevent absorption of moisture.

### **Tests**

#### **Factory tests**

The circuit breakers panel shall be subjected to routine tests at manufacturers works in accordance with the details specified in the relevant IS specifications.

The vendor shall submit the type test certificate for following

- a. Temperature rise test.
- b. Impulse & power frequency voltage test.
- c. Short time current test on circuit breaker.

#### **Site test**

1. Verification for completion of equipment, physical damage/ deformities.
2. Alignment of panel, interconnection of bus bars & tightness of bolts & connection etc.
3. Interconnection of panel earth bus bar with plant earthing grid.
4. Inter panel wiring between transport sections.

5. Cleanliness of insulators and general Cleanliness of panel to remove traces of dust, water etc.
6. Control wiring verification after interconnecting of panel.
7. Check for free movement of circuit breaker, lubrication of moving part & other Parts as per manufacturers manual.
8. Manual/Electrical operations of the breaker and Functional test as per drawings.
9. megger before the Hi Pot test.
10. megger after the Hi Pot test.
11. CT/PT ratio/polarity primary injection test.
12. Secondary injection test on relays to practical characteristics.

These tests as per the clauses above will be witnessed by the owner/PMC/consultant at the works for which necessary information has to be given in advance to the owner/PMC/consultant.

#### Technical Particulars of Switchgear Equipment ( 11KV)

SI No.	DETAILS	(TEZPUR & JORHAT)-11KV	(DIPHU)-11KV
1	Type	Indoor, cubicle type Indoor	Indoor, cubicle type Indoor
2	System rated voltage	11KV	11KV
3	System maximum voltage	12KV	12KV
4	Frequency	50 Hz.	50 Hz.
5	Insulation Level		
a)	1.2/50 microseconds Impulse withstand voltage	75 KV peak	75 KV peak
b)	One minute power frequency withstand voltage	28 KV rms	28 KV rms
6	Rated Current		
a)	Continuous		
	Bus bar	800 Amp	800 Amp
	Incoming Vacuum circuit breaker	800 Amp	630 Amp
	Outgoing Vacuum circuit breaker	800 Amp	630 Amp
b)	Short time current for 1 seconds	18.3 KArms	18.4 KArms
7	Vacuum Circuit Breaker	Panel board VCB	Panel board VCB
a)	Quantity		
	Incoming feeder	01 Nos.	01 Nos.
	Outgoing feeder	02 Nos.	02 Nos.



	Bus coupler	No	No
<b>b)</b>	Rated breaking capacity	350 MVA	350 MVA
<b>c)</b>	Total breaking time	3 Cycles (maximum)	3 Cycles (maximum)
<b>d)</b>	Auxiliary voltage Control circuit	24 V DC	24 V DC
	Space heater and illumination lamp, etc.	230 V, 1 Ph., 50 Hz.	230 V, 1 Ph., 50 Hz.
<b>8</b>	Potential Transformers	(At Incoming)	(At Incoming)
<b>a)</b>	Quantity	1 each incoming panel	1 each incoming panel
<b>b)</b>	Voltage Ratio	11 KV / 110 V	11 KV / 110 V
<b>c)</b>	Over voltage factor	As per IS – 3156	As per IS – 3156
<b>d)</b>	Accuracy class	0.5	0.5
<b>e)</b>	Rated burden	100 VA	100 VA
<b>9</b>	Current Transformer		
	Incoming		
	Core01	80/5, 15VA, Class 1.0 for Metering as per requirements	80/5, 5VA, Class 1.0 for Metering as per requirements
	Core02	80/5, 15VA, Class 5P10 for Protection	80/5, 5VA, Class 5P10 for Protection
	Outgoings		
	Core01	40/5, 15VA, Class 1.0 for Metering	40/5, 5VA, Class 1.0 for Metering
	Core02	40/5, 15VA, Class 5P20 for Protection	40/5, 5VA, Class 5P20 for Protection
	Core03	40/5, Class PS for Transformer Differential Protection	40/5, Class PS for Transformer Differential Protection

### Warranty/Guarantee

Products will be a period of 18 months from the date of Dispatch and commissioning as per Manufacture defects

### 5.9. 11 KV/0.433 KV OIL TYPE DISTRIBUTION TRANSFORMER

#### General

The transformer shall be double wound core type with low loss, non ageing, high permeability, Prime Grade, CRGO with M4 grade or better, copper wound, perfectly insulated and clamped to minimized noise and vibrations. Major civil work such as foundations, trenches, etc will be paid as per civil works. Minor civil work like cutting and making good all damages caused during installation and restoring the same to their original

finish will be inclusive in the price. Transformers will be as per CPWD specifications.

### OLTC Type

Transformer shall be outdoor duty type. The transformer shall be fabricated as per IS 1180 specification amended up to date. The Transformer loss will be as per 1180 Amended up to Date.

### Specification Standard and Factory Test

Unless otherwise stated below, transformer & transformer oil shall conform to IS 1180 & 335 respectively.

#### 5.10. 11KV TECHNICAL DETAILS AS PER IS: 1180 LEVEL 2

Sl.No	Description	(TEZPUR & JORHAT)- 11KV	(DIPHU)-11KV
01]	Rating (kva)	1250 kva (Outdoor Type)	630 KVA (Indoor Type)
02]	Voltage Ratio (kv) (At No Load)	11/0.433 kv	11/0.433 KV
03]	Quantity	04 Nos	02 Nos.
	<b>TECHNICAL PARTICULARS</b>	Copper Wound, Class A Insulation	Copper Wound, Class A Insulation
A]	Vector Group	Dyn11	Dyn11
B]	Tapping Range	+5% To -15% @ 1.25% steps	+10% To -10% @ 1.25% steps
C]	Tap – Changer	(OLTC) on HV winding (OLG Make) RTCC Panel With AVR	On Load Tap Changer + RTCC & AVR
D]	Steps	16 Steps / 17 Positions	16 Steps / 17 Positions
E]	Temp. Rise (Oil/Wdg.)	40/45° C	40/45° C
F]	Total losses at 50% Load (Max.)	3.3 kw	1.745 KW
G]	Total losses at 100% Load (Max.)	9.2 kw	4.85KW
H]	Impedance at 75° C	5.1 % (+10% TO -10% IS TOL.)	4.5 % (+10% TO -10% IS TOL.)
I]	Insulation Level	Class A	Class A
J]	HV (KVp/KVrms)	75/28	75/28
K]	LV (KVp/KVrms)	NA/3	NA/3
L]	Termination		
M]	H.V./L.V./Orientation	Cable Box / Cable Box / 180	Cable Box / Cable Box / 180
N]	Fittings	Standard Fittings.	Standard Fittings.
O]	Paint	Polyurethane	Epoxy to Shade 631 of IS 5

### Core

The magnetic core shall be made up of cold rolled grain oriented low loss steel stampings.

**Cooling**

Natural oil cooling by means of pressed / round tubes around transformer tank (ONAN).

**Frequency**

50Hz plus minus 3%

**Rated voltage**

Transformer shall operate at its rated KVA at any voltage plus minus 10% of rated voltage of that particular tap.

**Vector group**

Corresponding to the vector symbol Dyn-11

**Connections**

H.V side of transformer shall be provided with suitable size cable box for 3 core XLPE cable. Indoor heat shrinkable termination kit shall be used for termination of HV Cable.MV side of transformer shall be suitable for bus duct connection/XLPE Al. Ar. Cabling arrangement.

**Tapping**

ON load tap changing arrangement on HV side. The range for circuit taps, which shall be provided on H.V. side, shall be plus 5.1% & minus 5.1% in steps of 1.25%

**Temperature Rise**

The transformer shall conform to the requirements of temperature rise specified in IS: 1180. Continuously rated for full load, temp. rise not to exceed 50 degree C by thermometer in oil ( 55degree C by resistance)

**Insulation Levels**

The insulation levels shall be in accordance with IS 2076 (Part III) 1977 . Terminal Markings, Tapping & Connections.

The terminal marking, tapping 21 connections shall be in accordance with IS 2026(Part1V)1977. Requirements With Regards To Ability To Withstand Short Circuit.

As per IS 2026 (part I) 1977

Impedance Voltage

As per table 3 of IS 1180/ECBC-2017

### **On Load Tap Changing Switch**

On load tap changer with RTCC panel and AVR PARALLEL OPERATION

Transformer shall be suitable for parallel operation with similar unit of same rates.

### **General Requirements Of Transformers**

- Transformer shall be suitable for operating at rated capacity continuously at any of the taps under ambient conditions and with the voltage and frequency variations indicated without exceeding permissible temperature rise and without any detrimental effect to any part.
- Transformer shall be designed to be loaded as per IS:6600.
- All windings shall have uniform insulation resistance to earth.
- Disconnecting chamber shall be air filled. Suitable cable end box shall be provided for termination of cables. Gland plate for single core cables shall be non-magnetic.
- Transformer shall be able to withstand electrodynamics and thermal stresses due to terminal short circuit of the secondary, assuming the primary side is being fed from an infinite bus. All leads and windings in cores shall be properly supported. Short circuits withstand and duration shall be 1 secs. As per IS:1180.
- Short circuit test results for similar transformers shall be furnished.
- There shall be a marshalling box for gathering all alarm signals. All alarm shall be wired up to terminal strip provided in marshalling box. 20% spare terminals shall be provided. Armoured cable of 2.5 sqmm cu shall be provided along with suitable size glands for terminating these contacts in marshalling box.
- Guides shall be provided to facilitate tanking and untanking of the core with the coil assembly. The details of anchoring of core and coils assembly of tank shall be furnished.
- Radiators shall be provided on the tank to facilitate cooling. These shall be detachable type and shall be provided with isolating valves at ends, drain plugs

and air release plug. Radiators of 1.2 mm thickness seamless steel tubing or pressed sheet steel.

- Means for lifting and jacking of transformer shall be provided.
- Class-A insulating material specified in IS:1271 shall be used. Paper insulation shall be new and free from punctures. Wood insulation, wherever used, shall be well seasoned and treated.
- The mineral oil shall comply with IS: 335. 10% extra oil in seal tins/ drums shall be supplied. All valves shall be of globe type. Valve body of carbon steel and trim of 135 cr. Steel.
- Oil temp. Indicator for measuring top oil temp. shall comprise 150mm dial type thermometer pocket and capillary tube jacketed with PVC sleeve. Thermo-meter shall have 2 sets of contacts, one for alarm and the other for trip, and set points can be set by hand. Contacts shall be wired up to marshalling box.
- Buchholz relay shall be provided as per IS: 3637. It shall be double float type with two sets of contacts for alarm and trip with facility for testing by injection of air by hand pump and with cock for draining and venting of air. Relay shall be provided with shut off valves on conservator side as well as on tank side.
- Alarm and trip contacts shall be suitable for 1A 230 AC.
- A marshalling box shall be provided to accommodate all auxiliary devices except those which are to be located directly on transformer. It shall be of dust, weather and vermin proof type of sheet steel 2mm thick and shall have sufficient Space for ease of cabling. 20%extra terminals shall be provided.
- All steel surfaces exposed shall be treated with suitable anti –rust, anti–corrosive paints.
- Bushing insulator shall be rated for max. System voltage and shall be as per IS. Bushing shall be enclosed in terminal box and shall be detachable from outside the tank. Separate neutral bushing shall be provided for earthing the neutral. When LT cable box is provided, a neutral bushing shall be brought out for solid earthing.
- Transformers shall have same percentage impedance & other characteristics with foundation plan parallel operation as per IS: 10028.

### **Fittings**

The following accessories and fittings shall be provided with the transformer

**LIFTING LUGS:** The arrangement of lifting the active part of the transformer along with the cover of the tank by means of lifting lugs without disturbing the connections. Also complete transformer lifting lugs shall be provided.

**ROLLERS:** The transformer to be provided with 4 Nos. rollers fitted on cross channels to facilitate the movement of transformer.

**OIL CONSERVATOR:** The transformer to be provided with a conservator with welded end plates. It is to be bolted to the cover and can be dismantled for purposes of transport. It has to be provided with oil gauge with marking for minimum level and an oil filling hole with a cap which can be used for filtering of oil. For draining purposes a plug is to provide. A connection pipe between the conservator and tank is to be provided, which projects inside the conservator.

**AIR RELEASE VALVE:** An air release valve shall be provided on top of the tank cover to facilitate of the entrapped air while filling of oil.

**BREATHER:** The transformer shall be provided with an indicating dehydrating silica gel breather of sufficient capacity.

**DRAIN VALVE WITH PLUG:** The transformer to be provided with drain valve with plug at the bottom of the tank.

**DIAGRM WITH RATING PLATE:** One diagram and rating plate indicating the details of transformer connection diagram vector group tap changing diagram etc.

**THERMOMETER:** Dial type thermometer (150mm dia ) with maximum set pointer 75 degree C electrical contacts for electrical contacts for electrical alarm at high temp.

**EXPLOSION VENT:** Explosion vent or pressure relief device shall be provided of sufficient size of rapid release of any pressure that may be generated within the tank and which might result in damage in the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank.

**FILTER VALVE:** Filter valve on the top of the tank.

**BUCHOLTZ RELAY:** Oil actuated relay equipment shall conform to IS 3637-1966(amended up to date) and shall be double float type having contacts which close following oil surge or under incipient fault condition. Bucholtz relay shall have contacts for alarm /trip.

**WINDING TEMPERATURE INDICATOR**

Winding temperature indicator with electrical contact for alarm/trip

**OIL TEMPERATURE INDICATOR:** Oil temp. Indicator with alarm & trip contacts.

**MARSHALLING BOX:** the transformer shall be provided with suitable size marshalling box to terminate the control cables of thermometer and bucholz relay.

**CONTROL CABLING:** All control cables required from Marshalling box to H.T panel board for Trip/alarm of winding temp. Indicator, oil temp indicator, bucholz relay etc. shall be provided and deemed to be included in the rate of transformer equipments.

**TRANSFORMER OIL:** First filling of oil.

**EARTHING:** Two separate earthing terminals are to be provided at the sides of the tank on both the sides for earthing.

**SOAK PIT**

Soak pit for oil filled transformer shall be made as per IS 10028 (Part II) 1981 with up to dated amendments. Sump shall be formed in the transformer room and shall be connected to soak pit outside the transformer room with a pipe. All the civil works required for the soak pit shall be done by the Contractor and the cost shall be deemed to be included in quoted rates of the transformer item.

**Instrumentation Manual**

The Contractor shall submit three copies of manual of complete instructions for the installations, operations, maintenance and repair, circuit diagrams, foundations and trenching details shall be provided with the transformer.

**Shop Drawings**

The selected supplier shall prepare and furnish shop drawings for the approval by the consultant/PMC/client before commencing fabrications/ manufacture of the equipment. Shop drawing shall be based on the requirement laid down in the specifications. The manufacture of the equipment shall be commencing only after the shop drawings have been approved in writing by the consultant. Transformer shall be manufactured conforming to specification of Local supply authority.

**Inspection**

The transformer shall be inspected on arrival as per the inspection manual of the supplier. Shall be examined for any sign of damage and special attention shall be given to the following parts.

Oil tank and cooling tubes Bushes cracks or broken Oil sight glass

**Installation**

The transformer shall be installed as per transformer manual of the transformer supplier and conforming to Indian standards.

The transformer is to be erected on suitable size M.S channels embedded in the cement concrete flooring including providing & fixing the channel. The transformer supplied shall be lifted by all lifting lugs for the purpose of avoiding imbalance in transit.

The transformer wheels shall be locked by suitable locking arrangement to avoid accidental movement of the transformer.

The transformer cable end boxes shall be sealed to prevent absorption of moisture.

The transformer natural earthing and body earthing shall conform to Indian Standard.

**Factory Test**

The transformer shall be subjected to test as laid down in IS 2026 (Part I) 1977 at factory/manufacturing unit prior to dispatch of the transformer to the site.

All original test certificates shall be furnished. TESTING AT SITE

Prior to commissioning of the transformer the following tests shall be performed

Insulation resistance of the winding between phases and earth of Primary and Secondary side.

Winding resistance of all the winding on all tap positions shall be taken.

The supplier gives sufficient advance information about the test schedule to enable the PMC/owner to appoint his representative.

**High Speed Resistor On Load Tap Changer General**

High speed resistor on load tap changer shall be provided with the transformer wherever specified. The high speed resistor OLTC shall be for rated voltage up to 11KV rating current of 100 Amp, 3phase, 17 step conforming to Indian standard with AVR & RTCC panel.



**Type And Construction**

OLTC shall be a compact unit for use with three phase distribution transformer. It shall be completely self contained and designed to bolt directly to a part flange on the transformer.

The assembly comprise of

- ❖ Tank
- ❖ Selector Switch
- ❖ Operation Mechanism
- ❖ Barrier Board
- ❖ Local control Gear
- ❖ Control cable Terminations
- ❖ AVR & RTCC panel

**Tank**

The complete tap changer shall be housed in a single tank of welded sheet steel construction. The tank shall be divided into two separate compartments to house the selector switch, driving mechanism and Local control gear. Access to the compartments shall be made easy by means of removable covers and a weather proof door. Anti- condensation heater shall be provided in the compartment which houses driving mechanism and control gear.

**Selector Switch**

A selector switch transformer is designed to serve dual purposes. Firstly, it acts as a selector switch, allowing the user to choose between different input or output configurations. Secondly, it incorporates a transformer function, which means it can step up or step down voltage levels as needed.

**Operation Mechanism**

An impulse is received either from a remote control panel or from a local manual operation switch, which energises the appropriate raise/lower contactor to initiate a tap changer in the required direction. The contactor when energized seals itself via its own contact and the driving motor commences to run. At a predetermined point a directional sequence switch closes, taking over the handling duties of the contactor whose original hold circuit shall be isolated. At the completion of the tap changer the directional sequence switch opens and de-energises the driving motor. The arrangement ensures that a short period initiating pulse shall be accepted by the control gear.

**Barrier Board**

Barrier board transformers serve similar purposes as other transformers, which is to step down voltage from a higher level to a lower level suitable for powering control circuits or devices. They are commonly used in industrial automation and control systems where space-saving and organized wiring are essential.

**Local Control Gear**

The primary purpose of a local control gear transformer is to step down voltage from a higher level (such as 208V, 240V, 480V, etc.) to a lower voltage suitable for powering control circuits and devices. Common output voltages for local control circuits can be 24V AC/DC, 120V AC, or 240V AC, depending on the specific application and requirements.

**Control Cable Termination**

A detachable undrilled gland plate and the terminal station for all the external connections shall be provided in the driving mechanism compartment of the tap changer.

**Automatic Voltage Regulator**

Solid state automatic voltage regulator shall be provided for the regulation of the secondary voltage of the power transformer with on load tap changer (OLTC). The band width control shall allow the dead band to be set in the terms of upper (LOWER VOLTS) and lower (RAISE VOLTS) voltage limit around a particular nominal value with a specified sensitivity. AVR shall be provided with time delay control to allow the regulator to respond only to voltage fluctuations lasting for period greater than a selected time delay. Where the voltage correction requires more than one tap change, the time delay shall be reinitiated before further tap changes. Regulations shall reset automatically after voltage correction. Solid state lamps (LED) shall be provided to indicate voltage outside the preset limit & control relay operation.

**RTCC Panel**

RTCC panel shall be provided to operate OLTC from control room located in substation. RTCC shall be provided with main switch, a sequence selector switch. RTCC shall be provided with lower push button & raise push button, tap change in progress & complete. A.C supply ON/OFF lamp indicator & AVR relay operated operation indication. Cubical panel shall be totally enclosed, floor mounting and fabricated with a framed structure with rolled/folded sheet steel channel section of minimum 2mm thickness. All the sheet steel work

forming the exterior of RTCC panel shall be smoothly finished and all steel work used in construction of RTCC panel shall undergone a regrious metal treatment process consisting of effective cleaning by hot alkaline degreasing solution followed by the cold water rinsing, pickling in dilute sulphuric acid to remove scales and rust formation, a recognized phosphating process, passivating in deoxidize to retain & augment the effects of phosphating, drying with compressed air and dust free atmosphere, primer coating with two coats of highly corrosion resistant primer applied under strictly controlled conditions and finished coat of stoving.

### **Warranty/Guarantee**

The product covered by a period of 18 months from the date of Dispatch and commissioning, This guarantee is subject to be installation, commissioning & operation and maintenance of the transformer as per IS - 10028 and as per manufacture defects

## **5.11. D.G. SET& DG Synchronizing Panel**

### **Scope of Work**

The specification shall cover complete supply, transportation, foundation, installation, testing and commissioning of diesel engine alternator set. All minor civil works including Foundation, electrical and other works associated with the testing, installation and commissioning of the sets shall be carried out by the Contractor as per specification.

- 1) Diesel engines directly coupled with alternators mounted on a rigid fabricated base frame with resilient anti-vibration mountings.
- 2) Alternator with excitation system and automatic voltage regulator (AVR) and necessary protection and metering CT's in terminal box of alternator.
- 3) DG Set mounted with Control Panel.
- 4) Acoustic Enclosure as per C.P.C.B. latest Norms.
- 5) Obtaining statutory approvals for DG set system.
- 6) Exhaust piping with Silencer, associated wiring and accessories.
- 7) Exhaust Gas Treatment System

### **Intent of Specification**

This specification covers the GAD, manufacture, assembly, shop testing, packing, dispatch, transportation supply, erection, testing, commissioning, performance and guarantee testing of

Diesel Gen-Sets, complete in all respects with all equipment, fitting and accessories for efficient and trouble free operation as specified here under.

### Codes and Standards

The equipment furnish under this specification shall conform to the following latest standard, except where modified or supplemented by this specification:

BS:5514	Specification for reciprocating internal combustion engine.
BS:5000	Rotating electrical machines of particular type or for particular applications.
IS:1239 (Part - I&II)	Mild steel tubes and fittings.
IS:1651	Stationary cells and batteries lead acid type (with tubular positive plates).
IS:9224	Specification of low voltage fuses, General Purpose.
IS:4540	Mono-crystalline semi-conductor rectifier assemblies and equipment.
IS:5	Colours for ready mixed paints.
IS:4722	Rotating electrical machines
IS:1248	Specification for electrical indicating instruments.
IS:10000	Methods of tests for internal combustion engines.
IS:10002	Specifications for performance requirements for constant speed compression ignition (Diesel) engine for general purposes (above 20KW).
IS:2147	Degree of protection provided by enclosure for low voltage switchgear and control gear.
IS:1600	Code for type testing of constant speed IC engines for general purposes.
IS:1601	Performance of constant speed IC engines for general purposes.
ASME Power	Internal combustion engines. Test Code PTC-17.

### Diesel Engine

Diesel Engine shall be stationary, compression, ignition, totally enclosed, water cooled, stroke cycle, cold battery starting, turbo charged and after cooled heat exchanger cooled 1500 RPM in accordance to BS:649/5514 and IS1000/3046 specification complete with all accessories.

### Cooling System

Cooling system shall have radiator, Thermostat & engine built pumps, Corrosion Resistor,

Self contained piping for secondary circuit, By pass thermostat.

### **Fuel System**

Fuel System shall have PT Fuel Pump, Injectors, Fuel filters, Self contained piping & houses, Complete piping.

### **Lubricating System**

Lubricating system shall have Oil pump, Strainer, Lube oil cooler, Oil filter, Bypass filter, Self contained piping, Lube oil priming pump if required.

### **Exhaust System**

Exhaust system shall have Exhaust Manifold, Flexible piping, Residential silencer to limit the noise level and extending silencer outside the canopy.

### **Starting System**

Starting system shall have Starter 24V with suitable ampere capacity, Charging Alternator with inbuilt regulator 24 V minimum 30 AMP DC or as per battery capacity, Connecting links between battery & alternator. The engine shall be suitable for black start.

### **Main and Big End Bearing**

The main and big end bearing shall be detachable shells of high grade bearing material, and shall be pre finished. The dimensions of big end bearings shall be such that the connecting rods can be withdrawn through the cylinder liners.

### **Coupling Arrangement**

Coupling arrangement shall have Flexible coupling, Flywheel, Flywheel Housing, Coupling Guard

### **Instrument Panel**

Instrument Panel shall have-

- Lube oil pressure gauge
- ATS System
- RMP Indicator & Hour Meter.
- Battery charger ammeter.
- Starting switch with key

**Safety Control Trip**

- Low Lube oil pressure
- High Water temperature
- Engine over speed.
- Lube oil temperature.

**Alternator**

Manufacturer	Stamford / Leroy Somer IS: 4722/BS 2613
Output	630 KVA self excited, self regulated foot mounted fitted with ball and roller bearings and having PMG, droop CT for paralleling. This shall give full output of 630 KVA at 40 deg. C.
Power factor	0.8
Rated Generating Voltage	415 Volts, 3 phase 4 wire systems
Voltage regulation	+/- 1.0% all load between no load to full load & power factor 0.8 to unity AVR shall be mounted in alternator.
Frequency	50 HZ
Speed	1500 RPM
Overload Capacity	10% for one hour in any 12 hours of operation without Exceeding temperature rise limits specified in BS:2613 when corrected to ambient temperature at site
Class of Insulation	H and temp. Rise limited to class H
Space Heater	To be provided if required.
Winding connection	Star connection (all six leads will be brought out of stator frame).
Termination	Termination box shall be amended to connect the bus duct.

The alternator shall be self-excited, self regulated, self ventilated in brush less for suitable automatic voltage regulator and shall conform to BS: 2613 or equivalent standard and shall give rated output at NTP conditions. The alternator shall have space heater which shall be connected with breaker NO/NC contacts and this should be able to cut off with thermostat.

**Other Accessories****Fuel Tank**

Day service fuel tank shall be made of 2mm thick MS sheet of 990 liters capacity for each set with all accessories such as oil level indicator, inlet pipe connection, outlet pipe connection, trough to collect split oil, air vent pipe with air filter, manhole with cover, low level and full level float valve arrangements with all fittings interconnections between tanks. The tank shall be provided with suitable calibration scale.

**Base Frame**

M.S. Fabricated adequately machined base frame complete with lifting, facilities pre-drilled foundation holes suitable for permanent installation on foundation shall also be supplied. The base frame shall be manufactured with steel and shall be stress relieved. Manufacturer shall specify what measures are taken to reduce the stresses.

**Batteries**

For electrical control ckt of 24V D.C. of suitable ampere hour complete with battery charger, leads and wooden base plate and shall be placed inside canopy.

**Fuel system**

The engine shall be capable of running on High Speed Diesel fuel oil. The fuel consumption of the engine at full, three quarters and half of its rated power output shall be indicated by the Contractor in the bid. A fuel service buffer tank, common for two DG set with 990 litres capacity shall be provided on a suitably fabricated steel platform. The tank shall be complete with level indicator marked in liters, filling inlet with removable screen, an outlet, a drain plug, an air vent and necessary piping. The fuel tank shall be painted with oil resistant paint. Service tank level switches (2 Nos. per tank) for alarm & trip shall also be provided by the bidder. All pipe joints should be brazed/welded. A hand pump for pumping the fuel into the fuel service tank together with necessary pipes or tubing shall be provided.

**Silencer**

Exhaust silencer shall be residential type to reduce the noise level.

**Cooling**

The diesel engine shall be radiator cooled type if installed on site plan and heat exchanger cooled if installed in basement.

**Engine Governor**

The governor shall be Electronic type suitable for class A-1. This shall control the generator frequency, and shall be suitable for operation as per the selected battery voltage (24 V DC.). The governor shall be provided with a manually adjustable over speed trip mechanism to automatically shut-off the engine or the fuel supply if the set reached 120 % of rated speed. Governor shall be capable to maintain zero speed rate or regulation and shall be AI type as

per BS:5514 in order to take care of heavy motor starting. It shall have necessary characteristics to maintain the speed substantially constant even with sudden variation in load. However, a tripping shall be provided if speed exceeds maximum permissible limit.

### **Turbo Charger**

It shall be of a robust construction, suitable of being driven by engine exhaust having a common shaft for the turbine and blower. It shall draw air from filter of adequate capacity to suit the requirements of the engine.

### **Starter Battery**

The battery shall conform to the requirement of IS: 1651. Starting battery sets of 24 V, heavy duty high performance approved make/quality shall be provided to enable crank & start the engine even in cold/winter morning conditions. Type/voltage/AH capacity of same on 20 hour rated discharge period shall be indicated in the offer. The battery shall be capable of performing at least (6) six normal starts without recharging.

The battery shall be provided with 2 Nos. cables, minimum 1.5m long heavy duty PVC insulated cabling with brazed tinned lug at one end and with brazed tinned brass terminal lug at battery end - for connecting batteries to cranking system - with 0.25 m long inter battery connecting cable.

The lugs shall be clearly stamped (+) or (-) and positive cable also red sleeved for easy identification.

### **Engine Safeguard**

- Safeguards shall be provided and arranged when necessary to stop the engine automatically by the following:
  - Energizing a solenoid coupled to the stop lever on the fuel injection pump rack.
  - De-energising the “fuel on” solenoid.
  - Energizing the “fuel - cut off” solenoid.
  - If any of the door opens.
- The operation of the safeguard shall at the same time give individual warning of the failure by illuminating an appropriate local visual indicator and remote alarm at generator panel.
- The contactors, relays and other devices necessary for signal and control, for above purposes shall be provided at Generator panel.



- At the set at a easily accessible place an “EMERGENCY STOP” mushroom head stay put type P.B shall provided to stop the set in emergency mode.
- The safe guard to “STOP THE SET” shall stop the set irrespective of mode selection of the set viz Auto, Manual or test for following cases, with simultaneous isolation of alternator ckt.
- Emergency stop P.B’s operation.
- Over speed.
- Low lube oil pressure.
- Sound Attenuating Acoustic Enclosure.
- Sound Attenuating Acoustic Enclosure should have pleasant and aesthetical looks and should be able to bring down the noise to 75 decibels when measured at a distance of 1 meter away from the set.
- The DG set should be supported on a base frame in an MS Sheet enclosure with suitable ducting for air inlet and outlet. The door and enclosure should be given corrosion resistant treatment and painted to be weatherproof and long lasting. Resin bonded Glass / Mineral / Rock wool of high density with perforated MS Sheet should be provided and covered with tissue paper. Enclosures should be provided with durable locking system with doors duly gasketed with neoprene rubber.
- Exhaust gases should be taken out from the DG Set by means of MS Pipe and a noise suppressor.
- Proper care should be taken for engine heat rejection in order to have safe working temperature inside the enclosure by provision of fans etc, as required. The design aspect should ensure free and uninterrupted flow of suction and exhaust air in order that the temperature rise of the enclosure with respect to the ambient is less than 7°C.
- Radiator hot air shall be throughout on top instead of front. The arrangement shall be made accordingly in acoustic enclosure.

**DEF Tank**

- IDEF/Aqueous urea to sets off the chemical reaction with Exhaust gas
- Tank size is optimized in accordance to DEF consumption
- Supply Module & DCU (DCU - Dosing control unit)
- Control & monitor the DEF(DEF - Diesel exhaust fluid)
- Exhaust Gas Treatment System
- DOC & SCR system sets off the reaction to meet the latest CPCB norms

- (DOC - Diesel oxidation catalyst & SCR - Selective catalytic reduction)
- Reduction in NOx & HC
- Reduction in PM

### **Erection, Testing & Commissioning**

The entire work of erection, testing and commissioning of equipment supplied under this package shall be carried out by Contractor and performance and guarantee tests to be conducted at site are also included under the scope of this specification. For this purpose the Contractor shall depute suitable qualified technical supervisor to site on advance intimation to the Owner along with all special testing equipment required for testing and performance and guarantee tests. The supervisor(s) shall be responsible for the installation, testing, commissioning checks and performance & guarantee tests mentioned in relevant clauses of this volume and the checks recommend by the Contractor.

The Contractor shall submit sufficiently in advance the bio-data of the supervisor giving details of his experience for Owner's approval.

The Contractor shall ensure that the equipment supplied by him are installed in a neat workman like manner such that they are leveled, properly aligned and well oriented. The tolerances shall be established in Contractors drawings and/or as stipulated by the Owner.

All special tools and tackles and spares required for erection, testing and commissioning of equipment shall be supplied by the Contractor. The bid shall include a list of these special tools, tackles and spares along with their item wise prices. The total cost for these tools, tackles and spares shall be included in the bid price.

Erection, testing and commissioning manuals and procedures shall be supplied, prior to dispatch of the equipment.

The Contractor shall ensure that the drawings, instruction and recommendations are correctly followed while handling, setting, testing and commissioning the equipment.

### **Commissioning Check Tests / Performance and Guarantee Test**

- In addition to the checks and test recommended by the manufacturer, the Contractor shall supervise the following acceptance tests to be carried out on each test.
- Load test

- The engine shall be given test run for a period of at least 2 hours depending upon the actual power factor of the load and set shall be subjected to the maximum achievable load without exceeding the engine or alternator capacity.
- This full load test is to be followed immediately by a 10% overload run for one hour. The performance of the engine, alternator and exciter shall be satisfactory at the end of this overload run.
- At the end of the full-load run, and again at the end of the over-load run, tests for temperature rise and insulation resistance of the alternator as specified shall be taken.
- Full load test can be performed at site or at manufacturer's works before dispatch and shall be monitored by the Client/Consultants/Representative.
- Regulation Test
- The automatic and manual regulation of the alternator load at half and full rated load shall be tested for a nominal volts of 240 Volts, between phase to neutral and at 0.8 p. f. to verify the requirements of voltage and frequency variation as per IS:4722.
- Speed and Governing
- The speed of the engine shall be verified to ensure that it conforms to the requirement of BS: 5514.

### **Warranty/Guarantee**

The DG Set is covered by Warranty/Guarantee for 2 years from the dispatch and commissioning and as per manufacture defects.

## **5.12. DG SYNCRONIZING PANEL**

### **GENERAL**

Free floor standing indoor type cubicle D.G. control panel, fabricated out of 14/16 SWG steel sheet with front hinged bolted rear doors, with dust and vermin proof totally enclosed should be supplied.

### **Scope**

This specification covers the technical requirements of GAD/Shop Drawing, Manufacture, Test at works and Supply of 415V Synchronize & Control panel, complete with all

accessories for efficient and trouble free operation.

### **Standards**

The equipment covered by this specification shall, unless otherwise stated, be designed, constructed and tested in accordance with the requirements of the latest revision of Indian Standards.

IS : 4237        General requirements of switch gears and control gears for Voltage not exceeding 1000V.

IS : 8623        Factory Built assemblies.

IS : 2147        Degree of protection provided by enclosures for low voltage Voltage Switch gear and control gear.

IS : 375         Marking and arrangement for switch gear bus bar main connections and auxiliary wiring.

IS : 4064        Heavy duty switches.

IS : 2959        Air Break contactor.

IS : 8544        Motor starters and over load relays.

IS : 9224        HRC Fuses.

IS : 2705        Current transformers.

IS : 1248        Electrical indicating instruments.

IS : 13947Circuit breakers.

### **Construction**

The control panel shall be metal enclosed, compartmentalized, modular type, and construction suitable for indoor installation.

The control panel shall be dust and vermin proof and the enclosure shall provide a degree of protection of not less than IP54 as per IS 2147. Control panel shall be fabricated out of adequate thickness mild steel structural sections. The frames shall be enclosed with steel sheet of not less than 2.0mm thickness with rubber gaskets at all joints and openings including doors. All bolts, nuts and other fastener shall be cadmium plated only.

The ACB control panel shall be fully draw out type.

The draw out module shall consist of 'plug in' contacts for power connection and sliding contacts for secondary control connection. The power contact shall be spring loaded silver – plated electrolytic copper.

Each draw out module shall have three positions viz. service, test and isolated position with necessary position interlocks. All bolted joints shall be provided with toothed / spring washers to ensure good earth continuity.

The control panel shall have a series of cubicles of uniform height placed side by side with front access for operation. The maximum operating height of the devices on the panel shall not exceed 2100mm and minimum operating height shall not be less than 400mm.

Control panel shall be supplied along with base channel fabricated out of 3mm thick steel sheet, painted black.

### **Drawing and Manuals**

The Contractor shall furnish general arrangement of the panel.

- a. General arrangement drawing showing :
  - i. Overall dimensions.
  - ii. Terminal location & dimensional data
  - iii. Total weight
  - iv. Bill of Materials
  - v. Foundation details.
  - vi. Sectional views.
- b. Single line diagram.
- c. Technical details for starters, contactors, switch fuses, lamps, meters etc.
- d. Manufacturing schedule and test schedule.
- e. Operation and Maintenance Manual.
- f. Component layout of Typical Modules (scaled)

### **Spares:**

#### **Commissioning Spares**

The quoted price shall be inclusive of all necessary commissioning spares.

#### **Maintenance Spares.**

Contractor shall recommend and quote for maintenance spares.

### **5.13. PARTICULAR REQUIREMENTS**

<b>SL NO.</b>	<b>DESCRIPTION</b>	<b>TYPE/SCOPE</b>
1	Service	Indoor
2	Typestanding	Cubicle, Metal enclosed free
3	Degree of Protection	IP 52

4	Rated Voltage	433V
5	Bus bars	
a	Number phase / wires	3 Phase, 4 wire.
b	Continuous current	As per particular requirement
c	Frequency	50 HZ
d	Fault level	35 KA
e	Material	Aluminium
6	Insulation level	
a	Power frequency withstand voltage dry	2.5 KV RMS
7	Bus bar support insulator	
a	Material	FRP /DMC /SMC
8	Design Ambient Temperature	50 Deg.C
9	Painting	Epoxy Powder coating.
10	Earthing	
a	Material	Aluminium
b	Size	As required
11	Reference Standard	IS 13947

#### **5.14. EXHAUST PIPING (D.G. FLUE GAS EXHAUST SYSTEM):**

##### **Scope of Work**

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust System pipes & pipe fittings etc. As detailed below in specifications. All pipes and fittings etc. Shall conform to relevant Indian standards.

##### **D.G. Flue Gas Exhaust Piping**

D.G. Exhaust pipes shall be M.S. Black pipes (B Class / 5.0 mm thick) up to 150 mm and MS ERW Black Pipes above 150 mm and it shall conform to IS:1239 (Part 1) -1991 & IS:3589 – 1991 Grade 330 with latest amendments.

All piping and their steel supports shall be thoroughly cleaned and primer coated before installation.

##### **Pipe Insulation (D.G. Flue Gas Exhaust Piping System)**

The scope of this section comprises supply, installation, testing & commissioning of D.G. Flue Gas Exhaust Pipe Insulation and Aluminium Cladding. All insulation material and aluminium cladding shall conform to relevant Indian standards.

**Safety Materials****Description of Work**

- A. Insulation Mats
- B. First Aid charts and First Aid Box
- C. Danger Plate
- D. Fire Extinguishers
- E. Fire Buckets
- F. Tool Box
- G. Caution Board
- H. Key Board

**Applicable Codes & Standards**

- A. IS : 15652 Insulation mats
- B. IS : 2878 Portable C02 Fire Extinguisher
- C. IS : 2546 : Fire Buckets
- D. ANSI/NFPA 70 - National Electrical Code

**Specification**

Shock Treatment Chart with 8 mm thickness Photo lamina  $\Theta$  on -Size 18" X 24"

**First Aid Chart and First Aid Box**

A. Charts (one in English, one in Hindi, one in Regional Language), displaying methods of giving artificial respiration to a recipient of electrical shock shall be prominently provided at appropriate places. Standard First Aid Boxes containing materials as prescribed by St. John Ambulance brigade or Indian Red Cross should be provided in sub-station.

B. Acrylic door with Medicines - Medium - Size : 11" x 12" x 6"

**Danger Plate**

A. Danger plates shall be provided on HV and LV equipments. LV danger notice plate shall be 200 mm x 200 mm made of mild steel at least 2 mm thick vitreous enameled white on both sides and with inscriptions in signal red colour on front side as required.

B. Size of the HV Danger Notice plate shall be 250 mm x 200 mm and 2 mm thick.

**Fire Extinguishers**

- A. Portable CO<sub>2</sub> conforming to IS: 2878-1976 dry chemical (conforming to IS 2171-1976) extinguishers shall be installed in the sub-station at suitable places (like HT/LT panel rooms) as specified.
- B. Foam type fire extinguisher shall be installed in Transformer Room.

**Fire Buckets**

- A. Fire buckets conforming to IS: 2546-1974 shall be installed with the suitable stand for storage of water and sand.

**Tool Box**

- A. standard tool box containing necessary tools required for operation and maintenance shall be provided in sub-station.

**Caution Board**

- A. Necessary number of caution boards such as "Man on Line""Don't switch on" etc. shall be available in the sub-station.
- B. The caution Board shall be of size 300 mm x 200mm made of mild steel, 2mm thick, vitreous enameled white on both sides and with inscriptions in original red colour on front side as required.

**Key Board**

- A. A key board of required size shall be provided at a proper place containing castle keys, and all other keys of sub-station and allied areas.
- B. The key board shall be made of 12mm thick first class teak wood shall be of size 400 mm x 300mm and with adequate depth to hold the keys. It shall be provided with a lockable type hinged glass door made of 12 mm. Thick first class teakwood frame with 3 mm thick sheet glass fixed with piano hinges. The key board shall have enough number of hooks for hanging the castle keys and all other keys of the sub-station and allied areas. It shall be painted with one coat of wood primer and two coats of white enamel paint.

**Insulation Mats**

- A . Insulation mats conforming to IS: 15652 shall be provided in front of main switch



boards and other control equipment as specified.

- B. Insulating Mat Class-B. 2.5mm Thickness x 1mtr width, Working Voltage: Up TO 11kv, AC Proof Voltage : 22KV, Dielectric Strength: 45 KV as per IS:15652-2006 ISI marked, Color: Black

### **5.15. MAIN LT PANEL (AS PER IEC 60439 PTTA PANEL)**

#### **General**

This System covers the detail requirements for GAD/Shop Drawing Manufacturing, Testing at works. Main L.T. Panel shall be made out of CRCA sheet steel indoor type, floor mounted, free standing, totally enclosed, extensible type, air insulated type for use on 415 Volts, 3 phase with neutral, 50 cycles/sec system. The both incomers (Transformer and DG) have mechanical and electrical interlocking with Automatically changeover the power to the system.

IEC 60439 and IEC 61439 are standards for low-voltage switchgear and control gear assemblies, including main low-tension (LT) panels. Both standards specify the requirements for these assemblies, but they have different approaches and updates reflecting advancements in technology and changes in industry practices.

The equipment shall be designed to conform to the requirements of:

- i. IS: 8623- Factory Built Assemblies of switchgear and control gear.
- ii IS: 4237- General requirements for switchgear and control gear for voltages not exceeding 1000 volts.
- iii. IS: 2147- Degree of protection.
- iv. IS: 375- Marking and arrangement of bus bar.

Individual equipment housed in the Main L.T. Panels shall conform to the following IS Specification.

- i. Air circuit breakers/Moulded case circuit breaker IS: 60947 (Part-II) & IEC 60947(2)
- ii. Fuse switch and switch fuse units - IS: 13947 (Part-3) & IEC 947 (3).
- iii. HRC fuse links - IS: 13703
- iv. Current Transformers - IS: 2705
- v. Voltage Transformers - IS: 3156

- vi. Indicating Instruments - IS: 1248
- vii. Integrating Instruments - IS : 722
- viii. Control Switches & Push Buttons - IS : 6875
- ix. Auxiliary Contactors - IS: 13947 (Part-4/Sec.-I) & IEC 947 (4/1) Relays - IS: 3231

### **Submittals, Shop Drawing and Technical Data**

The Contractor shall furnish relevant descriptive and illustrative literature on breakers and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering and relay compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams for control and supervision of circuit breakers.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- d) Type test certificates.

### **Construction**

- 1. Made out of the requisite vertical sections, which when coupled together shall form continuous dead front switchboards.
- 2. The degree of protection being not less than IP 42 to IS: 2147.
- 3. Suitable for extensible on both sides by the addition of vertical sections after removal of the end covers.
- 4. Shall be suitable for cable entry from top / bottom both except wherever indicated through removable cable gland plate of 3mm thick. Compression gland shall be staggered in alleys so as to maintain necessary clearance between cables.
- 5. Fire retardant polycarbonate sheet shall be provided for viewing panels housing MCB's at eye level. Cable channels are to be used wherever possible for aesthetic look.

Lifting hooks / angles shall be provided on the panel. Panel shall have 20% free space for future use.

Panel shall be provided with louvers having wire mesh inside for ventilation. Each vertical section shall comprise of:

- i. A minimum 2mm thickness front framed structure of rolled/folded sheet steel channel section rigidly bolted together. This structure shall house the components contributing to the major weight of the equipment, such as circuit breaker cassettes, fuse switch units, main horizontal bus bars, vertical risers and other front mounted accessories. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 100mm height. The design shall ensure that the weight of the components is adequately supported without deformation or loss of alignment during transit or during operation.
- ii. Cable chamber housing (In rear of panel) the cable end connections, and power/control cable terminations. The design shall ensure generous availability of space for ease of installation and maintenance of cabling, and adequate safety for working in one vertical section without coming into accidental contact with live parts in an adjacent section.
- iii. Front and rear doors fitted with dust including neoprene gaskets with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be assured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust. All door shall be lockable mounted lock.

he height of the panels should not be more than 2400 mm. The total depth of the panel should be adequate to cater to proper cabling space and should not be more than 1500mm. Operating handle shall not be higher than 1800mm. The minimum height for operating handle shall be 300 mm from floor level.

Doors and covers shall be of minimum 2mm thick sheet steel. Sheet steel shrouds and partitions shall be of minimum 2mm thickness. All sheet panels shall be smoothly finished, leveled and free from flaws. The corners should be rounded.

The apparatus and circuits in the power control centers shall be so arranged as to facilitate their operation and maintenance and at the same time to ensure the necessary degree of safety.

Apparatus forming part of the Main L.T. Panel shall have the following minimum clearances.

- |      |                            |        |
|------|----------------------------|--------|
| i.   | Between phases             | - 26mm |
| ii.  | Between phases and neutral | - 19mm |
| iii. | Between phases and earth   | - 19mm |
| iv.  | Between neutral and earth  | - 19mm |

For any reason, the above clearances are not available, suitable insulation shall be provided. Clearances shall be maintained during normal service conditions. Creepage distances shall comply to those specified in relevant standards. All insulating material used in the construction of the equipment shall be of non-hygroscopic material, duly treated to withstand the effects of the high humidity, high temperature tropical ambient service conditions.

Circuit breakers and fuse switches shall be arranged in multi-tier formation, except that not more than two air circuit breakers shall be housed in a single vertical section. Cable entry for various feeders shall be from the rear. Panel shall be suitable for termination of bus duct for incoming breakers.

Metallic/insulated barriers shall be provided within vertical sections and between adjacent sections to ensure prevention of accidental contact with:

- i. Main bus bars and vertical risers during operation, inspection or maintenance of functional units and front mounted accessories.
- ii. Cable termination of one functional unit, when working on those of adjacent unit/units.

All doors/covers providing access to live power equipment/ circuits shall be provided with tool operated fasteners to prevent unauthorized access.

Provision shall also be made for permanently earthing the frames and other metal parts of the switchgear by two independent connections.

### **Metal Treatment and Finish**

All steel work used in the construction of the L.T. cubicle panels should have undergone a rigorous metal treatment process as follows:

- i. Effective cleaning by hot alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution.
- ii. Pickling in dilute sulphuric acid to remove oxide scales & rust formation, if any, followed by cold water rinsing to remove traces of acidic solution.
- iii. A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the

paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.

- iv. Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- v. Drying with compressed air in a dust free atmosphere.
- vi. Powder Coating paint of colour approved by Architect/Consultant/ The Engineer.

### **Bus Bar**

The bus bars shall made of high conductivity, high strength aluminium alloy complying with the requirement of grade E-9IE of IS-5082 and air insulated. The bus bars shall be suitable braced with non-hygroscopic SMC supports to provide a through fault withstand capacity of required rating of fault level as per actual calculation for one second. The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creepage distances shall be provided on the bus bar system to minimize possibilities of fault.

The Panel shall be designed that the cables are not directly terminated on the terminals of breaker/switch fuse/fuse switch etc. but on cable termination links. Capacity of aluminium bus bars shall be considered as 0.8 Amp/sq.mm of cross section area of the bus bar. The main bus bars shall have continuous current rating throughout the length of L.T. Panel. The bus bar system shall consists of main horizontal bus bar and auxiliary vertical bus bars run in bus bar alley/chamber on either side in which the circuit could be arranged/connected with front access. The minimum size of vertical bus bar shall be as per fault level of panel i.e 50 KA.

In case of copper bus bars, high conductivity electrolytic grade copper with current density not less than 1.4 Amp/ sq. mm shall be used. Bus Bar shall be tinned.

Connections from the main bus bars to functional circuit shall be arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars to be colour coded with PVC sleeves.

Cadmium plated G.I. nuts and bolts shall be used for making bus bar to bus bar connections in aluminium bus bars.

Whenever copper bus bar and aluminium bus bar are connected to each other, bimetallic strip shall be used. In case of copper bus bar, tinning shall be done.

Bus bar calculation shall be submitted along with manufacturing drawing of panel for

approval with bus bar manufacturer data sheet.

### **Medium Voltage Air Circuit Breaker**

#### **Type And Construction**

The ACB shall conform to the requirements of IS 13947-2 and shall be type tested & certified for compliance to standards from CPRI. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing / sheet metal housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON""OFF" "TRIP" indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity (Icu) and short circuit withstand values (Icw) for 1 sec.

$I_{cu} = I_{cs} = I_{cw}$  = shall be based on actual calculation.

Circuit breakers shall be designed to 'close' and 'trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. It should be possible to change settings on load.

Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker. Break time of ACB shall not be more than 70 millisecond in case of short circuit.

Rated insulation voltage shall be 1000 volts AC.

### **Cradle**

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions mechanically.

The following safety features shall be incorporated:

- a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.
- b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.
- c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.
- d. All Switchgear module front covers shall have provision for locking.
- e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

### **Protection**

All breaker (ACB's) should be equipped with static release to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones:

- Time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

### **Safety Features**

- a. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.
- b. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- c. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Farthing bolts shall be provided on the cradle or body of fixed ACB.
- d. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- e. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.
- f. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.
- g. The insulation material used shall conform to Glow wire test as per IEC60695.
- h. The ACB shall provide in built electrical and mechanical anti-pumping.

### **Testing**

Testing of each circuit breaker shall be carried out at the works as per relevant IS Code of Practice and the original test certificate shall be furnished in triplicate. The tests shall incorporate at least the following.

- i. Impulse withstand test.
- ii. Power frequency withstand test.



- iii. Short circuit test.
- iv. Temperature - rise test under rated conditions.

### 5.16. Moulded Case Circuit Breaker

#### General

Moulded Case Circuit Breakers shall be incorporated in sub distribution boards wherever specified. MCCB's shall conform to IS 13947-2 and / or IEC 947-2 in all respects. MCCB's shall be suitable either for single phase AC 230 volts or three phase 415 volts.

#### Frame Sizes

The MCCB's shall have the following frame sizes subject to meeting the fault level specified elsewhere.

- |      |                    |       |               |
|------|--------------------|-------|---------------|
| i)   | Up to 100A rating  | ..... | 100Amp frame. |
| ii)  | Above 100A to 200A | ..... | 200Amp frame. |
| iii) | Above 200A to 250A | ..... | 250Amp frame. |
| iv)  | Above 250A to 400A | ..... | 400Amp frame. |
| v)   | Above 400A to 630A | ..... | 630Amp frame. |

#### Constructions

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick break, trip-free type. The operating handle shall be simultaneous operation and tripping of all the three phases.

Suitable fire extinguishing device shall be provided for each contact. Tripping unit shall be of thermo magnetic type up to 250 A for adjustable overload & short circuit protection and shall be microprocessor type above 250 A for adjustable overload, short circuit & earth fault protection. MCCB shall be line load reversible type. Device shall have IDMT characteristics for sustained overload, and short circuits. MCCB shall be current limiting type.

Contacts trips shall be made of suitable are resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

**Rupturing Capacity**

The Moulded Case Circuit Breaker service breaking capacity (Ics) shall be based on actual calculation.

**Testing**

Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished. Pre-commissioning tests on the sub distribution boards incorporating the MCCB shall be done as per standard.

**5.17. SURGE PROTECTION DEVICE****General**

The Internal Surge Protection Device shall be selected as per zone of protection described in IEC 62305, 61643-11/12/21, 60364-4/5. Depending on Zone concept of provided in IEC 62305 – 1 & 4.

LPZ -OB & LPZ 1: At Mains entry point (Main LT Panel): Type 1 + 2, i.e.

SPD Combined Arrester with Integrated Backup Fuse.

**Power Line Protection**

Main Distribution Board shall have Type 1 SPD to discharge Lightning current surges for 415 V AC, 3 phase 4 wire (TT) configuration. UPS / Sub Distribution Board shall have Type 2 SPD to discharge switching surges for 415 V AC,

3 phase 4 wire (TT) configuration. Server and sensitive equipments shall have Type 3 SPD at their power input to discharge switching surges.

Type 1 and Type 2 devices shall be from same manufacturer to achieve the co-ordination.

**Type 1 (At Main Lt Panel)**

- a) The device shall be non-exhausting metal encapsulated, spark gap based technology and tested as per latest and valid IEC 61643-11:2011 or EN 61643-11:2012 standards. It shall have integrated fuse protection.
- b) The device shall be capable to discharge Lightning current (10/350µs) of 25kA (L-N) and 100kA(N-E).

- c) The device shall have voltage protection level of device shall be  $\leq 1.5$  KV including inbuilt fuse for L-N.
- d) The device shall have Follow current extinguishing capability [L-N]/[N-PE] : 100kArms / 100Arms
- e) The device shall have built in fuse and operation of SPD shall be independent of Line current for L-N SPD. The short circuit with stand capability of the device shall be 100 KArms for L-N SPD.
- f) The device shall have mechanical indication for both the states (green for 'healthy' and red for failure) on L-N and N-PE.
- g) The device shall be certified by KEMA or VDE or NABL lab as per IEC 61643-11:2011 or EN 61643-11:2012 for testing of all parameter at 10/350  $\mu$ s and 8/20  $\mu$ s.

## **5.18. MEASURING INSTRUMENT FOR METERING**

### **General**

The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

### **Digital Ammeters**

Digital Ammeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

### **Digital Voltmeters**

Digital Voltmeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

**MFM Meter**

Digital MFM shall be confirmed to ISO:62053. Multi-Function Meter used in electrical panels. These meters are designed to measure various electrical parameters such as voltage, current, power (active, reactive, apparent), energy consumption, power factor, and frequency. They are commonly used in industrial, commercial, and sometimes residential settings to monitor and manage electrical usage, ensuring efficient operation and sometimes for billing purposes in larger installations.

**Current Transformers**

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 15A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

Measuring : Class 1.0

Protection : Class 5 P10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault on medium voltage system. The fault level of CT shall be same as fault level of panel. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

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.

**Control Switches**

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

### **Cable Termination**

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

### **Control Wiring**

All control wirings shall be carried out with 1100V grade single core PVC cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

### **Terminal Block**

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

### **Labels**

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

### **Miscellaneous**

Push buttons shall be of the momentary contact, push to actuate type fitted with self reset

contacts & provided with integral escutcheon plates marked with its functions.

### **Battery and Battery Charger**

A set of 24V DC power supply shall be provided for indication, relay operation etc. for Main L.T.Panel. DC Power supply shall be sealed maintenance free batteries of suitable capacity. Suitable battery chargers shall also be provided to charge the battery to perform during mains failure.

## **5.19. APFC PANEL**

### **Scope of Work**

This specification covers the technical requirements for GAD/Shop Drawing, Manufacture, Testing at Works, Supply at Site, Install, Test & Commissioning of 415V APFC Panel, Complete with all accessories for efficient and trouble – free operation.

### **Standards**

The equipment covered by this specification shall, unless otherwise stated, be designed, constructed and tested in accordance with the latest revisions of relevant Indian Standards and shall conform to the regulations of local statutory Authorities.

- IS : 722 A.C. electricity meters
- IS : 732 Code of practice for Electrical wiring installation.
- IS : 375 Marking and arrangement for switchgear Busbar main connections and auxiliary wiring.
- IS : 1248 Direct acting electrical indicating instruments.
- IS : 13947 LV Switchgear and Control Gear.
- IS : 2705 Current Transformers.
- IS : 3231 Electricity relays for power system protection.
- IS : 8623 Specification for factory Built assemblies for Voltages. Upto 1000V A.C. and 1200V.D.C
- IS : 4237 General requirement of switchgear and Control gear for Voltages not exceeding 1000V.
- IS : 2959 AC Contactors for voltage not exceeding 1000V.
- IS : 162 Specification for Electric Power Switchgear and Associated apparatus.

IS : 2834 Capacitors.

The panel supplied shall satisfy all the requirement of Local Statutory authorities and modification if any required site shall be carried out by the Contractor without extra cost.

## **5.20. CONSTRUCTION**

### **General**

The panel shall be metal-enclosed, free standing, modular type, suitable for indoor installation. The panel shall be dust and vermin proof and the enclosure shall provide a degree of protection of not less than IP-52.

The fabrication shall be rigid, robust, flaw less and shall have a smooth finish.

The board shall be fabricated out of 3mm thick mild steel structural sections. The frames shall be enclosed with steel of not less than 2.0mm thickness. The internal partition shall of 1.6mm thick.

The panel shall be extensible type.

Each capacitor shall be provided with a fast acting controller which shall be capable of a very fast response.

Due consideration shall be given to the following during design of the panel and locating the various components viz. Circuit Breakers, Instruments & Relays, Busbar, Capacitors and secondary wiring.

Facility for inspection, maintenance & repair Minimum vibration and noise.

Risk of accidental short circuit, open circuit and damage to personnel due to accidental contact with live parts.

Inter charge ability of components.

Secure and vibration proof connection for power and control circuit.

Shrouding of all live parts in feeder component and cable chamber.

All retaining catches, Screws and bolts for doors and covers shall be zinc passivated. Screws and bolts shall be captive. All covers, doors and joints shall be gasketed.

Equipment to be mounted outside cubicles shall be flush mounted on cubicle door. No.externally mounted equipment shall be mounted above 1.9m or below 0.4m from floor

level.

All components including ACB/MCCB/Contractor shall be of same make.

Control Circuit shall be protected by MCBs and not by fuses.

### **BUSBARS**

The busbars shall be air insulated and made up of EC grade aluminium alloy equivalent to E91E WP as per IS 5082, 1981.

The busbars shall be TP and N, the section of the neutral bus being half the size of the phase busbar.

The busbar shall be provided with proper grade & colour of heat shrinkable PVC sleeve with colour strips of red, yellow, blue and black and the same shall be arranged in accordance with IS-375.

The busbar shall be properly segregated, suitable braced with insulated supports (SMC) placed at appropriate intervals to withstand the electro magnetic stresses during short circuit.

Minimum electrical clearances shall be maintained between phase, neutral and body as per standards.

The insulation used shall be non – hygroscopic and shall be treated for preventing fungus growth.

### **INTERCONNECTION**

For each and every tapping from the busbars, separate connections shall be made. No direct tappings from the busbar shall be made for any feeder without control and protection.

All interconnections shall be by rigid busbars only.

Wherever lugs are used for terminated of rigid busbars, it shall be soldered and not crimped.

### **AUTOMATIC POWER FACTOR CORRECTION**

Due to high load fluctuation, automatic control of power factor by capacitors shall be provided to achieve, as far as possible, a power factor of 0.95 lagging. To achieve the present desired power factor, suitable micro processor based reactive power controller to switch ON and OFF the regulating stages shall be provided in the panel. The capacitor shall be subdivided into regulating stages as specified.. In case of supply interruption, the zero voltage



relay shall be provided to reset the control devices to their neutral position as that on restoration of supply, the capacitor stages are switched on again stage by stage, thus preventing any undesirable current voltage peak.

### **APFCR Relay**

The APFCR relay shall be micro processor based and shall be suitable for controlling capacitors in number of stages as specified. The Relay shall be acceptable of accepting kVAR ratings of the banks in any random denomination with Measurement sensitivity of 1%..

The relay shall be suitable for three phase or single phase current sensing as specified in the BOQ.

The relay shall have Field settable target power factor, on/off delay, CT ratio and will constantly monitor the kVAR compensation required and select the right combination of banks to ensure that the plant PF is maintained very close or equal to the set value.

The relay shall have seven segment super bright LED or backlit LCD panel to display PF, KW or KVAR, Voltage and Current.

The relay shall have fault/Alarm indication for Over / Under Voltage, Over / Under Frequency, Over / Under compensation and under current, CT polarity

Reversal.

The relay shall be provided with field selectable Auto / Manual Mode for control of capacitor banks.

### **Capacitor**

The dielectric system shall consist of metallized polypropylene film. The dielectric shall be wound to form a winding and shall be impregnated with non-PCB oil/flexible epoxy. The metallising shall be done either by aluminium or zinc. The dielectric shall have self healing properties.

Each capacitor unit shall be provided with inrush current limiting devices within the container. The capacitors shall be enclosed in heat proof, dust proof, water proof containers.

Permissible tolerance of capacitor

- a. Operating Voltage : 440 Volts +1-10% Max.

- b. Output KVAR : -5% to +10%
- c. Measured loss angles : +10%
- d. Line Current : +30% (including transients)
- e. Losses : <0.5KW per KVAR.

**Note:**

The discharge resistor contained in the capacitor unit shall reduce the residual voltage to 50 Volts or less than within 5 minutes after the capacitor unit is disconnected from the source of supply.

**Measuring Instruments**

Digital MFM shall be confirmed to ISO:62053. Multi-Function Meter used in electrical panels. These meters are designed to measure various electrical parameters such as voltage, current, power (active, reactive, apparent), energy consumption, power factor, and frequency. They are commonly used in industrial, commercial, and sometimes residential settings to monitor and manage electrical usage, ensuring efficient operation and sometimes for billing purposes in larger installations.

**Control Wiring**

Panel shall be supplied with all internal wiring comprising of PVC insulated 1.1 KV grade, multi stranded flexible copper conductor of 1.5 sq.mm cross section.

Wiring associated with a particular phase shall be the colour of that phase viz. Red / Yellow, or Blue, wiring associated with earthing shall be with green colour insulation and for neutral it shall be with black colour insulation.

Wiring shall be neatly laid and run on insulated cleats of limited compression type insulated straps.

All cables shall have crimped terminations and shall be identified by means of glossy plastic ferrules at both ends, showing the wire number as indicated in the schematic diagrams. The ferrules shall be indelibly marked.

Wiring to items mounted on hinged doors or wiring that is subject to movement, shall run in helical binding. The binding shall be securely anchored at both ends and sufficient slack provided to prevent any strain being imposed on wiring.

**Earthing**

All the metal parts of all equipment supplied within the panel (including doors and gland plates) other than those forming part of all electric circuit, shall be connected by means of two independent earth conductors to continuous copper earth bar of size 25 x 3 mm running along the full length of the panel. The panel shall be provided with two brass earthing stud terminals, with suitable nuts, washers etc. for connection to ground bus.

**Terminal Block**

The Terminal Blocks shall be 650V grade, multiway terminal blocks of non-tracking moulded plastic complete with insulated barriers, stud type terminals, washers, nuts and lock nuts and identification strips. Power and control terminals shall be segregated. Control terminals of minimum rating 10 amps suitable to receive 2.5 sq. mm copper conductor.

20% spare terminals in each control terminal block shall be provided. Not more than two wires shall be connected to any terminal block.

**Labels**

Labels shall be provided to describe the duty of or otherwise identify every Instrument, or other item of equipment mounted internally and externally. Switch positions shall be fully identified. Wording shall be clear, concise and unambiguous.

Each label shall be permanently secured to the panel surface below the item to which it refers.

The labels shall be engraved in plastic with white letters in black background.

In addition to component labels, each cubicle door shall bear a large identification labels and the panel shall include large, prominent overall identification label.

**Cable Compartment**

Ample space for connection for incoming cables shall be provided at the rear of the switch board. In order to avoid accidental contact in the cable compartment while carrying out inspection by opening the back cover, a removable expanded metal barrier shall be provided in the cable compartment. The various cable sizes shall be as indicated in the Bill of Quantities.

Cable lugs and the requisite bushes for sealing power cable entries shall be included in the

scope of supply of the switch board.

The head room available between cable gland plate and terminal shall not be less than 750 mm.

In case cable termination cannot be accommodated inside panel a suitable box for mounting at bottom / rear of panel shall be supplied by vendor. Each strip shall also be brought to this box.

### **PAINTING**

Care shall be taken in workmanship and selection of materials to prevent the occurrence of any form of damage or corrosion due to damp or humid conditions.

The Board shall be prepared, primed, filled and painted to the highest standards.

All items shall be cleaned and debarred, after fabrication and welding is completed. External surfaces shall be filled and rubbed down as necessary to obtain a perfectly flat smooth surface, free from blemishes and imperfections.

The painting process shall be using a seven tank phosphating system with primer coating within 4 hours of phosphating and two coats Epoxy Powder Coating.

The paint shall not rust especially in comers and holes.

### **Tests**

The panel shall be completely assembled, wired, adjusted and tested for operation under simulated conditions to ensure accuracy of wiring, correctness of control scheme and proper functioning of all equipment.

### **Routine Test**

1. Mechanical operation test
2. Dielectric tests

### **Drawings and Documents**

The following drawings and documents shall be furnished.

- a. General Arrangement drawing of the panel showing.
  - i. Overall Dimensions

- ii Terminal locations
- iii. Total weight
- iv Foundation details
- v. Sectional view
- vi. Bill of materials
- b. Single line diagram and wiring diagram.
- c. Technical details for Switchgear, lamps, meters etc.
- d. Manufacturing schedule and test schedule,
- e. Calculation for sizing of bus bars.

### 5.21. TECHNICAL REQUIREMENTS FOR APFC PANEL

SL NO	DESCRIPTION	SCOPE/VALUE
1	Application	Indoor
2	Type	Cubicle, Metal enclosed free Standing
3	Degree of Protection	IP 52
4	Rated Voltage	433V
5	Rated Short Circuit Current	35KA
6	Design Ambient Temperature	45°C
7	Temperature rise over ambient Temperature	45°C
8	Busbar	
A	Number Phase/Wires	3 Phase, 4 Wire
B	Continuous Current	As specified
C	Frequency	50 Hz
D	Fault Level	As specified.
E	Material	Copper/Aluminium as specified.
9	Earthing	
A	Material	Copper
B	Size	25 x 3 mm
10	Insulation Level	
A	Power Frequency withstand Voltage	3KV
11	Painting	Epoxy Powder Coated

12	Control Voltage	230V AC/220V DC
13	Control Wiring	
A	C.T. Circuits	2.5 Sq.mm Cu. Multistranded
B	Others	1.5 Sq.mm Cu. Multistranded
C	Voltage Grade	660V/1100V
14	Reference Standard	IS: 8623

**Warranty/Guarantee:**

Products Warranty/Guarantee will be a period of 18 months from the date of Dispatch and commissioning as per manufacture defects.

**5.22. 11KV HT CABLE& LAYING****General**

The cables shall be supplied, inspected, laid, tested and commissioned in accordance with Drawings. Specifications, Indian Standard Specifications IS: 7098, Part-II IS: 1255- 1967 and cable manufacturer's instructions. The recommendations of the cable manufacturer with regard to jointing and sealing shall be strictly followed.

**Material**

The H.T. cables shall be 11KV, aluminum conductor XLPE insulated, galvanized flat strip armoured, inner and out sheath of FRLS PVC, cable laid underground and or in masonry trenches as shown in Drawings. The conductor shall be made of Electrical purity Aluminium wires and stranded together and compacted. The cable shall be of 1/ 3 Core type. The insulation shall be of high quality XLPE, as per IS: 7098 Part-II applied by extrusion process. Armouring is applied over inner sheath and shall be of galvanized flat strips. The inner and outer sheath shall be of FRLS PVC. This shall be of black colour.

**Inspection**

All cables shall be inspected upon receipt at site and checked for any damage during transit.

**Joints In Cables**

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoidance of

jointing cable. This cable shall be got approved from the Engineer In-Charge before the cables are cut to lengths. Where joints are unavoidable, the location of such joints shall be got approved from the The Engineer.

### **Jointing Boxes For Cables**

Cable joint boxes shall be of appropriate size, suitable for Aluminium conductor XLPE/FRLSH insulated cables of 11KV ratings.

### **Jointing Cables**

All cable joints shall be made in suitable, approved cable joint boxes. Jointing of cables shall be done in accordance with the best practice in trade, in accordance with IS.

All cables shall be jointed color to color and tested for continuity and insulation resistance before jointing commences. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection for the weather shall be arranged. Joints shall be made by means of suitable solder for conductors, the conductors being firmly butted into the connections or thimbles or ferrules and the whole soldered with proper solder and soldering flux or resin. The conductors shall be efficiently insulated with high voltage insulating tape and use of spreaders of approved size and pattern.

The joints shall be completely filled with epoxy compound being topped as necessary to ensure that the box is properly filled.

### **Cable Terminations**

Cable termination shall be done with heat shrinkable jointing kit complete with accessories and lugs suitable for the cable.

### **Bonding of Cables**

Where a cable enters any piece of apparatus, it shall be connected to the casing by means of an approved type of armoured clamp and gland. The clamps must grip the armouring firmly to the gland or casing, so that in the event of ground movement no undue stress is passed into the cable conductors.

### **Laying of Cables**

H.T. cables shall be laid either buried directly underground or in Masonry/Concrete trenches/

RCC/Hume/Metal Pipes . The cable shall be laid underground as per CPWD's General Specifications for Electrical Works Part-II External -1994 . Sand cushion of not less than 25 mm shall be provided both above and below the cable with mechanical protection of second class brick of size 22 Cm X 11.4 Cm x 7 cm placed on top of sand . The cable trench shall be back filled and compacted and surplus earth will be disposed off as per direction of Engineer-In- Charge,

All cables shall be laid as per Latest C.P.W.D General Specifications for electrical Works (Part-IV Substation) - 2013 with all upto date amendments.

### **Protection of Cables**

The cable shall be protected by placing precast reinforced 50mm, thick (1:2:4) concrete slab 200mm wide on the top layer of sand for the length of the cable. Where more than one cable is running in the same trench, the concrete blocks shall cover all the cables and shall minimum 80mm on either side of the cables.

Cables under road crossings and any surfaces subjected to heavy traffic, shall be protected by running them through Hume pipes of suitable size.

### **Route Marker**

Route Markers of RCC or CI shall be provided along the cable laid in ground at regular interval and at all turnings.

### **Testing of Cables**

All cables shall be tested as per Latest C.P.W.D General Specifications for electrical Works (Part-IV Substation) - 2013 with all up to date amendments.

## **5.23. II EXTERNAL LIGHTING WORK**

### **External Lighting**

**Bollard LED 8-10 Watt** Architectural bollard LED 3000K 230-240Vac 50-60Hz CRI > 80  
Input power: 8W Height 800mm, Electronic driver ON/OFF CE and RoHS compliance  
TYPE: Bollard, IP rating IP65, impact resistance IK10. MATERIAL CHARACTERISTICS :  
Extruded aluminium bottom pipe Ø100 x H800mm with polycarbonate diffuser and integral base plate Ø180 with PG gland. Luminaire contains built in LED modules. Operating



ambient temperature range is from -20°C to +40°C. Lumen output 300 lm, light source 96 power LEDs. Resistance to heat and fore for plastic part should be 850 degree celcius. Housing Color Dark grey RAL 7043. CCE, CE and RoHS compliance.



### **Bollard LED 8-10 Watt Lighter**

**Gate Light** shall have circular LED post having housing made of pressure die-cast aluminium (including top canopy & pole mounting piece) with integrated optics & having Polyester powder coating in addition to a specific weathering resistance treatment. The dia of the post top shall be of the post top shall be minimum 450mm & height of minimum 200mm (including the pole mounting piece). The colour shall be RAL 7011 textured. The post top shall have Non-yellowing transparent and textured polycarbonate diffuser, 1.5mm thick. It should have concentric circular radial pattern for reduced glare & even light distribution. The luminaire must have round symmetrical optics/distribution. The luminaire shall be IP66 rated (without any glue) & shall have IK10 rating. The luminaire shall use high performance LEDs having CCT of 3000K/4000K/5700°K/6500K, CRI $\geq$  70 & SDCM  $\leq$  5. The luminaire shall deliver initial system lumen output of minimum 5000lumens & must have system luminous efficacy  $\geq$ 110lm/w. The luminaire shall have Class-I electrical insulation & Serviceability of Class-B. The luminaire shall use BIS registered electronic driver having voltage range of 122V-277V with in-built surge protection of 4KV, THD $\leq$ 10%. The driver shall have high cut-off ( $>325V\pm 15V$ ) & auto restart. The luminaire shall have in-built additional SPD of 10KV. The pole mounting piece shall be suitable for mounting on pole dia of 60mm. The luminaire shall be BIS registered. Luminaire manufacturer shall have In-house NABL accredited lab to conduct LM79, Type test as per IS10322 & "FAT" before dispatch as per IS 10322.



### **Gate Light shall have v circular LED Lighter**

**10 W LED round LED post top light fixture** suitable for mounting on 3-4 mtr pole, housing made up of High-quality Pressure die-cast aluminum housing LM6 alloy (Excellent corrosion resistance and robustness) with UV protected Polycarbonate cover comes with IK08 protection, sturdiness and embossed brand name/logo name of manufacturer. The fixture should have high power LED with minimum system efficacy of 115 lumen/Watt and a minimum system lumen output of 4000 lumens, CCT of 5700K & CRI 70, PF >0.95 & THD<10%. The fixture & LED Driver shall be designed for a system life of 50,000 hours @70% lumen maintenance. Ingress Protection of IP66 (lamp and gear Compartment) and Mechanical Impact Resistance Rating of IK10. The fixture driver should have an operating voltage range of 120-270V with Auto Restart, High Cut off ( >325V), Auto Restart, surge protection of >=4KV Internal. Fixture & LED driver should be of same make. LED Fixture & LED Driver must have BIS. Luminaire manufacture shall provide LM79 report from NABL/UL accredited lab.



### **10 W LED round LED Post Top Lighter**

## **12Mts High Mast**

### **Mast Structure**

**The high Mast** shall be of continuously tapered, polygonal cross section polygon type of 12 Mtrs in height presenting good visual appearance and shall be based on proven design to given assured performance, reliability and service. The Mast shall have an approximate top

diameter of say 150 mm to 200 mm and bottom diameter of 350 mm to 450mm. The weight of the Mast shall not exceed more than 1600 kgs. Excluding weight of Luminaire, to maintain good elasticity of slender structure.



**High MastLighter**

### **Mast construction**

The Mast shall be fabricated from special steel plates of BS EN 10025 grade, cut and folded to form polygonal section and shall be telescopically jointed and fillet welded. The welding shall be in accordance with BS : 5135. The procedural weld geometry and the workmanship shall be exhaustively tested by the radiography on the completed welded and certificates submitted.

The Mast shall be delivered in only 2 sections without any circumferential welding at site, which shall be joined together by slip-stressed-fit method. The joining shall be with stressing equipment, thus forming the sleeve joint. No site welding or bolted joint will be accepted. The overlap distance shall have full penetration of longitudinal welds. The base plate of the mast shall be at least 25mm. thick. An adequate door opening of min. 1400 mm x 300 mm shall be provided at the base of each Mast. The opening shall be such as to permit clear access to equipment like winches, cable plug and socket, etc. The opening shall be complete with a close fitting vandal resistant, weather- proof door provided with a heavy duty lock. For metal protection of the Mast, the entire fabricated Mast shall be not dip galvanised internally and externally, having minimum average thickness of 65 microns.

### **Dynamic Loading**

The Mast structure shall be designed for an assumed maximum reaction arising from the maximum win speed (3 seconds gust) and measured at a height of 12 Mtrs. above ground level as per IS 875, Part III, 1987. The design life of the Mast shall be min. 25 years. Wind

excited oscillation shall be damped by the method of constructions and adequate allowance made for the related stresses. The offered High Mast shall be a tested design.

### **Foundation**

The Contractor shall see the site closely and minutely with regard to the nature of the soil, average depth of decomposed garbage and debris at proposed Mast locations and the other site conditions before working out the type of foundation and specifications for the proposed High Mast to the manufacture standard. The Contractor/Manufacture shall be responsible of the foundation and safe erection and installation of the High Mast in mechanically and structurally safe working condition for the designlife of the Mast. The load bearing (safe) capacity of the soil shall be indicated by purchaser to decide the type of foundation and its specifications. The holding down bolts shall be at least 20 nos. of high tensile strength and shall be supplied complete with anchor plate of 6 mm thick for casting into the foundation. The precision made steel template with tube holes shall be provided to ensure correct verticality and horizontality of bolt alignment.

### **Lantern Carriage**

The fabricated lantern carriages shall be provided for holding the floodlight fittings and control gear provided on each High Mast. The lantern carriage shall be of special design and of durable steel tube construction designed to act as electric conduit with cable holes fully protected by grommets. The diameter of the lantern Carriage shall be suitable so as to hold designed number of floodlight fittings, as specified in the tender design along with the control gear boxes and lantern.

The lantern carriage shall be fabricated in three parts joined by bolted flanges with SS bolts with nuts to enable easy removal from the erected mast for replacement/ maintenance purpose. The carriage shall be supported / suspended by three wire ropes for better stability. The lantern carriage Assembly shall not touch the lower surface of the Mast. The carriage design and fabrication shall be such that the lantern carriage will suit the lanterns and their control gear boxes to be used in the work.

The Lantern Carriage shall be so installed that it does not cause any damage to the surface of the Mast and is provided with protective buffer arrangement. The complete Lantern Carriage shall be hot dip galvanised after fabrication.

The weather – proof cast aluminum junction boxes (IP-55) shall be provided on the Lantern

Carriage assembly from which the inter – connections will be made to the designed number of floodlight fittings and lanterns on the carriage.

### **Mechanical Arrangement**

For installation and maintenance purpose, it will become necessary to raise or lower the lantern carriage assembly. To enable this, a suitable winch arrangement shall be provided in the base of the Mast, complete with top pulley, winch stainless steel wire ropes and winch driving power tool.

### **Winch**

The winch shall be of completely self – sustaining type. The winches shall be of self – sustaining type by means of an oil bath and the lubrication shall be of recommended quality. Termination of the ropes of the winch shall be in such a way, that it does not involve distortion or twisting of the rope configuration. At least 6 turns of rope shall remain in tension on the drum even when the lantern carriage is fully lowered. The winch shall be designed to be installed or removed from the door opening at the base of the mast. The winch drums shall be grooved to ensure mechanically strong, stable and tidy rope lay with no chances of rope slippage or skip page. The winch shall be capable of operation by hand or by means of external power tool. Integrated power tool with worm is not acceptable.

A test certificate shall be supplied along with each winch in support of the maximum load operated by the winch and for the safety of operation at the full load rotation. A handle shall also be provided for hand operation of the winches.

### **Top Pulley Assembly**

The top pulleys shall be of a diameter, appropriately large enough to accommodate the steel wire ropes and the multicore electric cable. The material of construction of the pulley blocks shall be non – corrosive and made of dia cast (LM - 6) aluminum alloy. The pulley assembly shall be complete with self lubricating bearing and stainless steel spindle.

### **Stainless Steel Wire Ropes**

Stainless steel wire ropes shall be of 7 / 19 construction of 5 mm diameter, having a breaking load of not less than 1350 kgs. Complete with stainless steel thimbles. The end for connection to the winch drum shall be fitted with thimbles and the thimbles shall be secured by copper compression splices.

**Cable and Cable Connections**

The connections shall be made with flat core flexible round sheath power cables of appropriate rating as per the schedule. The base compartment of the High Mast shall have one terminal box for terminating the incomer cable. The maintenance cables equal to that within the Mast and fitted with a 5 core plug socket shall be provided to energise lanterns while in lowering position by hooking up at the base compartment socket supply. Similarly, the provision shall be made for electric supply at the base compartment to enable operation of the external power tool for lowering or rising of the lantern carriage assembly. The trailing cables of the lantern carriage rings shall be terminated by means of metal cased plug and socket provided in the base compartment to enable flexibility.

**Winch Driving Power Tool**

The electric driven tool shall be single speed, (1.2 Mt./min.) reversible three phase & hand operated motor. The power tool shall be complete with very robust remote control switch such that the tool can be operated from safe distance of 5 Mtrs. There shall be an arrangement for self alignment off power tool which can be self supported during operation. Manual handle shall be provided for hand operation of the winches. The capacity rating and speed of the electric motor used in the power tool shall be specified by the tenders.

**Lighting Final & Aviation Obstruction**

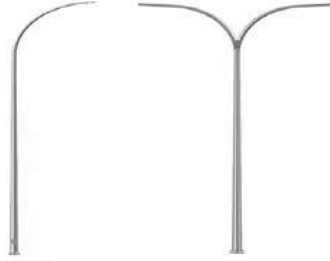
One number heavy duty hot dip galvanized lighting finial shall be provided for each mast. Suitable Aviation Obstruction Lights of reliable design and reputed manufacturer shall be provided on top of each mast.

**200-watt FLOOD LIGHT****200-watt FLOOD LIGHT**

Glatt a high-performance floodlight(200watts) with pressure die cast IP66 housing,secondary lens with 120 lm/W efficiancy and superior aesthetics suitable for various application.

**Meter Height Hot-Dip Galvanized Tube Street Light Pole**

**The 6 mtr high hot dip galvanised Tube poles** with 155mm bottom A/F & 70mm top A/F made up of 3mm thk. HR sheet along with base plate of size 250X250X16mm thk, 1 m long hot dip galvanised standard bracket made up of 48 Outer dia. GI pipe suitable to mount on pole having top 70mm A/F with 4Nos of M24X750 long 'J' type EN 8 grade foundation bolts along with template.



**Galvanized Tube Poles**

**70 Watt LED type Street Light**

**The 70 watt LED type street light** with a nominal system lumen output of 5400 lumens and a minimum system efficacy of 100 lumen/watt. The luminaire shall have rated system lifetime of 50,000 burning hours at L70B50. The luminaire should have CCT 3000K/4000K/5700K/6500K and a CRI>70, SDCM<5. The luminaire shall meet IP66 and IK07 rating with THD<10% at full load, Wide operating Voltage(CLO) 100-270VAC, & PF>0.95 at full load and PF>0.9 at half load, electrical insulation class 1, interface to mains should be via 3C 1 .0sq.mm,0.5m- fying cable, T ambient 35°C. Inbuilt surge protection 4KV. The luminaire housing should be made of pressure die cast aluminium, lens and optical cover should be made of PC window. The total power consumption should not exceed 54W (including driver). The luminaire should have HV Cut off @ 325V/440V protection for 8 hrs. LM 79 and LM80 reports need to be submitted from a NABL/UL accredited lab to verify above parameters.



**70 watt LED type Street Light Lighter**

**Warranty/Guarantee** as per manufacturing defects.

### **FEEDER PILLAR (OUTDOOR TYPE)**

#### **General**

Feeder Pillar shall be metal clad totally enclosed, rigid, floor mounting, air insulated, cubicle type totally enclosed free standing type moisture, dust, vermin & weather proof outdoor type Floor Distribution Panel made out of 2.0mm thick & front cover 1.6mm thick CRCA sheet complete with following equipments, including digital ammeter with inbuilt ammeter selector switch, digital voltmeter with inbuilt voltmeter selector switch, indicating lamps, CT's, internal wiring with suitable size wires / cable. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions. This outdoor pillar box will be utilised for providing/interconnecting MVAC distribution network.

#### **Applicable Standards**

- a) IS 5039-1983: Specification for distribution pillars for voltages not exceeding 1000V AC & 1200V DC.
- b) IS 13703 (Part-1&2)-1993 / IEC 60263/1-1986: Specification for LV fuses for voltage not exceeding 1000V AC & 1500V DC.
- c) IS 12063-1987 / IEC 60529: Classification of degree of protection provided by enclosure of electrical equipment.
- d) IS 13947 (Part-1) / IEC 60947/1-1988: Specification for LV switch gear & control gear.
- e) IS 8623 (Part-2)-1993 / IEC 60439/2-1987: Specification for LV switch gear & control gear assemblies – particular requirements for Bus bar trunking system.
- f) IS 2551-1982: Danger Notice Plates.
- g) IEC 60664: Insulation co-ordination within low voltage systems including clearance cree page distances for equipment.
- h) IS 2147: Enclosure & Degree of protection of the Pillar Box
- i) IS 6005: Code of Practice for phosphating iron and steel



j) IEC 60269 : HRC Fuses

### Climatic Conditions of the Installation

- a) Max. Ambient Temperature : 42 deg. C
- b) Min. Ambient Temperature: 10 deg. C
- c) Max. Humidity : 98%
- d) Min. Humidity : 60%
- e) Average Annual Rainfall : 2500 mm
- f) Average No. of rainy days per annum: 150 days
- g) Altitude above MSL : 6 metres
- h) Average wind velocity: 18 km/hr

### General Technical Requirement

Sl.No	Description	Requirement
1.	Installation	Outdoor
2.	Rate Voltage	430V
3.	No. of Phases	3
4.	Frequency	50 Hz
5.	Wiring System	3 Phase 4 Wire
6.	System Earthing	Solid at source end.
7.	Impulse withstand voltage	8 kV
8.	Rated short time fault current	50 kA for 1 sec.
9.	Busbar Material	
	6 way (2 I/C + 4 O/G)	Aluminium (75 X 12) mm dimension.
	8 way (2 I/C + 6 O/G)	Aluminium (100 X 12) mm dimension.
10.	Max. current density of AlBusbar	1 Amp/sqmm.
11.	Degree of Protection	IP-43
12.	Temperature Rise	Max. permissible temperature rise for the Busbar and terminal should be 45°C & 65°C respectively at ambient not exceeding 42°C
13.	No. of Incoming unit with solid link	2
14.	No. of Outgoing unit with fuse link	4 for 6 Way, 6 for 8 Way Pillar box
15.	Type of Incoming Fuse-Link / Fuse Base	Knife type Solid Links with tinned copper contacts & fuse base with high stability glass fibre reinforced thermosetting polyester.

Sl.No	Description	Requirement
16.	Type of Outgoing Fuse-Link / Fuse Base	Knife type DIN HRC Fuses with tinned copper contacts & fuse base with high stability glass fibre reinforced thermosetting polyester.
17.	Type of Incoming Solid-Link / Base	Knife type solid link with tinned copper contacts & base with high stability glass fibre reinforced thermosetting polyester. However for 4 Way PB there won't be any solid link and all the units should have fuse link.
18.	Fuse Base Rating & Size	
	6 way	630 Amps (Size-3)
	8 way	1000 Amps
19.	DIN HRC fuse Rating & Size	315 Amps (Size-3)/400 Amps (Size-3) depending upon site selection.
20.	Current rating of Busbar	
	6 way (2 I/C + 4 O/G)	900 Amps
	8 way (2 I/C + 6 O/G)	1200 Amps
21.	Busbar spacing (center to center)	185 mm
22.	Neutral Busbar rating	
	6 way (2 I/C + 4 O/G)	900 Amps
	8 way (2 I/C + 6 O/G)	1200 Amps
23.	Size of Incoming Cables	2X 4C X 300 sqmm.
24.	Size of Outgoing Cables	4C X 185 sqmm.
25.	Pillar box dimension	1400 X 1200 X 415 mm.
	6 way (2 I/C + 4 O/G)	1400 X 1400 X 415 mm.
	8 way (2 I/C + 6 O/G)	1400 X 1200 X 415 mm.
26.	PB Leg dimension	910 mm X 4 (made of 75X75X 6 mm angle iron)
27.	Enclosure material	Cold rolled steel of 3.15 mm thickness
28.	Colour of enclosure	Light Grey 631 of IS:5

NB.: Suitable Correction factor and Diversity factor as per requirement of IEC/EN 61439-2 are to followed during designing the assembly within the PB enclosure.

### Tests

#### Type Tests: On Complete Pillar Box

The equipment should have been successfully type tested at NABL laboratories in India or

equivalent international laboratories in line with the relevant standard and technical specification.

The list of type tests is as follows

Following type tests as per IS: 5039/1983 shall be carried out on complete L.T. feeder Pillars.

1. Temperature rise test:-The temperature rise test should be carried out as per IS: 8623-1993.
2. High voltage test shall be carried out as per IS: 8623/ 1993 amended up to date.
3. Short Time Withstand Current Test on L.T. Pillar shall be carried out as per IS 8623: or latest version.
4. Degree of protection for IP- 43 on complete L.T. Pillar shall be carried out as per IS: 13947/1993 or the latest version thereof.
5. Verification of clearance & creepage distances.

#### **Acceptance Test: On Complete Pillar Box**

Following tests shall be carried out as per acceptance tests in addition to routine tests on one random sample of each rating out of the lot offered for inspection:

Temperature rise test on one sample of each rating.

#### **Routine Tests: On Complete Pillar Box**

- a) Routine and acceptance tests as per relevant IS shall be carried out at the manufacturers' works.
- b) Overall Dimensions Checking.
- c) Insulation Resistance Tests.
- d) High Voltage Test at 2500 V, 50 Hz AC for one minute.

### **5.24. ADVANCED LIGHTNING ARRESTER**

#### **General**

The lightning protection system shall be of the enhancing type designed to attract lightning from a predetermined volume and to safely convey the lightning current to earth through a known and preferred route.

The lightning protection system shall include components as follows: air termination(s)

mechanical support(s), down conductor(s), performance recording equipment, and an earthing system.

The lightning protection components (Air termination(s) and down conductor(s)) shall be compliant to UL-96.

### **Air Termination**

The air termination shall be of the type that responds dynamically to the appearance of a lightning down leader by creating free electrons and photo-ionisation between a spherical surface and an earthed central finial.

Arcing is not to be continuous and shall only occur during the progress of the lightning leader. Arcing shall not occur solely due to electrostatic field when a thunderstorm is overhead except when there is leader activity in the region.

The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The air termination shall be non-radioactive and require no special licensing.

The external shape of the terminal shall be such as to significantly reduce the build up of sharp point corona discharge under static field thunderstorm conditions.

The air termination shall not be dependent upon batteries or external power supplies for any part of its operation. It shall have no moving parts.

The materials of the air termination shall be non-corroding in normal atmosphere. The center earthed finial shall be at least 300mm<sup>2</sup> in cross section and be made of electric grade non ferrous material. The outer metallic surfaces of the terminal shall be manufactured of anodised aluminium.

The air termination shall be insulated from the protected structure under all conditions.

The size of the collection volume and attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The termination shall be mounted a minimum of 10 metres from the ground.

The air termination(s) shall be compliant to UL-96: Lightning Protection Components (Standard for Safety).

The air termination shall be installed strictly to the manufacturer's instructions. It shall not be installed in corrosive environments or atmospheres without prior written approval from the manufacturer.

The protective zone provided by the air termination shall be such that it becomes the preferred strikepoint for all discharges exceeding a peak amplitude return strike current of XX\*kA according to the statistical level YYYY\* of protection required. The designing shall take account of upward leader competing projections on the structure.

<b>CURRENT (XX)</b>	<b>LEVELS OF PROTECTION (YYYY)</b>
3kA	Very High
6kA	High
10kA	Medium
15kA	Standard

#### **Air Termination Support**

The support shall consist of a minimum of 2 meters of insulating fiberglass cylindrical tube. The tube shall have a minimum wall thickness of 4mm and have such diameter as to allow neat in-line mounting of the terminal. The down conductor shall pass through the center of the tube. The support shall be securely bolted to other mast materials with guy wires used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

#### **Down Conductor**

The down conductor shall consist of a plastic filler, copper conductor, inner insulation, outer copper conductor, conductive sheath, all concentrically arranged.

The outer diameter of the down conductor shall be less than 37mm.

The main copper conductor shall be made of electrical grade copper of minimum cross sectional area of 50mm<sup>2</sup>. The down conductor shall have a maximum characteristic impedance of 8 Ohms and a maximum inductance of 40 nH/m.

In the final 3m to the ground and where it is exposed to human intervention, the down conductor shall be placed in a protective PVC pipe of 3mm minimum wall thickness so as to avoid mechanical damage and increase human safety.

The main copper conductor shall be capable of direct connection to the base of the air

termination by use of a compression coupling.

The down conductor shall be installed in accordance with the manufacturer's instructions and should not be subject to bends of less than 0.5 meters radius..

The down conductor after routing must be kept in constant physical contact with the structure via conductive clamps. The top 10% of the installed length from the terminal must be anchored at least every 1 meter. The lower must be anchored at least every 2 meters.

Impulse ratings between conductors shall be no less than 200kV, i.e: core - screen 200kV based on 1.2/50 wave shape.

The down conductor(s) shall be compliant to UL-96: Lightning Protection Components (Standard for safety)

### **Performance Recording Equipment**

Every protection system shall be supplied with a lightning event counter.

The lightning event counter shall have an electronically controlled mechanical register which activates one registration for every discharge at the point of measurement over 1500A - 8/20ms peak current.

The lightning event counter shall be robust, easy to install and housed in a IP67 rated enclosure. It requires no batteries or external power source to operate.

The lightning event counter shall be installed to the manufacturer's instructions in a readily accessible manner so that readings can be taken at regular intervals. It shall be positioned such that it's operating temperature is in the range of -40 °C to +50°C.

### **Grounding**

The grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the specifying engineer or manufacturer of the lightning protection system.

Grounding will be done by copper wire or tape buried not more than 750mm deep or by deep driven copper bonded steel core ground rods especially designed for electrical grounding or a combination of these. In all cases the grounding system shall be electrically connected to the center ground rod which is securely clamped to the down conductor system.

Bonding of the grounding system to metallic parts of the building, the structural reinforcing steel of the building and to arriving services is recommended. The resistance should be

measured and the 10 ohms maximum figure achieved before such bonding is done.

Electrically conductive, non soluble Earth Enhancing Compounds may be used to help achieve low ground resistance provided the materials are mixed and installed strictly in accordance with the manufacturer's instructions.

## **5.25. A III 1.0 EARTHING & LIGHTING PROTECTION**

### **Scope**

This Section covers the essential requirements of earthing system components and their installation. For details not covered in these specifications, IS Code of Practice on Earthing (IS: 3043-1987) as per relevant Indian Electricity Rules 1956 Amended up to date, shall conform to CPWD General specifications for Electrical works(part-I-Internal) 1994 and in the regulations of the local Electrical Supply Authority shall be referred to.

### **Application**

The electrical distribution system is with earthed neutral (i.e. neutral earthed at the Transformer / Generator). In addition to the neutral earthing, provision is made for Body earthing to the metallic body of equipments and non-current carrying metallic components in the sub-station, as well as in the internal/external electrical installations such as for Transformers, HT/LT Panel, Capacitor Panels & DG Sets etc. through a common grid formed in the Substation building. Earthing requirements are laid down in Indian Electricity Rules, 1956, as amended from time to time, and in the Regulations of the Electricity Supply Authority concerned. These shall be complied with.

Each equipment shall be connected with two independent earth conductors to earth bar located in respective area. Each earth bar shall be connected to Earth Grid by two independent earth conductors. Earthing Grid shall be directly connected by two independent earth electrodes. Earthing shall be 600 x 600 x 3mm thick with copper earth plate.

### **Materials**

The material of earth and earth conductor shall be as specified in Indicative Items.

### **Earth Electrodes**

The type of earth electrode shall be any of the following

A. Plate/ Pipe earth electrode as specified in INDICATIVE ITEMS.

B. Electrode materials and dimensions

The materials and minimum sizes of earth electrodes shall be as specified.

### **Earthing Conductor**

The earthing conductor (protective conductor from earth electrode upto the main earthing terminal/ earth bus, as the case may be) shall be of the same material as the electrode, viz. GI or copper and in the form of wire or strip as specified. The size of earthing conductor shall be as specified.

### **Neutral Earthing of Equipment**

Neutral terminals of Transformers shall be earthed independently. Each neutral terminal shall be earthed with two independent earth electrodes. Earth electrode shall be 600 x 600 x 3mm thick copper plate. Copper Strip as earth conductor laid in ground shall be protected for mechanical injury & by providing GI Pipe of required dia as specified.

### **Plate Earth Electrode**

Earthing shall be provided with copper/GI plate electrode as mentioned in Indicative Items of following.

- i Copper Plate Electrode : 600mm x 600mm x 3mm thick
- ii GI Plate Electrode : 600mm x 600mm x 6mm thick

The electrode shall be buried in ground with its faces vertical and not less than Three(3) metres below ground level. 40mm dia medium class GI pipe shall be provided and attached to the electrode. A funnel with mesh shall be provided on the top of this pipe for watering and earth electrode. Earth electrode the watering funnel attachment shall be housed in masonry enclosure of not less than 300 x 300 x 300mm deep. A cast iron MS frame with cover having locking arrangement shall be provided at top of chamber. Earth electrode may not effect the column footing or foundation of the building. In such cases electrode may be further away from the building.

### **Artificial Treatment of Soil**

If the earth resistance is too high and the multiple electrode earthing does not give adequate low resistance to earth, then the soil resistivity immediately surrounding the earth electrodes



shall be reduced by addition of sodium chloride, calcium chloride, sodium carbonates copper sulphate, salt and soft coke or charcoal in suitable proportions.

### **Hardware Items**

All hardware items used for connecting the earthing conductor with the electrode shall be of GI in the case of GI pipe and GI plate earth electrodes, and in case of copper plate electrodes.

### **Location of Earth Electrodes**

Normally an earth electrode shall not be located closer than 1.5 m from any building. Care shall be taken to see that the excavation for earth electrode does not affect the foundation of the building; in such cases electrodes may be located further away from the building, with the prior approval of the The Engineer.

The location of the earth electrode will be such that the soil has a reasonable chance of remaining moist as far as possible. Entrances, pavements and roadways, should be avoided for locating earth electrodes.

### **Installation**

#### **Various Types of Electrodes**

Pipe electrode shall be buried in the ground vertically with its top at not less than 20 cm below the ground level. The installation shall be carried out as shown in drawin and as per the direction of The engineer.

In locations where the full length of pipe electrode is not possible to be installed due to meeting a water level, hard soil or rock, the electrode may be reduced length, provided the required earth resistance result is achieved with or without additional electrodes, or any alternative method of earthing may be adopted, with the prior approval of the The Engineer. Pipe electrodes may also be installed in horizontal formation in such exceptional cases.

Plate electrode shall be buried in ground with its faces vertical, and its top not less than 3 m below the ground level. The installation shall be carried out as shown in drawing.

When more than one electrode (plate/pipe) is to be installed, a separation of not less than 2 m shall be maintained between two adjacent electrodes.

Artificial treatment of soil When artificial treatment of soil is to be resorted to, the electrode shall be surrounded by charcoal/coke and salt and as indicated in enclosed drawings. In such

cases, excavation for earth electrode shall be increased as per the dimensions.

#### **Watering arrangement**

- a) In the case of plate earth electrodes, a watering pipe of 20mm dia. medium class G.I. pipe shall be provided and attached to the electrodes and a funnel with mesh shall be provided on the top of this pipe for watering the earth.
- b) In the case of pipe electrodes, a 40 mm X 20 mm reducer shall be used for fixing the funnel with mesh.
- c) The watering funnel attachment shall be housed in a masonry enclosure of size not less than 30 cm X 30 cm X 30 cm.
- d) A cast iron/MS frame with MS cover of 6 mm thick, and having locking arrangement shall be suitably embedded in the masonry enclosure.

#### **Earthing conductor (Main earthing lead)**

- a) In the case of plate earth electrode, the earthing conductor shall be securely terminated on to the plate with two bolts, nuts, check nuts and washers.
- b) In the case of pipe earth electrode, wire type earthing conductor shall be secured as indicated in drawing using a through bolt, nuts and washers and terminating socket.
- c) The earthing conductor from the electrode up to the building shall be protected from mechanical injury by a medium class, 15 mm dia. GI pipe in the case of wire, and by a minimum of 40 mm dia, medium class GI pipe in the case of strip. The protection pipe in ground shall be buried at least 30cm deep (to be increased to 60 cm in case of road crossing and pavements). The portion within the building shall be fixed on walls.
- d) The earthing conductor shall be securely connected at the other end to the earth stud/earth bar provided on the switch board by: Soldered or preferably crimped lug, bolt, nut and washer in the case of wire, and, Bolt, nut and washer in case of strip conductor.

#### **Earth bus and main earthing terminal**

In all installations, main earthing terminal shall be provided at the main switchboard. This may be in the form of earth stud or single earth bar depending on the type of the switchboard.

A ring earth bus shall be provided in the substation building, switch room, and various panels shall be connected to that earth ring.

Following conductors shall be terminated on to the main earthing terminal.

- a) Earth connection from electric supply company (where provided)
- b) Earthing conductor from electrode.
- c) Protective conductors.
- d) Equi - potential bonding conductors

### **Protective (Loop earthing/ earth continuity) conductor**

Earth terminal of every switchboard in the distribution system shall be bonded to the earth bar/terminal of the upstream switch board by protective conductors.

Two protective conductors shall be provided for a switchboard carrying a (3) Three-phase switchgear thereon.

### **Earth Resistance**

The earth resistance at each electrode shall be measured. No earth electrode shall have a greater ohmic resistance than 5 ohms as measured by an approved earth testing apparatus. Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode, or artificial chemical treatment of soil etc., as may be directed by the The Engineer.

### **Marking**

Earth bars/terminals at all switch boards shall be marked permanently, as "E".

Main earthing terminal shall be marked "SAFETY EARTH - DO NOT DISCONNECT".

### **Measurement of Earth Electrode Resistance**

Two auxiliary earth electrodes, besides the test electrode, are placed at suitable distance from the test electrode. A measured current is passed between the electrode 'A' to be tested and an auxiliary current electrode 'C' and the potential difference between the electrode A' and auxiliary potential 'B' is measured. The resistance of the test electrode 'a' is then given by

$R = V/I$  Where,

R - Resistance of the test electrode in ohms

V- Reading of the voltmeter in volts

I - Reading of the ammeter in amps

Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

At the time of test, the test electrode shall be separated from the earthing system.

The auxiliary electrodes shall be of 13mm diameter mild steel rod driven up to 1 m into the ground.

All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode C shall be placed at least 30m away from it and the auxiliary potential electrode 'B' shall be placed mid-way between them.

Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C up to 50m, and each time placing the electrode B mid-way between them.

On These principles, " Megger Earth Tester" containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

### **Excavation**

- 1) Bore a hole into the earth (minimum diameter 6"). Hole should be bored to allow installed unit to be as close to vertical as possible
- 2) A 14" hole must be provided for the cover box.
- 3) Depth of hole must be 6" deeper than the vertical length of the system.
- 4) Top vent ports must be left open to the atmosphere for continuous air circulation by using the protective test well provided.

5) Plate Type Earthing (Cu/GI), Crow Foot Earthing and Cu Claded rod earthing, the mixing procedure of Backfill will be same as like in the electrolytic Earthing.

### **Installation**

- 1) Remove sealing tapes from the bottom of unit only. Tapes must be saved and made available to the electrical inspector to verify removal and proper installation. Do NOT remove the green and white “Bury to Here” marker from the top of the unit.
- 2) Position the unit in the hole. Use green and white “Bury to Here” marker as a guide to depth in which unit shall be buried. Three bags of are included with each 10' electrode.
- 3) Pour around electrode in augured hole. Do not mound backfill past green and white marker.
- 4) Place box with cover over the top of the electrode so that the cover is at grade level. Use backfill to stabilize box around the electrode. This keeps the breather holes free of obstruction and debris. Top of box should not contact the top of the electrode.
- 5) Remove top sealing tape ONLY after backfill is complete. This prevents soil from blocking the vent ports

### **Connection**

- 1) Connect grounding conductor to ground rod pigtail exothermally.
- 2) Bury grounding conductor 30inch below grade.

### **Conventional Lightening Protection System**

The lightning protection system shall be based on conventional Lightening protection system and shall be carried out as per IS / IEC – 62305-3 as relevant.

The lightning protection system shall be designed to attract lightning includes current level sometimes in excess of 200 KA and speed approx. 1/3 the speed of light. For lightning protection, Finial Air terminal shall be installed above the highest points of the building which captured lightning & mast should be provided at the appropriate

height corresponding to the area to be protective by the lightning rod.

Gel/Chemical earthing can be done with a chemical compound which is capable of absorbing and retaining the moisture for a long time. It reduces the soil resistivity and low earth impedance.

### **Lightning finial Rods**

Air terminals should be designed to attract a lightning strike, thereby becoming the preferred lightning attachment point.

### **Down-Conductor, Bonding and Shielding**

Down conductors should be installed in a safe manner through a known route, outside of the structure. It leads the current of the lightning stroke from the capturing head to the earth electrode.

### **Surge protection device**

This shall also installed as per relevant IEC-62305-3 a required .

### **Grounding**

The grounding system must address low earth impedance as well as low resistance. A spectral study of lightning's typical impulse reveals both a high and low frequency content. The high frequency is associated with an extremely fast rising "front" on the order of 10 microseconds to peak current. The lower frequency component resides in the long, high energy "tail" in the impulse. In lightning protection, low earth impedance at higher frequencies.

A single point grounding system is achieved when all equipment within the structure(s) are connected to a master bus bar which in turn is bonded to the external grounding system at one point only. Earth loops and differential rise times must be avoided. The grounding system should be designed to reduce AC impedance and DC resistance. The shape and dimension of the/earth termination system is more important than a specific value of the earth electrode. Ground rings around structures are useful. They should be connected to the facility ground. Exothermic (welded) connectors are recommended in all circumstances

Man-made earth additives and backfills are useful in difficult soils circumstances: they should be considered on a case-to-case basis where lowering grounding

impedances are difficult and/or expensive by traditional means. Regular physical inspections and testing should be a part of an established preventive maintenance program.

### **Earthing**

Gel/Chemical earthing technology with adequate galvanization filled with a suitable earth enhancing chemical compound, which give low earth impedance. Which also capable of absorbing and retaining the moisture for a long time, it reduces the soil resistivity and helps in faster dissipation of fault current.

### **Absence of Corrosion**

Practically no need to change i.e. fit and forget.

Earthing should be non-corrosive, so there is not much variation in Ohmic value.

The compound should become part of the soil around the electrode.

It should require less space and time to install the earthing electrode.

### **Bonding**

In order to achieve a common earth base at any installation, equipotential bonding of the system is necessary. To achieve this, copper strip of 25mm x 3mm dimension is dug in and around the site in the 45cm deep trench and all earth pits are connected together. The communication earth should be connected with the earth grid through Isolation Spark Gap or directly as per advice of the equipment provider.

## **5.26. A IV 1.0 PHOTO VOLTAIC ON GRID ROOF TOP WORK**

### **General**

#### **ON Grid Solar Power Plant Roof Top System**

In this system Supply. Install and commission of solar power plant on your roof, produce electricity in the day time and directly convert them into AC power and use for loads during day time or export to Grid .This system is most common for applications above 125 Kwp (Tezpur & Jorhat) and 40 Kwp (Diphu) upto MW size.

### **Solar PV Modules**

Solar cells produce direct current electricity from light, which can be used to power

equipment or to charge a battery. Cells require protection from the environment and are usually packaged tightly behind a glass sheet. When more power is required than a single cell can deliver, cells are electrically connected together to form photovoltaic modules, or solar panels. A photovoltaic module is a packaged interconnected assembly of photovoltaic cells, which converts sunlight into electrical power. The cells are hermetically sealed between glass and back cover (Tedlar) to protect them from harsh environments.

### **Module Mounting Structure**

The module mounting structure is designed for holding suitable number of modules in series. The frames and leg assemblies of the module mounting structures is of Mild Steel hot dip galvanized of suitable sections of Angle, Channel, Tubes or any other sections conforming to IS:2062 to meet the design criteria. All hardware considered for fastening modules with this structure are of very good quality of Stainless Steel (SS304). The module mounting structure is designed in such a way that it will occupy minimum space without sacrificing the output from SPV panels at the same time it will withstand severe wind speed up to a maximum 150 kmph.

### **Junction Boxes**

The junction boxes (AJB) are of dust, vermin, and waterproof and made of Thermo Plastic. The terminals will be connected to copper bus-bar arrangement of proper sizes. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.

### **Solar Inverter**

The solar inverter shall supply continuous power to the dedicated load with support to the load coming from the solar array, Grid Power in order of preference. The PV String Inverter has MPPT charge controller which will provide the required output within the range for any variation of solar panel voltage. The DSP control circuit should automatically adjust the DC-DC converter to ensure that it should always match to the PV array under varying conditions and transfers the maximum possible power. The DC output from the MPPT is fed to the high efficiency Inverter and the same is synchronized with the grid and feeds power to the grid thereby exporting the same.



**DC Distribution Board (DCDB)**

This is made of MS enclosure with suitable powder coating. There is a separate suitable switchgear arrangement in this DB for input from AJB and suitable output with 3 or 6 connections to the string inverter. We draw the connections to the PV inverter through MC4 connectors for firm current flow. This can also be fitted with an energy meter for display and recording the data optionally. vi. AC Distribution Board (ACDB). This is made of MS enclosure with suitable powder coating. One breaker will be provided in ACDB with MCB of suitable capacity to link PV inverter and EB supply side. This is to facilitate disconnection during maintenance. One electronic energy meter of Single/three phase as required is fitted in ACDB to measure the energy exported from the SPV power plant.

**Lightning Arrestor**

The SPV Power Plant needs be provided with suitable lightening and over voltage protection. The principal aim in this protection is to reduce the over voltage to a tolerable value before it reaches the PV or other sub-systems components. The source of over voltage can be lightening or any other atmospheric disturbance. Each LA will have to be earthed through suitable size earth bus with earth pits.

**Earthing**

Each array structure of the PV yard needs be grounded properly using adequate number of earthing kits. Each kit will contain super earth mixture and galvanized clamp and SS rod. All metal casing/shielding of the plant will be thoroughly grounded in accordance with Indian Electricity Act/IE rules. Each Resistance should be tested after earthing by calibrated earth tester. The Contractor/Manufacture shall make testing arrangements. The earthing pit shall have to be made as per IS: 3043. All the array structures, equipments & control systems will be connected to the earth.

**Cables & Accessories**

All cables will be of copper as per ISI and should be of 650V/1.1 KV grade as per requirement. All connections are properly made using suitable connector/lug/terminal crimped with use of suitable proper cable glands. The size & type of cables/wires are chosen considering the line loses, maximum load on line, keeping cable drop within permissible limit and other related factors.

**System Design**

<b>I</b>	<b>SPV POWER PLANT</b>	<b>(Tezpur &amp; Jorhat) &amp; Diphu</b>
<b>1</b>	System Size	125 & 40kWp
<b>2</b>	Expected Annual Energy Generation-day/Month/Year	180000 units
<b>3</b>	Proposed PV (Photovoltaic) Module Type	Poly PERC
<b>4</b>	Module rating	325Wp
<b>5</b>	Number of modules	228 Nos
<b>6</b>	PCU /Inverter Rating	100Kwatt-1No.& 25kwatt-01 (3Phase in-3 Phase Out)
<b>7</b>	No.of power conditioning unit/ Inverter	1 No
<b>8</b>	Electrical parameter for interconnection	415V 3- Phase
<b>II</b>	<b>Mounting Arrangement</b>	
<b>1</b>	Type of Installation	Root top
<b>2</b>	Mounting type	Fixed mounted
<b>3</b>	Surface azimuth angle	180
<b>4</b>	Structure Angle	As per latitude of the place
<b>5</b>	Area required for installation	100 Sq. ft/ kWp
<b>6</b>	Wind resistance	150 km/ hr

<b>Sl No.</b>	<b>DESCRIPTION</b>	<b>SCOPE</b>
<b>1</b>	Detailed Bill of Materials	
<b>2</b>	Project Activity Chart	
<b>3</b>	Supply of Materials as given in Techno Commercial Proposal	
<b>4</b>	Access Ladder to Roof	
<b>5</b>	Place for storing materials during installation with lock and Key	
<b>6</b>	Erection of PV modules on Structures	
<b>7</b>	DC Wiring & Cabling for Module strings, AJB & Inverter	
<b>8</b>	AC Cable from ACDB to LT Panel (Interconnection point)	
<b>9</b>	Erection of Inverters	
<b>10</b>	Erection, Testing & Commissioning of ACDB	
<b>11</b>	Space Provision for ACDB	

<b>Sl No.</b>	<b>DESCRIPTION</b>	<b>SCOPE</b>
<b>12</b>	Laying and Termination of LV cables from ACDB to Distribution Boards	
<b>13</b>	Erection of Earthling for PV array Area	
<b>14</b>	Erection of Earthling from Ground to terese area	
<b>15</b>	Erection of Earthling For Lightening arresstor	
<b>16</b>	Installation of Remote Monitoring system	

### **Installation & Commissioning**

Installation is done by well trained personnel which includes checking the delivered items for transit variations, specifications as per requirement, BOQ. Then the MMS is fitted with necessary anchoring, grouting, concreting also considering the shadow free space, inclination and direction. After the MMS the SPV modules are mounted suitable with horizontal symmetry. Then AJB is suitably fixed to the MMS pole to achieve the least distance of wiring and with no joints. Suitable connectors are used to make the wiring joint free. Then the cables are drawn to the DCDB near the string inverter in a suitable control room near to grid mains distribution where to inverter is to be fixed. Then the inverter is fitted with anchor bolts and the bracket suitable for wall mounting. Then ACDB is fitted next to the inverter so that both grid and inverter are side by side to the ACDB for ease of connection and lowest distance of wiring.

### **Warranty/Guarantee**

Warrants that the Rooftop Solar PV Power System and the Interconnection Facilities for a period of 18 months from Dispatch and Commissioning as per manufacture defects.

## **5.27. B.I. INTERNAL ELECTRIFICATION**

### **Conduit and Wiring System**

#### **P.V.C Conduit**

#### **Scope**

This system covers the detailed requirements for wiring work in PVC/non-metallic conduits and covers both surface and recessed types of wiring work.

**Standard Applicable**

Indian Electricity Act 1910 and Indian Electricity Rules 1956 amended up to date.

Relevant Indian Standard codes of Practice for type of work as per appendix.

**Conduits and accessories steel conduits**

The Conduits shall be of steel, the wall thickness shall not be less than 1.6 mm (16 SWG) for conduits up to 32 mm dia and not less than 2 mm (14 SWG) for conduits above 32 mm dia. They shall be solid drawn or seamed by welding and finished with galvanised or black stove enamelled surface as specified in Schedule of Works.

**Accessories**

- (i) All conduits accessories shall be threaded type and under no circumstances pin grip type or clamp grip type accessories shall be used.
- (ii) Bends, Couplers etc., shall be solid type in recessed type of works and may be solid or inspection type as required in surface type works.
- (iii) Minimum 60 mm depth junction boxes shall be used in roof slabs in recessed conduit system and in other places shall be as per IS 2667 - 1977.
- (iv) Saddles for surface conduit work on walls shall not be less than 0.55 mm (24 Gauge) for conduits up to 25 mm dia and not less than 0.9 mm (20 Gauge) for larger diameter. The corresponding width shall be 19 mm & 25 mm.

**Conduit Joints**

- (i) The conduit pipes and accessories shall be of suitable material complying with IS:2509 - 1973 and IS:3419 - 1976 for rigid conduits. The interior of the conduits shall be free from obstruction. The make shall be as specified.
- (ii) The conduits shall be circular in cross section. The conduits sizes are designated by their nominal outside diameter. The dimensional details shall be as follows:

SL.No	Nominal Outside Diameter	Maximum Outside Diameter	Minimum Inside Diameter	Maximum Permissible Eccentricity	Maximum Permissible
1	20	20 + 0.3	17.2	0.2	0.5
2	25	25 + 0.3	21.6	0.2	0.5
3	32	32 + 0.3	28.2	0.2	0.5
4	40	40 + 0.3	35.8	0.2	0.5
5	50	50 + 0.3	75	0.5	0.8

**Note: All Dimensions are in MM**

**Protection against Condensation**

The Conduit pipes shall be fixed by means of staples, hooks or means of saddles not more than 60 cm apart or by any other approved means of fixing.

All threaded points of conduit pipes shall be treated with some approved preservative compound to ensure protection against rust.

**Protection of Conduit against Rust**

- a. Conduit work of each circuit section shall be completed before cables are drawn.
- b. Conduit Pipes shall be joined by sleeved coupler and sleeved accessories only and threads on conduit pipes in all cases shall be 15 mm long, sufficient to accommodate full threaded portion of coupler and accessories in case of conduits. In case of rigid PVC Conduit, all points shall be sealed / cemented with an approved cement.

Cut ends of conduit pipes shall have no sharp edges nor any burrs left to avoid damage to the insulation of conductors while pulling than through the pipes.

**Bends In Conduit:**

All necessary bends in the system including diversion shall be done by either neatly bending the pipes without cracking with a bending pipe of not less than 7.5 cm. In respect of rigid PVC Pipes the bending shall be achieved with approved method of heating. Alternatively the bends may be formed by using suitable accessories such as bends, elbows and Junction Boxes (cast iron / MS in case of rigid steel conduits and PVC in case of rigid PVC Conduits).

No length of conduit shall have more than equivalent of four quarter bends from outlet to outlet.

**Painting of Conduit and Accessories**

- a. Conduit work of each circuit section shall be completed before cables are drawn.
- b. Conduit Pipes shall be joined by sleeved coupler and sleeved accessories only and

threads on conduit pipes in all cases shall be 15 mm long, sufficient to accommodate full threaded portion of coupler and accessories in case of conduits. In case of rigid PVC Conduit, all points shall be sealed / cemented with an approved cement.

Cut ends of conduit pipes shall have no sharp edges nor to avoid damage to the insulation of conductors while pulling than through the pipes.

### Sizing of Conduits:

- (i) Conduit size shall be so selected that the maximum number of PVC Insulated cables including earth conductor that are drawn in one conduit shall not exceed the numbers shown in the table below : Maximum number of PVC insulated 650V/1100V Grade Aluminium/Copper Conductor Cable as per IS: 694 - 1990.

Nominal Cross-sectional Area of conductor in Sq. mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

### Note:

- (i) Column headed 'S' apply to runs of conduits which have distance not exceeding 4.25 mm between draw in boxes and which do not deflect from straight by an angle of more than 15 degrees. The columns headed 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.
- (ii) The minimum size of conduit shall be 20 mm for lighting and 25 mm for power wiring.

**Fixing of conduits****Surface Conduit**

- a. Conduit Pipes shall be fixed by saddles, with sleeves in an approved manner at an interval of not more than one meter, in respect of rigid steel conduit and 60 cm in respect of rigid PVC Conduit but on either side of coupler or bends or similar fittings. Saddles shall be fixed at a distance of 30 cm from the center of such fittings.
- b. In long distance straight run of conduits, inspection type couplers at reasonable intervals shall be provided.
- c. In respect of rigid PVC Conduits, if the pipes are susceptible to mechanical damage, they shall be adequately protected.

**Recess / Concealed Conduit**

All necessary bends in the system including diversion shall be done by either neatly bending the pipes without cracking with a bending pipe of not less than 7.5 cm. In respect of rigid PVC Pipes the bending shall be achieved with approved method of heating. Alternatively the bends may be formed by using suitable accessories such as bends, elbows and Junction Boxes (cast iron / MS in case of rigid steel conduits and PVC in case of rigid PVC Conduits). No length of conduit shall have more than equivalent of four quarter bends from outlet to outlet

**Outlet Boxes**

Switch/outlet boxes shall be made of metal on all sides except on the front. Boxes shall be G.I. Up to 10cmx20cm size Box shall have wall thickness of 18 SWG and above 10cmx20cm shall have 16 SWG. The metallic boxes shall be painted with anti corrosive paint before erection. Clear depth of the box shall not be less than 50mm all fitting shall be fitted in flush pattern. Switch/outlet boxes shall be suitable to house modular type light and

**Fan Box**

Fan Box shall be made out of 14 gauge M.S. sheet in hexagonal shape. The dia of box shall be 150 mm and depth of box shall be 80 mm. A M.S. covers plate size 160 mm x 160mm x 16 gauges to be provided in the back of fan box. 12 mm dia M.S.Rod to

be provided for fan hanging arrangement in the box. A 28 mm dia knockout To be made in all six hexagonal vertical part for conduit entry in the box. The box shall be painted with 2 coat of primer. A 180 mm dia, 2 mm thick hylem sheet Cover to be provided. (The sample to be approved before procurement / execution by owner / consultant ).

## **5.28. B. II DISTRIBUTION BOARDS**

### **General**

a) Distribution Board shall be double door type with extended loose wire box & M.S. Junction Box at the top and suitable for flush installation. All distribution boards shall be of three phases (415 Volts) or single phase (240 Volts) type with incoming isolator or MCB and/or RCCB as in Bill of Quantities. Distribution boards shall contain plug in type miniature circuit breaker mounted on bus bars. Miniature circuit breakers shall be quick make & quick break type with trip free mechanism. MCB shall have thermal & magnetic short circuit protection. MCB shall conform with IS 8828-1978 & IS 8828 - 1996. Bus bars shall be of electrolytic copper. Neutral bus bars shall be provided with the same number of terminals as there are single ways on the board, in addition to the terminals for incoming mains. An earth bar of similar size as the neutral bar shall also be provided. Separate neutral & earth bus bar link to be provided for each phase. Phase barrier shall be fitted and all live parts shall be screened from the front. Ample clearance shall be provided between all live metal and the earth case and adequate space for all incoming and outgoing cables. All distribution board enclosures shall have an etched zinc base stove painted followed by synthetic stove enamel, colour light gray. A circuit identification card in clear plastic cover shall be provided for each distribution board. IK (Mechanical Stress) rating of distribution board enclosure shall not be less than IK -07/ 08 / 09.

b) Distribution Board with single phase outgoings requirement shall be Horizontal type. Distribution Board with three phase outgoings requirement shall be Vertical/ Horizontal type. Distribution Board installed in indoor dry locations shall conform to IP-42. Distribution Board installed in outdoor & wet locations shall conform to IP- 65.

c) Miniature Circuit Breakers for lighting circuits shall be of "B" series where as the



circuits feeding discharge lamps (HPMV or HPSV) halogen lamps, all power outlet points, equipment/ machinery shall be of "C/D" series (Motor circuit) types. All miniature circuit breakers shall be of not less than 10KA rated rupturing capacity. All miniature circuit breaker terminals shall have safety shutter.

d) Distribution board shall be provided with isolator or MCB and/or earth leakage circuit breaker. Earth leakage circuit breaker shall be current operated type and of 30mA sensitivity unless otherwise stated. RCCB shall be mounted within distribution board box for single phase distribution board while in three phase distribution board RCCB shall be either mounted within distribution board box or in a separate MS box below distribution board. Width and depth of RCCB box shall be same as that of distribution board box and of same finish. Height of RCCB box shall be sufficient to accommodate RCCB & termination of incoming & outgoing wires. Distribution board box ,isolator, MCB'S used shall be of one/same manufacturer. Standard size manufactured by approved manufacturer shall be used. In case size required is not standard size of manufacturer, in that case next standard size distribution board box shall be used with incoming & outgoing MCB. Additional cutout/space for outgoing MCB shall be plugged with blank plates. No extra cost shall be paid for using bigger/higher size distribution board box and blank plates. (The sample to be approved before procurement / execution by owner / consultant ).

### **Sub Distribution Panel (PTTA)**

#### **General**

Sub Distribution Board shall be metal clad totally enclosed, rigid, floor mounting, air insulated, cubicle type for use on 415 volts, 3 phase, 50 cycle system. Equipment shall be designed for operation in high ambient temperature and high humidity tropical atmospheric conditions.

#### **Standards**

The equipment shall be designed to conform to the requirements of:

IS 8623 – Factory Built Assemblies of switchgear and control gear.

IS 4237 – General requirements for switchgear and control gear for voltages not exceeding 1000V.

IS 2147 – Degrees of protection provided by enclosures for low voltage switchgear

and control gear.

IS 375 – Marking and arrangement of bus bars.

Individual equipment housed in the sub distribution boards shall conform to the following IS specifications:

- |    |                                    |   |                            |
|----|------------------------------------|---|----------------------------|
| a) | Moulded Case Circuit Breakers      | - | IS: 13947-2/IEC 947-2      |
| b) | Miniature Circuit Breaker          | - | IEC - 60898                |
| c) | Contractors                        | - | IEC – 947-4-1, IS13947-4-1 |
| d) | Current Transformers               | - | IS: 2705                   |
| e) | Indicating Instruments (Analogue)  | - | IS: 1248,                  |
| f) | Indicating Instruments (Digital)   | - | IS: 13875                  |
| g) | Integrating Instruments (Analogue) | - | IS: 722, IS: 13779-1999    |
| h) | Integrating Instruments (Digital)  | - | IS: 13779- 1999, IS: 14697 |
| i) | HRC fuse links                     | - | IS: 13703 / IEC 269        |

### **Submittals**

The Contractor shall furnish relevant descriptive and illustrative literature on switchgears and associated equipment and the following for approval before manufacture of the panel.

- a) Complete assembly drawings of the panel showing plan, elevation and typical section views and locations of cable boxes, bus bar chamber, metering compartment and terminal blocks for external wiring connections.
- b) Typical and recommended schematic diagrams and control wiring.
- c) Foundation plan showing location of foundation channels, anchor bolts and anchors, floor plans and openings for cables etc.
- d) All drawings and data shall be in English.

### **Constructions**

Sub Distribution boards shall be metal enclosed, indoor, floor mounted free standing and/or wall mounted type made up of the required vertical section, which when coupled together shall form continuous dead front. Sub distribution boards shall be dust and damp protected, the degree of protection being no less than IP: 54 to IS:2147. Sub distribution boards shall be fabricated with a framed structure with rolled/folded sheet steel channel section of Sheet steel shroud and partitions shall be of minimum 2mm thickness, doors and covers shall also be of

2mm thickness. All panel doors shall be pad lockable type. All sheet steel work forming the exterior of sub distribution boards shall be smoothly finished, leveled and free from flaws. The corners to be rounded. Front and rear doors to be fitted with dust proof including neoprene gasket with fasteners designed to ensure proper compression of the gaskets. When covers are provided in place of doors, generous overlap shall be ensured between sheet steel surfaces with closely spaced fasteners to preclude the entry of dust.

Following minimum clearance to be maintained after taking into account connecting bolts, clamps etc.

- |      |                            |   |      |
|------|----------------------------|---|------|
| i)   | Between Phases             | - | 32mm |
| ii)  | Between Phases and neutral | - | 26mm |
| iii) | Between Phases and earth   | - | 26mm |
| iv)  | Between Neutral & earth    | - | 26mm |

All insulating, materials used in the construction of the equipment shall be of non hygroscopic materials, duly treated to withstand the effect of high humidity, high temperatures, tropical ambient service conditions. SMC (Sheet Moulded Compound) supports & shrouds shall be used.

Functional units such as moulded case circuit breakers shall be arranged in multi-tier formation. The design of the sub distribution boards shall be such that each MCCB unit shall be fully compartmentalized.

Insulated barriers shall be provided with vertical section and between adjacent section to ensure prevention of accidental contact with main bus bars and vertical risers during operation, inspection or maintenance of functional units. All doors/covers providing access to live power equipment/circuits shall be provided with tool operated fastness to prevent unauthorized access. Sub distribution boards shall be so constructed that the cable alley shall be sufficient enough to accommodate all the outgoing and incoming cables.

For each cable alley, there shall be separate cable gland plate of detachable type at the bottom and/or top of the panel as required. Gland plate shall be 3 mm thick.

A base frame made out of 75mm x 40mm x 5.0mm M.S. Channel to be provided.

### **Metal Treatment and Finish**

All metal work used in the construction of the sub distribution boards should have undergone a rigorous metal treatment process as follows:

- a) Effective cleaning by hot non alkaline degreasing solution followed by cold water rinsing to remove traces of alkaline solution
- b) Picking in dilute sulphuric acid to remove oxide scales & rust formation, if any followed by cold water rinsing to remove traces of acidic solution.
- c) A recognized phosphating process to facilitate durable coating of the paint on the metal surfaces and also to prevent the spread of rusting in the event of the paint film being mechanically damaged. This again, shall be followed by hot water rinsing to remove traces of phosphate solution.
- d) Passivating in de-oxalite solution to retain and augment the effects of phosphating.
- e) Drying with compressed air in a dust free atmosphere.
- f) A finishing coat of powder coating of Siemens gray colour and thickness of powder coating shall not be less than 90 micron.

### **Bus Bars**

The bus bars shall be air insulated and made of high conductivity, high strength Aluminium complying with the requirement of grade E-91E.

The bus bars shall be suitably braced with non-hygroscopic SMC supports to provide a through fault withstand capacity shall be as per actual calculation.

The neutral as well as the earth bar should be capable of withstanding the above level. Ridges shall be provided on the SMC supports to prevent tracking between adjacent bus bars. Large clearances and creep age distance shall be provided on the bus bar system to minimize the possibility of fault. The main phase bus bars shall have continues current rating throughout the length of the panel. The cross section of neutral bus bars shall be same as that of the phase bus bar for bus bars of capacity up to 250 Amp; for higher capacities, the neutral bus bar shall not be less than half (50%) the cross section of that of the phase bus bars. Connections from the main bus bars to functional circuits shall be so arranged and supported to withstand without any damage or deformation the thermal and dynamic stresses due to short circuit currents. Bus bars shall be colour coded with PVC heat shrinkable sleeves.

The sub distribution boards shall be designed that the cables are not directly terminated on the terminals of MCCB etc. but are terminated on cable termination links. Capacity of

aluminium bus bars shall be considered as 1.0 Amp per sq. mm of cross section area of the bus bars.

### **Moulded case Circuit Breaker**

#### **GENERAL**

Moulded Case Circuit Breakers shall be incorporated in sub distribution boards wherever specified. MCCB's shall conform to IS 13947-2 and / or IEC 947-2 in all respects. MCCB's shall be suitable either for single phase AC 230 volts or three phase 415 volts.

#### **Frame Sizes**

The MCCB's shall have the following frame sizes subject to meeting the fault level specified elsewhere.

- |      |                    |       |               |
|------|--------------------|-------|---------------|
| i)   | Up to 100A rating  | ..... | 100Amp frame. |
| ii)  | Above 100A to 200A | ..... | 200Amp frame. |
| iii) | Above 200A to 250A | ..... | 250Amp frame. |
| iv)  | Above 250A to 400A | ..... | 400Amp frame. |
| v)   | Above 400A to 630A | ..... | 630Amp frame. |

#### **Constructions**

The MCCB cover and case shall be made of high strength heat treatment and flame retardant thermo-setting insulating material. Operating handle shall be of rotary type quick make/quick break, trip-free type. The operating handle for simultaneous operation and tripping of all the three phases.

Suitable fire extinguishing device shall be provided for each contact. Tripping unit shall be of thermo magnetic type up to 250 A for adjustable overload & short circuit protection and shall be microprocessor type above 250 A for adjustable overload, short circuit & earth fault protection. MCCB shall be line load reversible type. Device shall have IDMT characteristics for sustained overload, and short circuits. MCCB shall be current limiting type.

Contacts trips shall be made of suitable arc resistant, silver alloy for long electrical life. Terminals shall be of liberal design with adequate clearance.

#### **Rupturing Capacity**

The Moulded Case Circuit Breaker service breaking capacity (Ics) shall be based on actual calculation.

**Testing**

Test certificate of the MCCB as per relevant Indian Standards (IS) shall be furnished. Pre-commissioning tests on the sub distribution boards incorporating the MCCB shall be done as per standard.

**5.29. MEASURING INSTRUMENTS FOR METERING****General**

Direct reading electrical instruments shall be in conforming to IS 1248. The accuracy of direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments direct reading shall be 1.0 for voltmeter and 1.5 for ammeters. Other type of instruments shall have accuracy of 1.5. The errors due to variations in temperature shall be limited to a minimum. The meter shall be of flush mounting type of 96mm square pattern. The meter shall be enclosed in a dust tight housing. The housing shall be of steel or phenolic mould. The designing and manufacture of the meters shall ensure the prevention of fogging of instruments glass. Instruments meters shall be sealed in such a way that access to the measuring element and to the accessories with in the case shall not be possible without removal of the seal. The meters shall be provided with white dials and black scale markings.

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.

The specifications herein-after laid down shall also cover all the meters, instrument and protective devices required for the electrical works. The ratings, type and quantity of meters, instruments and protective devices shall be as per the bill of quantities.

**Digital Ammeters**

Digital Ammeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Ammeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The ammeters shall be capable of carrying sustained overloads during fault conditions without damage or loss of accuracy. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition.

**Digital Voltmeters**

Digital Voltmeters shall be confirmed to IS: 13875. It shall be digital type 7 segment LED display. Voltmeter shall be suitable for accuracy class 1.0 and burden 0.2 VA approx. The range for 3 phase voltmeters shall be 0 to 500 volts. The meter shall be suitable for working in ambient temp 0 degree to 50 degree and 95% humidity condition. The voltmeter shall be provided with protection MCB of suitable capacity.

**MFM Meter**

Digital MFM shall be confirmed to ISO:62053. Multi-Function Meter used in electrical panels. These meters are designed to measure various electrical parameters such as voltage, current, power (active, reactive, apparent), energy consumption, power factor, and frequency. They are commonly used in industrial, commercial, and sometimes residential settings to monitor and manage electrical usage, ensuring efficient operation and sometimes for billing purposes in larger installations.

**Current Transformers**

Current transformers shall be in conformity with IS: 2705 (Part I, II & III) in all respects. All current transformers used for medium voltage applications shall be rated for 1KV Current transformers shall have rated primary current, rated burden and class of accuracy as required. However, the rated secondary current shall be 15A unless otherwise specified. The acceptable minimum class of various applications shall be as given below.

Measuring : Class 1.0

Protection : Class 5 P10

Current transformers shall be capable of withstanding without damage, magnetic and thermal stresses due to short circuit fault on medium voltage system. Terminals of the current transformer shall be marked permanently for easy identification of poles. Separate CT shall be provided for measuring instruments and protection relays. Each C.T. shall be provided with rating plate.

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.

**Control switches**

Control switches shall be of the heavy duty rotary type with escutcheon plates clearly marked to show the operating position. They shall be semi-flush mounting with only the front plate and operating handle projecting.

Indicating lamps shall be of the LED type, and with translucent lamps covers. Bulbs & lenses shall be easily replaced from the front.

Push buttons shall be on the momentary contact, push to actuate type fitted with self reset contacts & provided with integral escutcheon plates marked with its functions.

**Cable Terminations**

Cable entries and terminals shall be provided in the sub distribution boards to suit the number, type and size of aluminium conductor power cable and copper conductor control cable specified.

Provision shall be made for top or bottom entry of cables as required. Generous size of cabling chambers shall be provided, with the position of cable gland and terminals such that cables can be easily and safely terminated. Cable glands shall be brass compression type, barriers or shrouds shall be provided to permit safe working at the terminals of one circuit without accidentally touching that of another live circuit.

Cable risers shall be adequately supported to withstand the effects of rated short circuit currents without damage and without causing secondary faults.

**Control Wiring**

All control wirings shall be carried out with 1100V grade single core ZHFR cable conforming to IS 694/IS 8130 having stranded copper conductors of minimum 1.5 sq. mm for potential circuits and 2.5 sq. mm for current transformer circuits. Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wiring shall be identified by numbering ferrules at each end. All control fuses shall be mounted in front of the panel and shall be easily accessible.

**Terminal Block**

Terminal blocks shall be 500 Volts grade of the stud type. Insulating barriers shall be provided between adjacent terminals. Terminals block shall have a minimum current rating



of 10 Amps and shall be shrouded. Provisions shall be made for label inscriptions.

### **Labels**

Labels shall be of anodized aluminium, with white engraving on black background. They shall be properly secured with fasteners.

### **Testing at Manufacturing Work**

All routine tests specified is IS:8623-1977 shall be carried out and test certificates submitted to the Engineer – in –Charge.

### **Testing and Commissioning**

Commissioning checks and tests shall be included all wiring checks and checking up of connections. Primary/secondary injection tests for the relays adjustment/setting shall be done before commissioning in addition to routine megger test. Checks and tests shall include the following:

- a) Operation checks and lubrication of all moving parts.
- b) Interlocking function check
- c) Insulation test: When measured with 500 V megger, the insulation resistance shall not be less than 100 mega ohms.
- d) Trip tests & protection gear test.

### **Automatic transfer switch**

#### **General requirements**

The following covers the Automatic Transfer Switch Equipment (ATSE) and its By-Pass equipment.

The ATSE shall be composed of

- Two separate Load Break Switches,
- A mechanism to operate and mechanically interlock the switches,
- An actuator made of a motorized unit or a double solenoid mechanism (both momentarily energized)
- A 3 phases monitoring device and control module (MDCM) for monitoring supply circuits and for transferring the load circuit from one supply to another.

The ATSE shall be fully integrated in one device. No additional wiring other than the power

connection shall be allowed to facilitate the proper functioning of the ATSE with the MDCM.

All the elements of the transfer switch equipment and control module shall be of the same manufacturer.

The ATSE shall be of the PC type.

The ATSE shall have 3 stable positions: Normal, Isolated and Emergency.

The ATSE shall be of a Dis connector type with fully visualized breaking.

The ATSE shall be able to do On Load Manual switching.

The ATSE must be proposed in 3 and 4 poles versions.

### **GAD requirements**

1. The transfer switch unit shall be electrically operated and mechanically held.
2. It shall be no power consumption while in a stable position other than the one required for the control unit.
3. The electrical actuator shall be a motorized unit or a double solenoid mechanism, which is momentarily energized.
4. The switches shall be inherently mechanically interlocked to ensure at any moment only one out of the three stable positions.
5. The system shall incorporate a position indicator for the 3 stable positions.
6. To prevent source overlapping the transfer is operated through distinct isolated positions. The sensing and logic shall be built-in microprocessor for maximum reliability and with option of serial communications feature. To facilitate flexibility of installation there shall be provision of Line/ Load reversibility.
7. The switching contact shall be silver plated and maintenance free in various environments. It shall be of self cleaning capability to optimize the quality of the contact during operation
8. The Neutral pole of ATS shall be fully rated (100% rating as that of all 4 poles).
9. The 4 poles shall switch simultaneously.

### **Standards & Codes**

The ATSE shall conform to the requirements of the IEC Standard 60947-6-1 for the source transfer function and 60947-3 for Disconnection and manual on load switching.

The MDCM shall comply with the following standards:.

**Emission General standard**

- EN 55022 Conductor Emission
- EN 55022 Radiated Emission

**Immunity General standard**

- EN 61000-4-2 Electrostatic Discharge (ESD)
- EN 61000-4-3 Radiated electromagnetic field
- EN 61000-4-4 Electrical fast transient (EFT)
- EN 61000-4-5 Surges
- EN 61000-4-6 Conducted radio frequency field
- EN 61000-4-8 Power frequency magnetic field
- EN 61000-4-11 Voltage dips, short interruptions and variations
- EN 61000-4-13 Harmonics and inter harmonics
- IEC 61010-1 Electromagnetic compatibility

**Safety requirements & features**

The ATS shall be of Disconnector type as per IEC 947-3

It shall not be possible to mix the two supplies (Normal supply and Emergency supply) in case of any failure of the equipment. This characteristic must be guaranteed by a proper design of the mechanism.

Opening and Closing operations of the contacts must be independent from the driving mechanism. The speed of the contacts shall be independent of the speed of motor or manual operation to ensure the safety of the operator.

In case of contacts welding, the ATSE must remain in its actual position, in Manual or Automatic operation, according to IEC 60947-3. Neither the manual nor the automatic operation can lead to a failure of the mechanism or of the interlocking. The mechanical indicator shall show the actual position in contact welded situation.

The ATSE shall have a Manual and Automatic mode: the swap between both modes shall be possible only with a key or selector on the front face. Manual operation shall be prohibited in automatic and Automatic operation shall be inhibited in Manual mode.

The ATSE shall have a built-in provision for padlocking in the Isolation position for the safety of the operators. A provision for a padlocking in Normal or Emergency positions shall also be provided.

Automatic commands shall be inhibited when the product is padlocked

The padlocking shall be possible only in Manual position.

The ATSE shall be able to accommodate up to three padlocks at the same time.

A handle for manual operation shall be provided for emergency transfer purposes.

The handle shall be located on the ATSE itself to ensure a safe and quick operation during power outages. The handle shall be easily removable for automatic operation.

Manual transfer shall be possible on load, without any upstream disconnection, with respect to the safety of the operator. This feature is essential in case of emergency and panic.

It shall be possible to block the re-transfer process via programming. When selected, re transferring to the Main source must be validated locally or remotely via keypad or external contact.

The replacement of the motor operated actuator shall be possible under live condition with respect to the operator safety (isolation distances, easy access to the fixing elements).

### **Operations**

The ATSE shall be supplied by any present source. It shall allow the ATSE to be controlled in the 3 positions with only one source present.

The ATSE shall have high short time current withstand capability ( $I_{cw}$  1 second in accordance to IEC 60947-3).

Manual re transfer function can be inhibited and must be possible either locally or from remote.

The ATSE shall have the possibility to be electrically controlled in any of the 3 positions by mean of dry contacts. It overrides the automatic sequence. Once back in Auto mode, the ATSE shall come back to the proper position.

### **Automatic operation via the MDCM**

The monitoring device and control module (MDCM) must be integrated within the ATSE. Electrical Control of the product position must be possible and controlled locally or

remotely. Any automatic command must be inhibited during control operation

### **Parameters sensing & setting**

The MDCM shall include 3 phases sensing for monitoring of voltage and frequency to detect the presence and loss of the power supply for activation of the automatic transfer. The settings are as following.

<b>PARAMETER</b>	<b>SOURCES</b>	<b>THRESHOLD</b>	<b>HYSTERISIS</b>
Under voltage	Mains and Backup, 3 phases	80 to 98%	81 to 99%
Over voltage	Mains and Backup, 3 phases	102 to 120%	101 to 119%
Under frequency	Mains and Backup	80 to 99%	80.5 to 99.5%
Over frequency	Mains and Backup	101 to 120 %	100 to 119.5%

Voltage settings shall be field adjustable in 1% increments either locally with the display and keypad, or remotely through serial communication. Frequency settings shall be adjustable in 0.1% increments either locally with the display and keypad, or remotely through serial communication. All settings shall be adjustable directly from the front face, opening of the MDCM is strictly forbidden for obvious reasons of safety and possible damages. The MDCM shall have a phase sequence detection to ensure the proper voltage vectors sequence on both power supplies. The MDCM shall have programming for selection of network type 4NBL/41NBL/42NBL/3NBL/2NBL/2BL/1BL and capability to monitor the minimum and maximum voltages and frequencies threshold and hysteresis. The MDCM shall allow the setting of the sources priority. The MDCM shall be equipped with the activation of manual re-transfer mode. The MDCM must be equipped with a permutation counter to enable to record the life span of the ATSE represented by the number of transfer operations. Resetting of this counter shall be conditioned by 4 digits numerical password with 2 levels of security. Interface with the MDCM The MDCM must be easily configurable via a HMI dialogue interface complete with a 2 levels security 4 digits numerical Password for programming access right. The MDCM shall be equipped with local visualization of threephase currents, powers (P, Q, S), frequency and power factor through 3 current transformers measurement from the 2 sources. Source status shall be clearly visible on the front of the unit for both normal & emergency, stated in a clear schematics diagram. The controller shall provide digital readout of voltage on all 3 phases, frequency and phase rotation. Inputs/outputs, communication.

The MDCM shall be able to provide up to four Inputs (Programmable NO or NC) and four Outputs (NO Type) for interfacing with control system. The inputs and outputs functions shall be versatile (no unique function), the assignment being done by the HMI or the communication. The MDCM can be equipped with an option to enable communication via RS485 module MODBUS protocol with a transmission speed up to 38400 bps. The link shall be capable of reading the voltages, timers and inputs values, setting all parameters values and inputs/outputs functions.

### **Timers settings**

An adjustable timer of 0 to 60 seconds shall be provided to detect the priority network failure, to override any transient outages of the normal supply. (Main Failure Timer, MFT). A timer of 0 to 60 seconds shall be provided to validate the stability of emergency network before transfer, once the Generator Set supply is available. (Delay To Transfer, DTT). While transferring to emergency, a possibility to stay in position 0 shall be provided from 0 to 20 seconds (O Main Failure timer, 0MF). An adjustable timer of 0 to 30 minutes shall be provided to detect priority network return to normal, to override any false availability of the normal supply. (Main Return Timer, MRT). While transferring back to primary source, a possibility to stay in position 0 shall be provided from 0 to 20 seconds (O Main Return timer, 0MR). An adjustable timer of 0 to 30 minutes shall be provided to allow the generator cooling down after load retransfer from standby source to Mains source (Cool Down Timer, CDT). The controller shall provide the ability to prevent retransfer to Mains from happening, except if the user validates manually the retransfer. (Manual Re-Transfer).

### **Maintenance & testing**

The MDCM shall provide the possibility to run a test ON load and OFF load.

It shall be possible to actuate these sequences from the front face HMI or via the Modbus link.

Maintenance of the electrical parts (Controller or Motorization unit) shall be possible without disconnection of the power conductors.

It shall be possible to change any actuator unit based on a motor technology in less than 10 minutes without disconnection of the power conductors. During this operation, it shall still be possible to operate manually the switch with the MDCM and motorization removed.

Both Local and Remote control of test sequences shall be possible on the Switch.

**Inspection at factory**

The inspection / testing of all the ATS / STS shall be done at manufacturer works before dispatch by client/PMC& consultant.

**Factory testing and certification**

The complete ATSE shall be factory tested to ensure proper operation of the individual components together and correct overall sequence of operations. The test must also ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.

The manufacturer shall be certified ISO 9001 : 2003 International Quality Standard and the manufacturer shall have third party certification verifying its quality assurance in GAD /development, production, installation and servicing in accordance with ISO 9001.

**Training**

The manufacturer / supplier shall ensure the training for Operating staff in the local national language, by means of fully configured Training kits to impart hands-on training to simulate various parameters and for trouble shooting exercise.

**5.30. SANDWICH BUS DUCT & RISING MAIN****Scope**

This specification covers manufacturing, Supply, Installation, testing and commissioning of Sandwich type metal enclosed bus duct suitable for 415V, 50Hz and having Ampere rating as per requirement.

**Codes and Standards**

The design, material used, construction, manufacture and testing for Sandwich type Bus duct shall conform to IS 8623 Part 1 &2 and IEC 60439 Part 1 & 2 standards and IEC 61439.

In case of conflict between the standards and the specifications, specifications shall hold good.

**Application data**

Sandwich bus trunking system shall be compact & maintenance free design with low impedance construction & low voltage drop.

Rated operational voltage shall be 1000V AC,

Rated insulation voltage shall be 1000V AC,

Rated dielectric voltage shall be 3.5 KV rms for 60 seconds.

Ingress protection shall be IP 54/55 for indoor application & IP 65 for outdoor application.

The maximum permitted temperature rise for the system shall be max 55°C over an ambient of 40°C.

### **Enclosure**

The enclosure shall be Fabricated out of 1.6mm thick GI in such a way that it gives very good short circuit withstand capacity & shall conform to latest IS standards applicable.

The enclosure design shall be totally dust and vermin proof, weather proof and shall conform to High degree of protection IP-55 as per IS 13947 for feeder application and IP 54 for rising mains (plug in bus trunking).

The Bus duct shall be painted with Textured finished powder coated from Outside.

The color of the enclosure shall be RAL 7032 of minimum thickness of 70 microns & max upto 100 microns.

The enclosure shall be tested for SALT SPRAY test for minimum 1000 Hours from an independent testing Laboratory.

### **Earthing**

Two separate runs of earthing shall be provided which should run along with the entire Length of the Busduct. The size for the total earth bus bar shall be capable to withstand the earth fault current (earthing bus bar material shall be GI).

### **Bus Conductor**

The material of the bus bars shall be electrolytic grade Aluminum with min 98% purity & minimum conductivity of 57% IACS & copper conductors shall be OFC ETP grade with 99.9% purity & conductivity upto 100% IACS .Copper shall be TIN plated throughout the length and for Aluminum bus bars ends shall have tin/silver plating

The specifications and the system should be suitable for 100% loading for Horizontal and vertical installation at an ambient temperature of 40 degree C and temperature rise of bus



bars shall not exceed 55 Degree C.

### **Jointing Coupler**

Each Bus duct section shall be joined to the adjacent section by UNIBLOCK coupler operated by one/two HTS bolts. The joint assembly shall be such that, it can be installed or removed at any time to isolate / join two adjacent sections of the bus duct in installed conditions.

The Uni block joint shall have disc spring washers for uniform distribution of pressure.

The joint shall have shear nut with default torque for 100% tightness. The disc spring washers shall accommodate the thermal expansions of the bus bars and housing at joint area.

The insulation material at joint shall be of CLASS 'F' temperature grade.

Serrated aluminum fin type pressure plates for improved heat dissipation at every joints shall be provided

For multiple tire / stack Bus duct, multiple bus bar runs for each phase shall be shorted at every joint itself.

### **Insulating Material of the Bus bars**

The Insulating material of the bus bars shall be Multilayer Class 'F' insulation with high class P.E.T. insulation having superior thermal characteristics. In case the manufacture is offering Epoxy Insulation is not allowed.

Insulation BDV shall be min 20kV per layer.

The rated Insulation voltage shall be 1000V and rated Impulse withstands voltage  $U_{imp}$  shall be 12KV. Manufacturer shall submit the Impulse voltage test report.

### **Temperature Monitoring at Joints**

Thermal Stickers shall be provided at each joint pack for regular monitoring of temperature raise after the Bus duct has been put into operation.

### **Type Test Reports**

Manufacturer shall submit following type test reports as per IEC 61439,

Verification of Temperature Rise Limits

Short Circuit Withstand Test.

Verification of dielectric strength.

Verification of Clearances and creep age distance.

Verification test for abnormal heat.

Verification of 12 Kv impulse voltage test.

Verification of Resistance and Reactance

Degree of Ingress Protection

### **Routine Test Reports by Manufacturer**

The following tests shall be conducted at manufacturers works prior to dispatch of the Busduct assembly.

One minute power frequency withstand voltage test of 3.5KV.

Insulation resistance test. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greeter than 200 Mega Ohms at 500 V between Phases to Phase.

Temperature Rise test at Factory.

Physical verification of all components.

### **Routine Tests during Installation at Site**

The following routine tests shall be carried out during Installation at site:

A general visual check shall be carried out. This shall cover measurement of overall dimension, number and type of devices, terminal boxes, connection of terminals and phase sequence etc.

Dry insulation test with power frequency voltage shall be conducted.

Insulation resistance shall be checked after high voltage test is conducted. Insulation resistance shall be greater than 100 Mega Ohms at 500 V between Phase to Neutral and greater than 200 Mega Ohms at 500 V between Phase to Phase.

Electrical Operational Test and Relay / Release Setting.

**Tap off box**

Shall be fabricated with 1.6mm Electrogalvanized steel.

Plug in contacts shall be silver coated & spring loaded construction to ensure adequate and firm contact area.

Shall contain adequate Clamps such that the entire load / weight / mass of Tap off Boxes should not rest on the spring loaded plug in contacts.

Earthing in the plug-in contacts shall make first contact when inserting plug in contacts and break last while removing tap off boxes.

Safe interlocking mechanism shall be provided to prevent accidental opening of the door & also it should not be possible to plug-out or plug-in to the busbar, when the Switching device is in 'ON' position.

Suitable external earthing shall be provided in the tap off box to maintain the earth continuity.

The live parts inside the tap off box shall be safe guarded by transparent insulator plate which will allow visible inspection but prevents physical touch.

The tap off box shall be designed in such a way to accommodate different reputed isolating / tripping devices.

**Warranty/Guarantee**

Products for a period of 12 (Twelve) months from the date of Delivery and commissioning as per manufacture defects.

**5.31. B III 1.0 LIGHT FIXTURES & FANS****General**

All light & power accessories shall be of modular range of plate switch type and shall be of one manufacturer (brand) and type.

**Light Switches Modular Type**

All switches for control of light shall be of 6/10 Amp unless otherwise stated. All switches shall be modular range of plate switch type. The switches shall be rocker mechanism type with silver contact. All switches shall be of white finish or as sample approved by

owner/consultant.

### **6/16 Amp Switch Socket Outlet Modular Type**

Switch socket outlet shall be of 3 pin 6Amp outlet shall have safety shutters. The switch shall be of rocker mechanism type with silver contact. Socket outlet shall be shutter type and of modular range of plate type and having white finish or as approved by owner / consultant.

### **Wiring**

All FRLS insulated copper conductor multi-stranded wires shall conform to relevant IS codes. Cable conductor size and material shall be as required.

All internal wiring shall be carried out with FRLS insulated wires of 1100 volts grade. The circuit wiring for points shall be carried out in looping in system and no joint shall be allowed in the length of the conductors. Circuit wiring shall be laid in separate conduit originating from distribution board to switch board for light/fan. A light/fan switch board may have more than one circuit but shall have to be of same phase. Looping circuit wiring shall be drawn in same conduit as for point wiring. Each circuit shall have a separate neutral wire. Neutral looping shall be carried out from point to point or in light/fan switch boards. A separate earth wire shall be provided along with circuit wiring for each circuit. For point wiring red or yellow or blue colour wire shall be used for phase and black colour wire for neutral. Circuit wiring shall be carried out with red, yellow or blue colour FRLS insulated wire for RYB phase wire respectively and black colour FRLS insulated wire for the neutral wires. FRLS insulated green colour wire shall be used as earth continuity conductor and shall be drawn along with other wires. No wire shall be drawn into any conduit until all work of any nature, that may cause injury to wire is completed. Care shall be taken in pulling the wires so that no damage occurs to the insulation of the wire.

Before the wires are drawn into the conduit, the conduits shall be thoroughly cleaned of moisture, dust and dirt. Drawing & jointing of copper conductor wires & cables shall be as per CPWD specifications.

All the wire & cables shall be copper up to 16 sq.mm and above 16 sq.mm shall be aluminum except UPS cables. For UPS Incoming & outgoing, only copper cable/ wire shall be used.

<b>Nominal Cross-sectional Area of conductor in Sq. mm</b>	<b>20mm</b>		<b>25mm</b>		<b>32mm</b>		<b>38mm</b>		<b>51mm</b>		<b>64mm</b>	
	<b>S</b>	<b>B</b>	<b>S</b>	<b>B</b>	<b>S</b>	<b>B</b>	<b>S</b>	<b>B</b>	<b>S</b>	<b>B</b>	<b>S</b>	<b>B</b>

Nominal Cross-sectional Area of conductor in Sq. mm	20mm		25mm		32mm		38mm		51mm		64mm	
	S	B	S	B	S	B	S	B	S	B	S	B
1.50	5	4	10	8	18	12	-	-	-	-	-	-
2.50	5	3	8	6	12	10	-	-	-	-	-	-
4	3	2	6	5	10	8	-	-	-	-	-	-
6	2	-	5	4	8	7	-	-	-	-	-	-
10	2	-	4	3	6	5	8	6	-	-	-	-
16	-	-	2	2	3	3	6	5	10	7	12	8
25	-	-	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	-	-	4	3	5	4

### Joints

All joints shall be made at main switches, distribution board socket and switch boxes only. No joint shall be made in conduits & junction boxes. Conductors shall be continuous from outlet to outlet.

### Sub Mains

Sub-main wiring shall be carried out with FRLS Insulated Copper multi-standed wires/cables.

Sub-main cable where called for shall be of the rated capacity and approved make. Every sub-main shall be drawn into an independent adequate size conduit. Adequate size draw boxes shall be provided at convenient locations to facilitate easy drawings of the sub-main cables. Cost of junction box/drawn box is deemed to be included in the rates of sub-main wiring. An independent FRLS insulated copper earth wire of proper rating shall be provided for every sub-main. Single phase sub-main shall have single earth wire whereas three phase sub-main shall be provided with two earth wire.

Where sub-mains cables are connected to the switch-gear, sufficient extra lengths of sub-main and mains cable shall be provided to facilitate easy connections and maintenance. For termination of cables crimping type cable socket/lugs shall be provided. Same colour code as for circuit wiring shall be followed.

**Load Balancing**

Balancing of circuits in three phase installation shall be planned before the commencement of wiring and shall be strictly adhered to.

**Light Fixture & Fan Technical Specification: (Normal Light)**

**IP20 Recessed 10W LED** Downlighter made of pressure die cast aluminum housing, Fixture should have minimum efficacy at System level (Not Chip Level)  $\geq 110$  lumens/watt with Minimum system Lumens 1000 with maximum system wattage of 9W. Life of fixture (Including Driver) : 50000 burning Hrs. @ L70B50 Lumen maintenance, CCT of 300K/400K/5700K/6500K (SDCM $\leq 5$ ), CRI  $> 80$ , PF  $> 0.95$ , working temp range -  $0^{\circ}\text{C} < T_a < 45^{\circ}\text{C}$ , and operating Voltage Range of 240 VAC. It should has a Minimum Internal Surge Protection of 2.5KV. Electronic Switchable ballast. The fixture design should comply with EMC / EMI compliance along with BIS certification for LED Driver & Luminaire. Luminaire manufacture shall provide LM 79 report from NABL accredited lab & LM80 report issued by LED manufacturer.

**IP20 Recessed 10W LED Lighter**

Integral **Mirror light LED 2 ft** luminaire made of CRCA housing and PC diffuser (Diffuser-Non yellowing type). The luminaire should have a LEDs with colour consistency SDCM  $\leq 5$ , CRI  $\geq 80$  and CCT of 3000K/400K/5700K/6500K. Luminaire shall be designed to emit at least minimum 2000 system lumens at a system efficacy of at-least 120 lumen/watt. Power consumption should not be more than 12W ( $\pm 5\%$ ). The Life of fixture (Including Driver): 50000 burning Hrs. @ L70B50 Lumen maintenance @ design ambient temp 45 deg C. The electronic driver used shall have a power factor  $\geq 0.95$  and THD  $\leq 10\%$ , suitable for an operating voltage range of 140-270V AC, Current Ripple  $\leq 5\%$ , Internal surge protection should be minimum 4KV, electrical insulation class should be Class I & driver should be of Class B serviceability. The luminaire shall be IP20 & IK02 compliant. The minimum dimensions ( $\pm 5\text{mm}$ ) of the batten shall be

44mm(±5mm) X 51mm (±5mm)X 585mm(±5mm). Luminaire manufacturer must have NABL accredited lab to conduct LM79, Type test as per IS10322 & "FAT" before dispatch as per IS 10322.



### **Integral Mirror light LED 2 ft luminaire Lighter**

**18W to 22W LED downlight** recess IP20 Downlighter made of pressure die cast aluminum housing, Fixture should have minimum efficacy at System level (Not Chip Level)  $\geq 110$  lumens/watt with Minimum system Lumens 1500 with maximum system wattage of 13.5W. Life of fixture (Including Driver) : 50000 burning Hrs. @ L70B50 Lumen maintenance, CCT of 3000K/4000K/5700K/6500K (SDCM $\leq 5$ ), CRI  $> 80$ , PF  $> 0.95$ , working temp range -  $0^{\circ}\text{C} < T_a < 45^{\circ}\text{C}$ , and operating Voltage Range of 240 VAC. It should has a Minimum Internal Surge Protection of 2.5KV. Electronic Switchable ballast. The fixture design should comply with EMC / EMI compliance along with BIS certification for LED Driver & Luminaire. Luminaire manufacture shall provide LM79 report from NABL accredited lab & LM80 report issued by LED manufacturer.



### **18W to 22W LED downlight recess Lighter**

**Surface mounted Linear Batten 40W 4ft** luminaire of CRCA housing and PC diffuser (Diffuser-Non yellowing type). The luminaire should have a color consistency SDCM  $\leq 5$ , CRI  $\geq 80$  and CCT of 3000K/4000K/5700K/6500K. The luminaire shall be compliant with IP20 classification. Luminaire shall be designed to emit at least 4000 nominal lumens at a system efficacy of minimum 120 lumen/watt. Power consumption should not be more than 36W. The luminaire shall have CRI  $\geq 80$ . The Life of fixture (Including Driver): 50000 burning Hrs. @ L70B50 Lumen maintenance @ design ambient temp 45 deg C. The electronic driver used shall have a power factor  $\geq 0.95$  @ full load and THD  $\leq 10\%$  @ full load and suitable for an operation voltage range of 140-270V AC. Ripple

$\leq 5\%$  and surge protection should be minimum 4KV, electrical insulation class should be Class I & driver should be of Class B serviceability. Driver should have high & low voltage cut off with auto restart @140-270V. The LED driver should comply to IEC61000-3-2 ed.3.2, 2009 for Harmonics, IEC61347 -2 -13, 2006 in Conjunction with IEC61347-1 ed.2.0, 2007 for Electrical Safety, CISPR 15/ EN 55015 (9 KHz to 30MHz) for RFI, EMI/EMC, IEC 62384 for driver performance test. The luminaire driver shall be of the same make/manufacturer/brand as that of LED luminaires. The luminaire driver shall have efficiency of  $\geq 85\%$ .



#### **Surface mounted Linear Batten 40W 4ft luminaire Lighter**

**36W to 40W 2X2 LED flat panel** for surface mounting which provides soft-light and glare free symmetrical illumination.. CRCA powder coated white after phosphochromate treatment and High transmittance polystyrene opal diffuser. High efficiency long life LED package in integral module with system lumen efficacy of  $>110$  lm/W and viewing angle of  $120^\circ$  to ensure better uniformity. Powered by built-in Isolated, SELV Output electronic LED driver (SMPS based constant current supply) with Output Short-circuit protection, Surge protection & other reliability test. CRI  $>80$ , Color temperature 3000K/4000K/5700K/6500K, THD  $<20\%$  and PF  $>0.95$ , IP20, IK03. Lumen output of 4650 lumens. Life class of 50,000 hrs @ L70, Operating Temperature:  $-10$  TO  $+45$  DEG.C; Input Supply Voltage Range: 140-270 V, Frequency : 50-60 HZ; Internal Surge Protection: 3 KV. The luminaire shall be designed so as to ensure L70B50 @ 30K Hrs. @ 45 Degree Ambient. The electronic driver used shall have a power factor  $>0.95$  and THD  $<10\%$  The fixture should comply with the parameters as per IS10322. Similar to SM367 LED42S-6500 G6 L54W54 PSU OD



#### **36W to 40W 2X2 LED flat panel Lighter**



**Integral driver LED 5W** wall light with a system lumen output of 40 lumens and a minimum system efficacy of 10 lm/W. The luminaire shall have a rated system lifetime of 25,000 burning hours at L70. The luminaire should have a color temperature of 3000K/4000K/5700K/6500K and CRI > 75. The luminaire shall meet IP67 rating with THD < 20% and PF > 0.9. The luminaire shall have polycarbonate diffuser.



#### **LED 5W wall Lighter**

**20W wall mounted 4ft luminaire** of CRCA housing and PC diffuser (Diffuser-Non yellowing type). The luminaire should have a LEDs with colour consistency SDCM ≤ 5, CRI ≥ 80 and CCT of 3000K/4000K/5700K/6500K. Luminaire shall be designed to emit at least 2000 nominal lumens at a system efficiency of at-least 120 lumen/watt. Power consumption should not be more than 16W (±5%). The Life of fixture (Including Driver):50000 burning Hrs. @ L70B50 Lumen maintenance @ design ambient temp 45 deg C. The electronic driver used shall have a power factor ≥0.95 and THD ≤10%, suitable for an operating voltage range of 140-270V AC, Current Ripple ≤5%, Internal surge protection should be minimum 4KV, electrical insulation class should be Class I & driver should be of Class B serviceability. The luminaire should be at least IP20 & IK02 rated. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79, Type test as per IS10322 & "FAT" as per IS 10322. The LED Luminaire



#### **20W wall mounted 4ft luminaire Lighter**

**20W 2X2 Recess LED** flat panel for which provides soft-light and glare free symmetrical illumination..CRCA powder coated white after phosphochromate treatment and High transmittance polystyrene opal diffuser. High efficiency long life

LED package in integral module with system lumen efficacy of  $>95$  lm/W and viewing angle of  $120^\circ$  to ensure better uniformity. Powered by built-in Isolated, SELV Output electronic LED driver (SMPS based constant current supply) with Output Short-circuit protection, Surge protection & other reliability test. CRI  $>80$ , Color temperature 3000K/4000K/5700K/6500K, THD  $<20\%$  and PF  $>0.95$ , IP20, IK03. Lumen output of 2400 lumens. Life class of 50,000 hrs @ L70, Operating Temperature:  $-10$  TO  $+45$  DEG.C; Input Supply Voltage Range: 140-270V, Frequency: 50-60HZ; Internal Surge Protection: 3 KV.



### **20W 2X2 Recess LED flat panel Lighter**

**Surface mounted 10/12 watt LED type Bulk-head fitting 1100lm** made up of pressure die-cast aluminium housing and Polyster Powder coated with High quality polycarbonate diffuser in opal finish for glare free light distribution. High efficiency long life LED module with SMD LED package efficacy of  $>110$  lm/W. Powered by integral electronic LED driver with CCT 3000K/4000K/5700K/6500K, CRI  $>80$ , THD  $<10\%$ , PF  $>0.9$ , IP66, IK 09, Life class of 50,000 hrs @ L70, Operating Temperature:  $0$  TO  $+45$  DEG.C; Input Supply Voltage Range: 140-270 V, Frequency :50-60 HZ. Driver Safety requirement standards: IS 15885, Test Report to be submitted, Photobiological Safety Norms: IS 16108, test Certificate to be submitted, Certification: LM79 for Luminaire, Lm80 for LED Source.



### **10/12 watt LED type Bulk-head Lighter**

**Surface mounted 10 watt LED vertical downlighter** having dia of 130mm( $\pm 3$ mm)

& height of 60mm( $\pm$  3mm) delivering minimum system lumen output of 1000 lumens ( $\pm$ 5%) and system wattage of 10W ( $\pm$ 5%) & with a minimum system efficacy of 100 lm/W. The luminaire should have a color temperature of 3000K/4000K/57000K/6500°K, CRI $\geq$ 80 and SDCM $\leq$ 5. The driver shall have THD $\leq$ 10% (@full Load) and PF  $\geq$  0.95 (@full load). The luminaire housing should be made of pressure die-cast aluminum. The fixture should comply with the parameters as per IS10322. The luminaire shall have impact resistance of IK02 & ingress protection of IP20. Luminaire manufacturer must have In-house NABL accredited lab to conduct LM79, Type test as per IS10322 & "FAT" as per IS 10322.



**Surface mounted 10 watt LED Lighter**

**Recess mounted 70 watt LED High bay vertical down lighter** complete with all accessories and replaceable electronic driver, directly on false ceiling including connection with 1.5 sq.mm FR PVC insulated copper conductor cable and earthing the body etc.



**70 watt LED High Bay Lighter**

**Aviation obstruction light with Light Emitting Diodes (LEDs)** similar to Bajaj make cat no. BGAV 302 LED or its equivalent as per approved list of make complete with all accessories.



**Aviation obstruction Lighter**

**Wall fans**

The relevant standards would be the Indian Standard (IS) and the Electrotechnical Commission (IEC) standards. Here are the key standards

IS 555: This is the Indian Standard for wall mounted fans. It specifies the general requirements, constructional details, and performance characteristics of electric wall mounted fans.

IEC 60335-2-80: This is the International Electrotechnical Commission standard that applies to the safety of electric fans, including wall mounted fans. It covers safety requirements related to construction, insulation, temperature, protection against electric shock, and other aspects.

Both standards ensure that wall mounted fans meet specified safety, performance, and quality requirements. Manufacturers and importers typically adhere to these standards to ensure compliance with regulatory requirements and to provide safe and reliable products to consumers.



**Wall fans**

**Exhaust fans**

The relevant standards include both Indian Standards (IS) and International Electrotechnical Commission (IEC) standards. Here are the key standards.

IS 2312: This Indian Standard specifies requirements for exhaust fans, including design, construction, performance, and testing methods. It covers aspects such as air flow rate, power consumption, noise levels, and safety requirements specific to exhaust fans.

IEC 60335-2-80: This International Standard applies to the safety of electric fans, including exhaust fans. It covers general safety requirements related to electrical components, insulation, temperature, protection against electric shock, and mechanical hazards.

These standards ensure that exhaust fans manufactured and sold in India (IS 2312) and globally (IEC 60335-2-80) meet established criteria for safety, performance, and quality. Manufacturers typically adhere to these standards to ensure compliance with regulatory requirements and to provide consumers with safe and reliable products that meet international norms.



**Exhaust fans 150MM**



**Exhaust fans 300MM**

### **Ceiling Fan**

These standards ensure that BLDC ceiling fans manufactured and sold in India (IS 374) and globally (IEC 60335-2-80) meet established criteria for safety, performance, and quality. Manufacturers typically adhere to these standards to ensure compliance with regulatory requirements and to provide consumers with safe and reliable products that meet international norms.

A 1200 mm sweep ceiling fan with a BEE 5-star rating and a Brushless Direct Current (BLDC) motor is designed for high efficiency, energy savings, and optimal performance. Here's a comprehensive overview of the specifications, features, and considerations for such a ceiling fan:

## Technical Specifications

### 1. General Description:

Sweep Size: 1200 mm (approximately 48 inches)

Rating: BEE 5-star (Bureau of Energy Efficiency rating for high energy efficiency)

Motor Type: Brushless Direct Current (BLDC) motor for quiet and efficient operation

### 2. Electrical Specifications:

Power Consumption: Typically between 30W and 50W, depending on design and speed settings

Voltage: 230V AC, 50Hz (standard voltage for most regions)

Motor Type: BLDC (Brushless DC Motor)

Speed Settings: Usually includes 3 to 5 speed settings



**Ceiling Fan 1200MM**

## 5.32. B IV CABLE, CABLE TRAY & TERMINATION

### Description of Work

The Supply, laying, testing and commissioning of cables as per specifications, schedule of quantities and drawings.

### Applicable Codes & Standards

IS: 10242 (Part-3,Section-12) : Installation of cables for low voltage system

IS: 7098 (Part-1&2)/IS: 5831/

IEC: 60502/BS: 6746/BS:5467:Cross linked polyethylene insulated PVC sheathed cables.

Part-I	:For working voltages up to & including 1100 Volts.
Part-II	:For working voltage from 3.3 KV up to & including 11KV.
IS: 10810	: Method of test for cables
IS: 1255	: Code of practice for installation & maintenance of power cables up to & including 11KV rating.
IS: 8130/IEC: 60228	: Conductors for cables
IS: 10418	: Drums for electric cables.
IS: 2062, IS: 800, IS: 816	: Structural wedding steel

### **Submittals**

Cable schedule as per site conditions & good for construction drawings.

Layout of various cables on cable tray / trench along with sections showing no. of cables, distance between cables etc, size of cable trays etc.

Cable tray layout, as per site condition, duly coordinated with other services.

### **Test reports**

Routine test certificates for each drum of cable brought to site.

### **Specifications**

#### **General**

Cable shall be supplied inspected, laid, tested and commissioned in accordance with drawings, specifications, relevant Indian Standards Specifications and cable manufacturer's instructions. The cable shall be delivered at site in original drums with manufacturer's name clearly written on the drum.

#### **Material**

The MV power cable of 1100 V and upto 16 sq.mm shall be XLPE insulated & PVC sheathed copper conductor armoured cable as per relevant IS.

The MV power cable of 1100 V and above 16 sq.mm shall be XLPE insulated & PVC sheathed Aluminium conductor armoured cable as per relevant IS.

The MV control cables shall be PVC insulated copper conductor armoured cable.

The HT power cable of 11KV grade shall be XLPE insulated Aluminium conductor armoured cable.

The cable shall be Supply, installation, testing & commissioning of LPCB approved Fire armoured cable as per BS 7846, fire Test as per BS 6387 CWZ, copper conductor /mica taped/ Flame Barrier/ Cross Linked Insulation/ Halogen Free Inner Sheath/ SWA/ Halogen Free Outer Sheath (1000V), LPCB Certified for power cables.

## **Installation**

### **General**

The cable installation including necessary joints shall be carried out in accordance with the specifications given herein. For details not covered in these specifications, I.S. 1255 shall be followed. No straight through joint shall be permitted in the system. The cables shall be supplied as per cable schedule submitted by the Contractor & approved by PMC/The Engineer.

### **Proximity to Communication Cables**

Power and communication cables shall as far as possible cross at right angles. Where power cables are laid in proximity to communication cables the horizontal and vertical clearances shall not normally be less than 30 cm.

### **Cable Laying Direct in Ground**

#### **General**

This method shall be adopted where the cable route is through open country along roads/lanes etc. and where no frequent excavation are encountered and where excavation is easily possible without affecting other services.

#### **Trenching**

**Width of Trench:** The width of trench shall be determined on the following basis:

- a) The minimum width of trench for laying single cable shall be 35 cm.



- b) Where more than one cable is to be laid in the same trench in horizontal formation, the width of trench shall be increased such that the inter-axial spacing the cables, except where otherwise specified shall be at least 20 cm.
- c) There shall be a clearance of at least 15 cm between axis of the end cables and the sides of the trench.

**Depth of Trench:** The depth of trench shall be determined on the following basis:

- a) Where cables are laid in single tier formation, the total depth of trench shall not be less than 75 cm. for cables up to 1.1 KV and 1.20 m for cables upto 11KV.
- b) When more than one tier of cables is unavoidable and vertical formation of laying is adopted, depth of trench in a (i) above shall be increased by 30 cm. for each additional tier to be formed.

#### **Excavation of Trenches**

- a) The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided complying with the requirements.
- b) Where gradients and changes in depth are unavoidable, these shall be gradual.
- c) Excavation shall be done by any suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.
- d) Adequate precautions shall be taken not to damage any existing cables, pipes or other such installations in the proposed route during excavation. Wherever bricks, tiles or protective covers or bare cables are encountered, further excavation shall not be carried without the approval of the The Engineer.
- e) Existing property exposed during trenching shall be temporarily supported or propped adequately as directed by the The Engineer. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled.
- f) If there is any danger of a trench collapsing and endangering adjacent structures, the sides should be well shored up with timbering and/or sheeting as the

excavation proceeds. Where necessary, these may even be left in places when back filling the trench.

- g) Excavation through lawns shall be done in consultation with the staff of the department/Owner concerned.
- h) 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.

### **Laying of Cable in Trench**

- a) At the time of issue of cable for laying, the cores shall be tested for continuity and insulation resistance.
- b) The cable drum shall be properly mounted on jacks or on a cable wheel, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.
- c) 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 pulled 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.
- d) i) 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 m 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.  
  
ii) For short runs and sizes up to 50 Sq. mm of cables up to 1.1 KV grade, any other suitable method of direct handling and laying can be adopted with the prior approval of the The Engineer.
- e) When the cable has been properly straightened, the cores shall be tested for continuity and insulation resistance. In case of PVC cables, suitable moisture seal tape shall be used for this purpose.

- f) i) Cable laid in trenches in a single tier formation shall have a covering of clean, dry sand of not less than 17 cm above the base cushion of sand before the protective cover is laid.
- ii) In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 30 cm 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 cm. as stated above. The top most cable shall have a final sand covering not less than 17 cm. before the protective cover is laid.
- g) At the time of original installation, approximately 3 m of surplus cable shall be left on each end the cable and on each side of underground joints (Straight through/Tee/Termination) and at entries and places as may be decided by the The Engineer. The surplus cable shall be left in the form of a loop. Where there are long runs of cable length loose cable may be left at suitable intervals as specified by the The Engineer.
- h) A final protection to cables shall be laid in accordance with Clause j to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.
- i) Unless otherwise specified, the cables shall be protected by second class bricks of not less than 20 cm x 10 cm x 10 cm (nominal size) as per CPWD Building Specification or protection covers placed on top of the sand, (bricks to be laid breadth wise) for the full length of the cable to the satisfaction of the The Engineer. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5 cm. over the sides of the end cables.

**Back Filling**

- a) The trenches shall be back-filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 30 cm. Unless otherwise specified, a crown of earth not less than 50 mm. In the center and tapering towards the sides of the trench shall be left to allow for subsidence. The crown of earth however should not exceed 10

cm. so as not to be a hazard to vehicular traffic. The temporary re-instatements of roadways should be inspected at regular intervals, particularly during the wet weather, and any settlement should be made good. Further trenches cut through roadways or other paved areas shall be restored to the same density and material as the surrounding area and repaved in accordance with the relevant Specifications to the satisfaction of the The Engineer.

- b) Where road berm or lawns have been cut or kerb stones displaced, the same shall be repaired and made good except turfing/asphalting to the satisfaction of the The Engineer and all surplus earth or rock removed to places as specified.

### **Route Markers**

- a) Route markers shall be provided along straight runs of the cables at locations approved by the The Engineer and generally at intervals not exceeding 100 m. Markers shall also be provided to identify change in the direction of the cable route and also for location of every underground joint.
- b) Route markers shall be made out of 100 mm x 100 mm x 5 mm GI/Aluminium plate, welded or bolted on to 35 mm x 35 mm x 6 mm angle iron 60 cm. long. Such plate markers shall be mounted parallel to and 0.5 m or so away from the edge of the trench.
- c) Alternatively cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) marker 60 cm x 60 cm 10 cm in size shall be laid flat and centered over the cable. The concrete markers unless otherwise instructed by the The Engineer shall project over the surrounding surface so as to make the cable route easily identifiable.
- d) The work 'cable' and other details such as voltage grading, size etc. as furnished by the The Engineer shall be inscribed on the marker.

### **Laying in Pipes / Closed Ducts**

In location such as road crossing, entry to building, on poles, in paved areas etc. cables shall be laid in pipes or closed ducts.

GI or Hume Pipes (spun reinforced concrete pipes) shall be used for such purposes. In the case of new construction, pipes as required shall be laid along with the Civil works and jointed according to the instructions of the The Engineer as the case may be. The size of pipe

shall be as indicated in the electrical drawings. GI pipe shall be laid directly in ground without any special bed. Hume pipe (Spun reinforced concrete pipe) shall be laid over 10 cm. thick cement concrete 1:5:10 (1 cement: 5 coarse sand: 10 graded stone aggregate of 40mm nominal size) bed, after which it shall be completely embedded in concrete. No sand cushioning or tiles need be used in such situations. Unless otherwise specified, the top surface of pipes shall be at a minimum depth of 1mtr. from the ground level when laid under roads, pavement etc.

Where steel pipes are employed for protection of single core cables feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

The pipes on road crossing shall preferably be on the skew to reduce the angle of bends as the cable enters and leaves the crossings. This is particularly important for high voltage cables.

Manholes of adequate size as decided by the The Engineer shall be provided to facilitate feeding/drawing in of cables and to provide working space for persons. They shall be covered by suitable manhole covers with frame of proper design. The construction of manholes and providing the cover is not in the scope of this Contract and shall be got executed and paid for by the The Engineer through another agency.

Pipes shall be continuous and clear of debris or concrete before cable is drawn. Sharp edges at ends shall be smoothed to prevent injury to cable insulation or sheathing.

Pipes for cable entries to the building shall slope downwards from the building and suitably sealed to prevent entry of water inside the building. Further the mouth of the pipes at the building end shall be suitably sealed to avoid entry of water. This seal in addition to being waterproof shall also be fireproof.

All chases and passages necessary for laying of service cable connections to buildings shall be cut as required and made good to the original finish and to the satisfaction of the The Engineer.

Cable grips/draw wires and winches etc. may be employed for drawing cables through pipes/closed ducts etc.

### **Laying on Cable Tray**

Cables, where indicated in approved shop drawings, shall be laid on overhead cable trays

which are suspended from ceiling or supported from wall, by anchor fasteners as required.

The Contractor shall provide for all accessories for the installation of the cable trays, such as bends, tees, reducers coupler plates, and structural steel members (comprising of channels, angles, flats, rods) for structural supports for cable trays etc.

### **Cable Tray Mounting**

Unless otherwise specifically noted on the relevant layout drawing, all cable tray mounting works to be carried out ensuring the following:

- a) Cable tray mounting arrangement type to be as marked on layout drawing.
- b) Assembly of tray mounting structure shall be supplied, fabricated, erected & painted by the Contractor.
- c) Cable tray running along the wall should be supported at intervals not exceeding 1.5 m. In case of branching, there should be a support on all branches at a distance of 30 cm from the point of branching. Support should not be less than 40 mm x 40 mm x 5 mm MS angle-secured in an approved manner where runs are along the walls. In case of ceiling suspended cable tray horizontal supports made of 40 mm x 40 mm 5 mm MS angle iron shall be provided. The horizontal interval between two such supports shall be 1.0 meter. These supports shall be suspended from C.I. boxes or suitable approved suspension devices such as dash fastener of suitable sizes in the ceiling by means of 10 mm diameter GI threaded rods. All above mounting accessories form part of installation of cable trays.

### **Testing & Commissioning**

#### **Inspection**

All cables shall be inspected upon receipt at site and checked by the The Engineer for any damage during transit.

#### **Testing**

- i. All 650/1100 Volt grade cables before laying shall be tested with a 500 V megger or with a 2,500/5,000 V megger for cables of higher voltages. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance to earth/sheath/amour and insulation resistance between conductors.
- ii. All cables shall be subject to above mentioned tests during laying, before

covering the cables by protective covers and back filling and also before the jointing operations.

### **Completion Plan and Completion Certificate**

a) After completion of the work the Contractor shall draw completion plans to a suitable scale and shall submit to the Consultant/PMC/Client The Engineer. The completion plans shall, inter-align, give the following details

- i) Layout of cable work
- ii) Length, size, type and grade of cables.
- iii) Method of laying i.e. direct in ground, in pipes etc.
- iv) Location of each joint with jointing method followed.
- v) Route marker and joint maker with respect to permanent land marks available at site.
- vi) Wherever the previously laid cable is cut and additional joints are introduced etc., the cable records shall suitably be amended.

### **Testing of Cables**

The cables shall be tested before and after laying. The Megger value in normal dry weather shall be 50 Mega ohm for 1.1 KV grade cable. This value shall be 200 Mega ohm for 11KV grade cable.

### **Cable Tags**

Cable tags shall be made out of 2mm thick aluminium sheets. Each tag shall be 2" in dia or 3" x 3" square with one hole of 2.5mm dia, 6 mm below the periphery, or as approved by Consultant. Cable designations are to be punched with letters / number punches and the tags are to be tied to cables with piano wires of approve quality & size. Tags shall be tied inside the panels beyond the glanding as well as above the glands at cable entries. Along trays tags are to be tied at all bends. On straight lengths, tags shall be provided at every 5 meters.

Cables shall be secured to cable trays with 3mm thick x 25mm wide aluminium strips/suitable GI clamp, or as approved by Consultant, at 1000 mm intervals and screwed by means of rust proof screws and washers, of adequate but not excessive lengths. Cable trays for horizontal runs suspended from the ceiling will be supported with mild steel straps or

brackets, at 1000 mm intervals and the overall tray arrangement shall be of a rigid construction. External cabling route marker with C.I. plate marked with “DANGER 1.1 KV CABLE” with 0.6 meter long GI angle iron grouting bracket including 1:3:6 ratio cement concrete base block of minimum size 200 x 200 x 350 mm to be provided or as approved by Elect. Supply Company.

### **Cable Tray**

All cables trays shall be made of G.I. sheet.

Cable trays shall be complete with bends, joints, coupler plates and accessories as may be required for joining the cable trays. The bends, Tee joint, Cross joint for all sizes of cable tray shall be factory fabricated.

Cable trays shall be either perforated or ladder type as called for in the schedule of quantities.

### **Perforated Cable Tray**

Standard dimensions of perforated cable trays shall be as follows:

1. Width : 100 mm to 900 mm
2. Length : 2500 mm
3. Thickness : 2mm up to 750 mm width and 3mm from 900mm to 1200 mm
4. Collar height : 50 mm up to 600 mm and 75 mm from 750 mm to 1200mm

### **Ladder Type Cable Tray**

Standard dimensions of ladder type cable trays shall be as follows:

<b>Size of tray</b>	<b>size of main channel</b>	<b>size of rung /spacing between rungs</b>
900mm to 1200mm	25 x100 x 25 x 3mm	20 x 50 x 20 x 2 @ 200C/C
Up to 750mm	25 x 75 x 25 x 2mm	20 x 50 x 20 x 2 @ 200C/C

Sizes of angle for cable tray supports shall be minimum 40 x 40 x 5 mm up to 600mm & 50 x 50 x 5mm minimum as specified in the drawings/schedule of quantities for sizes above 600 mm. Hangers shall be of minimum 10 mm dia steel round bars up to 600 mm & 12 mm dia



steel from 750 mm to 1200 mm as specified in the drawings/schedule of quantities. All the support shall be G.I. Fixing arrangement shall be as approved by the Consultant. Hardware to be used in cable tray system shall be galvanized or zinc passivated.

### 5.33. B V. RACE WAY & JUNCTION BOARD

#### Race way

All Race way shall be made of GI sheet.

Race ways shall be complete with bends, joints, coupler plates and accessories as may be required for joining the race way. The bends, Tee joint, Cross joint for all sizes of cable Race way shall be factory fabricated.

Race way shall be either perforated or under floor/ceiling type as called for in the schedule of quantities.

#### Perforated Race Way

Standard dimensions of perforated cable trays shall be as follows:

1. Width : 100 mm to 300 mm
2. Length : 2500 mm
3. Thickness : 2mm up to 300 mm width and 3mm from 300 mm to 750 mm
4. Collar height : 50 mm up to 600 mm and 75 mm from 750 mm to 1200mm

#### Under floor / ceiling Type Race Way

Standard dimensions of under floor/ceiling type race way shall be as follows:

Size of race way	size of main channel	size of rung /spacing between rungs
Up to 300 mm	25 x 75 x 25 x 2mm	20 x 50 x 20 x 2 @ 200C/C

Sizes of angle for race way supports shall be minimum 40 x 40 x 5 mm up to 600mm & 50 x 50 x 5mm minimum as specified in the drawings/schedule of quantities for sizes above 300 mm. Hangers shall be of minimum 10 mm dia steel round bars up to 300 mm & 12 mm dia steel from 750 mm to 1200 mm as specified in the drawings/schedule of quantities. All the

support shall be G.I. Fixing arrangement shall be as approved by the Consultant. Hardware to be used in race way system shall be galvanized or zinc passivated.

### **5.34. B VI.1.0 UPS SYSTEM**

#### **System Components**

The Capacity to be designed as per the electrical SLD in Insulated Gate Bipolar Transistor (IGBT) Technology.

#### **Product Certification / Testing**

The product shall have certification from any one of the following -

- a) ERTL
- b) ETDC
- c) Sameer
- d)STQC
- e)I E C
- f)ISO 9001

#### **Operating Temperature**

0-40 degree Centigrade

#### **Humidity**

Upto 90%

#### **Output Frequency**

50 Hz +/- 0.01% Hz

#### **Wave Form**

Pure Sine Wave

#### **Transient Response**

+/- 1% maximum under following conditions:

- a) Loss or Return of Input AC supply
- b) 100% step load

**Load Power Factor**

0.9 lag to unity.

**Crest Factor**

Greater than 3:1

**Switch Over Time**

Zero

**verload Rating**

110% for 30 minutes

125% for 01 minutes

**Switching speed**

Minimum 2 KHZ

**Indication**

Mains ON/OFF, /Battery HIGH/LOW, Battery ON, Invertor ON/TRIP, O/P

HIGH/LOW, Battery HIGH/LOW, Alarm for Battery Discharge.

**Protection**

Input - Over/Under voltage, Over Current.

Battery - Over/Under Voltage, Over Current, Battery Low Alarm/Trip.

Output - Over/Under Voltage, Over Current.

Output - Short Circuit Over Temperature DC Over Current

**Control Circuitry**

Microprocessor based control circuitry be provided and all indications will be digitally displayed using microprocessor based software.

**Metering**

Digital display with multifunctional key panel indicate.

Output Voltage/Current

DC Voltage/Current

Output Frequency

**Communication Port**

RS 232, RS485

**Diagnosis & Configuration Software**

Compatible with Unix/Windows.

**Out Look**

Compact size with aesthetically good look (specify the size and weight)

**Battery**

Lead Acid, S.M.F. for 20 minutes back-up under full load. Battery sizing calculations to be submitted

**Ups Failure**

During failure in the UPS equipment the static switch automatically transfer the A.C. load directly to the AC. line in less than 1/4 cycle so that transfer does not affect critical equipment operation.

**Harmonic Distortion of Wave Form**

Total harmonic distortion (THD) should be below 3% for linear load and below 5% for nonlinear load.

**Maintenance by Pass Switch**

The portion of UPS module used to connect the alternator supply to critical load while electrically isolating static switch and inverter for maintenance purpose.

**Battery Disconnect Switch**

The switch used to electrically isolate the storage batteries from UPS module.

**Static Transformer Switch**

The switch senses an inverter shutdown signal or degradation of inverter output item.

It shall automatically transfer the loads from one inverter to the alternative AC power without interruption.

**Retransfer to Inverter**

The static transfer switch shall be capable of automatically re-transferring the load back to inverter after the inverter has returned to normal voltage and stabilized for period of time.

**Quality Assurance**

The manufacturer shall have quality assurance program with check on incoming parts and final products. A final test procedure for product shall include a check of all performance specifications and a minimum 24 hour running.

**Installation Drawing**

The minimum two sets of installation drawings showing outline dimension, weights and connections and a one line drawing of the UPS shall be sent to the purchaser to be used in planning the installation of the system.

**Product Documentation**

Manufacturer shall supply a comprehensive set of product documentation for:

1. Installation
2. Operation
3. Maintenance

This should include complete outline and external connection drawings and schematic and physical wiring diagrams as well as parts list and parts layout down to the smallest

components level. It should include startup and service manuals with complete privation and remedial maintenance and trouble showing instructions. This should include all ancillary equipment and accessories.

### **Training**

It is important that at least -2 personnel who are to be responsible for operation and maintenance of UPS be trained at the manufacturer site.

### **Spare Parts**

The recommended spare parts to be listed and should be quoted along with main modules as per manufacture defects

### **Material and Workmanship**

- 1) Workmanship shall be first class in every respect.
- 2) All material shall be new and of best commercial grade.
- 3) Brackets and securing hardware shall be electroplated with corrosion resistance material.
- 4) Internal wiring conductors shall be combined into cable or bundles and shall be tied securely together and numbered or coded to correspond with documentation.

### **Storage Battery**

The storage battery shall be furnished with racks connecting hardware and standard service resistance material accessories. The battery shall be delivered charged and filled ready for service.

### **Service Report**

Assigned field service report describing start-up and on site testing shall be furnished.

### **Maintenance**

If the battery is taken out of service for maintenance by manually opening battery disconnect switch the UPS shall continue to function and meet all the performance criteria specified except.

**Inverter efficiency**

94% minimum

**Protection class**

IP – 20

**Warranty/Guarantee**

The date of Invoice UPS & Battery For 24 MONTHS as per manufacture defects.

**5.35. C. PA System Work****Basis of Design****Purpose**

1. The purpose of the system is to quickly evacuate people in an orderly manner via escape routes through the use of prepared clear text instructions. In addition, it should be capable to take all instructions that are announced live to be sent to circuits and groups.
2. The scope includes the shop drawing, supply, installation and commissioning of a audible and intelligible Public Address and voice alarm system and should be designed such that it could be integrated with existing fire alarm panel.

**Standards**

1. The Public Address & Voice Alarm system should be EN54-16 complied for the VA/PA system.
2. Compliance shall be verified by means of a manufacturer declaration, CPD certificate or by obtaining approval from certification authority with the VA/PA system provided and its additional components

**Definitions**

1. PA: Public Address
2. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.
3. Public Address (PA) Zone: A collection of one or more Zones. Each PA Zone shall

be provided with an independent paging button, allowing a unique paging to be independently addressed to that Zone or collection of Zones. PA Zones are provided to permit messages or other audio content to be independently transmitted to selected areas.

4. Voice Alarm Zone: A collection of PA Zones that are to receive a simultaneous emergency announcement. Voice Alarm Zones are used to permit phased evacuation.
5. Voice Alarm System: A fully functional and resilient emergency speech annunciation system, as specified in this section, including control equipment, microphones, loudspeakers, interfaces and all associated interconnections.
6. Fire Alarm System: For the purposes of this section of the specification, the Fire Alarm system shall form, in conjunction with the Voice Alarm system, the complete Fire Alarm and Detection system.
7. STI: Speech Transmission Index as described in IEC 60268-16: 2003.

## **System Components**

### **IP Based Digital Audio Controller**

- a. Digital audio distribution and connection system for up to 8 / 24 loudspeaker zones
- b. Module with audio signal processing for connecting and controlling power amplifiers and for connecting loudspeaker circuits.
- c. Four independent audio outputs for connecting power amplifiers (up to 400W per channel) and for simultaneous processing of up to four different audio information items per module.
- d. Connection of audio signal to one or up to six user-defined loudspeaker zones for each audio output to obtain upto twenty-four loudspeaker circuits per module.
- e. Upgrade to a complex alarm/public address system through integrated LAN interfaces.
- f. Continuous monitoring of power amplifiers by means of a 22 kHz test tone. In the event of a failure of a power amplifier, a backup amplifier will automatically and dynamically replace the faulty power amplifier. The defined loudness level is also taken into account for the backup amplifier.



- g. Continuous inaudible monitoring of loudspeaker lines (ground faults, short circuits, interruptions, and impedance deviations with specified tolerances for each loudspeaker circuit), even in power- saving mode, independent of activated announcements. An end of line module can also optionally be used as a line termination and the line to the EOL can be monitored. This ensures that short-circuited loudspeaker circuits are disconnected without affecting the rest of the system.
- h. Continuous monitoring of line and microphone of up to four connectable digital call stations or universal input modules.
- i. All errors are detected, displayed and recorded (message list) within seconds.
- j. Audio filters such as parametric equalizers, high and low-pass filters and delays per audio channel can be set.
- k. For each of the four amplifier channels, there are four sensor inputs for optional, continuous and automatic volume control in real time, independent of the ambient noise level.
- l. It is possible to monitor locally all of the input and output channels via the integrated loudspeaker and monitor button.
- m. Eight programmable, potential-free contact outputs for controlling external components (e.g. priority relays) or for signaling various indicator states (collective fault messages).
- n. Four Ethernet 100 M bit/s interface connections with switch function.
- o. Integrated TWI bus for optional connection of an additional module (e.g. time synchronization using TCM-GPS). Display for indicating operation status, errors, circuit connection, and active power-saving mode via multicolored LEDs.
- p. Emergency control operation during a power failure to preserve battery capacity – this means not activating low-priority announcements when there is a failure in the primary power supply. The connected amplifiers are switched to stand-by mode.
- q. Non-volatile audio memory for up to 260 seconds, freely scalable, for user specific canned audio. Various gong and alarm signals in accordance with DIN VDE 33404, ZBV.
- r. Emergency 24 V power supply as secondary power supply.

**Display**

- a. LEDs for device operating state:
- b. In operation,
- c. Warning/error
- d. Emergency control option
- e. Power-saving mode
- f. 8 LEDs for indicating the control contacts state
- g. 4 LEDs for indicating the state of each connected power amplifier
- h. 24 error and 24 loudspeaker circuit relay LEDs

**1.1.3 Operating elements**

- a. A button for sequential monitoring of local audio channels and acknowledging an acoustic error message
- b. 1 monitoring loudspeaker

**Audio output**

- a. Output type : electronically symmetrical
- b. Nominal level : 0 dBu
- c. Max. output level : +6 dBu
- d. Frequency range : 20 Hz to 20 kHz
- e. Max. deviation from linear frequency :  $\pm 1$  dB in frequency range
- f. Distortion factor at nominal level :  $< 0.03\%$  at 1 kHz
- g. Max. distortion factor :  $0.1\%$  in frequency range
- h. Signal-to-noise ratio at nominal level :  $> 75$  dB (A)  $> 70$  dB
- i. Load impedance : min. 5 k $\Omega$ , max. 500 pF
- j. Sensor input (AVC)

**Input type symmetrical, non-earthed**

- a. Nominal level - 51 dBu
- b. Nominal level for emergency call station - 0 dBu
- c. Frequency range - 100 Hz to 8 kHz
- d. Max. deviation from linear frequency -  $\pm 6$  dB in frequency range
- e. Distortion factor at nominal level -  $< 0.2\%$  at 1 kHz
- f. Max. distortion factor - 1% in frequency range
- g. Signal-to-noise ratio at nominal level -  $> 65$  dB (A)  $> 60$  dB

- h. Input impedance typ. - 200 Ohm

### Control contacts

- a. Max. voltage : 100 V DC/1 A
- b. Impulse withstand voltage : > 2.5 kV
- c. Pass-through contacts :
- d. Max. voltage : 250 V AC, 30 V DC/5 A
- e. Impulse withstand voltage : > 1.5 kV
- f. Power supply :
- g. Rated voltage : 90 V AC to 264 V AC
- h. Nominal frequency : 47 Hz to 440 Hz
- i. Power rating with/without AC : 4x DAL 50 W/80 W at 230 V
- j. Emergency power supply :
- k. Voltage range : 21.6 V DC to 30 V DC
- l. Ambient temperature range : -5°C to +55°C
- m. Relative humidity : 15% to 90%
- n. \*AVC = Automatic Volume Control

### Amplifiers

#### Power amplifier 2 x 250 W/100 V; class D, 24 VDC

- a. The power amplifier includes the following characteristics:
- b. Complies with IEC BS EN 60268-3, 55013, and 55020 standards
- c. Self-monitoring and self-testing via microcontrollers
- d. Protected against overload, short circuits and over-heating
- e. Built-in fan with temperature-controlled rotation speed control, with airflow from
- f. front to back of device
- g. Monitoring of the fan's t self, if one is failed – the left fan must set on 100%
- h. speed automatically

#### Power amplifier 2 x 500 W/100 V; class D, 24 VDC

The power amplifier includes the following characteristics:

- a. Complies with IEC BS EN 60268-3, 55013, and 55020 standards

- b. Self-monitoring and self-testing via microcontrollers
- c. Protected against overload, short circuits and over-heating
- d. Built-in fan with temperature-controlled rotation speed control, with airflow from front to back of device
- e. Monitoring of the fan's t self, if one is failed – the left fan must set on 100% speed automatically

**Ceiling Loudspeakers (6W/3W/1.5W/0.75W): EN 54-24 certified 6W ceiling loudspeaker with the following specifications**

Max power	:	9 W
Rated Power	:	6 W
Power taps @ 100V	:	6 W / 3 W / 1.5 W /
0.75 W SPL (1W / 1m, 100 Hz - 10k Hz)	:	91 dB
Frequency response ( - 10 dB )	:	170 Hz - 20k Hz
Dispersion angle ( 1k Hz / -6 dB )	:	170°
Rated input voltage	:	100 V
Rated impedance	:	1.7k $\Omega$ /3.3k $\Omega$ /6.7k $\Omega$ /13k $\Omega$

**6W/3W/1.5W/0.75W Wall mount Loudspeaker : EN 54-24 certified 6W wall amount loudspeaker with the following specifications**

Max power	:	9 W
Rated Power	:	6 W
Power taps @ 100V	:	6 W / 3 W / 1.5 W / 0.75 W
SPL (1W / 1m, 100 Hz - 10k Hz)	:	91 dB
Frequency response ( - 10 dB )	:	300 Hz – 15 k Hz
Dispersion angle ( 1k Hz / -6 dB )	:	170°

**Execution**

**Cable Installation**

- a. The system wiring shall comply fully with the requirements of this Specification.
- b. The work should comply to relevant IBC and ANSI standards and shall be responsible for the operation and performance of the system, including wiring.

- c. Cables [wiring & fiber], regardless of length, shall be marked with wraparound number or letter cable markers at both ends. All cables shall have a unique reference number. There shall be no unmarked cables at any place in the system.
- d. Inter-rack cabling shall be neatly strapped, dressed, and adequately supported. Terminal blocks, boards, strips, or connectors, shall be furnished for all cables which interface with racks, cabinets consoles, or equipment modules. Fire alarm rated cable shall be used
- e. Alternate loudspeakers shall be wired to independent circuits, on the A/B principle as specified herein, if need be.
- f. Cores shall be color coded or numbered.
- g. In-line connections shall be limited to the absolute minimum practicable. Any such connections shall be within suitable steel junction boxes, color red, permanently annotated 'VOICE ALARM SYSTEM'.
- h. Connections to equipment racks shall be via marshalling boxes, color red, also annotated 'VOICE ALARM SYSTEM'. The boxes shall be fitted with fixed terminal strips, which shall be permanently annotated with unique circuit reference numbers. Final connections between the marshalling boxes and the racks shall be via suitable flexible cables of sufficient length to gain working access to the rear of the racks.
- i. Internal rack connections shall be either hard-wired or via professional type audio connectors, preferably of the latching type.
- j. Terminate conductors; no cable shall contain un terminated elements. Make terminations only at outlets and terminals.
- k. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables shall not be spliced.
- l. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
- m. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.
- n. Separation of Wires: Separate speaker-microphone, line-level, speaker level, and power wiring runs. Install in separate raceways or, where exposed or in

same enclosure, separate conductors at least 12 inches (300mm) apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer. Cables shall only cross at right angles

#### **Installation of PA equipment and racks**

- a. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.
- b. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams

#### **Equipment Cabinets and Racks**

- a. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
- b. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.

#### **Blank Panels**

Cover empty space in equipment racks so entire front of rack is occupied by panels.

#### **Grounding**

- a. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- b. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

#### **Testing & Inspection**

- a) After complying with the procedures set out in the Preliminaries, the full tests shall be carried out to demonstrate that the works meet the requirements, in accordance with this Specification.
- b) A method statement shall be provided to the The Engineer for approval at least 10 days before the tests are scheduled to commence. Upon successful

completion of these tests, full system demonstration shall be done for acceptance purpose.

- c) The test shall include, but not necessarily be limited to:
  - i. Full operational tests on the rack equipment and system inputs, including a complete check on input routing and priority
  - ii. Test of interfaces to the fire detection system
- d) Impedance of each loudspeaker line
- e) Electrical safety and earth checks (by a competent person, to be approved)
- f) Sound level measurements, to ensure that the system sound levels for each input meet the Specification requirements
- g) Equalization of the system in each zone
- h) Set up of time delay to loudspeakers
- i) Set up and test of the ANS system
- j) Subjective assessment of the electro acoustic performance of the system, including the intelligibility of speech.
- k) Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. The test report shall include
  - l) Test details - dates, times, test personnel (with qualifications as appropriate); 5 Measured values in appropriate format for the parameter measured, e.g. Marked-up drawings and tables showing electro acoustic performance and completed matrices proving correct priority and routing operation.
  - m) The sound level measurement procedure shall be as follows: The sound level meter shall be calibrated immediately before commencing the measurements. The sound level meter shall be set to dB(A), slow ('S') response.
  - n) Measurements shall be taken at 1.5m above floor level (1m above floor level in seating areas.
  - o) The pink noise input gain setting shall be noted and used to set up the sound levels at all other locations. One zone shall be selected at a time to minimize disturbance.
  - p) Measurements shall be taken in all areas of the building covered by the system.
  - q) Measurement locations shall be chosen to indicate the maximum range of sound levels within an area.

- r) Measurement locations and corresponding sound levels shall be marked up on the loudspeaker layout drawings. The drawings shall also indicate the final tapping value of each loudspeaker or each set of similar loudspeakers. If the measured sound levels do not meet the required levels then adjustments shall be made to the pre-amplifiers, amplifiers and/or loudspeaker tappings. The documented levels shall be the measured levels after adjustment. Any areas where the required levels cannot be achieved shall be highlighted on the drawings.
- s) The pink noise test shall ensure that the relative sound levels between different areas are correctly set. Once this is completed each system input needs to be set correctly. This shall only involve measurements at 2 locations and adjustment of the pre-amplifier setting of each system input.
- t) Each of the recorded messages shall be broadcast and measured in turn. The sound levels of any pre-announcement tone and of the spoken message shall be measured and noted separately. The sound level shall be the dB(A) visual average or Leq over the length of the preannouncement tone or the spoken message.
- u) Adjustments shall be made to the pre-amplifier setting until the measured sound level of the spoken message meets the required sound level.
- v) The sound levels produced by each microphone input shall be measured and adjusted until the required sound levels are reached. Each microphone output shall be assessed using 3 different voices, repeating the words of the test message.
- w) The levels shall be set such that the arithmetic average of the three measured levels agrees with the target level. The microphones shall be used with the lips at the appropriate working distance from the microphone head. This distance shall be recorded with the documented sound levels.
- x) Upon successful completion of the tests full system demonstration shall be done for acceptance purpose.

**Warranty/Guarantee As per Manufacturing Defects**



### **5.36. D ELV AND ICT SYSTEM**

#### **I Passive (Data, Wi-Fi & Networking System)**

##### **Computer/ LAN Networking/ Wi-Fi Points**

The system has to provide Cat 6A RJ 45 data outlets points for Computers, Networking, Telephones, Wi-Fi, Access Control, CCTV, Information Display system, Systems, BMS, SCADA etc. as per requirement in rooms and other areas at various floors in all the blocks/buildings.

The Data Outlet points shall be connected to Rack Panel/Computer hub with 4 pair CAT-6A wiring in Raceways, recessed/ surface conduit as required. UPS Power supply shall be provided to Network Rack, Servers & Computers wherever required.

The maximum length of the CAT-6A cable from end user point to the Hub or Edge switches shall not be more than 90 M. Beyond 90 M length Fibre Optic Cable shall be used.

The Rack Panel/computer hub at various floors will be connected to Main rack of the building/ block with Fiber Optic Cable through conduit or raceways on surface/ recess.

Suitable Data center with false flooring shall be established in Administrative Building, which comprises both LAN server & IPABX server. There shall be proper redundant (24 X 7) cooling facility in the Data center to maintain the desired temperature, humidity & Indoor air quality for smooth operation of the System.

The server shall be connected to Core Switch and Core switch to Distribution Switch between Connectivity Minimum 40G and switch shall be through Optical Fibre cable. Distribution to edge switch connectivity minimum 10G and each building/ block with optical fiber cable in underground DWC HDPE pipe of suitable size for outside connectivity or in cable raceway/conduit inside the buildings.

The Network shall have Core switches, distribution switches, Firewall protection, Load balancer Bandwidth management, ITAM all in redundant mode.

The incoming Fiber cable from Service provider for the Campus Broadband connectivity shall be terminated in the Server room. The laying and termination of Fiber optic cable within the campus will be provided.

The Rack Panel comprising of jack/Patch panels, Network switches, patch cords, power supply units, Cooling Fans, Wire managers, LIUs, Trans-receivers, Fiber patch cord etc. of individual buildings/Blocks/ floors.

LAN Infrastructure at different Floors of various building shall be used commonly for IPABX, , CCTV etc. along with LAN.

Brick masonry manholes with covers shall be provided at suitable lengths to facilitate easy wire/cable pulling.

Wireless access points for Wi-Fi connectivity are proposed in Administrative, Faculty and etc. All types hospital facility areas shall have only Wi-Fi connectivity whereas other buildings in the complex shall be with wired data outlets along with the Wi-Fi connectivity.

### **Pure IP at Core Server Based PBX System**

#### **IP Telephony System Architecture:**

The IP telephony system must be based on a pure IP technology that is a software-only solution.

The IP telephony system must support unified communication (UC) server & gateways architecture for SIP, Digital and Analog trunks connectivity.

The system must be capable of supporting Analog, Digital, IP Telephones, and SIP based video desk phones.

The communication servers must work in an Active-Active redundancy mode. It should be possible to define servers load balancing mode. All servers should work together in load balancing mode with defined user capacity i.e. all servers should be active with call processing with at least 50% SIP phones and gateways register on any of the server for load distribution. If any Server Fails in the Cluster adjacent server should automatically take the load of the failed sever along with load of gateway and end points without breaking on-going calls.

All servers must be provided in a cluster mode. If one cluster server fails, one of the other cluster servers in the network must be able to take the complete load of the calls automatically (without any manual intervention) and without dropping any existing calls (IP, TDM & PRI) or data (CDR, CTI). Management of all servers in cluster should be from same web page. All servers should have same database.

The telephony system must be able to register SIP phones/SIP video phones and MGCP phones directly to it.

System should work on Geographically distributed Architecture

It should be possible to install Telephony system in VMware EXSi 5.5 or higher.

All Data (Numbers, COS, Routing, Applications) should reside in all the Servers

Database replication in All servers should be automatic and real time

Should support N+1 Redundancy Architecture as well as 1+1 redundancy Architecture

In case of failure of one server, the SIP Phones, SIP Gateways, MGCP Phones should register with second Server automatically

System Diagnostics should be done in Server

Hot Standby for SIP Phones and Gateways i.e. SIP Phones and Gateways should register automatically to next available telephony server.

COTS - commercial off-the-shelf Servers should be used for telephony system. OEM made or proprietary made servers will not be accepted.

Telephony system should use Linux Operating System

System should support CSTA phase III Protocol

Full continuation for call signaling and media must be supported

Calls must not be disconnected, and control must remain throughout the swap to an alternate server including full call control (transfer, conference actions, continuation of CDR data for the existing call).

Load Balancing of end points must be possible by the administrator

There must be no restriction on the number of endpoints being backed up in case of one server failure.

UC platform servers must provide full failover and redundancy

The tenderer must submit valid latest Type test TEC certificate issued by Telecommunication Engineering Centre, MOC, GOI as per GR approvals tested with IPv4 & IPv6 for both SIP terminals and SIP Trunks from days 1 for the particular model of Server & Media Gateway system quoted and the same must be issued in the name of manufacturer/ any dealer of OEM / Bidder. Notarised copy of the same is required to submit along with the technical bid. Notarised hard copy of the same is to be submitted for verification at the time of technical bid opening. The TEC-GR type approvals to be available with bidder at the time of publish of this tender. TEC-GR applied/ E-mail confirmation/Later submission will not be allowed.

Hardware of the offered IP Telephony Exchange of server – Gateway architecture with redundancy system should be from OEM, Hardware of Chinese/ ROC (Republic of China)/Countries taking ant India movements are not allowed quote. Call Manager Software, IP/SIP Phones, Media Gateways, Call Billing and accounting software, Auto attendance, Help Desk and voice mail should be preferably from the same OEM of IP Telephony Exchange. No Third-party solution from Chinese/ ROC (Republic of China)/ Countries taking ant India movements are allowed.

**System should support Session Initiation Protocol (SIP).**

The system must be scalable to at least 25,000 endpoints in single cluster architecture. The call signalling server must handle traffic at a minimum of 100K BHCC.

The UC platform must consist of one or many servers where each server in the cluster provides complete 100% application functionality.

The life cycle of the entire system being provided must be at least Ten (10) years

The UC platform must have distributed architecture and centralized control for all the sites in the network.

The proposed solution must support Hybrid cloud solution in order to guarantee business continuity with overall survivability regardless of a failure at any single location.

The proposed solution must enable part of the cluster to be hosted in a Cloud Service Provider (CSP) to run all applications.

**Quality of Service (QoS):**

The voice and signalling frames must be marked [tagged] in order to be recognized. Commercial Off-the-Shelf servers must be used (COTS).

**Server – Physical Attributes:**

The redundant server must have separate hardware, not sharing elements like hard drives and RAM etc., to avoid a single point of failure.

The server should have AC power supply.

The system must be based on server gateway architecture with external appliance servers

No card-based processor systems / soft switch should be quoted.

The call processor must run on Linux OS.

**Minimum Server Specifications:**

The CPU must be from the Intel® Xeon® processor

The server must have at least 8GB RAM

The server must have Hard Drives (300GB each) of storage

The server must have a Dual 1GB network interface.

Form Factor for physical server (Not Virtual Machine) should be 1 U

**VoIP Media Gateways:**

The VoIP media gateways shall be capable of being centrally managed via the telephony management application. The system should support multiple gateways.

The system gateway should be able to restart automatically without human intervention when the external ac power supply is resumed after complete power failure

**System Security:**

Administration of the system should be using HTTPS

It should support the Interop with leading SBC

System should use TLS (Transport Layer protocol) to encrypt SIP, HTTP, FTP and SRTP (Secure Real-time Transport Protocol) and SRTCP to encrypt RTP and RTCP

System Audit Logs for 30 days

Certificate management

System should have auto Provisioning profiles contain pre-configured sets of features that must automatically polls and updates registered phones with the latest phone firmware and configuration files.

**Mobility:**

The system should have Call Back feature. If the user dials his own extension from predefined number (mobile/landline) then system should disconnect the call and then system should call the user to provide the dial tone so that user can make intercom or PSTN calls.

The system should have Call Through feature. If the user dials his own extension from predefined number, then system should provide dial tone to make intercom or o/g calls.

**SIP Endpoints:**

All SIP phones must support the standard SIP protocol. No proprietary protocols are allowed to be used.

**Automatic Call Distribution (ACD):**

Busy ACD Group announcement

Hunt Group Release

IVR-ACD

Log In / Log Out

Multiple Announcements:

Mandatory announcement - All incoming callers to an ACD/HUNT group must be able to hear an introductory announcement in its entirety usually explaining about the company, product, or campaign.

First announcement - If all agents are busy, callers must be able to hear this announcement once usually informing them that their call has been placed in queue. (The system must be able to cut short this announcement if an agent becomes available to attend to the caller.)

Music - If no agents are available after the first announcement (or no First and Periodic announcers have been configured), the caller must be able to hear background music while in queue.

Periodic announcement - Alternating with background music, these announcements can also be played to callers in queue according to the Periodic Announcement Interval (see above) until the ACD/HUNT call is answered.

Release / Resume

Wait Queue

Wrap-Up Time

Automatic Release of ACD Agent

Automatic Call Distribution (ACD) Extended Overflow

**Zone Page:**

A phone user must be able to simultaneously broadcast a message over all types of endpoints.

The maximum quantity of endpoints in one zone should not be less than 100.

**System Administration:**

System administration should be web based.

All programming of system should be done through a web-based GUI interface.

The administrator should have Dynamic Profiles.

The system should allow for complete multi-level administration. The administrator must be able to define at least five (5) different administration level profiles that can be applied to allow subsets of users to access and manage particular pages in the systems Web Portal

**Certification Requirements:**

The OEM must comply with ISO 9001 certification in all the company's activities.

The products must comply with Safety and EMC standards like FCC, UL/TUV, CE, RoHS directive.

**Extension Features:**

Answer Call Waiting by Transfer

Auto Set Relocate

Auto-Answer

Automatic Disconnect

Automatic Number Identification (ANI) Display

Browse Personal Directory

Busy Lamp Field

Call Forward All

Call Hold

Call Log

Call Parking and Call Pickup

Call Waiting

Caller ID Control

Caller-ID Screening

Caller id-based routing for individual extension

Calling Number and Name

Camp-on Idle

Configurable DSS Buttons

Direct Dial without Off Hook (Hands Free)

Directed Call Pickup

Display Automatic Number Identification (ANI)

Display Dialed Number and Name

Display Dynamic Call Divert Information

Display Select Hold Display

Display Time/Date Function

Do Not Disturb (DND)

DSS/BLF

Elapsed Time Display

Group Call Pickup

Hands Free

Hands-Free Announce and Reply (Idle State)

Last Number Redial

Login and Logout

Message Waiting Indication

Multi Appearance (Call Waiting)

Multiple Line Appearance

On-Hook Dialling

Placing Multiple Calls on Hold

Privacy – ANI Restriction

Reminder/wakeup Call

Restrictions – Station

System Non-Exclusive Hold

Transfer with Consultation

Transfer without Consultation (Blind)

Voice Page

Emergency Pre-emption

Listen to Paging while in a call (Busy Condition)

ULA - User Line Appearance (ULA)

**Emergency Response communication / Emergency Conference Communication for code blue:**

The Emergency communication resource should be from the same telephony server and have the facility to automatic dial out to connect up to 100 participants in a single conference.

System should also have 100 party managed meet me conference. It should be possible to further divide 100 party conference bridge into any combination like 10 X 10 party, 5 x 20 party etc. if required. The meet me conference should be secured means to enter to the conference bridge; the user should enter the password.

The emergency communication management should be from Web Browser/HTML5 based GUI based interface from Windows PC and Touchscreen Devices if required in future.

It should have the ability to create an alarm and view the video (of the location) from a camera to the Dispatcher screen supporting Media Server.

It should have the ability to view video using streaming with HTML5.

It should have the ability to view video using Adobe Flash Player

**Specification of DESKTOP PHONE – Type1:**

SIP phone should be from the same OEM of IP telephony system

120x40-pixel or more, graphical LCD with backlight

2 VoIP accounts

Local phonebook up to 100 entries

Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment

SRTP/ HTTPS/ TLS

PoE, Headset, Wall-Mountable

Volume adjustment, ring tone selection

Voicemail, MWI

Call Park, call pickup

codec: G.711, G.726, G.729AB, G.722, iLBC, Opus

Transport Layer Security (TLS)

LED for call and message waiting indication

2xRJ45 10/100/1000 M Ethernet ports

Power over Ethernet

**Specification of SIP PHONE- Type2:**



SIP phone should be from the same OEM of IP telephony system

3.4" or more, 480 x 272-pixel colour display with backlight

4 VoIP accounts

10 one touch key with LED indication, key programming should be from IP PBX web management

Local phonebook up to 100 entries

Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment

SRTP/ HTTPS/ TLS, 802.1x

PoE, Headset, Wall-Mountable

Volume adjustment, ring tone selection

Voicemail, MWI

Call Park, call pickup

Codec: G.711, G.723.1, G.726, G.729AB, G.722, Opus

VAD, CNG, AEC, PLC

Transport Layer Security (TLS)

LED for call and message waiting indication

2xRJ45 10/100/1000 M Ethernet ports

Power over Ethernet

**Specification of Video IP Phone:**

7" 1024 x 600 capacitive adjustable touch screen

720p30 HD video call

2 mega-pixel HD camera with privacy shutter

Built-in Bluetooth 4.0+ EDR for headsets

Built-in Wi-Fi (Dual band:2.4GHz, 802.11a/b/g/n)

USB ports (2.0 compliant) for media and storage applications

Up to 16 SIP accounts

Three-way video conferencing

HD voice: HD handset, HD speaker

Audio codec: G.722, G.711 (A/μ), G.729AB, G.723, G.726, iLBC, Opus

Video codec: H.264 High Profile, H.264, VP8

Adjustable camera

LED for call and message waiting indication

Caller ID with name, number and photo

16 VoIP accounts

Three-way video conferencing

USB ports (3.0 compliant) for extending camera with USB3.0 cable

Onscreen keyboard

Busy Lamp Field (BLF)

Key programming should be from Telephony server administration web

27 one-touch DSS keys

Feature keys: message, headset, mute, hold, transfer, video, redial, speakerphone

Volume control keys

Dual-port Gigabit Ethernet

IPv4/IPv6

SIP v1 (RFC2543), v2 (RFC3261)

Call server redundancy

SRTP

Transport Layer Security (TLS)

Phone lock for personal privacy protection

1xRJ9 (4P4C) handset port / 1xRJ9 (4P4C) headset port

Dual-port Gigabit Ethernet

**Help desk Specification (5 Agents Contact Centre Software):**

**General capabilities:**

The proposed solution must be embedded within the platform, not installed on a separate server and should be from the same OEM of the telephony system.

The system must be an All-in-one solution that provides a one server solution for UC&C and 5 agent licence for help desk.

Single server deployment with intuitive and central management capabilities should support true multimedia

Help desk managers mdesk managers easily prioritize customers and incoming contacts regardless of the media used.

The same set of business and routing rules can be applied to voice / chat calls, emails, and faxes if required.

The help desk must support multi-layer routing including Priority, Skill Based, Statistical, Business Rules, and Customer Defined Values.

The supervisor must be able to see the status of help desk agents in real-time in his PC like logout, busy, free, release, non ACD etc. in graphical form in pie chart / bar chart.

**Help desk facilities**

Real-time Monitoring – must provide supervisors with statistical information about the current status of the help desk with online refresh (1sec). The application must include pre-defined list of reports and the customer (end user) should be able to choose reports as needed.

The Real Time application must provide the ability to build/change the workspace for each user and by user (not vendor or distributor).

The RT must provide the ability to move agents to/from different groups/queues for current login only.

Historical Reports – must be able to collect all information from call entry to call termination. Call profile details for internal investigation purposes should be part of the contact centre solution.

The help desk solution must have an embedded Management Information System (MIS) suite that monitors all help desk activities, generating reports that summarize the past performance of the system over a given time period, and providing statistical analysis of the help desk within a specified period. Real-time and historical reports provide:

**Gateway Specification - up to 96 port FXS / FXO ports:**

Gateway should have up to 96 FXS / FXO ports and should be from the same OEM of telephony system.

Voice Processing – voice codecs: G.711, G.729A, G.723.1, GSM, iLBC; echo cancellation: G.168 with 64ms echo tail; dynamic jitter buffer; voice activity detector (VAD)

Fax Processing – T.30, T.38 fax relay

DTMF – RFC 2833, SIP INFO, audio

Gateway Configuration – Web based user interface

Protocol – SIP (RFC3261, etc)

Standards – caller ID detection (FSK/DTMF), configurable call progress tone plan

Primary and Backup – the gateway can be configured and controlled in server clusters

FXS/FXO Connector – RJ-45

Ethernet Connector – Dual RJ-45, 10/100/1000

Power Input – 220V AC or - 48 VDC, should have dual AC/DC power supply

Operation Humidity – 10% to 90% (non-condensing)

Operation Temperature – 0 to 40°C

**PRI Gateway Specification:**

PRI gateway should have Configuration – 1 PRI / 2 PRI / 4 PRI (30 Channels / 60 Channels / 120 Channels) and should be from the same OEM of telephony system.

Voice Processing – G.711, G.729A, G.723.1, GSM, iLBC; echo cancellation: G.168 with 64ms echo tail; dynamic jitter buffer; VAD and CNG

Fax Relay – T.30 transparent mode, T.38 fax relay

Configuration Interface – Web Utility

PSTN – ISDN PRI standard: ANSI, NI-2, DMS, 5ESS

SIP – RFC3261, RFC2976, RFC3515, RFC3581

DTMF – tone detection generation and detection; DTMF relay: RFC2833, INFO (SIP)

T.30 and T.38

Ethernet – RJ-45, 10/100/1000 Base-T

Trunking Interface – RJ-45

Power Input – 220V AC or - 48 VDC, should have dual AC/DC power supply

Operation Humidity – 10% to 90% (non-condensing)

Operation Temperature – 0 to 40°C

**Integrated Voice Mail specification:**

The user should be able to review voice message from his phone, voice mail should support message wait indication

User should be able to listen to, delete, save, reply to, and forward through the phone

Should support below mentioned Unified Messaging Features:

Visual voice mail on soft phone - User should be able to play, save and delete the voice message from the soft phone.

Messages to email

**Integrated Voice Logger System (optional):**

Voice Logger should be fully integrated with Call manager application and should provide value added capabilities which optimize organization operational efficiency.

Voice logger should be from the same OEM of the Call Manager of IP telephony system.

Active Recording-

Should be based on SIP active recording, Voice Logger should enable recording of any endpoint and logical entity in the system. These include analog phones, digital phones, digital trunks, VoIP phones, SIP trunks and more. Should be Active recording and transparent to deployment and network topology. It should enable centralized recording and does not require any port mirroring.

Features:

Voice logger system with Diagnostics module should provide a comprehensive monitoring and alarm system, empowering the IT department to detect and manage any abnormalities that may occurs in the Recording System. Aeonix Logger Diagnostics supports notification via email, client notification and SNMP.

Search and Display - The voice logger should enable user to access and manage your voice recording files via a client or by using a web browser. It should also support monitoring agent’s screens and voice calls in real time.



**5.37. Technical Specification of Structured Cabling**

<b>Technical Specification for Structured Cable and Components:</b>	
1	<b>06 Core Fiber Cable (OFC)</b>
Type	6 core OS2 (9/125 micron) Single mode, Loose Tube water blocking jelly, two steel wire/ FRP Rods as strengthening component, Steel tape armouring, outdoor optical Fiber cable
Outer Jacket	HDPE (High Density Polyethylene)

<b>Technical Specification for Structured Cable and Components:</b>	
Strength Members,	Two Steel wire/ FRP Rods
Armouring	Corrugated Steel tape armouring
Moisture Protection	Waterproof Tape
Loose Tube construction	Water blocking Jelly
Loose Tube Diameter	2.3±0.2 mm
Cable Outer Diameter	8.5±0.5 mm
Tensile Load	2000 N as per IEC 60794-1-2-E1
Crush Load	4000N/100 mm as per IEC 60794-1-2-E3
Colour Code	ANSI/TIA/EIA-598-B
Max attenuation	<=0.34 dB per km@1310 nm, <= 0.20 dB per km@ 1550nm
Operating temperature	- 20°C to 60°C
Weight	90 kg/km (approx.).
Standard Compliance	ITU-T G.652.D Fiber, ISO/IEC 11801, ISO/IEC24702,
	ANSI/TIA/EIA 568C.3, IEEE 802.3z Gigabit Ethernet, ROHS compliant
Factory Test Report	Factory test report for each drum is mandatory along with the supply.
<b>2</b>	<b>LC Type 9/125µm OS2 Fiber Optic Simplex Pigtail</b>
Type	SC Single mode Pigtail
Fiber Type	Single mode OS2 as per ITU-T G.652.D

<b>Technical Specification for Structured Cable and Components:</b>	
Tight buffered	900µm
Jacket	Low Smoke Zero Halogen (LSZH)
Flame Test	IEC 60332-1
Other standard	LSZH IEC 60754, IEC 61034
Crush Load	800 N
Impact	0.2 Nm
Bend Radius	50mm (min)
Length	1.5 meter
Operating Temperature	-40°C to +85°C
Max attenuation	≤0.34 dB/km @ 1310 nm, ≤0.20 dB/km @ 1550 nm
Standard Compliance	ITU-T G.652.D OS2 Fiber, ISO/IEC 11801, EN50173 -1, ANSI
	TIA/EIA 568B
Factory test report	Factory test report is mandatory
3	<b>Patch Cord, LC, Duplex, SM, G657A2, PC, LSZH</b>
Type	SC-LC Duplex Type Patch Cord, 3 meters
Fiber Type	single mode OS2 as per ITU-T G.652.D
Jacket	Low Smoke Zero Halogen (LSZH)
Flame Test	IEC 60332-1
Other standard	LSZH IEC 60754, IEC 61034
Durability	500 cycles (0.2 dB max increase), 1000mate/demate cycles



<b>Technical Specification for Structured Cable and Components:</b>	
Operating Temp	-20 °C to +70°C
Ferrule Concentricity	< 1µm, Other Ferrule Concentricity < 1µm
Max attenuation	≤0.34 dB/km @ 1310 nm, ≤0.20 dB/km @ 1550 nm
Insert. Loss/Adaptor	0.2 dB Max. (0.15 dB typ.)
Pull strength	≥ 98 N
Standard Compliance	Telcordia (formerly Bellcore) GR-326-CORE, IEC 874-1, ANSI/TIA-568-C.3, ISO/IEC 11801 2nd Ed., CENELEC, EN
4	<b>Fiber Optic LIU Rack Mount LIU (12/24 Ports)</b>
Type	19” Easy Front Access (EFA) Sliding Rack Mount SC Duplex type
Material	Cold rolled carbon sheet steel with electrostatic spraying
Size	1U; Up to 24 SC Ports
Adaptor plate mounting	4 nos. of adaptor plate module can be accommodated
Environment Temperature - Relative	-40 °C to +80 °C
Intensity	≤15kv(DC) /1min.no spark-over and no flying arc
Fibre Bending Radius	≥40 mm
Clamps	Cable clamps on the inner surface for fixing cables.
Splice tray type	Fixed type Splice tray to access pigtails available
Lock	Lockable front door on front with push button

<b>Technical Specification for Structured Cable and Components:</b>	
Easy Front Access	Sliding patch panel for easy rework and maintenance.
Standard Compliance	EN 61587-1, Equipment - Tests for IEC 60917 and IEC 60297
	Climatic and Environment: EN 61587-1/4.2, IEC60068-2-1, IEC60068-2-2, IEC60068-2-30, Earth Bond: EN61587-1/6.2, Flammability: EN61587-1/6.3, RoHS
	Factory test report is mandatory
<b>5</b>	<b>12/16 Port LC/SC Type Adaptor Plates (Single mode)</b>
Type	SC Single mode Duplex Adapter
Sleeves	Phosphor Bronze
Adaptor Material	High Impart flame retardant thermoplastic UL94-V0
Capillary diameter tolerance	126 ± 0.5 µm (SM)
Operating Temperature	-40 °C to +75 °C
Mating durability	> 500 Mating Cycles
Insert. Loss/Adaptor	0.2 dB Max. (0.15 dB typ.)
Pull strength	≥ 98 N
Standard Compliance	IEC 61300-2-18, IEC 61300-2-19, IEC 61300-2-1, IEC 61300-2-2
	Factory test report is mandatory
<b>6</b>	<b>Cat 6A UTP Cable</b>
Type	Unshielded Twisted Pair, Category 6A, TIA / EIA 568-C.2 & ISO/IEC 11801

<b>Technical Specification for Structured Cable and Components:</b>	
Conductors	23 AWG solid bare copper
Insulation	High Density Polyethylene
Jacket	PVC
Pair Separator	Cross-member (+) fluted Spline
Operating temperature	-20°C to +60°C
Frequency	Tested up to Minimum 500 MHz
Packing Box	305 Meters/Box
Cable Outer Diameter	6.9 +/- 0.4 mm
Short Term Bend Radius	8 * Cable Diameter
Long Term Bend Radius	4 * Cable Diameter
Characteristic Impedance	100 Ohms + / - 6 ohms, 1 to 500 MHz
Capacitance	45 pF/m nom
DC Resistance	72 Ω/Km max.
Propagation Delay Skew	25 ns/100 Mtrs. MAX
Pulling Force	110 N/mm max
Standard Compliance	ANSI/TIA-568-C.2:2009 Category 6A
	ISO/IEC-11801, 2nd Edition Class EA
	IEC 61156-5:2002 Category 6A
Application	IEEE 802.3an :2006 (10GBASE-T)
Certification	UL, ETL Verified, ETL 4 Connector Channel Tested.

<b>Technical Specification for Structured Cable and Components:</b>	
	Test report to be submitted
<b>7</b>	<b>Cat 6A STP RJ 45 Keystone Jack</b>
Material	High Impact, Flame-Retardant Plastic Compound
Type	Category 6A
Insertion/Extraction life	750 cycle minimum
Jack Contact Material	50 $\mu$ Nickel over gold
Conductor Compatibility Range	22-26 AWG, Solid or Stranded
IDC Type	Dual (110 Or Krone) Type
Current rating	1.5A max
Insulation resistance	500 M ohm (min)@100 Vdc
Contact Resistance	20 M ohm (max) per contact
Retention	50N
Voltage rating	72 Vdc max.
Flammability Rating	UL 94V-0
Safety Rating	UL1863
Colour Coding	As Per 568 A/B Standards
Standards Compliance	TIA/EIA TSB155 (draft) Category 6A specifications and Class E channel requirements of 2nd edition. IEC 60603-7-5, ISO/IEC 11801 and CENELEC EN50173-1, the Cat 6A channel requirements of TIA/EIA-568-C.2-10

<b>Technical Specification for Structured Cable and Components:</b>	
Application	IEEE 802.af, IEEE 802.3at for PoE applications, The Modular Jack shall not require and Proprietary Termination Tool for termination of Cable.
	Should be UL Certified as per UL 1863
8	<b>Patch Cord, STP/UTP 4P, Cat.6A, length 1.0/ 2.0 m</b>
Cable Conductor	Stranded Bare Annealed Copper
Wire Insulation	HDPE
Jacket	Low Smoke Zero Halogen (LSZH)
Bend Radius	> 25 mm without load
Flame Test	IEC 60332-1
Gas Emissions testing	IEC 60754
Smoke Density Testing	IEC 61034
Conductor Resistance	< 73 $\Omega$ /km
Tensile Strength	96N min
Durability	1000 Mating Cycles
Propagation Delay	1-250MHz: < 25 ns/100m
Current rating	1.0A max
Insulation resistance	150 M ohm/km
Voltage rating	72 V DC
Contact resistance	20 m ohm (max) per contact
Length	1 & 2 meters

<b>Technical Specification for Structured Cable and Components:</b>	
Standards Compliance	ISO 11801 Class EA channel standards
	IEC 60603-7, ISO/IEC-11801, ANSI/TIA-968-A, ANSI/TIA-568-C.2 Category 6A
Application	IEEE 802.af and IEEE 802.3at for PoE applications IEEE 802.3an-2006
Certification	UL listed, ETL/NABL Lab verified
9	<b>19" 1U 24 port shielded Patch Panel</b>
Material	Powder Coated Steel
Ports	24 Port
Size	483mm X 44.2mm (1U)
Colour	Black
Mounting Style	Tool Less (Module)
Compatible	Compatible with both T568A and T568B wiring options.
	Backward compatible with Category 5e cabling standards
AWG Support	Supports solid 22-24 AWG wires and stranded 24-26 AWG
Connector Module Holder	High Impact, Flame-Retardant Plastic Compound
Flammability Rating	UL 94V-0
Safety Rating	UL1863
Identification	Each port of the panel is numbered and has a designated label area for clear port identification
Cable Management	Patch panel should be equipped with cable strain relief retention tray (Cable Support Bar) with slots to tie individual cable properly at the Support Bar

<b>Technical Specification for Structured Cable and Components:</b>	
Standards Compliance	ISO/ IEC 11281:2002, IEC 60603-7
	TIA-968-A (formerly FCC Part 68 Subpart F)
Application	IEEE 802.3an, IEEE 802.3af (PoE), IEEE 802.3at (PoE+)
Certification	UL listed
10	<b>Faceplate</b>
Type	Face plate
Ports	UK Style (Square) Keystone-Type Faceplates, Single port configurations, White Colour
Dimension	86 x 86mm
Identification	Button/tag for instant outlet identification, Elegant 2 Piece (2 Plate) design for better aesthetics
Material	High Impact Thermoplastic (ABS) UL94V-0 fire retardant
Colour	White or others as per request, Suitable for both Flush and Wall mount gang box
Standard Compliance	ANSI/TIA/EIA 568A-B.2
11	<b>Cat6A Shielded Field Termination Plug IP 20 grade outdoor type</b>
	SITC of Category 6A RJ45 Shielded Universal Modular Tooless Plug, ANSI/TIA/EIA 568-C.2 Category 6A, Min. 500Mhz, Min. 10Gbps, UL94-V0, Bend Limiting Boot for Cable, Operating Temperature -40 to + 70 DegC, Termination Without Proprietary Tool Termination, Re-Termination 200 cycles, Insulation Force 30N, Support IEEE 802.3bt 4PPoE upto 90Watts
	Suitable for 10GBASE-T applications up to 500 MHz as per Cat6A Standard

<b>Technical Specification for Structured Cable and Components:</b>	
	Should Accept 23-24 AWG Solid Conductors
	Should meet ANSI/TIA 568-C.2 Category 6A Standard Applications, Support IEEE 802.3bt 4PPoE upto 90Watts
	Should accept 5 to 8.0mm Diameter Cables
	Material: RoHS complied
	Material: PC UL 94V-2
	Industrial : IP 20 Rated
	Should be Universal suitable for both Shielded and Unshielded Cables.
	PCB Material : FR-4, UL 94V-0
	IDC Terminal : Phosphor bronze with Tin-plated
	Should have a Bend Limiting Removal Circular Boot for Cable with Retention strength of $\geq 7.5\text{kg}$ (between Jack and Plug)
	Operating Temperature : -40 to +70 °C
	Clamp/Re-Termination $\geq 200$ Cycles
	The Modular Plug shall not require any Proprietary Termination Tool for termination of Cable. It should be Tool Less termination.
12	<b>Slim Patch Cord, STP 4P, 30 AWG, Cat.6A, length 1.0/ 2.0 m</b>
	Standardization: ANSI/TIA-568-2.D Conform to ANSI/TIA-568-C.2, ISO/IEC 11801 2.1 edition and CENELEC EN50173 (2007) for Category 6A/CLASS EA standards
	Cable shield: UTP
	Number of conductors : 8
	Polyester Aluminum foil on each pair along with Braid shield
	Gold-Plated Copper Contacts Provide Corrosion Resistance and



<b>Technical Specification for Structured Cable and Components:</b>	
	Signal Conductivity
	Basic Wires: Conductor: Eight wires stranded bare copper, 7 x 0.10mm (30 AWG). Insulation: foam skin, polyolefin, 0.68±0.02mm OD.
	Shield: Overall Braid Shield
	Overall Diameter: 4.5 ± 0.2 mm max..
	Outer Sheath: LSZH – IEC-60332-1
	Electrical: DC Resistance: Max. 376 Ω/km at 20°C Resistance Unbalance: 2% max. at 20°C Mutual Capacitance: 43 pF/m nominal at 1 KHz Voltage Rating: 30 V rms Dielectric Strength: 500 VAC/one minute mean (wire to wire) Dielectric Withstanding: 1000 volts RMS, 1 min. (60Hz) Insulation Resistance: 500 mega-Ohms Current/Voltage Rating: 1.5 Amps, 30 VAC / 56 VDC
	Storage & Operating Temperature: -20°C to 60°C & -10°C to 50°C
	Plug Housing: PC Resin UL-94V2
	Contacts: High grade copper alloy
	Plating: 50 micro-inch (1.27 micro-meter) gold
	RoHS Complied

#### **Technical Specification of IP-PBX System**

<b>S.No.</b>	<b>Description</b>
	<b>IP Telephony System Architecture:</b>
	The IP telephony system must be based on a pure IP technology that is a software-only solution.
	The IP telephony system must support unified communication (UC) server & gateways architecture for SIP, Digital and Analog trunks connectivity.
	The system must be capable of supporting Analog, Digital, IP Telephones, and

S.No.	Description
	SIP based video desk phones.
	The communication servers must work in an Active-Active redundancy mode. It should be possible to define servers load balancing mode. All servers should work together in load balancing mode with defined user capacity i.e. all servers should be active with call processing with at least 50% SIP phones and gateways register on any of the server for load distribution. If any Server Fails in the Cluster adjacent server should automatically take the load of the failed sever along with load of gateway and end points without breaking on-going calls.
	All servers must be provided in a cluster mode. If one cluster server fails, one of the other cluster servers in the network must be able to take the complete load of the calls automatically (without any manual intervention) and without dropping any existing calls (IP, TDM & PRI) or data (CDR, CTI). Management of all servers in cluster should be from same web page. All servers should have same database.
	The telephony system must be able to register SIP phones/SIP video phones and MGCP phones directly to it.
	System should work on Geographically distributed Architecture
	It should be possible to install Telephony system in VMware EXSi 5.5 or higher.
	All Data (Numbers, COS, Routing, Applications) should reside in all the Servers
	Database replication in All servers should be automatic and real time
	Should support N+1 Redundancy Architecture as well as 1+1 redundancy Architecture
	Should support Remote Survival Nodes
	In case of failure of one server, the SIP Phones, SIP Gateways, MGCP Phones should register with second Server automatically
	System Diagnostics should be done in Server
	Hot Standby for SIP Phones and Gateways i.e. SIP Phones and Gateways should register automatically to next available telephony server.

S.No.	Description
	COTS - commercial off-the-shelf Servers should be used for telephony system. OEM made or proprietary made servers will not be accepted.
	Telephony system should use Linux Operating System
	System should support CSTA phase III Protocol
	Full continuation for call signalling and media must be supported
	Calls must not be disconnected, and control must remain throughout the swap to an alternate server including full call control (transfer, conference actions, continuation of CDR data for the existing call).
	Load Balancing of end points must be possible by the administrator
	There must be no restriction on the number of endpoints being backed up in case of one server failure.
	UC platform servers must provide full failover and redundancy
	The tenderer must submit valid latest Type test TEC certificate issued by Telecommunication Engineering Centre, MOC, GOI as per GR approvals tested with IPv4 & IPv6 for both SIP terminals and SIP Trunks from days 1 for the particular model of Server & Media Gateway system quoted and the same must be issued in the name of manufacturer/ any dealer of OEM / Bidder. Notarised copy of the same is required to submit along with the technical bid. Notarised hard copy of the same is to be submitted for verification at the time of technical bid opening. The TEC-GR type approvals to be available with bidder at the time of publish of this tender. TEC-GR applied/ E-mail confirmation/Later submission will not be allowed.
	Hardware of the offered IP Telephony Exchange of server – Gateway architecture with redundancy system should be from OEM, Hardware of Chinese/ ROC (Republic of China)/Countries taking ant India movements are not allowed quote. Call Manager Software, IP/SIP Phones, Media Gateways, Call Billing and accounting software, Auto attendance, Help Desk and voice mail should be preferably from the same OEM of IP Telephony Exchange. No Third-party solution from Chinese/ ROC (Republic of China)/ Countries taking ant India movements are allowed.
System should support	SIP: Session Initiation Protocol

S.No.	Description
Scalability	The system must be scalable to at least 25,000 endpoints in single cluster architecture.
	The call signalling server must handle traffic at a minimum of 100K BHCC.
System Survivability	The UC platform must consist of one or many servers where each server in the cluster provides complete 100% application functionality.
	The life cycle of the entire system being provided must be at least Ten (10) years.
Distributed Architecture	The UC platform must have distributed architecture and centralized control for all the sites in the network.
	The proposed solution must support Hybrid cloud solution in order to guarantee business continuity with overall survivability regardless of a failure at any single location.
	The proposed solution must enable part of the cluster to be hosted in a Cloud Service Provider (CSP) to run all applications.
Quality of Service (QOS)	The voice and signalling frames must be marked [tagged] in order to be recognized.
	COTS – Commercial Off-the-Shelf servers must be used.
	The redundant server must have separate hardware, not sharing elements like hard drives and RAM etc., to avoid a single point of failure.
	The server should have AC power supply.
	The system must be based on server gateway architecture with external appliance servers
	No card-based processor systems / soft switch should be quoted.
	The call processor must run on Linux OS.
Minimum Server Specifications:	The CPU must be from the Intel® Xeon® processor
	The server must have at least 8GB RAM
	The server must have Hard Drives (300GB each) of storage

S.No.	Description
	The server must have a Dual 1GB network interface.
	Form Factor for physical server (Not Virtual Machine) should be 1 U
VoIP Media Gateways	The VoIP media gateways shall be capable of being centrally managed via the telephony management application. The system should support multiple gateways.
	The system gateway should be able to restart automatically without human intervention when the external ac power supply is resumed after complete power failure
System Security	Administration of the system should be using HTTPS
	It should support the Interop with leading SBC
	System should use TLS (Transport Layer protocol) to encrypt SIP, HTTP, FTP and SRTP (Secure Real-time Transport Protocol) and SRTCP to encrypt RTP and RTCP
	System Audit Logs for 30 days
	Certificate management
	System should have auto Provisioning profiles contain pre-configured sets of features that must automatically polls and updates registered phones with the latest phone firmware and configuration files.
Mobility	The system should have Call Back feature. If the user dials his own extension from predefined number (mobile/landline) then system should disconnect the call and then system should call the user to provide the dial tone so that user can make intercom or PSTN calls.
	The system should have Call Through feature. If the user dials his own extension from predefined number, then system should provide dial tone to make intercom or o/g calls.
SIP Endpoints	All SIP phones must support the standard SIP protocol. No proprietary protocols are allowed to be used.
Automatic Call Distribution	Busy ACD Group announcement
	Hunt Group Release

S.No.	Description
(ACD)	<p>IVR-ACD</p> <p>Log In / Log Out</p> <p>Multiple Announcements:</p> <ol style="list-style-type: none"> <li>1. Mandatory announcement - All incoming callers to an ACD/HUNT group must be able to hear an introductory announcement in its entirety usually explaining about the company, product, or campaign.</li> <li>2. First announcement - If all agents are busy, callers must be able to hear this announcement once usually informing them that their call has been placed in queue. (The system must be able to cut short this announcement if an agent becomes available to attend to the caller.)</li> <li>3. Music - If no agents are available after the first announcement (or no First and Periodic announcers have been configured), the caller must be able to hear background music while in queue.</li> <li>4. Periodic announcement - Alternating with background music, these announcements can also be played to callers in queue according to the Periodic Announcement Interval (see above) until the ACD/HUNT call is answered.</li> </ol> <p>Release / Resume</p> <p>Wait Queue</p> <p>Wrap-Up Time</p> <p>Automatic Release of ACD Agent</p> <p>Automatic Call Distribution (ACD) Extended Overflow</p>
Zone Page	<p>A phone user must be able to simultaneously broadcast a message over all types of endpoints.</p> <p>The maximum quantity of endpoints in one zone should not be less than 100.</p>
System Administration	<p>System administration should be web based.</p> <p>All programming of system should be done through a web-based GUI interface.</p>

S.No.	Description
	<p>The administrator should have Dynamic Profiles.</p> <p>The system should allow for complete multi-level administration. The administrator must be able to define at least five (5) different administration level profiles that can be applied to allow subsets of users to access and manage particular pages in the systems Web Portal</p>
Certification Requirements	<p>1. The OEM must comply with ISO 9001 certification in all the company's activities.</p> <p>2. The products must comply with Safety and EMC standards like FCC, UL/TUV, CE, RoHS directive.</p>
Extension Features	<p>Answer Call Waiting by Transfer</p> <p>Auto Set Relocate</p> <p>Auto-Answer</p> <p>Automatic Disconnect</p> <p>Automatic Number Identification (ANI) Display</p> <p>Browse Personal Directory</p> <p>Busy Lamp Field</p> <p>Call Forward All</p> <p>Call Hold</p> <p>Call Log</p> <p>Call Parking and Call Pickup</p> <p>Call Waiting</p> <p>Caller ID Control</p> <p>Caller-ID Screening</p> <p>Caller id-based routing for individual extension</p>

S.No.	Description
	Calling Number and Name
	Camp-on Idle
	Configurable DSS Buttons
	Direct Dial without Off Hook (Hands Free)
	Directed Call Pickup
	Display Automatic Number Identification (ANI)
	Display Dialed Number and Name
	Display Dynamic Call Divert Information
	Display Select Hold Display
	Display Time/Date Function
	Do Not Disturb (DND)
	DSS/BLF
	Elapsed Time Display
	Group Call Pickup
	Hands Free
	Hands-Free Announce and Reply (Idle State)
	Last Number Redial
	Login and Logout
	Message Waiting Indication
	Multi Appearance (Call Waiting)
	Multiple Line Appearance
	On-Hook Dialling



S.No.	Description
	Placing Multiple Calls on Hold
	Privacy – ANI Restriction
	Reminder/wakeup Call
	Restrictions – Station
	System Non-Exclusive Hold
	Transfer with Consultation
	Transfer without Consultation (Blind)
	Voice Page
	Emergency Pre-emption
	Listen to Paging while in a call (Busy Condition)
	ULA - User Line Appearance (ULA)
Emergency Response communication / Emergency Conference Communication for code blue	<p>The Emergency communication resource should be from the same telephony server and have the facility to automatic dial out to connect up to 100 participants in a single conference. System should also have 100 party managed meet me conference. It should be possible to further divide 100 party conference bridge into any combination like 10 X 10 party, 5 x 20 party etc. if required. The meet me conference should be secured means to enter to the conference bridge; the user should enter the password.</p>
	<p>The emergency communication management should be from Web Browser/HTML5 based GUI based interface from Windows PC and Touchscreen Devices if required in future.</p>
	<p>It should have the ability to create an alarm and view the video (of the location) from a camera to the Dispatcher screen supporting Media Server.</p>
	<p>It should have the ability to view video using streaming with HTML5.</p>
	<p>It should have the ability to view video using Adobe Flash Player</p>
Specification of	SIP phone should be from the same OEM of IP telephony system

S.No.	Description
DESKTOP PHONE Type1	<p>120x40-pixel or more, graphical LCD with backlight</p> <p>2 VoIP accounts</p> <p>Local phonebook up to 100 entries</p> <p>Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment</p> <p>SRTP/ HTTPS/ TLS</p> <p>PoE, Headset, Wall-Mountable</p> <p>Volume adjustment, ring tone selection</p> <p>Voicemail, MWI</p> <p>Call Park, call pickup</p> <p>codec: G.711, G.726, G.729AB, G.722, iLBC, Opus</p> <p>Transport Layer Security (TLS)</p> <p>LED for call and message waiting indication</p> <p>2xRJ45 10/100/1000 M Ethernet ports</p> <p>Power over Ethernet</p>
Specification of SIP PHONE- Type2	<p>SIP phone should be from the same OEM of IP telephony system</p> <p>3.4" or more, 480 x 272-pixel colour display with backlight</p> <p>4 VoIP accounts</p> <p>10 one touch key with LED indication, key programming should be from IP PBX web management</p> <p>Local phonebook up to 100 entries</p> <p>Auto provision via FTP/TFTP/HTTP/HTTPS for mass deployment</p> <p>SRTP/ HTTPS/ TLS, 802.1x</p> <p>PoE, Headset, Wall-Mountable</p>

S.No.	Description
	Volume adjustment, ring tone selection
	Voicemail, MWI
	Call Park, call pickup
	Codec: G.711, G.723.1, G.726, G.729AB, G.722, Opus
	VAD, CNG, AEC, PLC
	Transport Layer Security (TLS)
	LED for call and message waiting indication
	2xRJ45 10/100/1000 M Ethernet ports
	Power over Ethernet

#### Technical Specification of Core Switch

Item	Technical Specifications
Type	Modular Or Fixed Configuration Switch & in case of modular switch, at least 6 service slots other than control card slots
Ports	24 ports (SFP+ slots) with 10 Gbps speed populated with 16 nos. of 10G single mode SFP modules, should be provided on the dedicated card in case of modular switch
	12 x 10/100/1000 BaseT RJ 45 ports. Should be provided on the dedicated card (separate from 10G card) in case of modular switch.
	04 x 40G/100G SFP slots populated with 04 nos. of 40G single mode QSFP modules, should be distributed across the cards to have redundancy in case of modular switch.
Switching capacity	For Modular switch, Aggregate capacity of 6 Tbps or more and performance of minimum of 4 Bpps applicable in case of Modular switch. For Fixed configuration switch, non-blocking architecture & wire-speed performance under fully loaded condition should be provided.
Per slot bandwidth	480 Gbps full duplex (applicable for modular switch configuration only)
Architecture	For modular switch configuration, Switch should have a Truly Distributed Architecture. All Interface Modules should have all the

Item	Technical Specifications
	resources for switching and Routing and should offer True Local Processing.
	For modular switch configuration, the chassis should be ready with all fabric cards (max supported) to provide full throughput of the System from day 1.
	Redundant CPU (applicable for modular switch), Redundant Switch Fabric (applicable for modular switch) and Redundant Power Supplies from Day 1
	Fully decoupled control plane and data plane (applicable for modular switch)
	Support for 40G and 100G ports from Day 1
High Availability features	There should not be any single point of failure in the switch. All the main components like power supplies and fans etc should be in redundant configuration. Components, like power supplies/fan tray should be Hot Swappable
	Support for Hot Swap of all redundant components: For modular switch Line Cards, Fabric, power supply, and fan trays & for fixed configuration switch power supply, and fan trays
Memory	16 GB DRAM
Layer 2 features	Should support Industry Standard Port/Link Aggregation for All Ports. Also in modular switch, Cross Module Link aggregation should be supported
	Jumbo Frames support up to 9K Bytes
	Should support port, subnet based 802.1Q VLANs. The switch should support 4,000 vlans
	The switch should support min.160K MAC addresses.
	The switch should support IEEE 802.1w RSTP and IEEE 802.1s MSTP, G.8032 ERPS, MLAG
Routing Protocols	Should support RIP v1/v2, OSPF v1/v2, Policy based routing from Day 1
	Should support BGPv4, IS-IS
	Should support IPv6 packet switching and routing using OSPFv3, RIPng from day 1.
	Should support minimum 100K Route entries for IPv4 and 100k for IPv6
Security features	Should support Access Control Lists

Item	Technical Specifications
	Should support various type of ACLs like port based/vlan based.
	Should support integrated security features like DHCP relay with option-82, Dynamic Arp Inspection
	Should Support MAC Address Filtering based on source and destination address
	Should have support for RADIUS and TACACS+
	The switch should support Port-security.
Network protocols	Should Support VRRPv1v2 or equivalent standard based Protocol from Day 1
Traffic policing	Should support Ingress/Egress Queuing
	Should be able to filter, mark and limit traffic flows
	Should support minimum 8 queues per port
	Should support policy based traffic classification based on Type of Service (ToS), IP Precedence mapping, Layer 2/3/4 defined traffic flows, MAC address, VLANs
Multicast	Should support IPv4 and IPv6 Multicasting
	Should Support IGMP v1, v2 , v3, IGMP Snooping
	Should support 1K IPv4/IPv6 multicast routes
	Should support Protocol Independent Multicast - Sparse Mode and PIM - SSM, MSDP
Network monitoring /management	Switch should be manageable through NMS on per port/switch basis with common interface for all manageable devices on the network. Should Support SNMP, RMON/RMON-II, SSH, telnet, web management through network management software.
	Should support port mirroring feature for monitoring network traffic.
	The switch should support access control to limit access to switch operations.
IEEE Standards	IEEE 802.1AB
	IEEE 802.1D
	IEEE 802.1p
	IEEE 802.1Q
	IEEE 802.1s
	IEEE 802.1w

Item	Technical Specifications
	IEEE 802.3ac
	IEEE 802.3ba
	IEEE 802.3ah
	IEEE 802.1AX
	IEEE 802.1x
Certifications	CE, FCC

#### Technical Specification of Access PoE Switch

S. No.	Detailed Technical Specifications
Port Density	24 X 1G RJ-45 PoE+ Ports with minimum 370W power budget
	4 x 1G/10G SFP+ Ports and 2 x 10G copper ports upgradable to 2 x 10G SFP+ Ports
Power Supply	Internal Power Supply
Virtual Chassis/ Stacking Option	Up to 8 Switches or more
RAM	1 GB or better
Flash	256 MB or better
Switching Capacity and forwarding Rate	168 Gbps or better and 125 million pps switching throughput
Latency & MTBF	Latency: < 4 $\mu$ s
	MTBF: 279,418 Hours
Layer 2 Features	Mac Address:16K or more
	VLAN: 4K or more
	Max Jumbo Frame: 9K
	Layer 2 Multicast 1024 IGMP groups
Quality of Service	Priority Queues: Eight hardware-based

S. No.	Detailed Technical Specifications
	queues per port, SPQ, WRR, IP precedence/DSCP, Time based QoS, CoS based on Switch port, MAC address, IP address, DSCP
Protocol Support	Static Routing, MSTP, RSTP, LACP, IGMPv3, DHCP, DHCP82, DHCP Relay for IPv4/IPv6, ARP, IPv6 ND Entries:1024
	128 Static ND Entries,
	IP Interface- Supports 128 interfaces,
	VRRP v2/v3
Management	Loopback IP address support for management per service, , Port Mirroring- One-to-one mirror, Many-to-one mirror, Mirroring based on Tx/Rx , Remote Monitoring (RMON), Unidirectional Link Detection (UDLD), Digital Diagnostic Monitoring (DDM), LLDP-MED, NTP , SNMP, sflow or equivalent
Security	MAC-based authentication for non-IEEE 802.1X hosts, MAC address lockdown, , Web based Authentication, Autosensing IEEE 802.1X RFC 1321 MD5, RFC 2284 PPP EAP, ARP Spoofing Prevention, Double VLAN (Q-in-Q)
	Port-based Q-in-Q
	Selective Q-in-Q,
	Extensible Authentication Protocol (EAP)-RFC1321, RFC2284, RFC2865, RFC2716, RFC1759, RFC3580, RFC3748
Resiliency	IEEE 802.3ad/802.1AX Link Aggregation
	Control Protocol (LACP)
Operating Temperature and Humidity	Operation Temperature-0 to 50 °C
	Operating Humidity-10% to 90% RH
Safety Certifications	Emission (EMI)- FCC Class A, CE Class A
	VCCI Class A, IC, RCM, BSMI.
	Safety- CB, cUL, BSMI
SFP	SFP should be of same make as switch.
	The Switch shall work with on-premises NMS without change in hardware/software/OS Image.

S. No.	Detailed Technical Specifications
OEM Criteria	5 Years from OEM with Toll free number for support in India Software upgrades/updates shall be included as part of the warranty

### 5.38. D II ACTIVE ICT (ACCESS CONTROL, DISPLAY, IP BASED CCTV CAMERA & TELEPHONE)

#### Technical Specification of Dome Camera

S.No	Features	Specifications
1	Image Sensor	1/2.7" CMOS Progressive
2	Lens Type	2.8 mm Fixed
3	Resolution	2304 x 1296
4	Minimum Illumination	0.005 Lux / F1.6 (Color,30 IRE), 0 Lux / F1.6 (IR ON)
5	IR Distance	Min 40 Mtr
6	Electronic Shutter Speed	1/8 ~ 1/32,000
7	Day/Night	Auto (ICR) / Color / BW
8	Noise Reduction	2D / 3D DNR
9	Backlight Compensation	120 dB WDR, BLC, HLC
10	Edge Base Storage	optional Micro SD (up to 256 GB)
11	Event	Video motion detection, Recording notification
12	Audio	Optional
13	Video Compression	H.265
14	Video Streaming	Triple
15	Supported Protocols	IPv4, IPv6, TCP / IP/ Kc, HTTP, HTTPS, RTSP / RTP / RTCP, IGMP /
16		Multicast, SMTP, DHCP, NTP, DNS, QoS, SNMP, 802.1X, UDP, ICMP,



S.No	Features	Specifications
17		ARP, TLS
18	Compatibility	ONVIF Profile S, G, T
19	Operating Temperature	-40°C ~ 60°C (-40°F ~ 140°F)
20	Relative Humidity	Less than 90%, non-condensing
21	Cyber Security	User account and password protection, HTTPS, IP Filter, Digest authentication, TLS1.2 only, Stream encryption, AES128 / 256, SSH / Telnet closed, PCI-DSS compliance
22	Analytics	Motion Detection, Tampering
23	Housing	IP67, IK10, Die-cast aluminum housing
24	Power Supply	DC12V, PoE (IEEE 802.3af) (Class 0)
25	Certificates	Emissions- FCC,
26		Immunity-CE,
27		Safety-UL, Rohs- CE (EN 63000), BIS

#### Technical Specification of Bullet Camera

S.No	Features	Specifications
1	Form Factor	Bullet
2	Certification	UL,CE,FCC,ROHS
3	Housing	IP 67 and IK 10 or better
4	System Compatibility	ONVIF profile S , G & T
5	Max Resolution	3 MP
6	lens	2.7mm to 13 mm motorized varifocal length

S.No	Features	Specifications
7	Focus	Auto focus
8	Image sensor	1/2.7" or larger
9	H-FOV	H: 84°~25°, V:46°~14°
10	Min illumination	0.005 Lux/F1.6 (Color,30 IRE), 0 Lux/ F1.6 (IR ON)
11	Shutter speed	1/8 ~ 1/32,000
12	Video compression	H.265
13	Video bit rate	(15K~2 Mbps for encryption)
14	Noise reduction	2D / 3D DNR
15	Video Streams	Triple stream
16	IP filter	OPTIONAL
17	Frame rate	Main stream upto 3MP@30fps
18	ROI	Should Support ROI for Better bandwidth consumption
19	BLC	Support
20	Day & Night	IR cut filter with auto switch
21	Day / Night Switch	Auto / Schedule / Triggered by Alarm In
22	Edge analytics	Motion Detection, Temper Detection,
23	Image setting	Flip/Rotation/Corridormode/Saturation/Brightness/Contrast/Hue/Sharpness adjustable
24	Rotate Mode	Yes
25	WDR	120 dB WDR
26	Alarm	Optional
27	Audio	Optional

S.No	Features	Specifications
28	SD Card support	Up to 128 GB
29	Protocols	IPv4, IPv6, TCP / IP/KC, HTTP, HTTPS, UPnP, RTSP / RTP / RTCP, IGMP / Multicast, SMTP, DHCP, NTP, DNS, DDNS, QoS, SNMP, 802.1X, UDP, ICMP, ARP, TLS
30	Video output	Optional
31	Reset button	Available
32	Security	User account and password protection, HTTPS, IP Filter, Digest authentication, TLS1.2 only, Stream encryption, AES128 / 256, SSH , Telnet closed
33	Digital Zoom	Support
34	Factory Default	Support
35	Privacy Zones	Min 4 Nos of selectable privacy Zones
36	User accounts	Should support 10 user accounts
37	Firmware upgrade	Firmware upgrade shall be done through web browser
38	Remote Update	Camera IP and firmware should be upgradable through the device search tool/Software without directly logging in to the camera. Firmware should also be upgradable through web browser
39	Defog	Should support Defog mode
40	IR Distance	Min IR distance 60 meters
41	Operating Temperature	-30°C ~ 60°C Humidity 90% or less (non-condensing)

#### Technical Specification of PTZ Camera

S.No	Features	Specifications
	Parameter	Value
a.	Image Sensor	1/1.8" CMOS

S.No	Features	Specifications
b.	RAM	1GB
c.	Flash	512 MB
d.	Optical Zoom	40X
e.	Lens	5.3 mm ~ 212 mm, F1.5 ~ F4.8, DC Iris
f.	Resolution	2592×1520
g.	PAN travel	360° endless
h.	Tilt Angle	-10° to 90° Auto flip 180°
i.	Manual Speed	0.01° ~ 300°/s
j.	Preset	400
k.	Auto Tracking	Supported
l.	FPS	(1920 x 1080) 50/60 fps
m.	Minimum Illumination	Color: 0.005 lux @ F1.6 BW: 0 lux @ F1.6 (IR on
n.	IR Distance	450 Mtr
o.	Electronic Shutter Speed	1/1 to 1/30,000 sec
p.	Day/Night	Auto/Day/Night/Timing
q.	Noise Reduction	3D DNR
r.	WDR	140 dB
s.	Defog	Supported
t.	Edge Base Storage	Support for micro-SD up to 1 TB
u.	Iris	DC-Iris
v.	Audio	In/Out, Full Duplex
w.	Video Compression	H.265 HEVC, H.264

S.No	Features	Specifications
x.	Video Streaming	Triple streaming
y.	Supported Protocols	IPv4, IPv6, TCP/IP, HTTP, HTTPS, UPnP, RTSP/RTP/RTCP,
z.		IGMP, SMTP, DHCP, NTP, DNS, DDNS, QoS, SNMP, 802.1X,
aa.		UDP, ICMP, ARP, TLS
ab.	Cyber Security	Software: Firmware encrypted & signed, SD card encryption,
ac.		User account and password protection, HTTPS, IP Filter,
		Digest authentication, TLS1.2 only, Stream encryption,
		AES128/256, SSH/Telnet closed, PCIDSS compliance & attestation
		Hardware: Secure boot, Secure authentication chipset built-in
	Standards	ONVIF G/S/T/M (Model Should be found in Onvif.org)
	Operational Temperature (Industrial Grade)	-40 °C ~ 70 °C
	Relative Humidity	Less than 90%, non-condensing
	Ingression Protection	IP67, IK10
	Bit Rates	100K~12Mbps
	Power Supply	AC24V, PoE++ (802.3 BT), Max 45 Watt
	Certificates	Emissions- FCC,
		Immunity-CE,
		Safety-UL, RoHs- CE (EN 63000), BIS
	Housing	Aluminum Body
	Built in heater & wiper	Only Heater

S.No	Features	Specifications
	Analytics	Motion detection, Smart motion, Tampering, Intrusion, Multi
		loitering, People counter, Tripwire, abandoned object, Missing
		object, Audio detection
	Warranty	5 years

### Technical Specification of 32 Channel NVR

S.No	Features	Specifications
1	NVR	32 Channel NVR
2	Recording bandwidth	Max 640Mbps
3	Recording Resolution	8MP (4K), 5MP, 3MP ,2MP(1080P) ,1.3MP (960P), 1.0MP (720P)
4	Display Split	1/4/6/8/9/10/13/14/16/17/19/22/25/32/36/64
5	live/Playback performance	4K: 4ch realtime , 4MP: 8ch realtime, 3MP: 10ch realtime , 2MP: 16ch realtime
6	Playback	Max 8ch playback
7	Output Interface	1 HDMI (up to 4K), 1 VGA
8	Display Resolution	1024*768, 1280*720, 1280*1024, 1440*900, 1920*1080, 2560*1440, 3840*2160
9	Alarm Input/out	16ch in / 4ch out
10	Ethernet	RJ-45 port (1000M)
11	Smart Phone	iOS, Android
12	Internal HDD	8 SATA HDDs, each HDD up to 8TB support RAID 0/1/3/5/10/JBOD/CLONE
13	RS485	1 X RS485
14	e-SATA	1 X e-SATA
15	Line in	1 X Line in
16	USB	1x3.0 USB for backup/upgrade, 2x 2.0 USB for mouse
17	Support AI with deep learning supported	10000 AI-Registered quantity

S.No	Features	Specifications
	cameras.AI-Registered quantity	
18	AI-Maximum captured quantity with deep learning supported cameras	200,000 faces
19	ONVIF	ONVIF Compliant
20	Power Supply	AC 110~240V
21	Certification	UL,CE,FCC

#### Technical Specification of 8 Port Industrial PoE Switch

S.NO	Parameters	Specifications
1	Port Density	8 X 1G RJ-45 PoE Ports with 130W Power Budget and Fan less Architecture 2 x 1G SFP Uplink Ports
2	Power Supply	Internal Power Supply
3	RAM	DRAM Size- DDR3 128MB
4	Flash	Flash Memory Size- 32MB
5	Switching Capacity and forwarding Rate	Switching Capacity- 20 Gbps, Packet Forwarding Rate- 14.88 Mpps
6	Latency & MTBF	MTBF- 1,274,005 hours
7	Layer 2 Features	Mac Address: 8K VLAN: 4K or more Max Jumbo Frame: 10,000 bytes Layer 2 Multicast 256 IGMP groups

S.NO	Parameters	Specifications
8	Quality of Service	Priority Queues: Eight hardware-based queues per port, SPQ, WRR QoS based on 802.1p priority queues, DSCP, MAC address, EtherType, address, Protocol type, ToS IP preference, IPv6 Traffic Class, TCP/UDP port
9	Protocol Support	Static Routing, MSTP, RSTP, , LACP, IGMPv3, DHCP, DHCP82,DHCP Rel for IPv4/IPv6, Static routing: 124 IPv4 static route entries 50 IPv6 static route entries, Supports 4 interfaces, IPv6 Neighbor Discovery (ND)
10	Management	Policy- and port-based mirroring, LLDP-MED, SNMP, Port Mirroring- One-to-one mirror, Many-to-one mirror, Mirroring based Tx/Rx, Support RMONv1, SNTP DoS attack prevention 802.1X Port-based Access Control Port Security
11	Security	MAC-based authentication for non-IEEE 802.1X hosts, MAC address lockdown, Prevention from ARP attacks, Web based Authentication, Traffic segmentation SSH v2 TLS v.1.2 DHCP Server Screening IP-MAC-Port Binding (Smart Binding) ARP Inspection DHCP Snooping
12	Resiliency	802.3ad Link Aggregation: IGMP Snooping IGMP v1/v2 Snooping, IGMP v3 awareness Supports 256 IGMP groups, Supports at least 64 static multicast addresses IGMP per VLAN. Supports IGMP Snooping Querier LLDP-MED, Jumbo Frame- Up to 10,000 bytes Spanning Tree Protocol 802.1D STP, 802.1W RSTP, 802.1s MSTP



S.NO	Parameters	Specifications
		Flow Control: 802.3x Flow Control HOL Blocking Prevention Port Mirroring One-to-One, Many-to-One Supports Mirroring for Tx/Rx/Both
13	Operating Temperature and Humidity	Operating Temperature- 5 to 50°C , Operating Humidity- 0% to 95%
14	Safety Certifications	EMI: CE Class A, VCCI Class A, FCC Class A, BSMI, CCC Safety: CB, UL, BSMI, CCC
15	SFP	SFP should be of same make as switch. The Switch shall work with on-premises NMS without change in hardware/software/OS Image.
16		5 Years from OEM with Toll free number for support in India

### 5.39. E TESTING & COMMISSIONING

#### General

The testing and commissioning for all electrical equipment at site shall be according to the procedure laid down below.

- All electrical equipment shall be installed, tested and commissioned in accordance with the latest relevant standards and codes of practices published by Indian standards, institution wherever applicable and stipulations made in relevant general specifications.
- The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. The inspection of the equipment shall be carried out to ensure that all materials, workmanship and installation conform to the accepted construction standards, as well as accepted codes of practice and stipulations made in the relevant general specifications.
- The Contractor using his own instruments, testing equipment as well as qualified testing personnel shall carry out all tests.

- The results of all tests shall be conform to the specification requirements as well as any specific performance data guaranteed during finalization of the contract.

#### General

- At the completion of the work, the entire installation shall be subject to the following tests in presence of ClientEmployer/PMC/Consultant.
  - Wiring Continuity Test
  - Insulation Resistance Test
  - Earth Continuity Test
  - Earth Resistivity Test

#### **Preparation of the Electrical System for Commissioning**

- After completion of the installation at site and for the preparation of Electrical system commissioning, the Contractor shall carry out check and testing of all equipment and installation in accordance with the agreed standards, codes of practice of Indian Standards Institution and specific instructions furnished by the particular equipment suppliers.
- Checking required to be made on all equipment and installations at site shall comprise, but not be limited, to the following:
- The following checks shall be made on all equipment and installation at site:
  - Physical inspection for removal of any foreign bodies, external defects, such as damaged insulators, loose connecting bolts, loose foundation bolts etc.
  - Check for grease, insulating/lubricating oil leakage and its proper quantity.
  - Check for the free movement of mechanism for the circuit breakers, rotating part of the rotating machines and devices.
  - Check for tightness of all - cable, bus bars at termination/joints ends as well as earth connections in the main earthing network.
  - Check for Clearance of live bus bars and connectors from the metal enclosure.
  - Check the proper alignment of all draw out device like draw out type circuit breakers.
  - Continuity checks in case of power cables.

- Checking of all mechanical and electrical interlocks including tripping of breakers using manual operation of relay.
- Checking of alarm and annunciation circuits by manual actuation of relevant relays.
- Check and calibrate devices requiring field adjustment/ calibration like adjustment of relay settings etc.,
- Check proper connection to earth network of all non-current carrying parts of the equipment and installation.
- Test reports for all meters are to be furnished.
- These tests shall be carried out on the equipment shall include but not be limited to the above.

### **Cables**

Insulation resistance test with 2,500V megger for high voltage power cables rated above 1.1KV grade and 1,000V megger for cables rated up to 1.1KV grade.

All cables of 1.1KV and all H.V. cables shall be subjected to high voltage test after joining and terminating but before commissioning as per relevant standards.

In each test, the metallic sheath/screen/armour should be connected to earth.

Continuity of all the cores, correctness of all connections as per wiring diagram, correctness of polarity and phase of power cables and proper earth connection of cable glands, cable boxes, armour and metallic sheath, shall be checked.

### **Earthing System**

1. Tests to ensure continuity of all earth connections.
2. Tests to obtain earth resistance of the complete network by using earth tester. The test values obtained shall be within the limits.
3. All documents / records regarding test data, oscillographs and other measured values of important parameters finalized after site adjustment shall be handed over to the Owner in the form of test reports for their future use and reference.

### **Electrical**

1. The scope of work for testing and commissioning of the total installation shall be

for the capital equipment's like switchgears, cables, etc., and also for the associated equipment like relays Cts, Pts cable etc.,

2. The scope of work for testing and commissioning of electrical equipment for the above shall include but not limited to the following.
3. Providing sufficient number of experienced Engineers, supervisors, Electricians, so that the installation can be commissioned in stipulated time.
4. All the instruments, tools, and tackles required for carrying out the testing and the bidder shall provide commissioning.
5. The testing of electrical equipments shall be carried but as per the relevant Indian standards/codes practices/Manufacturers instructions.
6. Cleaning of Electrical equipment, contracts, cleaning and greasing etc., All the equipment and material required for above shall be supplied by the bidder.
7. Correcting the panel/equipment wiring for proper functioning for the schemes required /called etc.,
8. Installation and wiring of additional equipment on panels like auxiliary Contractors, timers, etc., which may be additionally required for proper functioning of the schemes.
9. Checking of equipment earthing and system earthing as a whole.
10. Testing of all the cables.
11. Co ordination with other Contractors for testing and commissioning of interface cables.

#### **TEST TO BE CONDUCTED**

- a) All tests shall be performed in the presence of the Contractor and customer/PMC/consultant. For all types of visual inspections, checking, pre commissioning, commissioning test and acceptance tests, relevant IS for the tests given therein shall be followed in addition to the instructions in this technical specification the intention of giving the few test procedures, described below, is to provide a guideline for the bidder. However bidder shall not restrict themselves in carrying out only the tests described in this document.

- b) Contractor/Manufacture shall submit their proposed test procedures for approval and shall not commence testing without such approval is given.
- c) Contractor shall check and test all electrical equipment and system installed and supplied them, including equipment supplied by the owner.
- d) Contractor shall ensure that no tests are applied which may stress equipment above the limits for field-testing recommended by the manufacturer. Contractor shall be responsible for any damage to personnel or equipment resulting from improper test procedure including the equipments supplied by Client.
- e) All defective materials furnished by the Contractor and defects due to poor workmanship revealed through field testing, shall be corrected at Contractor expense without affecting the completion of the project.
- f) CLIENT reserves the right to interpret and approve all test results prior to energisation of circuits or apparatus.
- g) Contractor shall visually inspect all equipment for defects immediately results upon arrival at site including those supplied by CLIENT.
- h) Contractor shall test the buried earth grid and shall record the values. Contractor shall inspect and test all earthing work carried out by him, including all interconnections between ground loops, grounding of equipment and ensure all connections are permanent and that the earthing circuit is continuous.
- i) Contractor shall megger and record earth resistance at various earth connection points.
- j) Switchgear rated 433 volts or more shall be tested with a 1000 volts megger.
- k) Auxiliary wiring rated less than 415 volts shall be tested with a 500 volts megger.
- l) ALL protective relays shall be tested at sufficient points to establish their proper functioning in accordance with manufacturer's specification and curves.
- m) Operation checks and functional checks on all switchgear panels.
- n) Busbar, Wires and cables rated 433 volts or more shall be tested joints check

with torque wrench for tightness.

- o) Continuity testing of all wires and cables with a 1000 volts megger. Cables rated less than 433 volts shall be tested with a 500 volts megger.
- p) No wires or cable having resistance between conductors or between conductors and ground if less than 100 megohm shall be accepted.
- q) All pre-commissioning test stated as per IS for respective items.

**NOTE: The Contractor Shall Note That All The Rates Quoted By Them Are Including The Testing Charges For Doing The Above Tests. Scope Shall Not Reimburse Separately Any Amount For Any Testing Of Materials.**

#### 5.40. F. (I) PWD APPROVED MAKE LIST

S.No	Details of Materials	Manufacture Name
1	AIR CIRCUIT BREAKER	SCHNEIDER(MVS)/ABB(E-Max)/ LK (L&T (UPower) (FORMERLY L&T) /SIEMENS (3WL)/ Hager / Mitsubishi Electric (AE-SW)/ BCH /EQUIVALENT
2	MOLDED CASE CIRCUIT BREAKER WITH ROTARY OPERATING HANDLE.	SCHNEIDER(CVS)/ABB(T-Max)/L&T(D-Sine)LK(FORMERLY(L&T)/SIEMENS(3VA)/ Mitsubishi Electric(AE-SW)/ SOCOMEC /BCH/ EQUIVALENT.
3	SWITCH DISCONNECTOR FUSE UNIT	LEGRAND/LK(FORMERLY L&T)/SCHNEIDER/ABB/ SIEMENS /GE / HPL / BCH/EQUIVALENT.
4	HRC FUSES WITH FITTINGS	LK (FORMERLY L&T) / SIEMENS / SCHNEIDER / GE / BCH//ABB/EQUIVALENT
5	CONTACTORS, TIMERS	SCHNEIDER / ABB / LK (FORMERLY L&T) / SIEMENS /CUTLER HAMMER/BCH/EQUIVALENT
6	HYBRID CAPACITOR PANEL	SCHNEIDER/SIEMENS / LK (FORMERLY L&T) / ABB/ EQUIVALENT
7	VOLTMETER & AMMETER/ ENERGY ANALYZER	CONZERVE/SOCOMEK /NEPTUNE/SECURE/SCHNEIDER/TRINITY/ EQUIVALENT
8	SELECTOR SWITCH	SIEMENS/ LK (FORMERLY L&T) / SCHNEIDER/ABB/EQUIVALENT
9	CURRENT TRANSFORMER & VOLATAGE TRANSFORMER	SIEMENS/GE/AREVA/KIRLOSKAR/ABB/ EQUIVALENT

S.No	Details of Materials	Manufacture Name
10	INDICATING LAMP	LK(FORMERLYL&T)/SIEMENS/ SCHNEIDER/ABB/EQUIVALENT
11	PROTECTIVE RELAYS	AREVA / SCHNEIDER / ABB / (FORMERLY L&T) / SIEMENS/EQUIVALENT
12	BATTERY CHARGER	AMARARAJA/STATCON/CROMPTONGREA VES/EQUIVALENT
13	XLPE / PVC INSULATED ARMOURED CABLE 11000V / 1100V / 660V GRADE FOR HT / LT CABLE	POLYCAB / FINOLEX /RR KABEL / HAVELLS / KEI/BONTON/EQUIVALENT
14	AC MINIATURE CIRCUIT BREAKER	SCHNEIDER / LK (FORMERLY L&T) / SIEMENS / LEGRAND/HAGER/ABB/EQUIVALENT
15	CABLE LUG (TINNED COPPER)	DOWELLS/ACTION/JAINSONS/KABELS/ EQUIVALENT
16	CABLE GLAND	DOWELLS/COMET/GRIPWELL//EQUIVALE NT
17	MAIN L.T. PANEL, CAPACITOR PANEL & DISTRIBUTION PANEL / SYNC PANEL	LK(FORMERLY(L&T) /CONQUERENT- ABB/ExcelElectricCo(MakEngineers)/CROMPT ON/SCHNEIDER/SIEMENS/RYBNE/KRATOS /LOTUS CONTROL/TRICOLITE/SPC Electrotech Pvt. Ltd/EQUIVALENT
18	CABLE TRAY / RACEWAY	NPES/KAMBOJELECTROCONTROL/ADITY ASTEEL/SLOTCO/LEGRAND/SPCElectrotech Pvt.Ltd/EQUIVALENT
19	DISTRIBUTION BOARDS WITH MINIATURE CIRCUIT BREAKERS, RCCB	HAGER / LEGRAND / SCHNEIDER / LK (FORMERLYL&T)/ABB/SIEMENS/EQUIVAL ENT
20	PVC CONDUIT	BEC/AKG/POLYCAB/CAP/WELKM/EQUIVA LENT.
21	FRLS INSULATED COPPER CONDUCTOR SINGLE CORE STRANDED WIRES OF 650/1100 VOLT	FINOLEX/RRKABEL/HAVELLS/POLYCAB/ KEI/BONTON/EQUIVALENT
22	MODULAR SWITCHES & SOCKETS	MK/LEGRAND/SCHNEIDER/ WIPRO(Northwest)/HAVELLS/EQUIVALENT
23	AVIATION OBSTRUCTION LIGHT	BAJAJ/WIPRO/PHILIPS/CROMPTON/INSTA POWER/EQUIVALENT
24	LIGHT FIXTURE (INDOOR)	PHILIPS/LEGERO/ LK (FORMERLYL&T)/INSTAPOWERTRILUX/N EXTRAY/ CROMPTON /EQUIVALENT

S.No	Details of Materials	Manufacture Name
25	LIGHT FIXTURE (OUTDOOR)	PHILIPS/BAJAJ/HAVELLS/TRILUX/LK (FORMERLYL&T)/EQUIVALENT
26	CEILING FAN & EXHAUST FAN	CROMPTON/USHA/ORIENT/HAVELLS/ BAJAJ/EQUIVALENT
27	LIGHTNING PROTECTION	ARICO/LPI/JMV/ABB/EQUIVALENT
28	SURGE PROTECTION DEVICE	SCHNEIDER MG/LEGRAND/HAGER/ABB/LK (FORMERLYL&T)/EQUIVALENT
29	EARTHING	ARICO/LPI/JMV/ABB/EQUIVALENT
30	UPS	NUMERIC/TATALIBERT /SCHNEIDER/EMERSON/GEPOWER/3EM/O RION/RELIO/ELNOVA/EQUIVALENT
31	STREET LIGHT POLE	PHILLIPS/BAJAJ/KESELEC/ORIENTS/SKIPP ER/EQUIVALENT
32	SANDWITCH BUSDUCT	SCHNEIDER/C&S/L&K(FORMERLYL&T)/E AE/GODREJ/SPC Electrotech Pvt. Ltd/EQUIVALENT
33	ATS / STS	SOCOMEK/ASCO/L&K(FORMERLYL&T)HA VELLS/ABB/HAGGER/EQUIVALENT
34	SYNCHRONIZING RELAY	SIEMENS/WOODWARD/ALLEN BRADLEY/EQUIVALENT
35	PLC	SIEMENS/WOODWARD/ALLEN BRADLEY/EQUIVALENT
36	D.G. SET (ENGINE)	CUMMINS/KIRLOSKAR/MAHINDRA/PERKI NS/JAKSON/CATERPILLAR/MITSUBISHI/P OWERCONTROLSYSTEM&SWITCHGEARV IDYUT ENTERPRISES/EQUIVALENT
37	D.G. SET (ALTERNATOR)	STAMFORD/LERROY SOMMER/CROMPTON/EQUIVALENT
38	D.G. SET ACOUSTIC ENCLOSURE	AS PER D.G APPROVED BY OEM
39	EXHAUST SILENCER	TATA/ JINDAL/ SAIL/ PRAKSHSURYA/HISSAR/EQUIVALENT
40	EXHAUST FLEXIBLE BELLOW	TATA/ JINDAL/ SAIL/ PRAKSHSURYA/HISSAR/EQUIVALENT
41	EXHAUST PIPE INSULATION	TATA/ JINDAL/ SAIL/ PRAKSHSURYA/HISSAR/EQUIVALENT
42	M.S. ANGLE / CHANNEL	TATA/ JINDAL/ SAIL/ PRAKSHSURYA/HISSAR/EQUIVALENT
43	H.T. PANEL	SCHNEIDER/ABB/SIEMENS/SPCElectrotech



S.No	Details of Materials	Manufacture Name
		Pvt.Ltd./L&T /EQUIVALENT
44	TRANSFORMER	ARIVA/PVJ/CROMPTON/KIRLOSKAR/TECH NOVEL/ POWERSTAR/ EQUIVALENT
45	H.T. TERMINATION KIT	RAYCHEM/JAINSONS/3M/ DENSONS/EQUIVALENT
46	SOLAR POWER SYSTEM	MNRE APPROVED MANUFACTURER
<b>ELV &amp; PA SYSTEM</b>		
47	DESKTOP	SAMSUNG/PANASONIC/CHRISTIE/DELTA/ PELCO/PHILIPS/NEC/EQUIVALENT
48	TELEPHONE / CO AXIAL WIRE	FINOLEX/POLYCAB/ HAVELLS / D-LINK/EQUIVALENT
49	CAT 6/6A CABLES & INFORMATION OUTLET (I/O)	MOLEX/FUSIONPOLYMER/BELDEN SIEMON / R&M/ PANDUIT / DERWISER / CORNING / D-LINK/EQUIVALENT
50	CAT 6/6A JACK PANEL, PATCH CARD, FACE PLATE, FIBER EQUIPMENT	MK/LEGRAND/SCHNEIDER/ WIPRO(Northwest)/HAVELLS/ SIEMON / R&M/ PANDUIT / DERWISER / CORNING / D-LINK/EQUIVALENT
51	NETWORKING RACK	CISCO /D-LINK/NETGEAR /MTS / RITTAL / APC / DERWISER / APW/EQUIVALENT
52	CCTV CAMERA	JONSON/PELCO/BOSCH/HONEYWELL /SONY/HIKVISION/SAMSUNG/PANASONIC / SIEMENS /EQUIVALENT
53	IP-PBX SYSTEM & IP PHONES	SIEMENS/ERICSSON/MITEL/ALCATELLUC ENT/EQUIVALENT
54	LED DISPLAY	PANASONIC / SONY / SAMSUNG / BOSE VIDEO WAVE/EQUIVALENT
55	WIRELESS PRESENTATION SYSTEM	CRESTRON/AMX/ EQUIVALENT
56	PRESENTATION SWITCHER	AMX/CRESTRON/EXTRON/BOSCH EQUIVALENT
57	TRANSMITTER	KRAMER/CRESTRON/EXTRON/EQUIVALENT
58	RECEIVER	KRAMER/CRESTRON/EXTRON/EQUIVALENT
59	CONFERENCE SYSTEM DIGITAL CONTROL UNIT	BOSCH/BRAHLER/SCHINDLER/ EQUIVALENT
60	CONFERENCE SYSTEM DELEGATE UNIT	BEYERDYANMIC/ BRAHLER/BOSCH/EQUIVALENT
61	DSP	BOSCH / BRAHLER/ SENNHEISER/

<b>S.No</b>	<b>Details of Materials</b>	<b>Manufacture Name</b>
		HONEYWELL/EQUIVALENT
62	CEILING SPEAKER / MIXER POWER AMPLIFIER	BOSE/MARTIN AUDIO/D&B AUDIOTECHNIC/BOSCH/ELECTRO VOICE/ HONEYWELL/ EQUIVALENT
63	VIDEO CONFERENCING SYSTEM	POLYCOM / TANDBERG/SONY/EQUIVALENT
64	CABLES & CONNECTORS	NEUTRIK/SWITCHCRAF T/AMPHENOL EQUIVALENT
65	INTERACTIVE DISPLAY	WACOM-JAPAN/QOMO/EQUIVALENT
66	ACCESS POINTS	HONEYWELL/SIEMENS/SCHNEIDER/JOHN SON CONTROL/EQUIVALENT
67	PRINTERS	HP/SHARP/CANON/EQUIVALENT
68	NVR/SERVER	HONEYWELL/SONY/BOSCH/HIKVISION/S AMSUNG/PANASONIC/SIEMENS/JONSON/P ELCO/EQUIVALENT

**NOTE:** All makes shall conform to specifications of each items as enclosed with the tender documents. For any missing item make, take prior approval from Main Consultant.

**END OF SCHEDULE OF APPROVED MAKES SECTION**

**HVAC SYSTEM**

## 6. TECHNICAL SPECIFICATION FOR HVAC

### 6.1. DESIGN CRITERIA

**Indoor temperature & Humidity to be maintained as mentioned below in the table:**

Area Description	DBT (Deg C)	RH (%)
For OT area's	19 ± 1	50% ± 5%
For CT scan,MRI and CATH area	21 ± 1	50% ± 5%
For X RAY, FLUOROSCOPY and ULTRASOUND area	21 ± 1	50% ± 5%
For ANGIOGRAPHY	19 ± 1	50% ± 5%
For Isolation ICU, ICU,and ICCU area	21 ± 1	50% ± 5%
For Balance area's	24 ± 1	50% ± 5%

The refrigerant piping shall be extended up to 100mm with 50m level difference without any oil traps.

### 6.2. FOR CHILLED WATER SYSTEMS

#### DESIGN CRITERIA

#### SPECIFICATION SHEET – AIR COOLED CHILLING PACKAGE

<b>1.0 SERVICE CONDITION:</b>		
1.1	Capacity per machine – TR (Minimum)	200 TR
1.2	Refrigerant	R134a/ R470c/R410a
1.3	Type of installation	Outdoor Installation on Terrace
1.4	Type of finish	Epoxy paint / Non-Corrosive Acrylic Paint
1.5	Chilled Water entry temperature –	12.0 Deg C
1.6	Chilled Water leaving temperature – –Deg C	7.0 Deg C
1.7	Cooling capacity at 100% rated	200 TR

<b>2.0 COMPRESSOR &amp; COMPRESSOR MOTOR</b>		
2.1	Type of Compressor	Screw
2.2	Type of starter	Star - Delta
2.3	Type of Capacity control	Slide (Step less) valve
2.4	Range of capacity variation	25-100% (Continuous modulation)
2.5	Control	A command controlled Micro-processor-based controller panel which shall be built-in with each chiller with MOD Bus/BACNet protocol ready for connection to IBMS.
2.6	Sound Attenuation	Each compressor is individually enclosed by an acoustic sound blankets
2.7	Primary Chiller power connection	Single point Power Supply
<b>3.0 AIR COOLED CONDENSER:</b>		
3.1	Capacity (Refrigeration) - TR	200
3.2	Type of Condenser	Air Cooled type (Copper tube and Al. Fins)
3.3	Air Entry temperature	45 Deg C
3.4	Material of tubes	Copper Tubes
3.5	Type of Fins	Aluminum Integral fins
3.6	Type of Fan	Propeller Fan
<b>4.0 CHILLER</b>		
4.1	No. of chillers per machine	One
4.2	Capacity – TR	200 TR
4.3	Fluid to be cooled	Water
4.4	Specific Gravity	1.00
4.5	Entering water Temperature	12 C
4.6	Leaving water temperature	7 C
4.7	Water Flow Rate	
4.8	Water side pressure drop	
4.7	Fouling Factor	0.0001 fps
4.10	Safety devices	Relay for compressor, internal thermostat for compressor, reverse phase protection devices for compressor, thermal over current relay for fan motor, high pressure switch, low pressure cut out, suction gas temp. Controller, freeze protection, thermistor-controlled oil heater, discharge gas thermistor, fusible plug, fuse for control circuit and pressure relief valve.

### **6.3. DESIGN & CONSTRUCTIONAL REQUIREMENTS**

Each high temperature durability chiller package shall be factory packaged including compressor - motor units, water-cooled condenser, chiller with accessories, all interconnected refrigerant piping & fittings, refrigerant feeding devices, valves, strainer, liquid moisture indicator, suction line insulation, full charge of oil & gas, starter panel & identical Micro-processor panel interconnected electrical wiring etc., all the components being mounted on welded steel base frame. Each steel frame has a mounting holes and lifting eyes on four sides for spreader-bar lifting and rigging.

The base frame, structural profiles & panels made of galvanized sheet steel shall be protected with primary coating & finished with acrylic paint. The machine shall be mounted on vibration isolators. Vibration isolators shall be specially selected with neoprene base pads for fitting beneath the complete chiller package to ensure there is no transmission of discernible vibration to the structure and occupied space from the units. Isolation efficiency shall not be less than 98% and isolators shall be adjusted on site for optimum performance.

### **6.4. COMPRESSOR:**

Low Noise Rotary Screw type compressor:

The compressor shall be screw type in multiple numbers with independent circuits as specified. The screw compressor shall be semi-hermetic/hermetic. The compressor speed shall not exceed 2900 RPM. The compressor rotor shall have less tip clearances so that the leakage between high and low pressure side is minimized during compression. The compressor shall unload from full load to the minimum capacity by means of a slide valve. The slide valve shall be positioned over both the male and female rotors. The compressor shall be provided with electrical safety features such as phase loss, phase reversal apart from overload and under load protection.

The Compressor shall have automatic capacity control equipment, which will control the capacity at any point between 15% and 100% of full duty. The compressor shall be fitted with a device which ensures that it cannot start unless in the fully unloaded condition.

The oil feeding system shall be operated by differential oil pressure without using any electrical mechanism. The oil carry over from compressor should be minimum and there should not be any oil-recovery mechanism.

The motor of semi-hermetic compressor, which is refrigerant gas cooled, shall have in built protection against inadequate cooling.

### **6.5. AIR COOLED CONDENSER**

The condenser coil shall be multi-pass, cross finned type air-cooled with integral sub-cooler constructed of high-performance aluminum SLIT fins bonded to seamless copper tubes.

Condenser fans shall be direct driven propeller type. The fan motor shall be thermally protected from overload conditions with thermal overload relay and shall be permanently lubricated. The winding and bearing of the condenser fan motor shall be weather proof construction. The maximum operating pressure of condenser coil shall be 3 MPa.

### **Chiller**

The chillers shall be of shell and tube type with carbon steel shell and seamless copper tubes. The evaporator shall be factory insulated with minimum of 25 mm thickness. The chiller shall have flanged connection for water lines. The chillers shall be tested and constructed to all applicable codes and shall have two circuits for refrigerant flow, when the tonnage exceeds twenty tons. The chiller shall be factory tested.

The water circulation through the chiller shall be based on 9 to 11 lpm per ton. The maximum water velocity shall not exceed the figure of 2.5m per sec and the total pressure drop on the water side shall not exceed a figure of six meter head of water. The chiller selection shall be based on a fouling factor 0.0001 in FPS units...

### **Heat Reclaim**

The unit shall have a factory fitted Plate type heat exchanger in the hot gas line so that a minimum of 15 % of the total Heat Rejection is recovered and used for providing hot water for utility purposes other than drinking.

While the water in temperature is 30C, the maximum water temperature achievable should be

minimum 55C.

The PHE should be Stainless Steel & Brazed type with provision for water side connections.

### **Sound Level**

The Overall sound level of the unit shall not exceed 74 dB measured at a point of 1 m from the Centre of machine surface and 1.5 m from the floor level

### **Factory Run Test**

Pressure and leak test of individual components before and after unit assembly. Complete factory run test of individual components before and after unit assembly.

Complete factory run test at contract conditions to verify unit performance and operating and safety control system.

### **Quality Assurance**

Chiller performance should be rated in accordance with ARI std.

Chiller and condenser shall include ASME – U Stamp/Equivalent

Chiller shall be manufactured in a facility that has been registered by UL to the ISO Std for quality

Each compressor assembly shall undergo a mechanical run in test to check proper operation of components and to verify that vibration level.

The entire chiller assembly shall be leak tested with a refrigerant tracer gas

Prior to shipment the chiller packages shall be run tested for proper operation of controls.

**Chiller Technical Data Sheet Cum Submittal (Contractor need to submit the data sheet for the approval of Engineer , before purchase )**

#### **A. COMPRESSOR - WATER CHILLING MACHINE:**

<b>GENERAL</b>	
1.	Make & Model & origin of machine
2.	Capacity at operation conditions
3.	Operating Condensing Temperature [-°C]
4.	Operating Suction temperature [-°C]
5.	Leaving water Temperature [-°C]



6.	Overall dimensions including stand [- mm x mm x mm]	
7.	Operating Weight [- Kg]	
8.	Operating Charge [- Kg]	
9.	Minimum clearance required from adjacent structures [- m]	
10.	Minimum clearance required between two machines [- m]	
11.	Whether any platform or pedestal required For installation? If so, furnish details	
12.	Noise level at a distance of 1 m from the machine at intervals of 1 m along the perimeter	
<b>B. COMPRESSOR MOTOR UNIT:</b>		
1.	Type of Compressor	
2.	Manufacturer's Name	
3.	Model	
4.	Refrigerant	
5.	Type of motor	
6.	Class of insulation	
7.	Class of protection	
8.	Operating condensing and suction temperature [-°C]	
9.	Motors speed at design operating conditions [ rpm	
10.	IKW	
11.	Type of starter	
13	KW / TR at operating conditions	
14.	Capacity control - automatic or manual	
15.	Full load current [- amps]	
16.	Starting current [- amps]	
17.	Stepless capacity control	
18.	Capacities and corresponding IKW	
<b>C. CHILLER:</b>		
1.	Type of chiller (Single Circuit or Dual Circuit and Flooded/DX)	
2.	Chiller connections	
	a. Inlet Dia [- mm]	
	b. Outlet Dia [- mm]	
3..	Material of tube	
4	Material of shell	
5.	Flow rate [- lpm]	
6.	Leaving water temperature [- Deg C]	

7.	Entering water temperature [- Deg C]	
8.	Refrigerant temperature [- Deg C]	
9.	Fouling factor (FPS)	
10.	No. of passes/ No. of Circuits	
11.	Tube velocity [MPs]	
12.	Pressure drop [- Kg / Sqcm]	
<b>D.</b>	<b>CONDENSER:</b>	
1.	Type of Condenser	
2.	Tube Diameter – mm	
3..	Material of tube	
4	No. of fins/cm incase of finned	
5.	Type of condenser fan	
6.	Fan speed	
7.	Make of Fan	
8.	Material of Fan blades	
9.	No. of blades	
10.	Class of Protection	
11.	Motor power consumption in KW	
12.	Entering Air Temperature	
13.	Air Leaving Temperature	

### 6.6. AHU / FCU CONSTRUCTION FEATURES

#### Type

The air handling unit shall be of double skin construction, draw through type in sectionalized construction consisting of blower section, coil section, humidification section (where specified), filter section and insulated drain pan. Unless otherwise specified, the unit shall be horizontal type. Vertical type units are generally used whenever there is a space constraint.

#### Rating

- i) The capacity of the cooling/heating coil, the air quantity from the blower fan and static pressure of blower fan shall be as laid down in the tender documents. Where these parameters as calculated by the tenderer exceed the specified values, the coils and the blower fan shall satisfy these calculated values.

- ii) The coil shall be designed for a face velocity of air not exceeding 155 m/min.
- iii) The requisite static pressure demanded by the air circuit shall be developed by the fan at the selected operating speed. The static pressure value shall not in any case be less than 40 mm water gauge in normal cases, not less than 65 mm water gauge where microvee filters are also used and not less than 100 mm water gauge where absolute filters are also used. The fan motor HP shall be suitable to satisfy these requirements and the drive losses.
- iv) The air outlet velocity from the blower fan shall not exceed 610 m/min.
- v) Noise level at a distance of 2M from AHU shall not exceed 75 dBA

### **Material and Construction**

#### Housing/ Casing

- i) The housing/ casing of the air handling unit shall be of double skin construction. The housing shall be so made that it can be delivered at site in total/ semi knocked down conditions depending upon the requirements. The main framework shall be of extruded aluminium hollow structural sections. The entire framework shall be assembled using mechanical joints to make a sturdy and strong framework for various sections. For 100% fresh air application framework shall be made of thermal break hollow extruded aluminium profile.
- ii) Double skin panels shall be 25mm thick, made of 0.8mm preplasticized and pre-painted with PVC guard, GSS sheet on outside and 0.8mm galvanized sheet inside with Polyurethane foam insulation of density not less than 38 kg/cu. m injected in between by injection moulding machine. These panels shall be bolted from inside/ screwed from outside on to the framework with soft rubber gasket in between to make the joints airtight. The gaskets shall be inserted within groove in extruded aluminium profile of the framework. For units installed outdoor, the thickness of double skin panels shall be minimum 40 mm
- iii) Frame work for each section shall also be bolted together with soft rubber gasket

in between to make the joints air tight. Suitable doors with nylon handles, aluminium die-cast powder coated hinges & latches shall be provided for access to various panels for maintenance. However, AHU in the form of complete single unit shall also be acceptable with access door(s) for maintenance to various sections. The entire housing shall be mounted on galvanised steel channel frame work made out of G.I. sheet of thickness not less than 2mm. For higher capacity AHUs hot dip galvanized steel channel framework made of minimum 3 mm thick G.S. sheet shall be used.

#### Drain Pan

Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated with 10mm thick closed cell Polyethylene foam insulation or nitrile rubber or PUF with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

#### Cooling Coils

- i) The coil shall be made from seamless solid drawn copper tubes. The minimum thickness of tube shall be 0.5 mm for cooling / heating / heating-cum-cooling coils.
- ii) The depth of the coil shall be such as to suit the requirements, viz. recirculated air applications, or 100 % fresh air applications and the bypass factor required shall be specified in the tender specifications. The coil shall be 4 or 6 rows deep for normal recirculated air application and 8 rows deep for all outdoor air application, unless otherwise specified in the tender specifications. In case of 8 rows deep coils, it shall be made of 2x4 rows deep coils with a spacing of 200mm between the two coils, access door and independent drain pan.
- iii) U bends shall be of copper, jointed to the tubes by brazing, soft soldering shall not be used.
- iv) Each section of the coil shall be fitted with flow and return headers to feed all the passes of the coil properly. The headers shall be of copper and shall be complete with water in/out connections, vent plug on top and drain at the bottom. The coil shall be designed to provide water velocity between 0.6 to 1.8 m/s in the tubes.

v) The fins shall be of aluminium. The minimum thickness of the fins shall be 0.15 mm nominal. The no. of fins shall not be less than 4.7 per cm length of coil. Fins may be of either spiral or plate type. The tubes shall be mechanically expanded to ensure proper thermal contact between fins and tubes. The fins shall be evenly spaced and upright. The fins bent during installation shall be carefully realigned. For coastal areas fins shall be phenolic coated and for 100% F.A. application fins shall be hydrophilic type.

vi) The coil shall be suitable for use with the refrigerant specified or with water as the case may be. Refrigerating coils shall be designed for the maximum working pressure under the operating conditions. Water coils shall be designed for a maximum working pressure of 10 kg./sq.cm.

vii) Shut off and regulating valves at the inlet and outlet of water shall be provided. In the case of DX coils, solenoid valve and expansion valves shall be provided at the inlet of coil.

### **Supply Air Fan**

i) The supply air fan shall be AMCA certified centrifugal type with forward/backward curved blades double inlet double width type. For static pressure upto 65mm forward curved blades shall be used and for higher sizes backward curved blades shall be used.

ii) The fan housing of Galvanised sheet steel and the impellers shall be fabricated from heavy gauge steel sheet as per approved manufacturers standard. The side plates shall be die formed for efficient, smooth airflow and minimum losses. Fan impeller shall be mounted on solid shaft supported to housing using heavy duty ball bearings. Fan housing and motor shall be mounted on a common extruded aluminium base mounted inside the fan section on antivibration spring mounts or cushy- foot mount. The fan outlet shall be connected to casing with the help of fire retardant fabric.

iii) The fan impeller assembly shall be statically and dynamically balanced

iv) The fan shall be fitted with vee belt drive arrangement consisting of not less than two evenly matched belts. Belts shall be of oil resistant type. Adequate adjustments shall be provided to facilitate belt installation and subsequent belt tensioning by movement of the motor on the slide rails. A readily removable door guard shall be provided.

V) The fan motor shall be totally enclosed fan cooled squirrel cage induction motor with IP-54 protection & selected for quiet running. The motor shall be suitable for operation on  $415 \pm 10\%V$ , 3 phase, 50 Hz., A.C. supply. The fan motor shall be premium efficiency IE3 class, as per IS 12615.

### **Air Filters**

The air used in an air-conditioning system must be filtered to maintain a clean atmosphere in the conditioned space. The concentration of contaminants in the air and the degree of cleanliness required in the conditioned space will determine the type of filter or filters that must be used.

### **Type of filters**

i) Pre-filters :

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50mm thick, shall be provided on the suction side of AHU as a standard equipment with the unit. These filters shall have the efficiency of 90% down to 10 micron particle size. When these filters become loaded or full of dirt, it is removed from service and replaced by another filter. The dirty filter can then be washed in a cleaning solution in a tank, dried and then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 MPM.

ii) Dry fabric (fine) filters

These filters shall have efficiency of 99% down to 5 micron particle size as per EU 7 standard. These filters are provided only where special cleanliness standard is required such as for library, lab, wards, OTs etc. These are provided on the discharge side of AHU after fan section and are always backed by pre-filters provided on the

suction side of AHU. Face velocity across these filters shall not exceed 155 MPM. These filter shall be separately measured and paid for.

iii) Absolute (HEPA) filters

These filters shall have efficiency of 99.97% upto 0.3 micron particle size as per EU 13 standard & are required for applications like operation theatre, micro-labs etc. These are also provided in the AHU after fan section or at terminal point and always must be backed by fine filters & pre filters. These filters after they become dirty, can not be reused and have to be thrown away. Face velocity across these filters shall not exceed 155 MPM. These filters shall be separately measured & paid for.

General Construction of filters

- i) Each AHU shall be provided with a factory assembled filter section containing pre-filters made of cleanable metal viscous filters made of corrugated aluminium wire mesh, or dry cleanable synthetic filters. These shall be minimum 50 mm thick with a frame work of aluminium.
- ii) The filter area shall be made up of panels of size convenient for handling. The filter panels shall be held snugly within suitable aluminium framework made out of minimum 1.6 mm aluminium sheet with sponge neoprene gaskets by sliding the panels between the sliding channels so as to avoid air leakage.
- iii) In order to indicate the condition of these filters while in operation, a manometer shall be provided to indicate the pressure drop across the fine filters and absolute filters.
- iv) Special filters, if any specified in the tender specifications shall be provided in addition to the above filters. In that event, the latter shall function as pre-filters.
- v) v) Each fine and Hepa filter shall carry test certificate from manufacturer

Humidification Arrangement

Wherever specified in the tender specifications, humidification arrangements shall be provided with the AHUs. This shall consist of one of the following arrangements. The particular arrangement to be followed shall be specified in the tender specifications.

### 1 Pan type humidification arrangement

Pan type humidifier shall be complete with stainless steel sheet (minimum 2mm thick) tank duly insulated, steam outlet nozzle, top open able with stainless steel bolts, immersion heaters, low level cut out, humidistat, thermostat; safety stat, float valve & sight glass etc. The tank shall be insulated with 50mm thick expanded polystyrene (TF quality) slabs & finished with 0.5mm thick G.I. sheet.

### Ultrasonic humidification arrangement

These humidifiers consume lesser energy as compared to Pan type humidifiers. Use of this type may be done where the cost is comparable to other types.

An ultrasonic humidifier uses a metal diaphragm vibrating at an ultrasonic frequency to create water droplets that silently exit the humidifier in the form of a cool fog. Ultrasonic humidifiers use a piezoelectric transducer to create a high frequency mechanical oscillation in a film of water. This forms an extremely fine mist of droplets about one micron in diameter, which is quickly evaporated into the air flow. Unlike the humidifiers that boil water, these water droplets will contain any impurities that are in the reservoir, including minerals from hard water (which then forms a difficult-to-remove sticky white dust on 88 nearby objects and furniture). Any pathogens growing in the stagnant tank will also be dispersed in the air. Ultrasonic humidifiers should be cleaned regularly to prevent bacterial contamination from being spread throughout the air.

The amount of minerals and other materials can be greatly reduced by using distilled water, though no water is absolutely pure. Special disposable demineralization cartridges may also reduce the amount of airborne material,

### Instruments and Valves

The following instruments shall be provided at the specified locations in the AHUs for the chilled water / hot water system: -

- i) Pressure gauges at the inlet and outlet of the coil with tubing and gauge cock.



- ii) Stem type thermometers at the inlet & outlet of coil with tubing & gauge cock.
- iii) Butterfly valve at the inlet and outlet of coil
- iv) Balancing valve at the outlet of coil.
- v) Y-strainer at the inlet of coil.
- vi) Motorized -way diverting/ mixing valve along with proportionate thermostat.

#### Controls

These shall be as per details given under chapter 12 'Controls '.

#### Insulation

The insulation of casing shall be as per para 6.2.3.1 (ii) & that of drain pan shall be as per 6.2.3.2.

#### Installation

The air handling unit shall be so installed as to transmit minimum amount of vibration to the building structure. Adequate vibration isolation shall be provided by use of rubber/ neoprene pads and/or vibration isolation spring mountings.

#### **Mixing Box (Wherever Applicable)**

Mixing box shall be complete with fresh and return air dampers. Mixing box shall be provided whenever the return air is ducted back to the AHU.

#### **Dampers**

Dampers shall be opposed blade type. Blades shall be made of double skin air foil extruded aluminums sections with integral gasket and assembled within a rigid extruded aluminum or nylon, turning in Teflon bushes. In case of automatic dampers, sealed ball bearings shall be provided, in place of Teflon bushes. Manual dampers shall be provided with a Bakelite knob

for locking the damper blades in position. Linkages shall be extended for motorized operation if specified in data sheet A. Damper frames shall be sectionalized to minimize blade warping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure.

### **AHU Pressure Calculation**

Contractor shall submit calculations for the internal and external pressure of each AHU system based on the equipment to be selected and ducting system to be installed including pressure drops in coil, filter, ducts and fittings, VD, FD, and Diffusers etc. Contractor shall obtain approval from consultant on the SP Calculations before ordering AHU motor. Required motor HP based on actual Calculated SP shall be provided without extra cost.

### **Noise Level**

The noise level inside the AHU room should be less than 65 dBA.

## **FAN COIL UNITS**

### **General**

The fan coil units shall be floor/ wall/ ceiling mounted draw through type complete with finned coil, fan with motor, insulated drain pan, cleanable air filters and fan speed regulator and other controls as described.

### **Casing**

The casing shall be fabricated out of minimum 1.25mm thick G.S.S. sheet. 6.3.3

### **Cooling coil**

The coil shall be of seamless copper tubes with aluminum fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/s. The air velocity across the coil shall not exceed 155 m/min.

### **Fan**

This shall consist of two lightweight aluminum impellers of forward curved type, both

statically and dynamically balanced, along with properly designed GI sheet casings.

The two impellers shall be directly mounted on to a double shaft, single phase multiple winding motor capable of running at three speeds.

#### **Drain Pan**

Drain pan shall be fabricated out of minimum 1.00 mm thick stainless steel sheet overing the whole of coil section and extended on one side for accommodating coil connection valve etc. and complete with a 25mm drain connection. The drain pan shall be insulated with 10mm thick closed cell polyethylene foam insulation and jacketed from outside with single piece moulded FRP tray

#### **Air Filter**

The filter shall be cleanable type 15mm thick with 90% efficiency down to 10 micron of dry cleanable synthetic type to be mounted behind the return air grill in the unit casing.

#### **Speed control**

A sturdy switch shall be provided with the unit complete with wiring, for ON/OFF operation and with minimum three speed control of the fan.

#### **Automatic controls**

Each unit shall have a room type thermostat and a solenoid valve. The valve shall be fixed at a convenient location. The thermostat shall be mounted along with the speed control switch on a common plate. The plate shall clearly indicate the fan positions.

The water valves on inlet line shall be of gun metal ball type with internal water strainers, having BSP female pipe thread inlet and flare type male pipe thread outlet connection. The valves on return line shall be as above, but without the water strainer

#### **Water Connections**

The water lines shall be finally connected to the coil of the fan coil unit, by at least 300mm long, type 'L' seamless solid drawn copper tubing, with flare fittings and connections.

**INSULATION**

The drain pan shall be insulated as per para 6.3.5.

**Painting**

All equipment shall be supplied as per manufacturer's standard finish painting.

**Technical Requirements**

S.no	Description	Requirements
1	Numbers and minimum capacity	Refer the technical specification given in BOQ and HVAC drawing.
2	Cooled and Dehumidified air flow rate	Refer the technical specification given in BOQ and HVAC drawing.
3	Cooling coil face area	Air velocity across cooling coil face area to be less than 2.5 m/s (500 FPM)
4	Number of rows for cooling coil	4 ~ 6
5	Entering chilled water temperature – Deg C	7 Deg C
6	Leaving chilled water temperature – Deg C	12 Deg C
7	Chilled water flow rate – m <sup>3</sup> /hr.	Refer the technical specification given in BOQ and HVAC drawing.
8	Drain connection on both sides of	25 mm Dia socket connection
9	Coil tube Dia	12.5 mm
10	No. of Fins	Not more than 13 FPI
11	Type of fan motor	415 V, 3 PH, 50 Hz TEFC Sq. Cage energy efficient EFF 1
12	Type of starter	Star-Delta / DOL
13	Pre-Filters (cleanable type)	Pre filters (panel type) of 90% efficiency down to 20 microns Class EU3 as per BS EN 779. Maximum face velocity 1.75 m/s

**Data sheet –A (Contractor need to submit the data sheet for the approval of Engineer , before purchase )**

S.no	Description	Requirements
	Air Handling Unit No.	
	Type	Ceiling / Floor Horizontal / Floor Vertical

S.no	Description	Requirements
	Model / Make	
	Grand Total Heat (TR)	
	Total Sensible Heat (TR)	
	Minimum Supply Air Quantity (S/A – CMH)	
	Minimum Outside Air Quantity (O/A – CMH)	
	Air entering coil temperature (TE-DB Deg C)	
	Air entering coil temperature (TE – WB Deg C)	
	Air leaving coil temperature (TL – DB Deg C)	
	Air leaving coil temperature (TL – WB Deg C)	
	Maximum Air Face Velocity (m/sec) across coil	2.5
	Maximum Air side pressure drop across coil (Pascal's)	
	Total Fan Static Pressure (Pascal's)	
	External Static Pressure (Pascal's)	
	Chilled Water Entering Coil Temperature (Deg C)	
	Chilled Water Leaving Coil Temperature (Deg C)	
	Chilled Water Velocity – Maximum (m/sec)	
	Coil Rows	
	Coil Fins / Cm.	
	Chilled Water Flow Rate m <sup>3</sup> / hr.	
	Maximum Chilled Water Pressure Drop (m) through coil	
	Type of Fan	FC / BI / Aero foil
	Type of Fan Control	Variable Air Volume / Constant Air Volume.
	Maximum fan rpm	
	Maximum outlet velocity	M / sec
	Type of Filters	
	Pre filters Numbers Dimension Efficiency Face velocity	
	Type of Starter	
	Motor Voltage	
	Type of Vibration isolator	
	Interlock with smoke detector and fire alarm system	
	Supply and return air noise treatment	

S.no	Description	Requirements
	Controls	
	Dimensions L x B x H	
	Operating weight kg	
	AHU motor kW rating	KW

**Datasheet-B**

- Schedule of drawings and documents to be submitted for review, approval and information with submission dates.
- Quality Assurance Plan (QAP).
- Detailed P & I diagram showing clearly the scope of supply of equipment, piping with line sizes and material Specifications, valves, specialties, instrumentation and control and all accessories. This drawing or documents mentioned under following clauses shall include all design data and information furnished in data sheets A and B. The makes of all major components and controls shall be indicated.
- Dimensioned general arrangement drawing showing all equipment with accessories, mounting details, nozzle locations, etc.
- Overall space and head room requirement with details of handling during erection, operation and maintenance.
- Foundation drawing with static and dynamic loading data, pocket details, foundation outline, etc, for all items.
- Cross-sectional drawings of all items with part list and materials of construction.
- Performance curves and selection charts for fan, filters, etc. Selection charts and calculation for cooling coil and heating coil.
- Operation and maintenance manual with lubrication schedule.
- Catalogues furnishing detailed technical data for fan, coils, filters, etc.

**Datasheet-c(Contractor need to submit the data sheet for the approval of Engineer , before purchase )**

S.no	Description	units	Remarks
1.	Entering Air temp DB (Deg C)		
2.	Entering Air temp WB (Deg C)		
3.	Leaving Air temp DB (Deg C)		
4.	Leaving Air temp WB (Deg C)		
5.	Entering Water temp (Deg C)		
6.	Leaving Water temp (Deg C)		
7.	Coil / Filter area (SFT)		

S.no	Description	units	Remarks
8.	Face Velocity (FPM)		
9.	Air Flow (CFM)		
10.	Fan Speed (RPM)		
11.	Voltage		
12.	Current (A) = R- Phase		
13.	= Y- Phase		
14.	= B- Phase		
15.	Over load relay range A		
16.	Over load relay setting A		
17.	Inlet Water pressure (Kg / cm <sup>2</sup> )		
18.	Outlet water pressure (Kg / cm <sup>2</sup> )		
19.	Noise level AHU room (dBA)		
20.	Vibration level (Microns) = X – axis		
21.	= Y – axis		
22.	= Z - axis		
23.	Fresh air velocity (FPM)		
24.	Fresh air filter area (SFT)		
25.	Fresh air flow (CFM)		
26.	Designed CFM		

#### Air Handling Equipment Test Sheets.

The test sheets shall provide details of the following items: (Refer Checklist in AHU Spec. Section)

System Fan Number	Fan RPM
Fan Manufacturer	Size of Sheave Driver
Total CFM	Size of Sheave Driven
Return Air CFM	Belt sizes and number
Outside Air CFM	Motor Manufacturer
Total Static Pressure	Motor Size, Voltage
Suction Static Pressure	Phase & RPM KW
Discharge Static Pressure	Amperage Nameplate Rating
Coil Pressure Drop	Final Operating Amperage
Filter Pressure Drop	Overload Setting

**Test, Code Drawings**

Each Report shall contain a single line drawing of air distribution system with fan system and zone number indicated. Each and every outlet, supply, and return shall be indicated on this drawing by a number corresponding to the number on the outlet test sheet, enabling the Engineer to locate each outlet for this drawing.

Drawing shall be clear and neat and shall list name of job and location of same

**Temperature Test Sheets**

Temperature test sheets shall list both specified and test conditions in opposite columns.

Items listed on this sheet shall be as follows:

- a) Entering Air D.B. & W.B. Temperature
- b) Leaving Air D.B. & W.B. Temperature
- c) Entering Coil Water Temperature
- d) Leaving Coil Water Temperature
- e) Outside Air -D.B. & W.B. Temperature
- f) Room temperature reading to be checked against thermostat setting

**Air Side Testing And Balancing**

The Air System shall be tested and balanced as under:

- Test and adjust fan RPM to design requirements
- Test and record motor full load amperes.
- Make Pitot Tube traverse of main supply ducts and obtain design CFM at fans.
- Test and record system static pressures, suction discharge and total.
- Test and adjust system for design recirculated air.
- Test and adjust system for design outside air.
- Test and record entering air temperatures DB/WB.



- Test and record leaving air temperature DB/WB
- Adjust all main supply and return air ducts to proper design CFM.
- Adjust all zones to proper design CFM (supply and return).
- Test and adjust each diffuser, grille and register to within 10% of design requirements:
- Each grille, diffuser, register shall be identified as to location and area.
- Size, type and manufacturer of diffusers, grilles, registers, and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations.
- Readings and tests of diffusers, grilles, and registers shall include required velocity and test resultant velocity. Required CFM and test resultant CFM after adjustments.
- In co-operation with control manufacturer's representative, set adjustments of
- Automatically operated dampers to operate as specified, indicated and/or noted.
- All diffusers, grilles, and registers shall be adjusted to minimize drafts in all areas.
- As part of the work of this contract, the Contractor shall make any changes in the pulleys and belts for correct balance as required at no additional cost to Owner.

### **Mode of Measurement**

Representatives from the Contractor and Engineer shall conduct a joint inspection of the Equipment's. All the discrepancies observed either incomplete works or defective work shall be clearly indicated in the joint inspection report. The mode of measurements given below is for the purpose of measurement and payment and the scope of works shall be as specified elsewhere in the specification.

### **6.7. VALVES & PIPES**

Pipe sizes shown in tender documents are purely for contractor's guidance. The contractor shall be responsible for selection of sizes as per detailed engineering to be done by him. Plumbing design to be done by the Airconditioning contractor shall conform to the following:

- i) Water velocity in pipes shall not exceed 2.5 m/sec.
- ii) Butterfly/ Ball valves shall be provided at
  - a) suction and delivery sides of pumps.
  - b) inlet and outlet of each condenser, chiller, cooling tower, hot water generator.
  - c) all drain connections from equipments.
  - d) Inlet & outlet of every heat exchanger coil, namely for AHU's, FCUs's, convector etc.
- iii) Non return valve shall be provided at the delivery of each pump. This shall be of swing type
- iv) Balancing valve shall be provided at the outlet side of chiller, condenser, heating and cooling coils to regulate the maximum flow rate up to value preset as desired.
- v) Balancing valves shall be provided, where specified, for AHU's to regulate the maximum flow rate upto a value preset as desired. A mercury manometer shall be supplied with every 10 nos. or part thereof of balancing valves, whether or not specifically indicated in the tender specifications.
- vi) Air valves shall be provided at all high points in the piping system for venting with a size of 25 mm for pipes upto 100 mm and 40 mm for larger pipes.
- vii) Plumbing drawings showing the sizes of valves, layout and other details shall be prepared and shall be got approved from the Engineering-in Charge before the execution of the plumbing work.

#### PIPE MATERIALS

Pipes shall be of the following materials.

- (i) Mild steel medium class (Black steel) tube conforming to IS: 1239 for sizes upto 150 mm.
- (ii) Welded black steel pipe, class 2, conforming to IS: 3589, for sizes greater than 150 mm. These pipes shall be factory rolled & fabricated from minimum 6mm thick M.S. Sheet for pipes upto 350mm dia & from minimum 7mm thick M.S. sheet for pipes of 400mm dia & above.

#### Fabrication

- 1) Pipe to pipe joining with the fusion welding and for any fitting with socket welding procedures. Pipe should be well supported as per CPWD – 2017 standard, approved by PMC/ Consultant. The piping system should be tested for 1.5 times higher than its designed working pressure.
- 2) The CONTRACTOR shall ensure that undue thinning of pipe wall does not occur due to bending

#### PIPE JOINTS

Seismic considerations shall be taken into account while planning joint details. Joints in black

steel pipes shall be of any of the following types

- (i) Screwed joints and union joints screwed to pipes, upto 25 mm size
- (ii) Butt welded joints for pipe sizes above 25mm. Electric welding shall be used for sizes 100mm and above.
- (iii) Flanges joints with flanges as per IS: 6392 for all sizes. Flanges may be steel welded neck type or slip on type welded to pipe, or alternatively screwed type. The item of flanges shall be measured and paid separately.
- (iv) Flexible coupling V groove joints.
- (v) Flexible connections shall be provided at the pumps, and other machine where requires as per following specifications
  - a) The Flexible connections shall be flanged type expansion joint. Flanges shall be non-compressible and mechanically strong type and the Neoprene rubber shall be provided in between the flange ends.
  - b) The connections shall work for a temperature range of minus 10°C to 70°C.
  - c) The length and working pressure of bellows shall be as follows:
 

Nominal Bore (mm)	Length (mm)	Pressure (Bar)
20-25	125	15
32-200	150	15
250-350	200	10
  - d) Connections shall be provided with control rods to control the excessive elongation or compression of piping systems
  - e) these shall be capable to withstand torsional movement up to 3o without damage.

### **Cleaning of Piping**

All piping shall be wire brushed and purged with air blast to remove all Dust and mill scale from inner surface. The method of cleaning shall be such that no material is left on the inner or outer surfaces, which will effect the serviceability of the pipe.

### **Protection during transit**

Effective precautions such as capping and sealing shall be taken to protect all pipe ends against ingress of dirt and damage during transit or storage.

**Shop and field hydrostatic tests**

All pipes and fittings shall be tested hydrostatically at the shops where manufactured to test pressures which are given in the applicable codes mentioned. All piping systems shall be tested hydrostatically by the CONTRACTOR after erection.

The chilled water and condensate drain piping shall be suitably insulated as per specification. Automatic air vents shall be installed at all high sections of piping. The discharge from these air vents shall be piped via copper tubes of appropriate size to the nearest waste drain pipe.

**Pressure gauges & thermometers**

Bourdon type pressure gauges with aluminum casing with a minimum 100 mm dial and appropriate range complete with needle valves shall be provided at the inlet and outlets of heat exchangers, and pump sets.

Thermometers shall be of dial type mounted on a board with separable copper well. The case shall be of cast aluminum, weather & water proof type. Thermo well shall be provided at the inlet and outlet of all heat exchangers.

**PRESSURE TESTING**

- (i) All piping shall be tested to hydrostatic test pressure of at least one and a half times the maximum operating pressure, but not less than 10 kg./sq.cm. for a period not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified to the satisfaction of the The Engineer
- (ii) Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.
- (iii) System may be tested in sections and such sections shall be securely capped.
- (iv) It shall be made sure that proper noiseless circulation is achieved through all the coils and other heat exchange equipments in the system. If proper circulation is not achieved due to air-bound connections, the contractor shall rectify the defective connections. He shall bear all the expenses for carrying out the above rectification, including the tearing up and refinishing of floors, walls, etc. as required.
- (v) Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the The Engineer.
- (vi) Pressure gauges may be capped off during pressure testing of the installation.

- (vii) The contractor shall provide all materials, tools, equipments, instruments, services and Labour required to perform the tests and to remove water resulting from cleaning after testing.

#### VALVES

- i) The material of butter fly valves shall be as under: Body- Cast iron Disc- Cast Bronze or Stainless-Steel Seat- Either integral or Nitrile rubber O-ring- Nitrile/Silicon
- ii) Balancing valve shall be of cast iron flanged construction with EPDM/ SG iron with epoxy coated disc with built in pressure drop measuring facility (pressure test cocks) to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation.
- iii) Non return valves shall be of gun metal construction upto 65 mm, the metal conforming to class 2 of IS: 778. For 75 mm and above, the valve shall be of bronze or gun metal, body being of cast iron. While screwed or flanged ends may be provided upto 65 mm, flanged ends shall be provided for larger sizes.
- iv) Air valves shall be of gunmetal body.

#### STRAINERS

- (i) Strainers shall be of 'Y' type or pot type as specified
- (ii) 'Y' strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit.
- (iii) Pot strainers, where specified, shall be provided in return water headers, for chilled water and condenser water if enough floor area is available in the refrigeration plant room, as an alternate to individual Y type strainers with pumps.
- (iv) The strainers shall be designed to the test pressure specified for the gate valves.
- (v) Filtration area of Y-strainer shall be minimum four times the connecting pipe

size.

- (vi) Strainers shall have a removable bronze/ stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet.
- (vii) Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so as to enable blowing out accumulated dirt and facilitate removal and replacement of screen without disconnection of the main pipe.
- (viii) Strainers shall be provided with equal size isolating gate valves on either side so that the strainers may be cleaned without draining the system.

(ix) Pot strainer shall be fabricated out of MS sheet and the sizes shall be as under: -

Pipe sizes (mm)	Pot dia (mm)	Pot Height (mm)	Basket dia (mm)	Basket Height
50	300	400	200	240
80	350	450	250	250
100	450	500	300	280
125	500	600	330	340
150	540	700	360	390
200	610	815	400	470
250	800	955	550	510
300	1000	1105	750	580
350	1190	1300	895	678
400	1350	1500	1020	785
450	1518	1700	1060	890
500	1690	1800	1100	900

## INSTRUMENTS

- i) Pressure gauge of appropriate range and 150 mm. dial size shall be provided at the following locations.
  - a) Supply and return of all heat exchange equipments.
  - b) Suction and discharge of all pump sets.

The pressure gauge shall be duly calibrated before installation and shall be complete with shut off cocks.

- ii) Direct reading industrial type thermometer of appropriate range shall be provided at the inlet and outlet of all heat exchange equipments. The thermometers shall be installed in separate wells.
- iii) iii) Appropriate number of additional sockets shall be provided for the

installation of pressure & temperature transducers for BMS.

#### INSTALLATION

- i) The installation work shall be carried out in accordance with the detailed drawings prepared by the Air-conditioning Contractor and approved by the The Engineer.
- ii) Air-conditioning contractor shall utilize the structural provisions for Airconditioning services wherever provided by the Department in the building and make his own arrangements for additional changes.
- iii) Expansion loops or joints shall be provided to take care of expansion or contraction of pipes due to temperature changes.
- iv) Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- v) Wherever reducers are to be made in horizontal runs, eccentric reducers shall be used if the piping is to drain freely, in other locations, concentric reducers may be used.
- vi) Open ends of piping shall be blocked as soon as the pipe is installed to avoid entrance of foreign matter.
- vii) All pipes using screwed fittings shall be accurately cut to the required size and threaded in accordance with IS: 554 and burs removed before laying.
- viii) Piping installation shall be supported on or suspended from structure adequately. The Air-conditioning contractor shall design all brackets, saddles, clamps, hangers etc. and shall be responsible for their structure integrity
- ix) Pipe supports, preferably floor mounted shall be of steel, adjustable for height and prime-coated with zinc chromate paint and finish-coated gray. Spacing of pipe supports shall not be more than that specified below: -

Nominal Pipe size (mm)	Spacing (Metres)
12 and 15	1.25
20 and 25	2
32, 40, 50 and 65	2.5
80, 100 and 125	2.5
150 and above	3

Extra supports shall be provided at the bends and at heavy fittings like valves to avoid undue stress on the pipes. Pipe hangers shall be fixed on walls and ceiling by means of metallic or raw l plugs or approved shear fasteners.

- x) Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation.

- xi) Anti vibration pads, springs or liners of resilient and non-deteriorating, material shall be provided at each support, so as to prevent transmission of vibration through the supports.
- xii) Pipe sleeves of diameter larger than the pipe by least 50 mm shall be provided wherever pipes pass through walls and the annular spaces shall be filled with felt and finished with retaining rings.
- xiii) Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe with a 12 mm thick rubber pad or any other resilient material as approved by the The Engineer.
- xiv) The space in the floor cut outs around the pipe work (after insulation work where applicable) shall be closed using cement concrete (1:2:4 mix) or steel sheet, from the fire safety considerations, taking care to see that a small annular space is left around the pipes to prevent transmission of vibration to the structure.
- xv) Riser shall have suitable supports at the lowest point.
- xvi) Where pipes are to be buried under ground, the top of the pipes shall be not less than 75 cms. from the ground level. Where this is not practicable, permission of the The Engineer shall be obtained for burying the pipes at lesser depth. The pipes shall be surrounded on all sides by sand cushion of not less than 15 cms. After the pipes have been laid and top sand cushion provided, the trench shall be refilled with the excavated soil and any extra soil shall be removed from the site of work by the Air conditioning contractors.
- xvii) All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of Zinc chromate before being installed
- xviii) After all the water piping has been installed, pressure tested in accordance with clause 10.10, all exposed piping in the plant room shall be given two finish coats of paint, approved by the Engineer-in Charge. Similar painting work shall be done over insulated pipe work, valves etc. The direction of flow of fluid in the pipes shall be indicated with identifying arrows.
- xix) 3 mm gasket shall be used for flanged joints.
- xx) Cut-outs in floor slabs shall be sealed with cement concrete or steel plate after the plumbing work is done, from the fire safety point of view.



**Drains shall be provided at all low points in the piping system and shall be of the following sizes:**

**MAIN LINE SIZE IN MM DRAIN SIZE IN MM**

Upto 300 25 mm

Over 300 40 mm

Drain shall be provided with gate valves of equal size but with rising spindle. Alternatively, ball valves shall be provided. Drain shall be piped through G.I medium class pipe to the nearest floor drain. Piping shall be pitched towards the drain points. Wherever specified, drain pipes for the ceiling suspended units and fan coil units shall be provided with water grade blue HDPE/PVC pipe with screwed joints. The joints shall be proper so that no water leaks over the false ceiling. The pipes shall be tested for leaks to a minimum pressure of 1 KSC before the false ceiling sheets are fixed.

Air vents shall be provided at all high points in the piping system for venting. Air vents shall be of gun metal construction and of automatic type. Similarly drain valves shall be provided at all dirty legs. The size of the valves shall be 25 mm size for pipes up to 100 mm and 40 mm for sizes larger than 100 mm. Drain shall be closed with dummy caps to prevent accidental opening.

**Checklist And Performance Test Data To Be Provided After Installation**

Sl. No.	Description	Unit	Remarks
1.	Hydrostatic pressure conducted as per specification		
2.	Any leaks		
3.	Any defects in joints		
4.	Tested after rectifying defects		
5.	Test witnessed and certified		
6.	Any noise in piping system		
7.	Any water noise in coils		
8.	Any water noise in equipment		
9.	Proper flow achieved through AHU, Chiller, FCU		
10.	Piping insulation checked		
11.	All valves open		
12.	All motorized valves close / open		
13.	Expansion joints provided and checked		
14.	Pipe work cleaned		
15.	Water condition after pipe cleaning checked		
16.	Expansion tank Ball valve functional		

Sl. No.	Description	Unit	Remarks
17.	All strainers clean		
18.	Pressure gauges working		
19.	Thermometers working		
20.	Drain points provided at Low points		
21.	Air vents provided at High points		
22.	Pipe support and spacing checked		
23.	Pipe material checked		

#### BALANCING

- i) After completion of the installation, all water system shall be adjusted and balanced to first minimize throttling losses; then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Exceptions to above:
  - a) Where Variable frequency Drives are used as starter & capacity control.
  - b) Impellers need not to be trimmed nor pump speed adjusted for pumps with pump motors of 7.5 kW (10 hp) or less,
  - c) Impellers need not to be trimmed when throttling results in no greater than 5% of the nameplate horsepower draw, or 2.2 kW (3hp), whichever is greater.
- ii) Automatic control valves (Pressure Independent Balancing cum Control Valve) and three way diverting valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. These shall be permanently
- iii) marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

#### MEASUREMENT

Measurements of plumbing work shall be on following basis: -

- a) Piping shall be measured along the center line of installed pipes including all pipe fittings and accessories but excluding valves and other items for which quantities are specifically indicated in the schedule of work. No separate payment shall be made for fittings and accessories.
- b) The rates for piping work shall include all wastage allowances, pipe supports, hangers, nuts and check nuts, vibration isolators, suspension where specified or required, and any other item required to complete the piping installation. None of these items will be separately measured nor paid for.
- c) Piping measurement shall be taken before application of the insulation in the case of insulated pipe work.

## INSULATION

The insulation of pipes carrying hot or chilled water shall be carried out as per CPWD – 2017 Chapter 11.

### **Pre Balancing Checks**

The Air Balancing should have been completed before the Water balancing begins. The Contractor is to ensure that the following works are completed prior to commencement of water balancing.

- Open all valves to full open position, including coil stop valves, bypass valves, and return line balancing cocks.
- Remove all strainers and clean the same and replace in system.
- Examine water in system and ensure water has been treated and is cleaned. This is to be verified by Owner's representative.
- d)Check pump rotation
- Check expansion tanks to determine they are not air bound and the system is completely full of water.
- Check all air vents at high points of water systems and determine all are installed and operated freely. Bleed any air out of systems.
- Set all temperature controls so all coils are calling for full cooling.
- Check operation of all automatic valves.

Check and set operating temperatures of chillers to design requirements.

### **Initial Balancing**

- Set Chilled Water Pumps to proper gallons per minute delivery.
- Adjust water flow of chilled water through Chiller.
- Check leaving water temperatures and return water temperatures through Chiller.
- Reset to correct design temperatures.
- Check water temperature at inlet side of Cooling coils. Note rise or drop of temperatures from source.
- Proceed to balance each chilled water coil.
- Upon completion of flow readings and adjustments at coils, set all memory stops and record all data.

**Final Balancing**

Upon completion of the above, the final balancing shall be completed as follows:

- a) After adjustments to coils are made, recheck settings at the pumps and Chillers and read just if required.
- b) Install pressure gauges on coil, read pressure drop through coil at set flow rate on call for full cooling. Set Pressure drop across bypass valve to match coil full pressure drop. This prevents unbalanced flow conditions when coils are on full bypass.
- c) Set Chilled Water bypass to pressure differential specified on drawings.
- d) Record and check the following items at each cooling elements:
  - Flow Rate
  - Inlet Water Temperature
  - Leaving Water Temperature
  - Pressure drop of each coil
  - Pressure drop across by pass valve
  - Pump operating suction and discharge pressures and final total discharge head.
  - List of all mechanical specifications of pumps
  - Rated and actual running amperage and KW of Pump Motor

Up on completion of final balancing, all information shall be inserted of a sheet listing all items required by specifications and be included in complete test and balance report. All sheets shall be neatly typed.

Submit sample forms to the M & E Engineer for approval prior to starting balancing.

**6.8. CIRCULATING WATER PUMPS****Scope Of Work**

This chapter covers the general requirements of water circulating pumps for central air-conditioning, central heating, ETAC and cold room applications. This section does not cover either humidification pumps or spray pumps for spray over coils.

**Type**

The pumps shall be centrifugal type direct driven with a 3 phase, 415 + 10%volts, 50 Hz., A.C. motor. The motor for Chilled Water Pumps shall be suitable for use with Variable Frequency Drive. The motor starter for Condenser Water Pump shall be in accordance para

13.9. The motor shall be screen protected drip proof (SPDP) fan cooled or TEFC type. The efficiency class of motors shall be IE 3 class as per IS 12615. The pumps may be either of horizontal split casing (HSC) type with operating speed not exceeding 1500 rpm, or solid casing, mono block type with operating speed not exceeding 3000 rpm as specified in the tender documents. Efficiency of the pumps at selection should be preferably 70 % or above.

### **Rating**

The pumps shall be suitable for continuous operation in the system. The head and discharge requirements shall be as specified in the tender documents. The discharge rating shall not be less than the flow rate requirement of the respective equipments through which the water is pumped. The head shall be suitable for the system and shall take into consideration the pressure drops across the various equipments and components in the water circuit as well as the frictional losses. The pumps offered shall be of high efficiency.

Pump motors greater than or equal to 3.7 kW (5 hp) shall be controlled by variable speed drives

### **Material And Construction**

- i) The centrifugal pumps shall conform to IS 1620. The motor for chilled water pumps shall be suitable for use with variable frequency drive. The motor starter for condenser water pump shall be in accordance with para 13.9. The motor shall be screen protected drip proof (SPDP) fan cooled type. The efficiency class of motor shall be IE 3.
- ii) The pump casing shall be of heavy section close grained cast iron. The casing shall be provided with air release cock, drain plug and shaft seal arrangement as well as flanges for suction and delivery pipe connections as required.
- iii) The impeller shall be of bronze or gunmetal. This shall be shrouded type with machined collars. Wear rings, where fitted to the impeller, shall be of the same material as the impeller. The impeller surface shall be smooth finished for minimum frictional loss. The impeller shall be secured to the shaft by a key.
- iv) The shaft shall be of stainless steel and shall be accurately machined. The shaft shall be balanced to avoid vibrations at any speed within the operating range of the pump.

- v) The shaft sleeve shall be of bronze or gunmetal. This shall extend over the full length of the stuffing box or seal housing. The sleeve shall be machined all over and ground on the outside.
- vi) The bearings shall be ball or roller type suitable for the duty involved. These shall be grease lubricated and shall be provided with grease nipples/cups. The bearings shall be effectively sealed against leakage of lubricant.
- vii) The shaft seal shall be stuffing box type unless otherwise specified, so as to allow minimum leakage compatible with the operation of the seal. The stuffing box shall be of adequate length and shall be packed with graphite asbestos or any other suitable material for the operating temperature. A drip well shall be provided beneath the seal.
- viii) In the case of HSC pumps, the same shall be directly coupled to the motor shaft through, a flexible coupling protected by a coupling guard. In case of mono block pumps with solid casing, the motor and pumps shall be on a common shaft.
- ix) The pump and motor shall be mounted on a common base plate either of cast iron or fabricated from rolled steel section. The base plate shall have rigid, flat and true surfaces to receive the pump and motor mounting feet.

### **Accessories**

Each pump shall be provided with the following accessories: -

- a) Pressure gauges at suction and discharge sides,
- b) Butterfly valves on suction and discharge, and
- c) Reducers, as may be required to match the sizes of the connected pipe work.
- d) Non—return valve at the discharge.

The thermal insulation of the pump casing for hot/chilled water circulating pumps shall be of the same type and thickness as provided for the connected pipe work and is discussed in as per CPWD specifications.

### **Installation**

- i) The pump and motor assembly shall be mounted and arranged for ease of maintenance and to prevent transmission of vibration and noise to the building structure or excess vibration to the pipe work.
- ii) More than one pump and motor assembly shall not be installed on a single base or cement concrete block. The mass of the inertia block shall not be less than the combined mass of the pump and motor assembly. The inertia block shall be vibration isolated from the plant room floor by 25 mm. neoprene or any other equivalent vibration isolation fittings. Where spring mountings are used for vibration isolation, these shall be complete with leveling screws and lock nuts 100 and shall be placed over a concrete plinth for distribution of the mass of the assembly over the plant room floor. The pump motor sets shall be properly aligned to the satisfaction of the The Engineer.

### Painting

The pumps shall be supplied with the manufacturer's standard finish painting.

## 6.9. AIR DISTRIBUTION

### DUCTING

#### SCOPE

This chapter covers the general requirements for sheet metal ductwork for air distribution with associated items such as air outlets and inlets, fresh air intake and fire dampers.

#### MATERIAL

##### Ducts

- i) All ducts shall be fabricated either from Galvanised Sheet Steel (GSS) conforming to IS: 277 or aluminium sheets conforming to IS:737. The steel sheets shall be hot dip galvanized with MAT finish with coating of minimum 120 grams per square meter (GSM)
- ii) The thickness of sheets for fabrication of rectangular ductwork shall be as under. The thickness required corresponding to the longest side of the rectangular section shall be applicable for all the four sides of the ductwork.

Longest side (mm)	Minimum sheet thickness	
	For GSS	For Aluminium

750 mm and below	0.63	0.8
751 mm to 1500 mm	0.8	1
1501 mm to 2250 mm	1	1.5
2251 mm & above	1.25	1.8

## iii) Thickness of sheet for Round Ducts

Diameter of duct, mm	Thickness of Sheet, mm	
	GI sheets	Aluminium Sheets
150 to 500	0.63	0.8
501 to 750	0.8	0.8
751 to 1000	0.8	1
1001 to 1250	1	1.5
1251 and above	1.25	1.8

- iv) All sheet metal connections, partitions and plenums required for flow of air through the filters, fans etc. shall be at least 1.25 mm thick galvanised steel sheets, in case of G.I. sheet ducting or 1.8 mm thick aluminium sheet, in case of aluminium sheet ducting and shall be stiffened with 25 mm x 25 mm x 3 mm angle iron braces.
- v) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended unto date.
- vi) Aluminium ducting shall normally be used for clean room applications, hospitals works and wherever high cleanliness standards are functional requirements.

**Associated Items**

- i) Supply/ return air outlets, F.A. grilles and accessories shall be constructed from extruded aluminium sections.
- ii) Flanges for matching duct sections, stiffening angles (braces) and supporting angles shall be of rolled steel sections, and shall be of the following sizes.

Application	Duct Width	Angle size
Flanges	Upto 1000 mm	35 mm x 35 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	50 mm x 50 mm x 3 mm
Bracings	Upto 1000 mm	25 mm x 25 mm x 3 mm



-do-	More than 1000 mm	40 mm x 40 mm x 3 mm
Support angles	Upto 1000 mm	40 mm x 40 mm x 3 mm
-do-	1001 mm to 2250 mm	40 mm x 40 mm x 3 mm
-do-	More than 2250 mm	Size and type of RS section shall be decided in individual cases

iii) Hanger rods shall be of mild steel and of at least 10 mm dia for ducts upto 2250 mm size, and 12 mm dia for larger sizes.

iv) All nuts, bolts and washers shall be zinc plated steel. All rivets shall be galvanised or shall be made of magnesium - aluminium alloy. Self tapping screws shall not be used.

## CONSTRUCTION

### Ducts

i) Ducts shall be fabricated at site or factory fabricated and shall be generally as per IS: 655 "Specifications for metal air ducts", unless otherwise deviated in these General Specifications.

ii) The interior surfaces of the ducting shall be smooth.

iii) All the ducts upto 600 mm longest side shall be cross broken between flanges by a single continuous breaking. Ducts of size 600 mm and above shall be cross broken by single continuous breaking between flanges and bracings. Alternatively, beading at 300 mm centres for ducts upto 600 mm longest side, and 300 mm centres for ducts above 600 mm size shall be provided for stiffening.

iv) As far as possible, long radius elbows and gradual changes in shape shall be used to maintain uniform velocity accompanied by decreased turbulence, lower resistance and minimum noise. The ratio of the size of the duct to the radius of the elbow shall be normally not less than 1:1.5.

v) Flanged joints shall be used at intervals not exceeding 2500 mm. Flanges shall be welded at corners first and then riveted to the duct.

vi) Stiffening angles shall be fixed to the sides of the ducts by riveting at 1.25 meters from joints for ducts of size 600 mm to 1500 mm, and 0.6 m from joints for ducts of size larger than 1500 mm. Bracings for ducts larger than 1500 mm can alternatively be by diagonal angles.

- vii) Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.
- vii) Plenums for filters shall be complete with suitable access door of size 450 mm x 450 mm.

#### **Air Outlet and Inlets (Supply and Return)**

i) All air outlets and intakes shall be made of extruded aluminium sections & shall present a neat appearance and shall be rigid with mechanical joints.

ii) Square and rectangular wall outlets shall have a flanged frame with the outside edges returned or curved 5 to 7 mm and fitted with a suitable flexible gasket between the concealed face of the flanges and the finished wall face. The core of supply air register shall have adjustable front louvers parallel to the longer side to give upto 22.5 degrees vertical deflection and adjustable back louvers parallel to the shorter side to achieve a horizontal spread air pattern to at least 45 degrees. Return air grilles shall have only front louvers. The outer framework of the grilles shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminium section with minimum thickness of 0.8mm at front and shall be made of 0.8mm thick aluminium sheet. Louvers may be spaced 18 mm apart.

iii) Square and rectangular ceiling outlets/intakes shall have a flange flush with the ceiling into which it is fitted or shall be of anti smudge type. The outlets shall comprise an outer shell with duct collar and removable diffusing assembly. These shall be suitable for discharge in one or more directions as required. The outer shell shall not be less than 1.6 mm thick extruded section aluminium sheet. The diffuser assembly shall not be less than 0.80 mm thick extruded aluminium section.

iv) Circular ceiling outlets/intakes shall have either flush or anti smudge outer cone as specified in the tender specifications. Flush outer cones shall have the lower edge of the cone not more than 5 mm below the underside of the finished ceiling into which it is fitted. Anti smudge cones shall have the outer cone profile designed to reduce dirt deposit 104 on the ceiling adjacent to the air outlet. The metal sheet used for construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

v) Linear diffusers shall have a flanged frame with the outside edges returned 3.5 mm and shall have one to four slots as required. The air quantity through each slot shall be adjustable. The metal sheet used for the construction of these shall be minimum 1.6 mm thick extruded aluminium sheet.

vi) Grilles and diffusers constructed of extruded aluminium sections shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grilles and diffusers shall

have a rear set of adjustable blades, perpendicular to the face blades for deflection purposes.

vii) All supply air outlets shall be fitted with a volume control device, made of extruded aluminium gate section. The blades of the device shall be mill finish/ block shade pivoted on nylon brushes to avoid rusting & rattling noise, which shall be located immediately behind the outlet and shall be fully adjustable from within the occupied space without removing any access panel. The volume control device for circular outlets shall be opposed blade radial /shutter type dampers, or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling/wall outlets and intakes

viii) All the products supplied by contractor should supplement in performance by selection curves of product ratings from the manufacturer.

ix) Laminar supply air diffusers shall be made of 2mm thick powder coated aluminium sheet duly insulated with 5mm thick closed cell polyethylene foam insulation having factory laminated aluminium foil and joints covered with self adhesive aluminium tape and having holes 2/3 mm dia including frame work.

#### Fresh Air Intakes

i) Fresh air intake grills shall be made of extruded aluminium sections.

ii) A flanged frame using RS sections shall be provided on front face to conceal the gap between the louvers and the adjoining wall face. Corners of frame shall be welded. The frame shall be made structurally rigid.

iii) Louvers made from extruded aluminium section shall be in modular panel form for ease of handling. These shall be free from waves and buckles. Vertical blades shall be truly vertical and horizontal blades shall be truly horizontal. Butt joints in blades shall not be accepted.

iv) Additional intermediate equally spaced supports and stiffeners shall be provided to prevent sagging/ vibrating of the louvers, at not more than 750mm centres where the louver's length is longer than 750mm.

v) A bird wire screen made of 12 mm mesh in 1.6 mm steel wire held in angle or channel frame shall be fixed to the rear face of the louver frame by screens.

**BALANCING**

Air systems shall be balanced in a manner to minimize throttling losses. The entire air distribution system shall be balanced with the help of an anemometer. The measured air quantities at fan discharge and at the various outlets shall be within + 5 percent of those specified/quoted. For fans greater than 0.75 KW (1.0 HP), fans must then be adjusted to meet design flow conditions. Branch duct adjustments shall be permanently marked after the air balancing is completed so that these can be restored to their correct position if disturbed at any time.

**MEASUREMENT**

- i) Duct measurements (for insulated ducts) shall be taken before application of insulation
- ii) Duct work shall be measured section wise on the basis of external surface area by multiplying the axial length from flange face to flange face for each section by the corresponding duct perimeter in the centre of that section length.
- iii) Uniformly tapering straight sections shall also be measured as in (ii) above. However, for special pieces like tees, bends etc. area computations for surface areas shall be done as per the shape of such pieces
- iv) The quoted unit rate for external surfaces of ducts shall include all wastage allowances, flanges, gaskets for joints, vibration isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers for position indication, turning vanes, straightening vanes, and all other accessories required to complete the duct installation as per the specifications. These accessories shall not be separately measured.
- v) Grilles and diffusers (except linear diffusers) shall be measured by the cross sectional areas, perpendicular to the airflow, and excluding the flanges. Volume control dampers, where provided shall not be separately accounted for.
- vi) Linear diffusers shall be measured by linear measurements only, and not by cross-sectional areas, and shall exclude flanges for mounting of the linear diffusers. The supply air plenum for linear diffusers shall be measured as described above for ducting.
- vii) Fire dampers shall be measured by their cross sectional area perpendicular to the direction of the airflow. Quoted rates shall include the necessary collars and flanges

for mounting, inspection pieces with access door, fusible link/solenoid with wiring, but excluding the fire detectors, etc.

## Insulations

### General

The scope of this section covers the supply, installation, testing and commissioning of the insulation for chilled water piping, condensate drain piping refrigerant piping, expansion tanks, sheet metal ducting, walls, ceilings & floors of AHU rooms, sheet metal ducting, acoustic lining for supply air ducting etc.,

**Insulation Material:** The material to be used for insulation purpose shall be as under:

Item to be insulated	Material to be used
Condensate, Drain Piping, Refrigerant Piping, Ceiling and Floors etc.,	Closed Cell Elastomeric Nitrile Butadiene Rubber.

- Insulation material shall have **Micro ban anti-microbial** product protection. The antimicrobial product protection shall be an integral part of insulation that is built-in during the manufacturing process and the product protection should not allow the microbes to function, grow and reproduce.
- Resistance towards microbiological growth on insulation surface should confirm to following standards: Fungi Resistance – ASTM G21 and Bacterial resistance – ASTM E 2180.
- Thermal conductivity of Elastomeric Nitrile rubber shall not exceed **0.035 W/m<sup>2</sup>K** at an average temperature of 20°C.
- The insulation shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame as per BS 476 and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class ‘O’ Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Water vapour permeability shall not exceed **1.74 x 10<sup>-14</sup> Kg/m.s.Pa**, i.e. Moisture Diffusion Resistance Factor or ‘**μ**’ value should be minimum **10,000**
- **Density** of Material shall be between **45 to 60 Kg/m<sup>3</sup>**

- The insulation material shall have Microban®\* an anti-microbial product, which is EPA (Environmental Protection Agency), USA Approved, as an integral part of insulation that cannot be washed off or worn off
- The insulation material shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi and should conform to following standards: DIN EN ISO 846 Method A - Fungi / Mould Resistance and DIN EN ISO 846 Method C - Bacterial Resistance.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.
- Microban is a registered trademark of the Microban Products Company, USA.

### **Duct Insulation - Material Specification**

#### **Indoor & Outdoor Application – Duct Insulation – Thermal**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber with UV resistant metal finishing on one side.
- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667.
- Moisture Diffusion Resistance Factor or 'μ' value of laminated insulation material shall be minimum  $\geq 60,000$  as per EN 12086.
- The base foam insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- Density of laminated insulation material shall be between 50 to 65 Kg/m<sup>3</sup>.
- Density of base foam insulation material shall be between 40 to 55 Kg/m<sup>3</sup>.
- The insulation material shall be dust and fibre free.

- The insulation material shall withstand maximum surface temperature of +85 Deg.C and minimum surface temperature of 0 Deg.C as per EN 14706.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- System material is a double layer laminate of aluminium, coated with a special UV protection and a PVC backing.
- Water Absorption by Volume of insulation material shall be < 0.1%.
- System material shall be non-metallic.
- System material shall provide mechanical resistance with an excellent aesthetic look.
- System material shall be glossy finish.
- Weight of System material shall be 340 g/m<sup>2</sup>.
- Thickness of System material shall be 230 microns.
- System material shall have good puncture and tear resistance.
- System material shall have good UV resistance as per ASTM G 26A / ISO 4892-2 Method A.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.

### **Duct Insulation - Material Specification**

#### **Indoor Application – Duct Insulation – Thermal**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber with aluminium foil laminated on one side.
- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN 12667.

- Moisture Diffusion Resistance Factor or 'μ' value of insulation material shall be minimum 12,000 without any external barrier as per EN 12086.
- The insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- The insulation material shall have fire performance of V0, HB as per UL 94, 1996.
- The insulation material shall be FM (Factory Mutual), USA Approved.
- Density of insulation material shall be between 40 to 55 Kg/m<sup>3</sup>.
- The insulation material shall be dust and fibre free.
- The insulation material shall withstand maximum surface temperature of +85 Deg.C and minimum surface temperature of 0 Deg.C as per EN 14706.
- The Aluminium foil shall be of 12 micron thickness with reinforced glass scrim and weight shall be 70 gsm as per EN 22286, tensile strength shall be 250N/50mm as per ISO 527-3 with elongation of 4% as per DIN 53354.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.
- Pipe Insulation - Material Specification

#### **Indoor Application – Piping Insulation – Thermal**

- Insulation material shall be Closed Cell Elastomeric Nitrile Rubber with aluminium foil laminated on one side.



- Thermal conductivity of insulation material shall not exceed 0.035 W/(m.K) at mean temperature of 0°C as per EN ISO 8497.
- Moisture Diffusion Resistance Factor or 'μ' value of insulation material shall be minimum 12,000 without any external barrier as per EN 13469.
- The insulation material shall have fire performance such that it passes Class 1 as per BS476 Part 7 for surface spread of flame and also passes Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire category as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- The insulation material shall have fire performance of V0, HB as per UL 94, 1996.
- The insulation material shall be FM (Factory Mutual), USA Approved.
- Density of insulation material shall be between 40 to 55 Kg/m<sup>3</sup>.
- The insulation material shall be dust and fibre free.
- The insulation material shall withstand maximum surface temperature of +105 Deg.C and minimum surface temperature of 0 Deg.C as per EN 14707.
- The Aluminum foil shall be of 12 micron thickness with reinforced glass scrim and weight shall be 70 gsm as per EN 22286, tensile strength shall be 250N/50mm as per ISO 527-3 with elongation of 4% as per DIN 53354.
- The material shall have ODP (Ozone Depletion Potential) and GWP (Global Warming Potential) of Zero.
- Thickness of the insulation shall be as specified for the individual application.
- The insulation material shall be installed as per manufacturer's recommendation.

### **Fire Dampers**

- Fire dampers shall be provided in all the supply air ducts and return air ducts (where provided), return air passage in the air-handling unit room and at all

floor crossings. Access door will be provided in the duct before each set of fire dampers.

- Fire dampers shall be multi blade louvers type. The blade should remain in the air stream in open position & shall allow maximum free area to reduce pressure drop & noise in the air passage. The blades and frame shall be constructed with minimum 1.6mm thick galvanised sheet & shall be factory fitted in a sleeve made out of 1.6mm galvanised sheet of minimum 400mm long.
- Fire dampers shall be Fusible linkage type. It shall be supplied with spring loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature. Fire damper shall also close on receipt of fire alarm signal to cut off air supply instantaneously. An electric limit switch shall also be operated by the closing of fire damper, which in turn shall switch off power supply to AHU blower motor as well as strip heaters.
- Fire dampers shall be CBRI tested & certified for 90 minutes rating against collapse & flame penetration as per UL 555-1995.(Under writers laboratories)
- Fire dampers shall be compatible with the fire detection system of building & shall be capable of operating automatically through an electric motor on receiving signal from fire alarm panel.
- Necessary wiring from fire alarm panel up to AHU electric panel shall be provided by the department & further from AHU electric panel to fire damper shall be provided by air conditioning Contractor.

### **Mode Of Measurement**

Representatives from the Contractor and Engineer shall conduct a joint inspection of the Equipment's. All the discrepancies observed either incomplete works or defective work shall be clearly indicated in the joint inspection report. The mode of measurements given below is for the purpose of measurement and payment and the scope of works shall be as specified elsewhere in the specification.

### **6.10. TESTING OF ELECTRICAL WORK**

- Supply necessary meters, instruments, temporary wiring and Labour to perform all required tests and adjustment of equipment and wiring installed and connected under this Sub Contract, including the electrical equipment supplied by others to determine proper polarity, phasing, freedom from earth faults and shorts and the proper operation of equipment, meters relays etc.

- All materials and manner of installation shall be in strict accordance with the applicable requirements of the local Authorities. The installation must pass all inspections, and will be subject to the approval of such authorities and the Engineer.
- Wherever any codes, laws, etc., require any work to be tested or approved the Contractor shall provide proper facilities for access and for inspection, all at his own expense.
- Tests shall be made for continuity and identification of each conductor. Both ends of a given conductor shall be identified alike. Before circuit terminal connections are made, continuity and identification shall be checked by means of a D.C. test device using a bell or buzzer or battery powered phone to ring out the wires.
- All earth tests shall be made with 100 volt merger test-type instrument.
- Test each circuit for grounds and shorts by means of a merger insulation testing instrument which shall impress a voltage of not less than 100 volts D.C. upon the circuit under test. Any circuit showing an insulation resistance less than the minimum values given in the Wiring Rules shall be investigated and weak points corrected. All circuits under merger insulation test shall be connected to the respective final terminals and switches or breaker, in the 'OFF' position.
- Correct or replace any nominal current carrying circuit which is defective or earthed. Also correct all troubleen countered by test and set breakers and relays as directed so that equipment will be in proper operating condition, before being placed in service.
- Following establishing procedure, equipment will be energized after certification that the installation is Satisfactory .Final operational tests shall determine that the wiring connections are correct.

#### **6.11. PRE BALANCE CHECKS AND START UP**

The Air and Water Systems will be checked out at specified below, and started up prior to balancing.

- Complete "water pressure and duct pressure testing for leakage.

- Complete all 'Punch List' check items.
- Install all dampers and other balancing devices as called for in the construction documents and verify the same are properly installed, indexed and in good working order.
- Check all motor starters and verify that the heater sizing is correct, taking length of electrical feeders into consideration. Record amp readings on all motors.
- Check out and align all equipment drives.
- Set all fan sheaves to provide the indicated capacities at specified static pressures (RPM as specified).
- Set all manual balancing dampers, valves and balancing valves at 100% open position. Verify that all fire dampers are open
- All adjustable pitch pulleys shall be removed from the motor shaft. The shaft and pulley threads shall be
- Cleaned, lightly oiled, and pulley remounted, aligned and properly adjusted.
- Clean interior of all plenums, casings and ducts and install all filters before starting systems.
- Make sure all controls systems are calibrated and functioning properly.
- Place all systems in automatic operation.
- Operate systems for 16 consecutive hours without shutdown with all equipment in perfect working order.
- Manufacturers' representative must be present at initial start- up all equipment.
- Check fan and pump bearings for grease.
- Install clean pre filters and install high efficiency filters in all systems prior
- To starting air balance.
- Provide availability of personnel from all the related mechanical and
- Controls Contractors during balancing.

## **6.12. TEST REPORTING FORMS FOR AIR SIDE**

### **General**

Test forms used for testing and balancing shall be set up to include the following information. Each sheet shall have job name and address, name of air conditioning sub-Contractor, architect and engineer instruments used to perform tests, and name of test technician or test

engineer. All forms shall be submitted in typewritten form. minimum of 6 copies shall submit

#### **.Diffusers, Grilles and Registers -Test Sheets**

- Fan Systems and/or zone number
- Room number or area designation
- Outlet code number which shall correspond to code number of outlet on air balance code drawing.
- Size of Outlet -.
- Type of Outlet -.
- Manufacturer of Outlet
- Manufacturer's effective area for each size
- Required FPM and required CFM of each outlet
- Available FPM and CFM of each outlet

#### **APPLICATION OF ACOUSTIC LINING IN AHU ROOMS**

- i) The wall/ roof surface should be thoroughly cleaned with wire brush.
  - ii) A 610x610 mm frame work of 25mm x50mm x50mm x50mm x25mm shape channel made of 0.6mm thick G.S.S. shall be fixed to walls leaving 610mm from floor by means of raw plugs in walls and dash fasteners in ceiling. Similar frame work shall also be fixed on ceiling by means of dash fasteners.
  - iii) Resin bonded glass wool/ mineral wool as specified cut to size will be friction fitted in the frame work and covered with tissue paper
  - iv) Aluminium perforated sheet having perforation between 20-40% of thickness not less than 0.8mm shall be fixed over the entire surface neatly without causing sag/ depression in between and held with screws. Sheet joints should overlap minimum 10mm.
- iv) Aluminium beading of 25mm wide and thickness not less than 1.00 mm shall be fixed on all horizontal/ vertical joints by means of screws.

#### **MEASUREMENT OF INSULATION**

- a) Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurements shall be taken before the application of the insulation. For piping measurements, all valves, orifice plates and

strainers shall be considered strictly by linear measurement along the centre line of the pipes, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

- b) Duct insulation and acoustic lining shall be measured on the basis of surface area along the outer surface (ref IS14164 of 2008) of insulation thickness. Thus the surface area of externally thermal insulated or acoustically lined duct shall be based on the perimeter at the centre of thickness of insulation, multiplied by the centre-line length of ducting including tapered pieces, bends, tees, branches etc. as measured for bare ducting. In the case of tapering pieces, their average perimeter shall be considered.

### **6.13. MECHANICAL VENTILATION SYSTEM**

#### **SCOPE**

This chapter includes supply air fan, exhaust air fan and evaporative type air cooling plant. Specification for all associated works such as ducting, plumbing, electrical works etc are same as for air-conditioning works covered under CPWD – 2017 chapter 9, 10 and 13. For system para 2.3 may be referred.

#### **CENTRIFUGAL FANS**

- i) Centrifugal fans shall be of double-width, double-inlet construction, with bearing on both sides, complete with access door, squirrel-cage induction motor, V-belt drive, belt guard etc.
- ii) Housing shall be of heavy gauge sheet steel in welded construction. It shall be rigidly reinforced and supported by structural angles. Split casing shall be provided on larger sizes of fans. However neoprene/ asbestos packing shall be provided throughout split joints to make it airtight. 1.2 mm galvanised wire mesh inlet guard, of 5 cms sleeves shall be provided on both inlets. Housing shall be provided with access door with quick locking tension handles and neoprene gasket. Rotation arrow shall be clearly marked on the housing.
- iii) Fan wheel shall be of GSS and backward curved non-overloading type unless otherwise specified. Fan wheel and housing shall be statically and dynamically balanced. Fan outlet velocity shall not exceed 610 meters per minute.
- iv) Shaft shall be constructed of steel, turned, ground and polished.
- v) Bearings shall be of the sleeve/ball bearing type mounted directly on the fan housing. Bearing shall be self-aligned, oil grease packed, pillow block type.

- vi) Drive to fan shall be provided from 3 phase electric motor through belt with adjustable motor sheave and belt guard. Belt shall be of the oil resistant type. The number of belts shall be not less than two.
- vii) Drive motor shall be in accordance with para 6.2.3.4.(v).
- viii) Motor starter shall be in accordance with para 13.9.

#### AXIAL FLOW FANS

i) Casing shall be constructed of heavy gauge sheet steel. Casing shall be provided with hinged door enabling easy replacement of wheel, 149 shaft and bearings. A small inspection door with handle and neoprene gasket shall also be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts

Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be de-rusted, cleaned, primed and finish coated with enamel paint.

ii) Rotor hub and blades shall be of cast aluminium, or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blade mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control maybe manually readjust able at site, upon installation, for obtaining actual airflow values, as specified.

iii) Motor shall be of 3 phase squirrel-cage totally enclosed, fan cooled type. Motor and starter shall be in accordance with para 6.2.3.4(v) and 13.9 respectively. The speed of fan shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1450 RPM for fans with impeller diameter of 450 mm and less.

iv) Drive

#### For Duct/Wall Mounted Fan:

For duct/wall mounted fans the impeller shall be mounted directly on the motor. Drive unit and impeller shall be totally enclosed inside the duct.

#### For Floor/Ceiling Mounted Fan:

The fan shall be provided with belt drive and adjustable motor sheave, standard sheet steel belt guard with vented front for heat dissipation. Belt shall be of the oil resistant type.

#### Vibration Isolation

Base shall be provided for each fan. Base for both fan and motor shall be built as an integral part and shall be mounted on a concrete foundation through cushy foot vibration isolators.

The concrete foundations shall be at least 15 cm above the finished floor level and shall be further isolated from the structural floor through 5 cm. Thick layers of sand all around, topped with bitumen. In case ceiling hung fan within the ceiling shall be provided Vibration Isolation Suspension (VIS) shall be provided in each of string.

#### PROPELLER FANS

- i) Propeller fans shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.
- ii) Mounting plate shall be of heavy gauge sheet steel construction, streamlined venturi inlet (reversed) for supply applications. The size shall suit the fan size.
- iii) Fan blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub as
- iv) Motor shall be standard (easily replaceable) single phase, permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeves or ball bearings, designed for quiet operation with a maximum speed of 1000 RPM for fans of 3 cm. dia or larger and 1440 rpm for fans of 31 cm. dia and smaller. Motors for larger fans shall be suitable for 415 + 10% volts, 50 cycles, 3 phase, power supply. Motors shall be suitable for either horizontal or vertical services, as indicated in drawing/ schedule of quantities.
- v) The following accessories may be required and provided with propeller fans, as indicated in the tender specifications.
  - a) Wire guard on inlet side and bird screen at the outlet.
  - b) Gravity operated louver shutters built into a steel frame.
  - c) Regulators for controlling fan speed for single phase fan motors

#### ROOF MOUNTED FANS

- i) Roof mounted fans shall be propeller type or centrifugal fans, direct driven or belt driven, complete with motor drive and housing with weather-proof cowl.
- ii) Housing shall be constructed of heavy gauge steel sheet. The housing shall have adjustable flange to facilitate installation and shall be especially adapted to receive fan, motor, and drive. The housing shall have a low silhouette. For belt driven units,



motor shall be installed in ventilated water proof housing outside the air stream. The discharge cowl shall be hinged along one edge for easy access to motor and drive for inspection and maintenance. The entire assembly shall be weatherproof and raised from the roof terrace sufficiently to prevent down flow of rain water accumulated on the terrace. Galvanised steel mesh bird screen shall be provided on all discharge cowls around the outlet areas.

iii) Fans shall be backwardly inclined centrifugal wheel or propeller type as required, designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.

iv) Single phase motor shall be shaded pole with permanently lubricated sleeve bearing, or split capacitor type with permanently lubricated sleeve or ball bearings, designed for quiet operation. Bearing shall be 151 designed for vertical mounting. Motor name plate horsepower shall be such that the motor shall not be overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable. Motor's power supply characteristic and maximum speed shall be as specified for propeller fans

v) Fan bearings shall be heavy duty, self-aligning sleeve/ball bearing designed for thrust load and sealed for grease retention.

vi) Backdraft damper shall be provided where specified. Roof mounted fan shall be equipped with rattle-free backdraft damper to prevent air from re-entering the fan when fan is not in operation, thu

#### **6.14. LIST OF APPROVED MAKES FOR CHILLED WATER AIR CONDITIONING SYSTEMS**

##### **Enclosed**

- **BILL OF QUANTITY:** Enclosed
- **LIST OF DRAWINGS:** Enclosed

Items which are not mentioned in below list but required at site, can be taken from the approved list of Approved make of PWD Assam etc. Furthermore, the materials/equipment to be used which are not mentioned in any of the below list should have ISI or equivalent it shall be Certified from the engineer incharge during execution

##### **LIST OF PWD APPROVED MAKES OF MATERIAL FOR HVAC:**

<b>Sl. No.</b>	<b>Material / Items</b>	<b>Approved Makes/ Brands</b>
1	Chiller pumps.	Xylem / Armstrong / Grundfos
2	Air Handling Unit (AHU)	Zeco Aircon / Edgetech / VTS / System Air

<b>Sl. No.</b>	<b>Material / Items</b>	<b>Approved Makes/ Brands</b>
3	Fan Coil Unit (FCU)	Zeco Aircon/ Edgetech / Carrier / VTS
4	Centrifugal Fan for AHU	Kruger / Wolter / Nicotra / Greenheck
5	Air filter (Pre/fine/Hepa etc.)	Mechmaark / Pyramid / Camfil /Thermodyne
6	Ventilation Fan (Centrifugal /	Kruger / Systemair
7	Propeller Fan	Kruger / Systemair
8	Inline Fan	Kruger / Systemair/ Ostberg
9	MS Pipe / G.I. Pipe	TATA/ SAIL / Jindal (Hissar)
10	Pressurized Expansion Tank &Air Separator	Grundfos / ITT / Anergy
11	Butterfly Valve	Advance / Audco / AIP / Zoloto / Honeywell
12	Balancing Valve	Advance/ Audco/ AIP /Siemens /Honeywell
13	Check Valve	Advance/ Audco/ AIP / Honeywell
14	Y —Strainer	Sant/ AIP / Rapidcool / Emerald
15	Pot Strainer	Sant/ AIP / Rapidcool / Emerald
16	Ball valve h & hout strainer	Audco / Sant / AIP / Rapidcool / Castle /Kirloskar
17	Motorized Butterfly valve	Belimo / Siemens / Danfoss / Johnson Controls
18	Pressure Gauge	Fiebig / H-Guru / Emerald / Anergy
19	Thermometer	Fiebig / H-Guru / Emerald / Anergy
20	Flexible pipe connection	Resitoflex / Kanwal /Dunlop / Easyflex
21	Closed Expansion Tank	CIMM / Wellmate / ITT
22	Auto air vent h stop valve	Rapid Cool / Anergy / AIP / Emerald / Fiebig
23	Factory Fabricated Rectangular Duct	Zeco Aircon / Edgetech / Rolastar

<b>Sl. No.</b>	<b>Material / Items</b>	<b>Approved Makes/ Brands</b>
24	Vibration isolator / Rubbed pad / Duct support Arrangement	Dunlop / Resistoflex /Emerald
25	Volume Control Damper, Fresh / Exhaust air louver	Conaire / Pineair / Caryaire / Dynacraft / System Air
26	Grille / Diffuser / Jet Nozzle	Conaire / Pineair /Caryaire / Dynacraft / System Air
27	Fire Damper	Conaire / Pineair /Caryaire / Dynacraft /System Air / Ruskin / Trox
28	Nitrile Rubber Insulation	Armacell / K - Flex
29	Fastener	Hilti / Wurth / Fisher
30	Motor for AHU Fan	Siemens / ABB / Crompton
31	Motor for Ventilation Fan	Siemens / ABB / Crompton
32	Paint	Nerolac / Asian / Berger
33	Strip Heater	KEPL / Rapidcool / Emerald / Danfoss/ Siemens
34	Pan Humidifier	KEPL / Rapidcool / Emerald / Danfoss/ Siemens
35	Copper Tubes/Pipe	Rajco / Mandav tubes / Uniflow
36	Copper Tubes/Pipe	Rajco / Mandav tubes / Uniflow
37	DX- Hi-Wall Split AC Units	Mitsubishi Heavy, Mitsubishi Electric, Daikin, , Bluestar, Samsung, Carrier, LG
38	FCU Valve Package	Calefi / CNM / ATS
39	Thermostate	Dunlop / JOHNSON CONTROL/ SIEMENS
40	Copper Refrigerant Pipe Insulation	Armacell / K - Flex

**7. ALLIED SERVICES**

## **7.1. MEDICAL GAS PIPELINE SYSTEM (MGPS)**

### **7.1.1. SCOPE OF WORK**

**The Medical Gas Pipe Line System (MGPS) includes the following items to be included on turn key basis, as per individual site requirements:**

- Provision to connect to LMO tank system (of required capacity) which will be the primary source. Provision includes supply & commissioning of Control Panel & Automatic Switch overs which is part of the secondary source.
- Secondary oxygen manifold and emergency oxygen manifold with automatic control panels with switch over systems.
- Nitrous oxide manifold and emergency NO manifold with automatic control panel.
- CO2 Manifold and Emergency CO2 Manifold with automatic control panel.
- Medical Air 2 Supply System (4 Bar & 7 Bar) complete.
- Medical Vacuum (suction) Supply System Complete.
- AGSS systems complete Distribution Piping Complete with accessories.
- Area Valve Service Unit System.
- Control cabling from / to control panel and associated sensors Alarm systems (master & area).
- Gas Outlets with Probes.
- Surgeon Control Panel
- Bed Head Panels.
- Wall outlet boxes
- Anaesthesia Pendant
- Surgeon Pendant
- BPC Flow Meter
- Terminal Vacuum unit
- Theatre Vacuum Units
- Other associated works.
- Comprehensive Maintenance of MGPS Installations.

**7.1.2. The design of this MGPS installation must;**

- a) Ensure Quantity of Supply
- b) Ensure Identity of Supply
- c) Ensure Continuity of Supply
- d) Ensure Quality of Supply

**7.1.3. OXYGEN SCOPE AND TECHNICAL SPECIFICATION****Oxygen Supply Systems****Provision to Liquid Medical Oxygen Tank**

A ball valve (closed) is fixed on the feeder line of oxygen delivery system which can be opened when the LMO tanks are included in the MGPS, for delivery of oxygen to the main distribution line, as primary delivery system. The valve fixed on the oxygen copper pipeline is before the automatic control panel of oxygen delivery system.

**Oxygen Manifold Supply System (without Cylinders)**

The size of Manifolds shall be as mentioned in BOQ of respective site/ hospital and it shall be compatible with Class-D type bulk cylinders. Manifold shall consist of two high pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection.

Each header bar assembly shall be provided with a high pressure shut off valve. Oxygen Manifold shall consist of respective numbers of class D-type bulk oxygen cylinders. The manifold shall be hydraulically tested to atleast 3000 psig. The manifold shall be so designed that it shall suit easy cylinder changing and positioning. The system shall have non – return valves for easy changing of cylinders without closing the bank along with individual cylinder valve and pressure relief valve. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized. Shall be BIS/European CE certified.

**Oxygen Flow meter with Humidifier Bottle for other than ICU area**

Back Pressure Compensated flow meter for accurate gas flow measurement with following features:

Control within a range of 0-15 LPM.

It shall strict and durability standard.

The flow meter body shall be made of brass chrome plated materials.

The flow tube and shroud components shall be made of clear, impact resistant polycarbonate.

Flow tube shall have large and expanded 0-15 LPM range for improved readability at low flows.

Inlet filter of stainless-steel wire mesh to prevent entry of foreign particles.

The humidifier bottle is made of unbreakable & reusable polycarbonate/poly sulfone material auto clavable at 121 degrees centigrade.

### **Oxygen Flow meter & Humidifier Bottle for ICU**

Back Pressure Compensated flow meter for accurate gas flow measurement with following features:

Control within a range of 0-15 LPM.

It shall strict and durability standard.

The flow meter body shall be made of brass chrome plated materials.

The flow tube and shroud components shall be made of clear, impact resistant polycarbonate.

Flow tube shall have large and expanded 0-15 LPM range for improved readability at low flows.

Inlet filter of stainless-steel wire mesh to prevent entry of foreign particles.

The humidifier bottle is made of unbreakable & reusable polycarbonate/polysulfone material autoclavable at 121 degreescentigrade.

The humidifier should completely made of polycarbonate and it can be sterilized in autoclave at 121 °C for 15 min.

For the inlet connection it should have some snap inserts, identified with color-coded, with different threads to be chosen by the end user.

An ergonomic and big size rotating nut allows to easily connect and disconnect the humidifier to the oxygen supply device, the 360° rolling positioning hose connector ø

6 - 9 mm allows an easy use of the humidifier.

The bottle should have hollow shape, besides being a design unique element, offers the operator an easy and safe handling. The humidifier should have an integrated relief valve.

Shall be European CE certified with 4 digit notified body no./UL Listed/ETL listed.

#### **Fully Automatic Oxygen Control Panel (for High Pressure Oxygen Manifold Cylinder)**

Automatic control panel shall be constructed in accordance with the requirement of international standards. The fully automatic oxygen control panel shall comply with HTM 02-01/ ISO- 7396-1/ NFPA 99C standards and Medical Device Directive 93/42/EEC. It shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

The specifications shall be referred in the following order of preference:1) HTM 02-01,2) ISO 7396-1 3) NFPA 99. The preference shall be to follow Single Standard as specified above for relevant equipment

Product should be mechanical tested & certified from Third party for:

1. Regulators Ignition Test
2. BAM Test (Bacterial Analytical Test)
3. Adiabatic certification (thermodynamic process)
4. Pressure Test
5. Flow Test
6. Pneumatic Test in case of power failure.
7. Indicators Test
8. Change Over manifold test
9. Gauge Calibration test

The manifold assembly shall provide two stages of pressure regulation Each manifold header bar assembly shall be provided with a high pressure shut off valve along with individual cylinder valve. The Control Panel must have 2 stage network pressure reducing system equipped with safety valves, first stage reducer to reduce the high pressure from the source to



a medium pressure and the second stage reducer to reduce the medium pressure to the line pressure to ensure safety.. A single stage primary regulator, one for each cylinder bank shall be used to initially reduce cylinder pressure and two single stage pressure regulators shall be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one shall be ready for service in a standby mode. The Manifold control panel shall be with digital display, fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. It must have pressure gauges at all important control points so that the state of the system can still be assessed even in the event of a power failure. Changeover shall be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure (in case of electronically operated) the valves shall automatically open to provide an uninterrupted gas flow. Major valve must be of brass to avoid wear and to have long lasting service free lifetime. It shall be 100% automatic and shall not require manual adjustment. An emergency supply point via NIST connector coupling must be provided to ensure uninterrupted gas supply in case of any emergency during maintenance/ service.

**Indication for changing the cylinders shall be clearly identified on the front of the control panel.**

All functional components shall be enclosed in corrosion resistant robust material. The electronic control unit must be enclosed in galvanized metal housing, terminal strip on electronic housing to ensure safety. The power supply (AC-DC Converter unit) must be external to the Control panel to ensure safety. All components inside the Control Panel like Pressure Regulators, piping and control switching equipment shall be cleaned for Oxygen Service and installed inside the cabinet made of mild steel with epoxy powder coated with a viewing window to monitor digital display to minimize tampering with the regulators or switch settings. The cabinet must have hydraulically operated doors and should be able to operate/open easily (hydraulically) to save space during service or maintenance.

All functional components shall be enclosed in corrosion resistant robust material. The electronic control unit must be enclosed in galvanized metal housing, terminal strip on electronic housing to ensure safety. The power supply (AC-DC Converter unit) must be external to the Control panel to ensure safety.

All components inside the Control Panel like Pressure Regulators, piping and control

switching equipment shall be cleaned for Oxygen Service and installed inside the cabinet made of mild steel with epoxy powder coated with a viewing window to monitor digital display to minimize tampering with the regulators or switch settings. The cabinet must have hydraulically operated doors and should be able to operate/open easily (hydraulically) to save space during service or maintenance.

The Control Panel shall include two pressure relief valves, one high pressure approximate 200/350psi and one low pressure approximate 75 psi.

The heavy duty control panel shall be provided with a flow capacity of 1500 or more LPM at 50 to 60 psi or as per design.

The Automatic Control Panel shall be installed in such a way to meet the peak flow requirement of the Hospital/Institute (If the requirement is more than flow capacity requirement automatic control panel the bidders has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute)

Control Panel should have automatic acknowledgement/ reset facility. The manifold panel must be connected with Master Alarm to show the parameters on Master Alarm Panel.

#### **Automatic switch over of source gas of Medical oxygen**

##### **Technical Specs: -**

- Auto Change over Unit comes with IoT Capability and Compact Design with LCD Touch Screen Control System. Capable of supply from 3 different sources:
- Primary Source: - MBC Dura Cylinder 1.
- Secondary Source: - MBC Dura Cylinder 2.
- Reserve Source: - D Type Bulk Cylinder Manifold.
- Supply Sources can be customized as per the Hospital requirement/Need
- Auto Change Over / Augment System works with either Pressure based on the availability of supply sources
- If the selected Primary Source failed to supply at required pressure, the secondary available source will augment to compensate the required pressure. when the primary source reaches normal condition, the augmented source supply turned off automatically.

- Abnormalities of the Gas Pressure warnings to be communicated with respective persons via Telegram messages and Email (Customized feature) until the pressure level restored to the normal condition.

**Features: -**

- Compact Design with 10.1 HMI Inch LCD Touch Screen.
- Device/Sensor/Valve failure Alert / Error message will display until it gets rectified.
- Capable of storing device data logging into SD Card for Reporting Purpose download data logging from SD Card into Excel File report can be generated to check flow and overall consumption for the given period.
- Control panel access are password protected.
- BMS System Incorporated

**7.1.4. NITROUS OXIDE SYSTEM****Fully Automatic Nitrous Oxide Control Panel**

The fully automatic N<sub>2</sub>O control panel shall comply with HTM 02-01/ ISO 7396-1/ 2NFPA 99 C STANDARDS and Medical Device Directive 93/42/EEC. It shall be European CE Certified with 4 digit notified body number or American ETL/American UL listed.

The specifications shall be referred in the following order of preference:

- 1) HTM 02-01,ISO 7396-1 3) NFPA 99. The preference shall be follow Single Standard as specified above for relevant equipment.

Product should be mechanical tested & certified from Third party for:

1. Regulators Ignition Test
2. BAM Test
3. Adiabatic certification
4. Pressure Test
5. Flow Test
6. Pneumatic Test in case of power failure.
7. Indicators Test
8. Change Over manifold test

### 9. Gauge Calibration test

The manifold assembly shall provide two stages of pressure regulation. Each manifold header bar assembly shall be provided with a high pressure shut off valve along with individual cylinder valve. The Control Panel must have 2 stage network pressurereducing system equipped with safety valves, first stage reducer to reduce the high pressure from the source to a medium pressure and the second stage reducer to reduce the medium pressure to the line pressure to ensure safety. A single stage primary regulator, one for each cylinder bank shall be used to initially reduce cylinder pressure and two single stage pressure regulators shall be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one shall be ready for service in a Standby mode. The Manifold control panel shall be digital, fully automatic type and switches from “Bank in Use” to “Reserve bank “without fluctuation in delivery supply line Pressure. It must have pressure gauges at all important control points so that the state of the system can still be assessed even in the event of a power failure.

Changeover shall be performed by electrically/ pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure (in case of electrically operated) the valves shall automatically open to provide an uninterrupted gas flow. Major valve must be of brass to avoid wear and to have long lasting service free lifetime.

The manifold shall not require any manual resetting or adjustments after the replacements of the depleted cylinders. An emergency supply point via NIST connector coupling must be provided to ensure uninterrupted gas supply in case of any emergency during maintenance/ service.

All functional components shall be enclosed in corrosion resistant robust material. The electronic control unit must be enclosed in galvanized metal housing, terminal strip on electronic housing to ensure safety. The power supply (AC-DC Converter unit) must be external to the Control panel to ensure safety.

The Control Panel shall include two pressure relief valves, one high pressure approximate 200 psi and one low pressure approximate 75 psi. The control panel shall also have heaters to prevent ice formation on the regulators at high flow rates.

The Control Panel shall be made to provide Heavy Duty and have a flow capacity of 1500 LPM or more at 50to 60 psi. The Automatic Control Panel shall be installed in such a way to meet the peak flow requirement of the Hospital/Institute (If the requirement is more than flow

capacity requirement automatic control panel the bidder has to supply 02 numbers of Automatic Control Panel and design the system in such a way to meet the flow requirement of respective institute).

All components inside the Control Panel like Pressure Regulators, piping and control switching equipment shall be cleaned for Nitrous Oxide Service and installed inside the cabinet made of mild steel with epoxy powder coated with a viewing window to monitor digital display to minimize tampering with the regulators or switch settings. The cabinet must be able to operate/open easily (hydraulically) to save space during service or maintenance.

Control Panel should have automatic acknowledgement/ reset facility.

The manifold panel must be connected with Master Alarm to show the parameters on.

Master Alarm Panel.

**Nitrous Oxide Manifold (Without Cylinders) The size of Manifolds shall be as mentioned in BOQ of respective Institute and it shall be compatible with Class-D type bulk cylinders.**

Manifold shall consist of two high-pressure header bar assemblies to facilitate connection of primary and secondary cylinder supplies. Each header bar shall be provided with respective number of cylinder pigtail connections to suit cylinder valves as per IS.3224/ BS/ ASME incorporating a check valve at the header connection. Each header bar assembly shall be provided with a high pressure shut off valve along with individual cylinder valve. The manifold shall be hydraulically tested to at least 3000 psi.

The manifold shall be so designed that it shall suit easy cylinder changing and positioning. The cylinder shall be locked with the help of cylinder brackets and fixing chains which shall be galvanized. Shall be BIS/European CE certified with 4 digit notified body no./ UL Listed/ETL listed.

Emergency N<sub>2</sub>O Manifold (Without Cylinders)

The size of Manifolds shall be as mentioned in BOQ of respective Institute and it shall be compatible with Class-D type bulk cylinders.

Manifold shall consist of high-pressure header bar assemblies to facilitate connection of cylinder supplies. Header bar shall be provided with respective numbers of cylinder pigtail connections to suit cylinder valves as per IS 3224/ BS/ ASME incorporating a check valve at the header connection. Header bar assembly shall be provided with a high pressure shut off

valve. Nitrous oxide manifold shall consist of respective numbers of cylinders.

The manifold shall be hydraulically tested to at least 3000psig. The manifold shall be so designed that it shall suit easy cylinder changing and positioning. The system shall have non – return valves for easy changing of cylinders without closing the bank. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized. Shall be BIS/European CE certified with 4 digit notified body no./ UL Listed/ETL listed.

### **Carbon Di Oxide System**

The system shall consist of medical CO2 Manifold Primary & Standby (as per the 2 configurations mentioned in NIT) with Class-D type Cylinders and control panel. Control panel of CO2 shall be European CE Certified or American ETL/ American UL 2listed.

The Modular Manifold supply system shall provide carbon dioxide piped distribution system.

The Modular Manifold system shall be in such a way that it increases flexibility and allows easy enlargement of the manifold capacity in case of future expansion. Shall be compliant with HTM 02-01/ISO 7396-1/ NFPA 99 C standard and Medical Device Directive 93/42/EEC. The specifications shall be referred in the following order of preference :1) HTM 02-01, ISO 7396-1 , 3) NFPA 99. The preference shall be follow Single Standard as specified above for relevant equipment. The system shall have non – return valves for easy changing of cylinders without closing the bank along with individual cylinder valve and pressure relief valve. The cylinder shall be placed with the help of cylinder brackets and fixing chains which shall be galvanized.

### **Fully Automatic Control panel for CO2 System**

The Manifold Control System shall supply any type of medical gas from both left and right hand manifold banks. Operation and performance criteria shall fully satisfy the requirements of HTM 02-01/ ISO 7396-1/ NFPA 99 C standard. The fully automatic CO2 control panel shall comply with the standard and Medical Device Directive 93/42/EEC. It shall be European CE Certified or American ETL/ American UL listed. The Manifold Control System shall supply on uninterrupted flow of 500 L/min. to a 400 kPa (4 bar) distribution system. Either the left or right hand manifold bank may be designated "Duty" and shall automatically changeover to supply the distribution system from the "Standby" bank when pressure in the "Duty" bank falls to a predetermined level.

The Control Panel must have 2 stage network pressure reducing system equipped with safety valves, first stage reducer to reduce the high pressure from the source to a medium pressure

and the second stage reducer to reduce the medium pressure to the line pressure to ensure safety. A single stage primary regulator, one for each cylinder bank shall be used to initially reduce cylinder pressure and two single stage pressure regulators shall be provided in the control cabinet for final delivery pressure regulation. One delivery pressure regulator in service and one shall be ready for service in a standby mode. The Manifold control panel shall be with digital display, fully automatic type and switches from “Bank in Use” to “Reserve bank “ without fluctuation in delivery supply line pressure. It must have pressure gauges at all important control points so that the state of the system can still be assessed even in the event of a power failure. Changeover shall be performed by electrically/pneumatically operated valves contained in the control cabinet. In the event of an electrical power failure (in case of electronically operated) the valves shall automatically open to provide an uninterrupted gas flow. Major valve must be of brass to avoid wear and to have long lasting service free lifetime. It shall be 100% automatic and shall not require manual adjustment. An emergency supply point via NIST connector coupling must be provided to ensure uninterrupted gas supply in case of any emergency during maintenance/ service. All functional components shall be enclosed in corrosion resistant robust material. The electronic control unit must be enclosed in galvanized metal housing, terminal strip on electronic housing to ensure safety. The power supply (AC-DC Converter unit) must be external to the Control panel to ensure safety.

All components inside the Control Panel like Pressure Regulators, piping and control switching equipment shall be cleaned for Carbon Dioxide Service and installed inside the cabinet made of mild steel with epoxy powder coated with a viewing window to monitor digital display to minimize tampering with the regulators or switch settings. The cabinet must have hydraulically operated doors and should be able to operate/open easily (hydraulically) to save space during service or maintenance.

### **Medical and Surgical Air System**

**(Package Unit) - Tolerance of +/-5% is acceptable on plant flow capacity.**

Air-cooled, Oil Free/Oil-Less compressors for continuous duty application with highest output of compressed air, low power consumption and very low vibration resulting in low noise level.

**Note:** The system configuration shall be as per provisions in chapter 2 para 2.27

**Note:** The type of compressor to be decided and specifications to be mentioned in NIT

accordingly. The above is for Oil Free/ Oil less compressor screw/ scroll. The medical air plant shall fully comply with the requirements of the HTM 02-01/ ISO 7396-1/ NFPA 99 C. It shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed (In case of NFPA 99c the control panel of plant must be UL/ETL Listed and under taking from manufacturer for this tender reference must be submitted for using the same control panel in the system offered).

### **Air Compressor Modules**

It shall be Oil-Free/Oil-Less Screw Compressors /Scroll Compressors to produce the plant output of {Minimum113cfm to deliver each compressors Plant capacity} as mentioned in BOQ of respective institute as primary and same capacity as standby. The compressor shall have a sound insulating enclosure. Medical quality air shall be delivered at a nominal pressure of 400 kPa (4 bar) and 700kPa (7 bar) gauge for supply of the hospital medical air and surgical air.

**The Medical Air Quality parameter to be achieved shall be as per following:**

<b>Contaminant</b>	<b>Threshold</b>
H2O	67 ppm v/v
Dry Particulates	Free from visible Particulates in a 75 litre sample
<b>Oil (droplet or mist)</b>	<b>0.1mg/cubic metre</b>
<b>CO</b>	<b>5ppm v/v</b>
<b>CO2</b>	<b>500 ppm v/v</b>
<b>SO2</b>	<b>1ppm v/v</b>
<b>NO</b>	<b>2 ppm v/v</b>
<b>NO2</b>	<b>2 ppm v/v</b>

The medical air purification module shall incorporate high efficiency water separators, oil coalescing filters, heatless regenerative desiccant dryers, activated carbon filters with



hopcalite catalyst, bacterial filters and pressure regulators. The performance of the filters shall be according to below specifications: Oil coalescing two-in-one high efficiency filter: mass efficiency of 99,991%, tested according to ISO 8573-2 & ISO 12500-1 Activated carbon filter: max remaining total oil content of 0,003 mg/m<sup>3</sup>, tested according to ISO 8573-5 & ISO12500-2 Bacterial filter: particle count efficiency of 99,98% at MPPS=0.06µm, tested according to ISO 12500-3. Compressor plant shall be designed in such a way that compressors will switch on in a sequential manner as per flow demand. The compressors shall be standalone ones with independent power supply. Each Compressor shall be suitable for both continuous and frequent start/stop operation at a nominal plant pressure of 10 bar or more.

The duty compressors shall be automatically rotated by the plant control system to ensure even wear compressors shall be supplied and installed. Desiccant dryer shall be provided with a dew point sensing switch that shall provide an alarm on the plant control panel and central hospital alarm system when the water concentration in the delivered air rises above the limit. Duplex desiccant dryer and filtration modules shall be provided with three or more individual stages of filtration as follows:

Stage 1: Coalescing filter upstream of the desiccant dryer for removing liquid water particles down to 1micron.

Stage 2: Particulate filter after the desiccant dryer for dust protection and removing particles down to 1micron.

Stage 3: Bacteria filter for removing particles down to 0.01 micron. Purity shall be tested as per the American Pharmacopeia / European Pharmacopeia standard.

The plant control and power management system shall monitor the safe operation of the plant, providing signal into the alarm system as per the requirements of the standard.

**Pressure Reducing Station:**

For 4 bar and 7 bar shall fully comply and meet with the requirements of the standard. Simplex pressure reducing station shall comprise as in-line pressure regulator, with downstream pressure gauge. Isolation valves and pressure release valves shall be provided as per the standard. Duplex pressure reducing station to have two branches, connected to the MGPS in parallel in order to allow maintenance on the components of one branch, while the gas flow is maintained in the other branch.

**The compressor system shall have**

- a) Intake filter Delivery pipe
- b) Mounting on air tank along with all standard fittings viz. safety valve, pressure gauge, delivery valve, drain valve etc.
- c) Bidder shall provide all electric control panels, starters etc required for proper functioning of MGPS.
- d) Desiccant Air Dryer – 2nos. (Duplex each)
- e) 4-Stage or more Breathing Air Filters – 2 sets
- f) Outlet pressures for drills/equipment and ventilators shall be a minimum of 7 bar and 4bar respectively.
- g) Duplex pressure reducing station
- h) The compressor shall be heavy duty, reliable with long MTBF (Mean Time Between Failure). Each compressor cylinder is to be protected by a temperature switch, which will stop the drive MGPS and provide an alarm signal in the event of abnormal discharge air temperature. Each compressor module shall include an inline filter with particleretention of 10 microns, inlet isolation valve, discharge isolation valve, and pressure relief valve. The capacity shall be capable to take care of total load of all the outlets

Vertical Air Receiver Total air receiver capacity shall be at least 50% (+/- 5%) of the primary plant capacity (capacity as mentioned in the tender) in terms of free air delivered at normal working pressure. Each air receiver shall be protected by a pressure relief valve, a fusible plug and include a pressure gauge with isolating valve and a drain cock.

Air receivers should comply with BS EN 286-1: 1998 for all vessels up to 10,000 bar litres, and should be supplied with test certificates. The minimum water capacity of the receivers should be 50% of the compressor output, stated in terms of free air delivered at normal working pressure. Receivers should also be fitted with an automatic drain. Electrically operated automatic drains have been found to be more reliable. For systems that have a design flow in excess of 500 L/min, two receivers should be provided with valve arrangements to permit isolation of one or the other for inspection purposes.

Air Receivers Tanks should conform to ASME Boiler and Pressure Vessel Code 2017,Section VIII. It will preferably be a Vertical, Cylindrical, Stainless Steel Tank (304/304L), for providing rust protection. It must be durable, corrosion resistant and be able to maintain air purity. These shall be provided with valve arrangements to permit isolation of

one or the other for inspection purposes.

The corrosion resistant coated receiver is to be equipped with tested safety pressure reliefvalve, sight glass pressure gauge, automatic drain, three-valve by-pass and sourceisolation valve.

### **Air Treatment Module**

The air treatment module shall include dual dryers, dual filtration system and a dew point transmitter with local audible and visual signals and dry contacts for MGPS monitoring.

The components shall be mounted on a common base with interconnecting copper/brass piping and upstream and downstream isolation valves. The isolation valves must allow either set of components to be serviced without shutting down the system. Dryers shall be of heatless desiccant design and sized to provide for the peak calculated demand. The desiccant dryers shall be equipped with dew point dependent switching feature to minimize the need for purge air. The dual filtration system shall remove liquid and particulate matter, consisting of 0.5micron coalescing filters with differential pressure indicators and automatic drain, airline pressure regulators with gauges, final pressure relief valve, and sampling valve. Each bank shall consist of three stage treatment. Digital dew point monitor is to be supplied with alarm contacts as per requirement of the standard.

### **System Controls**

The “Continuous on Demand” feature will stop the operation of the MGPS during periods of low or no demand. The control include individual self-protected combination MGPS controls with short circuit protection, single phase and thermal overload protection, individual control circuit with transformers primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The cabinet shall have status display to include system pressure, dew point pump operation, accumulated time, maintenance interval, fault conditions, and silence button, lighted Hand-Off-Automatic selector switches and safety disconnect operating handles. All required local alarm functions shall be integrated in to the packaged system. The system shall be designed to function even if the programmable controller fails.

### **Accessories**

Accessories including for job site installation such as inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve shall be supplied. All the filters shall be

covered under warranty period and CMC Period.

## **VACUUM SYSTEMS**

**(Package Unit) – Tolerance of +/- 5% is acceptable in plant capacity.**

It shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed (In-case of NFPA 99c the control panel of Plant must be UL/ETL Listed and Undertaking from manufacturer must be submitted for using the same control panel in the system offered)and shall comply with HTM 0201/ ISO 7396-1/ NFPA 99 C

### **Vacuum Pump Module**

It shall be Oil Sealed Rotary Vane/ Screw Type to produces the plant output of {minimum Litres Per Minutes (5190LPM) Plant capacity} as mentioned in BOQ/NIT Designed flow capacity shall be minimum of LPM capacity as mentioned in BOQ/NIT of respective institute. The vacuum plant shall comprise air-cooled, oil lubricated rotary vane vacuum pumps suitable for both continuous and frequent start/stop operation at inlet vacuum levels between 450 mmHg and 660 mmHg. The control system shall normally employ automatic rotation of the lead pump to maximize pump life and ensure even wear. Vacuum pump inlets shall include a wire mesh filter and integral non-return valve to prevent oil suck back and pressure increases in the vacuum system. Each vacuum pump shall be fitted with anti-vibration pads between the pump foot and mounting frame. The plant shall be fitted with duplex bacteria filter system.

### **Vacuum Receiver**

The vacuum receiver shall be made of rust free corrosion resistant steel and fabricated as per ASME for a vacuum pressure of 760mmHg. It shall include bypass valves, manual drain valves, vacuum gauge. Vacuum reservoir shall have total volume of at least 100 % of primary plant output (+/- 5%) (capacity as mentioned in the tender) in one minute in terms of free air aspirated at normal working pressure for systems that have a design flow more than 500 L/min, two receivers should be provided with valve arrangements to permit isolation of one or the other for inspection purposes.

### **System Controls**

The control includes individual self-protected combination MGPS controls with short circuit, single phase and thermal overload protection, individual control circuit transformers with

primary and secondary protection, pressure sensors, temperature switches with reset buttons, and an electronic controller to automatically change the operating sequence of the compressors. The system shall have a status display to show the system pressure, elapsed time, maintenance interval, fault conditions, and silence button, lighted Hand-Off- Automatic selector switches and safety disconnect operating handles.

All required local alarm functions shall be integrated into the packaged system. The circuitry shall be designed so that the audible signal can be silenced and the visual indicator will remain until the fault has been cleared and the reset button resets. Local alarm functions shall be annunciate for reserve pump in use

### **Bacterial Filters**

The filters shall be designed for removal of solid, liquid and bacterial contamination from the suction side of vacuum pump systems, preventing damage to the pump and the potential biological infection of the surrounding environment. The dryer shall be particulate filter dryer with ability to remove particles as small as 1micron.

Each individual filter shall have the capacity to deliver full design flow such that one set is designated duty and the other will be standby. Bacteria filters shall have efficiency at least 99.999% when tested by the sodium flame method in accordance with BS 3928:1969/as per required standard utilising particles in the 0.02 to 2 micron size range.

The pressure drop across each clean filter at 50% of the system design flow shall not exceed 25 mm Hg (3 kPa) at a vacuum of 475mm of Hg (63 kPa). Bacteria filters shall be marked with the legend 'Bio-Hazard'.

Each bacteria filter shall be provided with a transparent sterilizable collection jar to collect condensate. The total water capacity of the pressure vessels shall be at least 100% of the design flow rate of the plant in 1minute in terms of free air aspired.

### **Accessories**

Accessories included for job site installation are inlet and discharge flexible connectors, vibration mounting pads, and source isolation valve, inlet check valve, thermal malfunction switch and vacuum control switch. Flexible connectors on inlet and exhaust of each pump, exhaust tee with union as well as copper tubing with Shutoff- cock for gauge/bypass valve and vacuum switch etc.

All the filters shall be covered under warranty period and CMC Period.

Master Electrical Control Panel A dedicated electrical control panel for Air Compressors and Vacuum pumps & Air Dryers, Auto Drain Valves, starter, MCB, ammeter, hours run meter, hand/auto switch, sensors contacts. Under normal conditions the capacity of the plant should be 100% system design flow with one compressor / pump running another one set compressor/pump stand by basis. Integrated with BMS Compatibility and Capable of communicating Master Alarm. Along with automatic sequencing and cascading facility

## **DISTRIBUTION PIPING**

### **Piping specifications**

Copper pipe shall be as per standard BS: EN 13348:2008/ ASTM B819 standards, Solid drawn, seamless, deoxidized, non-arsenical, half hard (hard can be accepted only for sizes 54mm or more), tempered and degreased copper pipe conforming to the standard. All copper pipes shall be degreased & delivered capped at both ends. The pipes shall be accompanied with manufacturers test certificate for the physical properties & chemical composition. Copper pipe must have reputed third party inspection certificate (Eg. Lloyd's or TUV or SGS). Fittings shall be made of copper and suitable for a working Pressure of up to 17bar and especially made for brazed socket type connections. All valves shall be pneumatically tested for twice the working pressure and factory degreased for medical gas service. Copper fittings shall comply with EN 1254:1 factory degreased and brazing filler metals shall comply with EN 1044. Fitting shall be degreased, individually packed for medical use.

The minimum thickness of copper pipes of 35mm and above outer diameter, shall be 1.2mm and the thickness of copper pipes less than 28mm outer diameter, shall be 0.9mm & 12mm outer diameter shall be 1.0mm as mentioned in respective hospital/ site requirement.

### **Installation & testing**

Installation of piping shall be carried out with utmost cleanliness. Only pipes, fittings and valves that have been degreased and fittings shall be used at site. Pipe fixing clamps shall be of nonferrous or non- deteriorating plastic suitable for the diameter of the pipe.

Inert gas welding technique shall be used by passing oxygen Free Nitrogen Gas inside the copper pipes during silver brazing, in order to avoid carbon deposition inside the copper pipes. Only copper-to-copper joints are permitted on site except threaded or flanged joints may be made where pipelines are connected to items such as valves and control equipment. No flux shall be used for joining Copper to Copper joints and on for joints made on site. Copper to copper joints shall be brazed using a 5% silver-copper phosphorous brazing alloy

CP104. A total of 5 joints shall be cut out for examination to establish the quality of the joints being made on site. The insides shall be clean and free from oxides and particulate matter and the minimum penetration of the brazing alloy at any point shall be three times the wall thickness of the tube. If the joints examined do not conform to these requirements, then adjacent joints shall be cut out and examined until the extent of faulty workmanship has been made good. Copper-to-brass or gunmetal joints shall only be made under controlled conditions off site. The joints are ordinarily used to join short copper pipe tails to brass, gunmetal or bronze fittings to permit their connection into the pipeline. Adequate supports shall be provided while laying pipelines to ensure that the pipes do not sag. Suitable sleeves shall be provided wherever pipes cross through walls / slabs. All pipe clamps shall be non-reactive to copper.

After erection, the pipes are to be flushed with dry nitrogen gas and then pressure tested with dry nitrogen at a pressure equal to twice the working pressure or 150psig, whichever is higher for a period of not less than 24hours.Length and quantity of individual items (Copper pipes, AVSUs, Alarm panels, Isolation Valves, Outlets, Pendants etc.) are to be provided as per the quantity stated in the NIT., The complete layout of different items including copper piping needs to be prepared to meet specific site requirement in conformity to the applicable standards and NIT and submitted for approval of the department and execution taken up accordingly thereafter as per the approved design and scheme. Maximum interval between supports (Horizontal and Vertical) (12mm Pipe - 1.0m, 15mm pipe - 1.0m, 22mm pipe – 2m, 28mm pipe-2m, 35mm pipe-2.5m, 42mm pipe -2.5m, 54mm pipe - 2.5m, 76mm pipe – 3meter)

NOTE: The interval between supports should be as per applicable standards.

### **Painting**

All the pipes from manifold/plant up to the outlets shall be painted with two coats of synthetic enamel paint and colour codification shall be as per standards followed and with consultation with competent authorities of the hospital/department.

### **AREA VALVE SERVICE UNIT with Inbuilt Area Alarm**

Area valve service units shall fully comply and meet with HTM 02-01/ ISO 7396-1/ NFPA 99 C. It shall provide a zone isolation facility for use either in an emergency or for maintenance purpose The Area Valve Service Unit shall incorporate pre-fitted ball valve in a

box with emergency access. It shall be reliable and easy to operate, easy purge, sample & pressure testing and emergency supply system. Quantity of valves to be worked out and mentioned in the BOQ. The complete design/ scheme needs to be prepared to meet specific site requirement in conformity to the applicable standards & NIT and submitted for approval of the department and execution taken up accordingly thereafter as per the approved design and scheme.

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Medical gas/vacuum services shall be fixed copper, piped to and from their respective area valve service units. A color coded service identity label shall be fitted behind the valve handle. The unit shall provide a zone isolation facility. Gas Flow direction shall be indicated. Area Valve Service Unit must have Inbuilt Area Alarm System to minimize space consumption. Area valve Service Unit 2 gas to 6 gas must be in a single box with a lockable door. Separate box for each gas should not be used to save space consumption. Each area valve must be equipped with pressure gauge and pressure sensor along with gas identification plate. The valve block must be brass and the inlet and outlet in the upward position. The valve lever must be vertical in direction of flow and it must not hinder with the closing of the Valve box door in both Valve ON and OFF position to avoid unauthorized access. It must contain Emergency NIST connection to ensure uninterrupted gas supply during maintenance/service .

**Area Valve Box or Zonal Valve Box.**

Valve boxes shall be constructed of 18-gauge mild steel/aluminium with powder coated white enamel finish. The valve box shall have a sliding, opaque door with pull ring and clear gauge window. The removable window cannot be replaced when any valve is closed. The frame assembly shall be capable of adjusting for variances in wall thickness up to 1". The window shall conceal piping and mounting screws. Window shall be labelled "Caution Medical Gas Isolation Valves - Close Only in Emergency." Provide clear viewing space in the window to display the gas service, the pressure gauges and the label for areas controlled by the valve. Gas Valve box configuration up to 7 Valves fitting inside the Valve Box. All Medical Gas Valves along with Gauges shall be incorporated with Valve box. All wetted parts (except seals and gaskets) shall be brass or copper. Each unit assembly shall be factory tested for gas tightness. Rubber pipe grommets shall be provided to ensure any leaking gas does not escape from the unit into a wall cavity. All visible aluminium surfaces shall be powder coated.

Shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed .



**AGSS (Anaesthetic Gas Scavenging System) Plant**

Anaesthetic Gas Scavenging System (AGSS) of minimum 1350LPM as Primary & 1350LPM as Standby (or as stated in the NIT based on specific site requirement). It shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed (In-case of NFPA 99c the control panel of Plant must be UL/ETL Listed and Undertaking from manufacturer must be submitted for using the same control panel in the system offered) and shall comply with HTM 02-01/ ISO 7396-1/ NFPA 99 C.

The package shall consist of duplex rotary vane/claw type vacuum pumps or blower as applicable to standards, a control panel with automatic changeover, and mounted on a common base frame.

AGSS pump: Each pump/blower shall be completely cooled and have absolutely no water requirements.

The requisite wiring from OTs to AGSS plant for MGPS control/suitable reservoir (as applicable) shall be within the scope of work to be done by the bidder. System in-line non-return valves shall allow individual pump servicing. Active anaesthetic gas scavenging systems shall be designed to safely remove exhaled anaesthetic agents from the operating environment and dispose of them to atmosphere from the highest point of the hospital building, thus preventing contamination of the operating department and providing a safe and healthy workspace for the personal. AGSS design shall be dependent upon flow rate and pressure drop characteristics of the individual components of systems. It is essential that terminal units, MGPS controls (If required) and pump units work in synchronized manner after connection of workstation to the AGSS System.

Installation shall be on roof top/suitable location. Piping, Non-Return-Valves (NRVs), and inlet nozzle shall be suitably placed. Connecting hose suitable to fit with anaesthesia workstation shall be provided.

**7.1.5. ALARM SYSTEM****Master Alarm (Digital) (Touch Screen)**

Shall be European CE Certified with 4 digit notified body number or American ETL/American UL listed. Complies with HTM 02-01/ ISO 7396-1/ NFPA 99 C Standards and Medical Device Directive 93/42/EEC.

Each Master Alarm shall be modular in design and be fitted with required number of master alarm modules.

The master alarms shall be capable to monitor minimum 40 Point. Each point represents an alarm condition that the source equipment might have. When an alarm condition exists, a red light flashes and the audible alarm sounds. If several alarm conditions occur simultaneously, the most recent alarm light shall flash, while the other alarm lights shall remain lit. When an alarm condition is created, an audible alarm shall be actuated. A dry contact module shall be available to interface with a building management system.

The box material shall be of gauge steel of requisite thickness and equipped with mounting brackets. The emissions from alarms shall conform with EMC standards.

Master alarm management system shall be designed to display alarm conditions from the source supply units indicating the broad status of the source equipment and manifolds as well as the master distribution status from the source supplies. Depending on the alarm priority, a visual and audible alarm shall be initiated to indicate an alarm condition.

Each panel shall display and/or input up to forty-point alarms. Panel shall be ready to use with BMS system.

The master alarm must be able to monitor the following source alarm conditions.

- Oxygen Source Empty/Fault
- Oxygen Cylinder Bank Empty/Fault (could be compatible supplied manufacturer of oxygen control panel)
- Oxygen Emergency Bank Empty/Fault - (could be compatible supplied manufacturer of oxygen control panel)
- Air Compressor Faulty/Operation - (could be compatible supplied manufacturer of electrical control panel)
- Vacuum Pump Faulty/Operational - (could be compatible supplied manufacturer of electrical control panel)
- Vacuum Deficiency Vacuum Reservoir
- And Other MGPS Signals & Alarms
- Master alarm shall be integrated with BMS/HIS

### **Medical Gas Area Alarm**

The medical gas central alarms shall be capable of monitoring up to 6 medical gases services (As specified in BOQ of respective institute) by means of pressure sensors which detect deviations from the normal operating limits of either pressure or medical vacuum. The area

alarm shall have a digital display of pressures. The medical gas area alarm shall fully satisfy the HTM 02-01/ ISO 7396-1/ NFPA 99 C requirements and shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed.

An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided.

"It should have each gas service shall be displayed on LCD touch screen Panel. The area alarm should be controlled by LCD display touch screen size minimum 5inch size. An audible warning shall sound simultaneously with any failure indication and a mute facility shall be provided. Following a mute selection, the audible will resound after approximately 15 minutes or shall operate simultaneously should a further alarm condition occurs. A "Mute" switch shall be provided inside the panel for use during any maintenance resulting in prolonged pipeline or plant shutdown. This facility shall automatically reset when the gas service returns to normal. The alarm panel shall have a 'Test' facility to prove the integrity of the internal circuits, visual and audible warning. The alarm panel shall incorporate a volt free normally closed relay to allow for interconnection to either a medical gas central alarm system or an event recording circuit of a building management system. In the event of an electrical power supply failure the 'System Alarm' LCD panel shall illuminate (flashing) and the audible warning shall be delayed for 30 seconds to enable standby generator tests. Line continuity monitoring circuits shall be provided to constantly monitor the integrity of the input sensors and interconnecting wiring. In the event of any fault the line continuity monitoring circuits shall initiate the specific gas service failure indication, a 'System Alarm' indication and an audible warning. Further aids to fault diagnosis shall be provided by means of varying flashing rates whilst operating the 'Test' switch. It should be connected through Pressure and Vacuum Switches: Pressure and vacuum switches shall be manufactured with brass wetted parts and house a PCBA with line continuity monitoring resistors. Electrical connectors shall be designed for frequent disassembly. Spade connectors are not acceptable. Pressure switches shall include both high and low-pressure settings in the same switch. The body and housing of the pressure switch shall be manufactured from impact resistance, rigid and inherently corrosion proof materials. Pressure switches shall connect directly to the area alarm panel. It is not acceptable to fit a separate connection box to convert switch signals to a data signal. Each gas service shall be displayed by coloured LEDs to show 'Normal' (green), 'Low' and 'High Pressure' (red) conditions. Medical vacuum systems shall be displayed in the 'Normal' (green) and 'Low Vacuum' (red) conditions only. Failure indicators shall be

displayed by flashing lights and normal indications shall be steady. The emissions from alarms should conform with EMC standards or as per guideline of standard to be followed. All MGPS warning and alarm indicating panels, including all operating room panels should comply with the requirements of specific standard as mentioned herein/ NIT.

### **GAS OUTLETS**

Terminal Units (Gas Outlets) with probes/Adaptors for O<sub>2</sub>, N<sub>2</sub>O, Compressed Medical Air 4, Surgical Air 7, AGSS, Vacuum & CO<sub>2</sub> (CO<sub>2</sub> can be optional depending on the requirement).

Terminal units installed in walls, bedhead trunking, headwalls or fixed pendants shall be connected to the pipeline with a copper stub pipe. Pressure gases and shall incorporate a 12mm O/D copper stub pipe. Terminal units for vacuum and anaesthetic gas scavenging shall incorporate a 15mm O/D copper stub pipe. These terminal units must be in two fixes to have valve assembly.

Each terminal unit shall consist of a primary valve (or assembly) and shall be permitted to include a secondary valve. The secondary valve shall close automatically to stop the flow of gas (or vacuum, if provided) when the primary valve is removed.

Front Loading Type Terminal Outlets shall be designed to dispense medical gases (or an inlet for medical vacuum) to the secondary equipment (flow meters, Suction regulators, etc.) at the point of use and is gas specific so that secondary devices cannot be “attached” to the wrong gas. When not in use the gas in a non-flowing state within the Outlet (Terminal unit) sealed by “O” ring. The adapter when inserted pushes the poppet inside and the gas starts flowing and sealing is ensured by the “O” ring or a seat. The Outlets are Quick Connect Type and gas specificity is accomplished by "Pin indexing." The outlets shall have following features:

- Push to insert and press-to-release mechanism for probes.
- Allows plugging of probes from front.
- Self-sealing valve on disengaging the probe (Quick disconnect)
- Smooth quite action.
- Non return valve for on line servicing/ repairing
- Indexed to eliminate inter-changeability of gas services
- Color-coded gas specific front plate
- Totally leak proof, safe & easy to operate
- Configurations possible: surface, flush & Bead-head.

- Outlets shall be European CE Certified with 4 digit notified body number or American ETL/American UL listed
- All outlets shall have respective labels (i.e.O / N O / CO / Air4 /Air7/Vacuum/AGSS/etc.) displayed accordingly.

The medical gas terminal units shall conform to BS EN ISO 9170-1 and accept probes to BS 5682. Terminal units shall be capable of single-handed insertion and removal of the medical gas probe. The anaesthetic gas scavenging (AGS) terminal unit shall conform to BS 6834.

OR

Terminal units conform to gas specific dimensions and connection requirements stated in DIN 13260-2. Components are designed and manufactured in accordance with BS EN ISO 9170 for medical gas distribution systems. Terminal units installed in walls, bedhead trunking, headwalls or fixed pendants shall be connected to the pipeline with a copper stub pipe. Pressure gases and vacuum shall incorporate minimum 12mm O/D or more copper stub pipe. Terminal units for anaesthetic gas scavenging shall incorporate minimum 15mm O/D copper stub pipe.

Medical gas terminal units consist of two parts: First fix – the wall mounted assembly consists of brass pipeline termination block with copper stub pipe secured between back plate and a gas specific plate to allow 130 degrees radial movement of the copper stub to align with the pipeline. The second fix components shall be manufactured with the pin index permanently moulded into the gas specific socket. The socket assembly shall retain a capsule assembly, containing the check valve and probe 'O' ring seals.

Second fix terminal units shall be supplied with the anti-rotation pin loose and bagged to be fitted as required. The socket is fixed to the base block with a design that ensure profile is always in the correct position. Probes are gas specific connectors that couple to the medical gas terminal unit sockets to provide access to gas systems. The replaceable capsule assembly shall enable all working parts subject to wear through usage to be replaced as a factory tested assembly, thereby reducing maintenance time. Each termination block assembly shall be pressure tested by the pressure decay method.

#### **BED HEAD PANEL**

The design shall be approved by the respective hospital authority/ department before installation and it is responsibility of the bidder after getting order they have to interact with

respective hospital authority/ department and finalize the Bed Head Panel (Horizontal) as per site condition. Level and all outlets and sockets shall be located at a height of 1475-1550 mm from FFL, as per the site conditions. Horizontal BHP shall be of maximum 1200mm for 2 Gas outlet configuration, maximum 1500mm for up to 3 & 4 outlets configuration and maximum 1800mm for 5 & 6 Outlet configurations

**It shall have following features: -**

Efficient, Safe & Robust design in extruded aluminium section.

Smooth curved surfaces, and choice of base colour and fascia plates.

Unit shall have integrated rail system to mount accessories

The headwall system shall be constructed of aluminium extrusions joined together to form a carcass to suit the particular application. Unit shall be factory assembled for electrical and mechanical components.

Segregation of services i.e. Low voltage supplies, High Voltage supply and Medical gases shall be maintained with minimum 2 tier, 2/3 channel arrangements with built-in LED Lighting (with ON/OFF control) Shall be European CE Certified with 4 digit notified body number or American ETL/American UL listed. Front fascia plate shall be removable individually to access for respective service.

**It shall have one rail for mounting Accessories.**

Each bed-head unit shall be supplied with cut out provision of electrical sockets, nurse call system, Data and Voice system.

**Shall have per unit as under :**

- Oxygen – 2
- Vacuum – 2
- Medical Air-1
- Holder for vacuum collection jar –1
- Cut Out provision for Nurse call switch – 1 (sample to be provided nurse call vendor)
- Cut out provision for 5/15A combined Electrical socket with switch – minimum 4 Nos. with 2 outlet combination, 6 Nos. with 4outlet combination and 8 Nos. with 6/8 outlet combination
- Cut out provision for RJ-45 socket/ Ethernet -01

- Two spare spaces with dummy plates.

**NOTE: Above provisions may vary which is subject the site conditions and client's requirement.**

#### **WARD VACUUM UNITS (Other than ICU Area)**

It must consists of the following:-

- 1no of Suction Regulator and 1no of 600 ml polysulfone /polycarbonate collection jar.
- Suction regulator (Digital/Analogue): Suction regulator shall be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Shall have wide membrane continuous suction controller.
- Shall have vacuum levels: 0-750 mm Hg or more Shall have vacuum gauge fitted with a protective bumper device.
- Shall have on/off knob allowing for the quick restoration of a readjusted vacuum level.
- Must have central adjustment knob with a colour coded for 0 to 750 mm Hg or more. Shall have Polysulfone/ polycarbonate 100cc safety jar, autoclavable at 121° C at 5mins, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. It shall be totally transparent, to ensure perfect sucked liquid visibility.
- Low flow ward vacuum unit - Shall have vacuum levels: 0-150 mm of Hg  $\pm$  10%

#### **Ward Vacuum Units (for ICU area)**

It must consists of the following:-

- 1no of Suction Regulator and 1no of 1000 ml polysulfone /polycarbonate collection jar.
- Suction regulator (Digital/Analogue): Suction regulator shall be supplied with a safety jar, including and antibacterial filter and an anti-overflow safety device. Shall have wide membrane continuous suction controller.
- Shall have vacuum levels: 0-750 mm Hg or more.
- Shall have vacuum gauge fitted with a protective bumper device.
- Shall have on/off knob allowing for the quick restoration of a readjusted vacuum level.

- Must have central adjustment knob with a color coded for 0 to 750 mm Hg or more.
- Shall have Polysulfone/ polycarbonate 100cc safety jar, autoclavable at 121° C at 5mins, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. It shall be totally transparent, to ensure perfect sucked liquid visibility. Low flow ward vacuum unit - Shall have vacuum levels: 0-150 mm of Hg  $\pm$  10%

**Theatre Vacuum unit for OT**

It must consist of the following: -

Suction Regulator (Digital/Analogue) and 2nos. 2000ml or more polysulfone/polycarbonate collection jar and both to be mounted on a trolley.

Shall be European CE Certified with 4 digit notified body number or American ETL/American UL listed.

In case of digital suction regulator, battery shall be replaced by the bidder during warranty & CMC period.

**Theatre Suction Trolley**

Theatre Suction Trolley shall be Certified as per Class I of Medical Device Directives(93/42/EEC) & CE marked. It should be manufactured in an ISO 13485:2003 quality management system duly certified constructed in accordance with the requirement of international standard. It will be trolley mounted. The unit will include one regulator having gauge and mounted on the trolley stand, having two reusable each 2000 ml plastic collection bottles mounted on the base of trolley unit and connected with regulator & low pressure tube inter-connections. Safety Jar 200 cc to be provided with regulator. The collection jar is made of unbreakable material, which is fully auto cleavable at 121 Degree Centigrade. The jars shall be mounted on Stainless Steel Trolley (SS304 material) having four (4) free moving castor wheels, with a stable base design and an easy grip handle.

Suction Regulator: Suction regulator shall be supplied with a safety jar, including an antibacterial filter and an anti-overflow safety device. Shall have wide membrane continuous suction controller.

Shall have vacuum levels : 0-750 mm of Hg or more.

Shall have vacuum gauge fitted with a protective bumper device. Shall have on/off knob



allowing for the quick restoration of a readjusted vacuum level.

Shall have polysulfone/ polycarbonate safety jar, auto clavable at 121° C, unbreakable, fitted with an anti-overflow safety device and equipped with antibacterial filter. Collection jar shall be totally transparent, to ensure perfect sucked liquid visibility.

#### **Medical Gas Shut of Valves or Line Ball Valves or Isolation Valves**

The line valves must be degreased and complete valve with stuffed pipe & fittings, factory tested and compliant with applicable standard.

- a) All Medical Gas Valves shall be specially prepared for oxygen service and shall conform to latest international standard. Valves shall be ball-type, with Teflon seats and adjusting stem packing gland with Teflon stem seal.
- b) Ball Valves shall operate from the fully open to the fully closed position by manual operation of a lever through 90°. Valve nominal bores shall be equal to the nominal pipework size.
- c) Furnish and install only valves with factory brazed Copper stub pipes shall be manufactured from medical grade copper pipe to BS EN 13348:2001 which should be Lloyds/SGS/TUV/DNVGL certified or any accredited third-party certified agency.
- d) Ball valve shall be provided with locking handles.
- e) All valves shall be cleaned for oxygen, capped and sealed in a polyethylene bag for shipping and storage.
- f) Apply labels to each valve in the assembly for gas service identification according to manufacturer's recommendations.
- g) Medical gas line ball valve assemblies shall be constructed in a two-piece full-bore design with brass body, Teflon ball seals, stem packing seal, stem 'O' ring seal and a hard chrome plated brass ball valve.
- h) Ball Valve sizes 15 to 54mm inclusive shall have flat-face connectors with 'O' ring seals.
- i) The 76 to 108mm inclusive shall be flanged and installed with stainless steel bolts, nuts and spring washers with sealing gaskets. PTFE tape or any other thread sealing media is not acceptable.

- j) All Medical Gas Valves should be factory tested and certified from OEM. Performance reports (Valve Size, Torque, Working pressure and material certification) has to be submit by the bidder on behalf of OEM.

### **High Pressure Tubes for Oxygen, Compressed Air & Vacuum**

It shall be colour coded for individual services i.e. white for Oxygen, Blue for N2O and Yellow for Vacuum, Black for air. Antistatic rubber tube shall be as per ISO standards. It shall be Shall be European CE Certified with 4 digit notified body number or American ETL/ American UL listed. (The 200m Hose- Gas wise requirement shall be taken from respective institute before supply total lengths shall be 200m inclusive of all type. If institute requires more than payment will be made on actual basis asper finalized BOQ rate)

### **Interconnection to LMO Tank**

Price shall be quoted per meter basis or as per scope defined in the NIT. The scope shall be inclusive of all installation, material (Copper Pipes, fittings, etc.), trenches and labour etc. charges as per site condition. The payment shall be made as per the conditions defined in the NIT. Items for LMO interconnections already covered in the BOQ

### **Extra/ Other essential items to be covered in NIT as per actual requirement at site.**

- Bidder shall co-ordinate with respective hospital authorities/ department for the finalization of required Office/ Control Room for & Toilet for MGPS maintenance staff into Manifold/Plant Room.
- Bidder shall assist in for all civil modifications and repair for successful completion of MGPS Plant, Manifold, and Pipeline installation and commissioning throughout the proposed blocks/buildings by providing need based inputs.
- Bidder will assist to hospital for internal walls/partitions & doors for creating separation between MGPS Plant and Manifold room, etc. as per site requirement by providing need based inputs/layout drawing

### **Anaesthesia Pendant – Rigid with Bottom Swelling**

- Weight Loading Capacity - 150Kgs.
- Bearing Topper Roller imported.

- Aluminium Ceiling Cover.
- Vertical piping seamless steel.
- Console Extruded 4mm Aluminium Alloy
- Tray Extruded Aluminium Alloy Loading Capacity - 50Kgs.
- Aluminium fabricated drawer sheet.
- SS 304G IV Pole.
- Leak tested high pressure piping.
- 340degree arm rotation.
- Console rotation 330degree.
- Electricals up to 10Nos.
- Poly powder coating.
- Medicine Basket.

**Surgeon Pendant – Single & Double Arm**

- Surgeon Pendant - Single Arm
- Weight Loading Capacity - 150Kgs.
- Bearing Topper Roller imported.
- Aluminium Ceiling Cover.
- Arm Extruded 11mm Aluminium 11mm Alloy
- Arm end covers with ABS Plastic.
- Vertical piping seamless steel.
- Console Extruded 4mm Aluminium Alloy
- Tray Extruded Aluminium Alloy Loading Capacity - 50Kgs.
- Aluminium fabricated drawer sheet.
- SS 304G IV Pole.
- Leak tested high pressure piping.
- 340degree arm rotation.
- Console rotation 330degree.
- Electricals up to 10Nos.
- Pneumatic braking system.
- Poly powder coating.
- Ceiling metal rod and service plate.
- Console Length 800mm\*1000mm

**Comprehensive Maintenance**

- ❖ The Contractor shall be responsible for defect liability, OEM warranty of products and comprehensive maintenance of MGPS installations for ten years (5 years warranty plus 5 years CAMC) from the date of completion of the work through the same MGPS firm.
- ❖ The MGPS firm shall be approved on the basis of work experience as per provisions of eligibility described in the CPWD Works Manual/ Chapter 1 para 4 of this specification.
- ❖ The comprehensive maintenance of MGPS installations includes complete MGPS installations, labour, spares, all consumables etc. as required including the following.
  - a) All MGPS equipment mentioned in the NIT.
  - b) Plastic and glass parts against any manufacturing defects.
  - c) All kinds of sensors.
  - d) All kind of coils, probes and transducers.
  - e) All kinds of painting, MGPS related areas (as executed by firm).
  - f) Preventive maintenance including testing & calibration as per technical/service/operational manual of the manufacturer.
  - g) MGPS installation inside the MGPS plant room/yards.

Note: Check for the requirement of spares and consumables in the system. The NIT authority can list these consumables on paid basis also on actual consumption, as deemed fit, for which suitable items needs to be incorporated in the BOQ.

- ❖ In the case of MGPS equipment, the comprehensive maintenance shall be done with back-to-back support from OEM. In such cases, authorized agent of OEM shall reach the site within 24 hours of raising a service call.
- ❖ The MGPS firm shall ensure uninterrupted service without compromising functioning of MGPS/ICU.
- ❖ The MGPS firm shall set-up a maintenance base in the vicinity of the hospital, to provide maintenance service of the entire MGPS installations.
- ❖ If the performance of any individual equipment or system is not satisfactory, the same shall be replaced free of cost.
- ❖ If it is found that to meet the performance criteria, any extra equipment is required, the same shall be provided free of cost.

- ❖ All faults and their rectification shall be promptly intimated to the hospital.
- ❖ Any lacunae noticed in the functioning of the installation as a result of any design feature shall be rectified free of cost.
- ❖ Proper marking has to be made for all spares for identification like printing of installation and repair dates.
- ❖ On receipt of any complaint, the MGPS firm shall, within 8 hours on a 24(hours) X 7 (days) X 365 (days) basis respond to take action to repair or replace the defective goods or parts thereof free of cost. The MGPS firm shall take over the replaced parts/goods after providing their replacements and no claim, whatsoever shall lie on the hospital/institute for such replaced parts/goods thereafter. The penalty clause for non-rectification will be applicable as per tender conditions.
- ❖ Upon failure of the MGPS firm to respond to take action to repair or replace the defect(s) within 8 hours on a 24(hours) X 7 (days) X 365 (days) basis, the hospital/institute may proceed to take such remedial action(s) as deemed fit by the hospital/institute, at the risk and cost of the Contractor without prejudice to right of Government to take other remedial actions under the agreement.
- ❖ If the MGPS firm fails to attend the complaint within 8 hours a penalty of Rs. 5000/hour will be charged from the firm and recovery made accordingly. The decision of the The Engineer shall be final and binding on the firm with respect to the imposition of overall penalty decision taking into view overall circumstances of the case.
- ❖ The Contractor/MGPS firm along with the Indian agent of the manufacturer shall ensure continued supply of the spare parts for the machines and equipment supplied by them for 10 years from the date of completion of the work.
- ❖ The payment of comprehensive maintenance will be made on six monthly basis after satisfactory completion of said period duly certified by end user.
- ❖ The Contractor shall ensure regular updates of newer technology as and when evolved during warranty period for all the equipment.
- ❖ There shall be no extra cost for software upgradation/ supply and installation of security patches/ lifetime license fee for system (if and as required for MGPS system). The software upgradation including security patches shall

be provided free of cost during the CAMC period. Bidder should submit OEM certificate to the effect that the software as well as security patches etc. shall be made available for enabling free upgradation of the system till the expiry of the defect liability period and CAMC period. The software validity shall be till the end of the CAMC period and will be got done by the OEM/through their authorised channel partners within the tendered cost.”

### **MAKE IN INDIA POLICY**

The MGPS work shall fully comply to Public Procurement (preference to make in India). Order (PPP-MII order) 2017 issued by DPIIT and corresponding notifications issued by concerned nodal ministry/department as amended up to the last date of receipt of tenders.

#### **Notes**

- ❖ Necessary modifications may be made in the additional conditions by the NIT approving authority as per actual requirements at site and/or to safeguard government interest.
- ❖ It is advised not to stipulate makes of materials/equipment in the NIT. The makes which conform to the specifications in NIT may be accepted.
- ❖ It is advised that procurement, installation, testing and commissioning of the MGPS medical equipment may preferably be included in the scope of EPC/composite contract in hospital projects by indicating minimum benchmark levels and related specifications.

#### **LIST OF APPROVED MAKESFOR MEDICAL GAS PIPE SYSTEM**

<b>S.No.</b>	<b>Item Description</b>	<b>List of Makes</b>
1	Medical Grade Copper Pipe	SAB INDIA/SRI SIVAM / BLAZE
2	Gas Outlet Points/Terminal Unit	SAB INDIA/SRI SIVAM / BLAZE
3	Matching Probe/adopter	SAB INDIA/SRI SIVAM / BLAZE
4	Area Valve Box	SAB INDIA/SRI SIVAM / BLAZE

<b>S.No.</b>	<b>Item Description</b>	<b>List of Makes</b>
5	Medical Gas Alarm	SAB INDIA/SRI SIVAM / BLAZE
6	Fully Automatic Oxygen Control System	SAB INDIA/SRI SIVAM / BLAZE
7	Oxygen Manifold	SAB INDIA/SRI SIVAM / BLAZE
8	Emergency Oxygen Supply System	SAB INDIA/SRI SIVAM / BLAZE
9	Oxygen Flow meter with Humidifier Bottle	SAB INDIA/SRI SIVAM / BLAZE
10	Ward Vacuum Units	SAB INDIA/SRI SIVAM / BLAZE
11	Nitrous Oxide Manifold	SAB INDIA/SRI SIVAM / BLAZE
12	Emergency Nitrous Oxide Supply System	SAB INDIA/SRI SIVAM / BLAZE
13	Duplex Medical Vacuum Plant	SAB INDIA/SRI SIVAM / BLAZE
14	Bacterial Filter	SAB INDIA/SRI SIVAM / BLAZE
15	Receiver	SAB INDIA/SRI SIVAM / BLAZE
16	Triplex Medical Air Plant	SAB INDIA/SRI SIVAM / BLAZE
17	Air Dryer	SAB INDIA/SRI SIVAM / BLAZE
18	4Stage Air Filtration	SAB INDIA/SRI SIVAM / BLAZE
19	Pressure Reducing Station	SAB INDIA/SRI SIVAM / BLAZE
20	Receiver of 3000liter	SAB INDIA/SRI SIVAM / BLAZE
21	Lockable line Medical valves	SAB INDIA/SRI SIVAM / BLAZE
22	Horizontal/Vertical Bed Head Panel	SAB INDIA/SRI SIVAM / BLAZE
23	Anesthesia Gas Scavenging System (AGSS) Plant (Simplex) 520lpm	SAB INDIA/SRI SIVAM / BLAZE

## **7.2. NURSE CALL SYSTEM (NCS)**

### **7.2.1. SCOPE OF WORK**

1.1. The Hospital Call System is the communication system in which the Nurse Call System including nurse call and emergency call are operated and managed in an integrated way. It aims to increase the performance and quality of hospital services by providing call and information infrastructure between healthcare personnel and patients. Clear definitions of these systems follow:

1.2. Nurse Call is the communication system allowing patients to call nurses from their rooms, patient toilets and bathrooms. The origin locations of these calls (room, bed if applicable) are indicated by Over Door Lights, and sent to the nurses as alerts on Nurse Control Panels. It increases the quality of the services provided by nurses by allowing the patients to reach the nurses quickly and easily when they are in need, while also reducing alarm fatigue experienced by nurses through intelligent call routing; the calls can be configured to go to any specific nurse or group of nurses depending on the call type or location.

1.3. Code Blue System allows personnel in the hospital to initiate Emergency Code Alarms when Cardiopulmonary resuscitation (CPR) is required in the hospital from the points decided by the institution. The system sends the origin to the responsible team.

### **7.2.2. GENERAL FEATURES**

1. All devices and materials that constitute the system shall be new and standard products. The products used must not have an EOL (End of Life) announcement declared. The company will commit to continue production of all devices and components used in a system for a minimum of 5 years after the implementation of the system.
2. Equipment shall be placed according to types of patient bed areas, location of nurse desks and architectural parts within the hospital. A patient handset shall be placed with each bed in the hospital and each short stay unit in emergency service unit.
3. A pull-cord call unit shall be placed in every WC/bathroom used by patients in



the hospital.

4. A nurse control panel in-ward nurse panel shall be placed on service nurse desks to be designated. The panel shall be located in a place that attracts attention, provides readability and is accessible by touching the screen in the event of audible and visual alerts. The Nurse Control Panel shall be able to make VoIP calls to other VoIP enabled devices within the nurse call system.
5. A Code Blue Call unit shall be placed in every location the institution requires. Room Control Units shall be used for initiating Code Blue Call where they are placed.
6. A Room control unit shall be placed in every private and semi-private room to ensure nurses as VoIP terminals, nurse routine check and emergency authorization points with built-in card readers.
7. A Zone Controller shall be placed in locations where multi bed wards and their associated shared bathrooms can have connectivity with the rest of the system.
8. An IP system controller will be placed for each hospital with an appropriate room capacity to configure, manage and maintain the entire system.
9. All device connections inside and outside the room shall be made with standard Cat6 UTP cable. Terminations shall be RJ45 with international standard B type connection.

### **7.2.3. PRODUCTS**

#### **GENRALS**

Nurse Call System consists of Zone Controllers, Over Door Lights, Patient Handsets, Bedside Call Units, Code Blue Call Units, Pull-cord Call Units, Nurse Control Panels, Ward Nurse Stations, Room Control Units, Personnel Smart Cards and IP System Controller with software designed to perform the jobs with properties stated above as well as keep detailed call logs of calls and display these logs in meaningful graphical reports to be filtered by parameters such as date, call type, and area.

**7.2.4. ROOM CONTROL UNIT**

- The Room Control Unit shall have a structure capable of controlling the call system within each private and semi-private room. It shall be used one for each Private and semi-private patient rooms as the connection point for in room devices in that particular room.
- Room Control Units shall send all calls and system information including timestamps and origin addresses for all Bedside Call Units, patient handsets, and Pull-cord Call Units within the room, to the IP system controller using IP.
- Room Control Units shall have hands free full duplex SIP VoIP speech communication support.
- Voice calls made over the Room Control Unit shall be able to be recorded over the IP System controller based on request. These records shall be able to be reviewed on the logs of the System controller interface.
- Room Control Units shall be able to work directly with a Nurse Control Panel without any issue if there is lost connection with the IP System Controller.
- The Room Control Unit shall have eight RJ45 Call Unit ports to support both Bedside Call Units and Pull-cord Call Units. These ports shall also support the assignable indicator lights.
- The Room Control Unit shall have one RJ45 Over Door Light port. This light will be used as the rooms activity indicator in the corridor installed over door.
- The room devices shall be able to be monitored on the Room Control Unit. The main screen of the room control unit shall show which patient made the call.
- The unit shall be flush mounted on the wall.
- The Room Control Unit shall perform general nurse call functions by reading personnel smart cards, initiating and terminating Blue/White/Red/Pink Emergency Code calls, Assist Calls and Nurse Presences and giving visual and audio alerts about the call status.
- Room Control Units shall have a built-in RFID card reader to identify personnel smart cards, preventing intervention of unauthorized persons, and when a healthcare personnel use their smart card on the panel, their name shall appear on the screen. Nurses responding to nurse calls shall note that they have arrived in the room by holding their card to the Room Control Unit's built-in RFID card reader.

- The built-in RFID shall be capable of reading smart phone NFCs. This shall be able to be configured to work as replacement for smart cards for permissions checks and ID logging.
- Room Control Units shall have an LCD TFT touch screen of at least 5". The screen shall show the information about the active calls in the room.
- There shall be an Emergency Codes menu with buttons for different emergency calls and these buttons shall only be able to be used by activation via personnel card. Without using a personnel card, no call shall occur even if these buttons are touched.
- The Room Control Unit shall have a default screensaver showing the current date and time.
- Nurses shall have the option perform routine observation procedure by signing into the room when there is no active call by any patient. The Over Door Light shall remain green for as long as the nurse is present in the room (as while responding to regular calls), and shall turn off when the nurse signs out of the room with her card.
- The Power supply of the Room Control Unit shall be PoE.
- When the nurse enters the room, the presence information shall be applied to update the status of all active calls within the room.
- Room Control Units shall be IP based and each room shall be connected to the network through an independent ethernet line. Each Room Control Unit shall have an independent IP address.
- The Room Control Unit shall allow calls from other rooms to appear on the Room Control Unit Screen when there is a Nurse Presence in the room.
- The settings menu of the Room Control Unit shall allow the reconfiguring of how many bed call units and WC call units are connected, as well as renaming them.
- The settings menu of the Room Control Unit shall also allow reconfiguring of the behavior of the attached Over Door Light, such as light color and blinking/non blinking status.
- The settings menu shall only be accessible with authorized cards.
- Device connections inside and outside the room shall be made with standard Cat6 UTP cable. Terminations shall be RJ45 with international standard B type connection.

### 7.2.5. ZONE CONTROLLER

- This is the main node device used to network the Nurse Call System devices to each other for areas are not private or semi-private rooms and do not have item 3.2(Room Control Unit). It is to be used for multi-bed wards areas in a single open space with a nurse desk overlooking the assigned patient beds.
- Each Zone Controller has 2 communication ports which support chains of up to 24 call initiation devices each, and up to as many over door lights as the number of call initiation devices, for a total maximum support of 48 call devices.
- The connection shall be made with Cat 6 UTP cable and RJ45 of B standard. Total cable length from the Zone Controller to the last call device cannot be longer than 500 meters for each communication line on each communication port.
- Zone Controller shall have 2 power injectors to be included with the device to be used for injecting 12V power to be used on each communication line. Each power injector has 2 RJ45 ports to be connected at suitable locations to prevent voltage drops on the lines. Each power injectors require 110-240 V power.
- There shall not be any limits to the number of Zone Controllers that can be used in a Nurse Call System, they may be placed in the network as necessary to extend the system.
- The Zone Controller shall have 1 uplink data port which is connected to the hospital network switch. Its connection shall be made with Cat 6 UTP cable and RJ45 of B standard.
- The Zone Controller shall have 1 port for 110-240 V power.
- The Zone Controller must be configurable from the IP System controller.

### 7.2.6. OVER DOOR LIGHT

- Over Door Lights shall use environmentally friendly LEDs
- It shall consist of red, green, and blue colored warning lights.
- In normal condition, no light shall be lit. If the patient makes a nurse call, a red light shall be lit within 0.5 seconds. After the nurse call, when the nurse presses

the green presence button on the Call Unit, the light of the Over Door Light will turn green.

- In Code Blue, the blue light shall be lit.
- The outer casing of the Over Door Light shall be made of non flammable PC-ABS-FR materials.
- Over Door Light shall have 2 Input / Output ports for RJ45 endings for cabling in a chain with call units on one of the communication lines of the Zone Controller? Alternatively, it connects to the Room Control Units in private, semi-private rooms.
- Its connection shall be made with Cat 6 UTP cable and RJ45 of B standard.
- This device shall be powered by the Zone Controller or black colored communication ports of Room Control Unit to which it is connected. It shall not require additional energy supply.
- A single RJ45 Output port version of the unit shall be available to connect to Room Control Unit through yellow colored room indicator port dedicated only for use of this alternative version of the Over door light.

#### **7.2.7. BEDSIDE CALL UNIT**

- The Bedside Call Unit shall be mounted on headboards where there are patient headboards or on the walls where it can be implemented within the system.
- The Bedside Call Unit has 2 Input/Output ports for RJ45 endings for cabling in a chain with Over Door Lights and other call units and eventually to one Zone Controller. Alternatively connects to the Room Control Units in private, semi-private rooms.
- On the standard Bed Side Call Unit front side there shall be; A “start call” button with a red nurse symbol. An “end call” button with a green tick mark symbol. Reassurance backlight in order to give visual information about the call status. Continuous backlight for easy visibility of the unit at night. Pressing on the End Call button ends the call and turns the assigned over door light to green. IP System Controller logs the event as “Presence”.

Pressing the End Call button for the second time ends the “Presence” and turns off the assigned Over door light.

- The Bedside Call Unit shall be made from non flammable PC-ABS-FR materials.
- It can be used individually as a call button where patient handset is not needed. Otherwise, its connection with the patient handset shall be easily established by connecting via RJ45 on its front side.
- A nurse call shall be initiated via the patient handset or the Bedside Call Unit. These two buttons shall be accepted by the system as equivalent. In the event that these buttons are pressed:
- If the unit is able to transmit the call to the zone controller, the LED on the unit shall flash with 1.0-second intervals. Call transmission information shall be audibly notified to the patient.
- If there is an error in call transmission, a continuous red light showing the error status shall only stop when the call termination button is pressed or room control connection is made. Subsequent presses of the button shall trigger an audio alert each time.
- Its connection shall be made with Cat 6 UTP cable and RJ45 of B standard.
- This device shall be powered by the Zone Controller or black colored communication ports of Room control unit it is connected. It shall not require additional energy supply.

#### **7.2.8. CODE BLUE CALL UNIT**

The Code Blue Call Unit shall be mounted on headboards where there are patient headboards or on the walls where it can be implemented within the system.

- The Code Blue Call Unit has 2 Input/Output ports for RJ45 endings for cabling in a chain with Over Door Lights and other call units and eventually to one Zone Controller. It also connects to the Room Control Units in private, semi-private rooms.
- On the Code Blue call unit front side there shall be; A “start code blue” button with a blue medicine symbol. Pressing the button initiates a Code Blue event, turning on the assigned Over door lights to Blue.
- An “end code blue” button with a green tick mark symbol. Pressing the Button shall cancel the Code blue alarm turning the assigned Over door lights.

- Reassurance backlight in order to give visual information about the call status. Continuous backlight for easy visibility of the unit at night.
- The Code Blue Call Unit shall be made from non flammable PC-ABS-FR materials. If the unit is able to transmit the call to the zone controller, the LED on the unit shall flash with 1.0-second intervals. Call transmission information shall be audibly notified to the patient.
- If there is an error in call transmission, a continuous red light showing the error status shall only stop when the call termination button is pressed or room control connection is made. Subsequent presses of the button shall trigger an audio alert each time.
- Its connection shall be made with Cat 6 UTP cable and RJ45 of B standard.
- This device shall be powered by the Zone Controller or black colored communication ports of Room control unit it is connected. It shall not require additional energy supply.

#### **7.2.9. PATIENT HANDSET BASIC**

This handset will be used in locations that are connected to the system by a Zone Controller.

- It should be ergonomically designed for handheld use and connected to the Bedside Call Unit with an independent cable. On its front side, there should be:
  - A "start call" button featuring a red nurse symbol.
  - A reassurance LED light to provide visual information about the call status.
  - A continuous LED light for easy visibility during nighttime.
- Call initiation and error notification procedures is the same as Bedside Call Unit except audio alerts are always issued by the Bedside Call Unit. Its call initiation button and call backlight work in parallel with the ones on the Bedside Call Unit.
- It shall have an easily cleanable surface that does not promote bacterial growth.
- Patient handset shall be made from nonflammable PC-ABS-FR materials.

**7.2.10. PATIENT HANDSET PRO**

- This handset shall be used in locations that are connected to the system through a Room Control Unit. This handset shall have a membrane keypad promoting extra sanitation. Its buttons shall be satisfying to press and responsive.
- This handset shall include an IR remote control, which shall be able to be synchronized with any remote control for any device. The buttons to be synchronized are marked for on/off, volume up, volume down, mute, channel up, channel down.
- There shall be a call button for the patient to initiate a call. There shall be two alternative buttons to control lighting. The handset shall be connected to a Bedside Call Unit with RJ45.
- New televisions shall be configurable to be compatible as the hospital changes them.
- Patient handset shall be made from non flammable PC-ABS-FR materials.

**7.2.11. PULL-CORD CALL UNIT (WC/BATHROOM):**

- The Pull-cord Call Unit has 2 Input/Output ports for RJ45 endings for cabling in a chain with Over Door Lights and other call units and eventually to one Zone Controller. It also connects to the black colored communication ports of Room Control Units in private, semi-private rooms.
- On its front side, there shall be:
- A call pull-cord with customizable length with minimum 1.5 meters to serve as a call-cord.
- A call termination button (indicated by a green tick mark symbol)
- Its connection shall be made with CAT6 UTP cable and RJ45 of B standard.
- A priority WC Emergency Call shall start when the cord is pulled.
- This device shall be powered by the Zone Controller or black colored communication ports of Room control unit it is connected. It shall not require additional energy supply.



**7.2.12. NURSE CONTROL PANEL**

- The Nurse Control Panel shall be put on Nurse Stations responsible for covering the need of private and semi-private patient rooms that is controlled by a Room Control Unit.
- The Nurse Control Panel shall have a minimum 7” touchscreen and include its own integrated phone handset. It shall have Android OS.
- The Nurse Control Panel shall be used for monitoring the status of every assigned room, including device errors and call and alarm status.
- The origin room and bed information of all active nurse calls, emergency code calls, assist calls, and nurse presences shall be shown with an audiovisual alert along with the call type.
- Onscreen call points shall have notifications of relevant icons, colors, and tones according to their call status.
- Calls shall be shown simultaneously, and icons showing the emergency calls shall shake and otherwise draw attention over icons showing regular calls.
- When a nurse is present in a room, the nurse presence in that room shall be displayed; when a call is cancelled, the call alert onscreen shall be cancelled.
- Timestamp and error logs for situations when the energy supply of the panel is cut or there is no network connection shall be recorded on hospital call System controller and shall be automatically sent to relevant technical personnel’s pagers and/or Android-based smart phones as error messages.
- If a call on the nurse panel is not responded to within a determinable amount of time, the call shall automatically be forwarded to other nurse panels. Panels shall be configurable to function as mirror panels either manually or automatically based on time of day.
- There shall be voice call feature between the panels.
- The panel shall be structured to allow speech communication with any Room Control Unit.
- If a panel needs to be changed, the new panel only needs to be given the old panel’s IP information, and this shall be enough to configure the panel. The other settings shall be automatically configurable from the System controller.

**7.2.13. WARD NURSE STATION**

- The Ward Nurse Station shall be used in locations that are connected to the system by a Zone Controller. It is placed in each multi-bed ward area at the nurse station overlooking the patient beds.
- The Ward Nurse Station shall have a minimum 10” touch screen and include its own integrated handsfree voice communication with other Nurse Control Panels.
- The Nurse Control Panel may be used to monitor the status of every assigned call point’s call and alarm status. The screen will show active calls and emergency code with top to bottom priority, highest priority active call is on top and longest awaiting call within same call type having more priority than same type.
- The origin room and bed information of all active nurse calls, code blue calls shall be shown with an audiovisual alert along with the call type.
- Onscreen call points shall have notifications of relevant icons, colors, and tones according to their call status as well as time the call started and time passed since.
- Calls shall be shown real-time. Each activity will be send to IP System Controller for logging enabling later inspection and reporting.
- Timestamp and error logs for situations when the energy supply of the panel is cut or there is no network connection shall be recorded on the IP System Controller.
- If a call on the nurse panel is not responded to within a determinable amount of time, the call should be able to automatically be forwarded to other nurse panels. Panels can also be set to function as mirror panels either manually or automatically based on time of day.
- If a panel needs to be changed, the new panel only needs to be given the old panel’s IP information, and this shall be enough to configure the panel. The other settings can be automatically configured from the IP System Controller.
- The panel should have 1 port for 110-240 V power.
- Emergency codes Blue, Red, Pink and White shall be initiated from the touch screen.

**7.2.14. CENTRAL MONITORING SOFTWARE**

- The Central Monitoring Software is a web-based monitoring software able to be viewed from a computer or smart screen, typically placed in a central location.

- The Central Monitoring Software shall display real time status of all or selected call types originating in all or selected areas of the hospital.
- The Central Monitoring Software shall display these calls with icons and colors indicating their type. The time elapsed since the initiation of the call and the timestamp of the call shall be visible.
- Nurse and Personnel presences shall be displayed on a separate part of the screen.

#### **7.2.15. IP SYSTEM CONTROLLER SOFTWARE AND HARDWARE**

- The IP System Controller shall be planned as a structure to operate without interruption and with backup.
- The IP System Controller interface shall include all system settings for nurse call and emergency code calls; it shall manage, direct, log, and report all calls and provide analytics.
- The system shall have a separate password protected web-based interface for management and log reporting.
- Areas, services, rooms within the hospital, telephone numbers and addresses, nurses, code teams, and user information shall be updated in the management interface.
- Message sending duration, intervals, and personnel assignments for services and areas of the hospital shall be visible for every call.
- There shall be a table showing active/passive status of all system devices. Devices that are nonoperational due to problems such as power, network connection, or other issues shall be automatically detected.
- The IP System Controller may test all or selected devices identified in the system with one process. Test results shall be reported. In case of errors, error information may be notified.
- Call types, locations, timestamps, and response durations shall be reported in the reporting interface.
- If a call is not responded to within a time period configured based on call type, it shall be cancelled and recorded as a non-responded call and escalated if requested by the institution.
- All calls shall be received on a single reporting system.

- Log reports shall be constructed in a way to maintain records for minimum 10 years.

#### **7.2.16. PERSONNEL SMART CARD**

- Contactless smart cards used throughout the system shall be ISO/IEC 14443 Type A, 13.56MHz MIFARE classic (Standard- 1 KB).
- Personnel information shall be accessible from the Access Control System database when integrated.

#### **7.2.17. BACKUP and STABILITY**

- The system must have a minimum 99.9% working structure.
- The System controller may be placed in two locations for hot swap functionality, and shall be structured to work without interruption.
- If the connection to the IP System Controller is interrupted for whatever reason, local Nurse Control Panels shall assume the System Controller function for their local area, and allow all rooms connected to them to continue to function without interruption.
- When the System controllers come back online, the data from the local Nurse Control Panels is synchronized to the System Controllers to prevent data loss
- If for whatever reason both the System Controllers and the Nurse Control Panels are unreachable at the same time, Room Control Units shall continue to operate under the card authorizations they last received before the connection outage, and continue service via the Over Door Lights.
- All terminals working in the system shall be monitored by the System controller for errors and the System controller shall notify defined technical service's pagers and/or Android-based smartphones of the location and description of the error in text.
- These error logs shall be able to be accessed through the Building Management System and/or Hospital Information System if such integrations are made.

**7.2.18. INTEGRATION WITH IPBX SYSTEM**

- The nurse call system shall be integrated with hospital IPBX system through SIP protocol. The nurse station & patient handset with speech shall have their dedicated IP so that both can be used as IP telephone. There shall be dial pad in nurse station & patient handset with speech to make call to intercom, or mobile phone/ STD etc. as permitted in the IPBX system.

**7.2.19. COMPLIANCE AND STANDARDS:**

- Compliance with Healthcare Regulations: Adherence to local and international standards for patient safety and system reliability.
- Certification: CE, UL, or other relevant certifications ensuring quality and safety.

**LIST OF APPROVED MAKES FOR NURSE CALL SYSTEM**

<b>S.No.</b>	<b>Item Description</b>	<b>List of Makes</b>
1	Nurse Call System	ZKR / AMBA / HELIX

### 7.3. KITCHEN EQUIPMENTS

1	<b>WORK TABLE FOR SUPPORT OF TWO BURNER RANGE</b>
	<b>Size 1350x600x850mm</b>
	Top & under shelf of S.S.sheet on MS.anlge frame work & S.S.tubular legs, with adjustable feet. Top to have sound deadning material lining as required.
2	<b>EXHAUST HOOD (Without Ducting, Fixing &amp; Extraction fan) FOR TWO BURNER RANGE</b>
	<b>Size 1950x750x600mm</b>
	Made of s.steel sheet, 20G th`ick duly welded & pop riveted as required. The hood will be complete with S.S.sheet removable type baffle filters. Complete with grease collection channel & grease collection cup/s.
3	<b>JUICER (table top model)</b>
	Cast Aluminum/CI body, duly polished / painted, with worm & perforated insert. Top feeding tray. Worm easily cleanable fitted with 1/2HP elect. motor.
4	<b>CONVEYOR TOASTER</b>
	<b>App. Cap. 100-125 Toasts/hr.</b>
	S.S.Sheet body, having S.S.sheet conveyor belt. App.225mm wide. The unit will have heating elements on top & lower portion of conveyor belt with variable heat & speed control switch. (MADE IN ITALY)
5	<b>WORK TABLE</b>
	<b>Size 1500X600X850mm</b>
	Top & under shelf of S.S.sheet on M.S.anlge frame work & S.S.tubular legs, with adjustable feet. Top to have sound deadning material lining as required.
6	<b>FOOD TROLLEY WITH 4 ROUND PANS, 1 RICE TRAY &amp; STORAGE beneath</b>

	<b>O/S 1350X750X900mm</b>
	S.S.Sheet insulated body, Frame work of M.S.anlge of size 38x38x5mm, mounted on 4 castors (2 with brakes) of size 150mm top to have cutout for 4nos. Round pans for Dal, Subzi etc. with 1 rice tray & storage below. Three side covered with S.S.sheet with s.
7	<b>TRAY CARRIER TROLLEY</b>
	<b>Size 1200X600X1200mm</b>
	S.S.Bottom base shelf mount at 150mm with all four sides turned down 50mm in 12mm and secured to welded S.S.anlge frame work & PROVIDED WITH THREE NOS. OF DETACHABLE TRAYS CUM SHELFS UNIT WILL BE MOUNTED ON 4" PILLAR TYPE CASTORS WHEELS (2 NOS. WITH BRAKE & 2 NOS. WITHOUT BRAKE)
	<b>TRAY SET UP COUNTER WITH BAIN MARIE &amp; DOUBLE OVERSHELVES</b>
	<b>Size 1800x600x850+375+225</b>
	Top of 16G S.S.sheet, Bain Marie water tank of 18G S.S.sheet, fitted with 3.0kw heating element with automatic temperature controller. Water outlet provision with drain valve, 3 sides covered with 20G S.S.sheet, Top to accommodate S.S.sheet Food Pans with GN pan 1x2x4" depth with lid 5 sets.
8	<b>STORAGE CABINET</b>
	<b>Size 1200X600X850mm</b>
	Top of 16Swg S.S.Sheet one over shelf, three sides of 20SWG S.S. sheet. Dish storage cabinet with 2 shelves and sliding door will be provided on service side.
9	<b>STORAGE RACK</b>
	<b>Size 900X450X1800</b>

	Vertical of 32 mm dia stainless steel pipe with adjustable feet 4 no of 18 S.S Sheet at equally distance.
10	<b>POT RACK-3 TIER</b>
	Size 1200X600X1500mm
	Verticals of 32mmX32mm square S.S.pipe, 3 shelves welded with vertical frame of 19mm dia S.S.pipe shelves with equal space between two tubes mounted on adjustable feet.

## LIST OF APPROVED MAKES

S.No.	Item Description	List of Makes
1	Kitchen Equipments	MPS / ADVANCE TECH HEALTH CARE/ GE PROJECTS

**7.4. SIGNAGE & ASSOCIATED WORKS****a. Signage (Internal & External)**

- i. The scope of the work includes preparation of the shop drawings (based on the architectural drawings), fabrication, supply, installation and protection of the Signage, till completion and handing over of the work.
- ii. The item of work for the respective signage shall be conforming to Specifications and shall cover all operations, fabrications and their installations and materials required for finished product. and nothing extra shall be payable on this account.
- iii. The signage work shall be got executed through specialized fabricator having experience of similar works. The Contractor shall submit the credentials of such fabricator for the approval of the The Engineer.
- iv. The Contractor shall submit the Design, Size and installation procedure along with samples to The Engineer for approval. Approved samples will be kept at



site till the whole work is completed. The Engineer has right to modify the design of the approved samples and Contractor is bound to follow these written instruction/ changes in design/ size etc. from The Engineer.

- v. The typical patterns shown in the drawings. The Contractor shall submit shop drawings, for approval of the The Engineer, for fabricating signage with detailing of frame work, if any, along with the fixing details. The details of the signage including location, etc. shall be shown in the shop drawings.
- vi. The Contractor shall procure and submit to the The Engineer, samples of various materials for the signage work, for approval. After approval of samples of materials, the Contractor shall prepare sample(s) for approval of Engineer-in- Charge. The material shall be procured and the mass work taken up only after the approval of the mock up by the The Engineer. The mock-up shall be dismantled and removed by the Contractor as per the directions of the Engineer-in- Charge. Nothing extra shall be payable on this account.
- vii. The finished surface shall be free of any defects like dents, waviness, scratches, stains etc. and shall have uniform finish. Any defective work shall be rejected and redone by the Contractor at his own cost. The finished surface shall therefore be protected using protective tape which shall be removed at the time of completion of the work. The surface shall then be suitably cleaned using nonabrasive approved cleaner for the material. Nothing extra shall be payable on this account.
- viii. The item includes the cost of all inputs of labour, materials, T & P other incidental charges, wastages etc. The items also included providing and fixing with stainless steel anchor fasteners or other suitable arrangement for fixing the signage.
- ix. The item includes the cost of all inputs of labour, materials, T&P, other incidental charges, wastage etc. The entire work shall be carried out to the satisfaction of The Engineer.

**b. External Signage**

- i. The electrical power supply points, if required, for operation of the signage shall be provided by the Client.
- ii. The Contractor shall submit the design for the support structure, including foundations, if required, for the approval of the The Engineer and nothing extra shall be paid to the Contractor in this account.

#### **7.4.1. SIGNAGES AND ASSOCIATED WORKS GENERAL**

1. The sign board shall be in both English and Hindi language
2. Suitable pictogram to be provided as per approved samples
3. The colour of signages to be as per discretion of Engineer.
4. All signages details including sizes of sheet, letters, pictogram and border allround to be submitted and got approved priorly
5. The quoted rate shall be for all heights and floor levels.
6. The scope of work include providing and fixing base frame with removable/interchangeable signages. Which will be paid in respective items

#### **7.4.2. PVC SHEET / SUN BOARD**

1. Sheet to be best available brand of minimum thickness 3mm.
2. Top vinyl film to be best available brands of LG, Samsung or equivalent.
3. The thickness of film without adhesive to be around 75 microns and with adhesive to be 100microns.
4. The fixing to be done with screws / hanging chains/pipes/rods of approved make & material as per discretion of Engineer.
5. The rates to be quoted per square inch inclusive of pictogram & fixing up to any floor and height, wall fixing or hanging on ceiling.

#### **7.4.3. MS**

1. The make of material to be as approved by engineer.

2. The thickness of GI sheet should be as per approved drawing/ design .
3. The shop drawings of supporting structural frame and its foundation for signages to be submitted for approval by JDA.
4. The welding joints to be rubbed and grinded to give a smooth finish. No undulations shall be visible.
5. The MS frame and sheets to be primered and painted with approved make material.

#### **7.4.4. Stainless steel**

1. The thickness of sheet to be as per approved drawing/ design.
2. The same to be fixed with SS screws.
3. The engraving of letters to be as per standard norms and colours.
4. The individual alphabets/ letters, wherever required to have an inbuilt arrangement for fixing to support base with stainless steel screws complete for all heights and levels. All corners to be smoothly finished & SS welding.
5. The sheet/letters may be shining or mat finish as approved by engineer.

#### **7.4.5. Aluminum**

The thickness of sheet to be as per approved drawing/ design.

1. Fixing to be done with SS or appropriate screws to avoid bimetallic action with aluminum.

Samples Of All Materials, Letters Matters And Designs To Be Got Approved By Architect/ Client Before Execution Of Work.

2. The hanging aluminum hollow section to be of 100mm and 150mm width & make to be got approved. The powder coating of approved colour to be done and letters of approved specs and design to be pasted on such hanging aluminium hollow sections.

3. The hanging will be done by adjustable MS/GI rods of approved diameter and painting thereafter

### **Neon Glow signages**

1. The diameter of tube to be got approved.
2. Make to be got approved.
3. Matter to be got approved.
4. To be made from 100% handcraft glass.

Samples of all materials, letters matters and Designs to be got approved by Architect/ Client before execution of work.

#### **LIST OF APPROVED MAKES**

<b>S.No.</b>	<b>Item Description</b>	<b>List of Makes</b>
1	SIGNAGES	MR LLUMINATIOL / RG CORPORATION / PROTECTOR

## **7.5. HOSPITAL CUBICAL CURTAIN & TRACK SYSTEM, WALL & COLUMN GUARD**

### **7.5.1. CURTAIN TRACKS**

The System of fixing the Optitrac® Cubicle Curtain Track System” heavy Duty Aluminium cubicle track made of Aluminum alloy (6063-T5) having minimum size 35mm wide x 19mm high x 1.52mm thick, made of aluminium Extruded with white powder coating having properties like Tensile Strength 195 MPa, Shear Strength 150 MPa, Corrosion resistance properties with 50-60 micron Standard white powder coating with seven stage processes, Tracks to have drill guide on the top. Runners shall be of Wheel Type Roller and made from Nylon, Deralin with SS 304 Hook. Roof suspender, wall support, bridge clamp all shall be made from Aluminum Powder coated. Shall Provide factory bent track sections with one-foot radius.

**End Cap:** Provide thermoplastic end caps in a colour matching the track. End cap shall have a removable inner cap that allows carriers to be removed. Provide track aluminium splice to fit track section, with finish matching that of the track. Provide support sets, designed to receive attachment from track support. Provide brackets to mount to angle ceilings and receive attachment from track support. Unit includes durable hinge, latch and standard length. Acetal ipc ball and chain carriers with nonbinding nylon rollers accurately fit to track. Carriers to be fitted to curtain to prevent accidental curtain removal.

### **7.5.2. CUBICLE / PRIVACY CURTAIN :**

Curtains fabric to comply with many safety protocols it must be stain retardant and has a coating of antimicrobial and fire retardancy effect, must be certified according to international standards, must be certified by Indian Govt approved laboratories. it has to contribute to the reduction of transferring bacteria, help in increasing/improvement of hygienic standards provide greater safety against infection. No need of sterilization after wash. The antibacterial component facilitates in reducing the growth of fungi, moulds and mildew that can develop in any type of an indoor environment. Effective after 100 washes and, it must be OekoTex certified

The Cubicals are 100% polyester cubical curtains. Fabric is to be opaque, water repellent, wrinkle free, shrink proof, Anti-odor, Anti-microbial, Anti-fungal with high strength 18" oval net nylon mesh on top and Fabric 7'6" (H) x 4' (W). Curtain Fabric shall be of 230GSM.

### **7.5.3. WALLGUARD**

The system fixed to brick wall at 900mm center high from finished floor level comprising continuous aluminum rail retainer, 2 impact absorbing strips, end cap and high impact vinyl acrylic snap-on textured surface cover. The wall guard must be 152 mm wide, as specified by the client, must have 2mm thick aluminum retainer, must have 2 mm thick scratch and stain resistance rigid vinyl cover, should be coated with antifungal and antibacterial chemical.

The superior impact resistance Wall Guard (inpro) having Vinyl: Snap on cover of .080" (2mm) thickness shall be extruded from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers. No plasticizers shall be added (plasticizers may aid in bacterial growth). Surface shall have a pebble texture for scratch resistant and Continuous aluminum retainer of .080" (2mm) thickness shall be fabricated from 6063-T5 aluminum, with a mill finish. Dimensions to be of 6" (152mm) height x 1" (25mm) depth. Inner snap-on vinyl impact black bumper of .080" (2mm) thickness x 3.930" (100mm) width x 21mm height which shall be extruded from chemical and stain resistant unplasticized polyvinyl chloride (uPVC). The system shall resist an impact of 45.5 ft-lbs/inch while producing no visual blemishes upon the vinyl cover surface and no deformations in the aluminum retainers, as tested in accordance with applicable provisions of ASTM F 476-84, paragraph 18, Impact Test and shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The ipc system shall also conform to class A fire rating and ASTM D-543 for chemical and stain resistance. It shall include injection moulded End Caps with black reveal strip.

### **7.5.4. CORNERGUARD**

The system fixed to brick wall at the corner from finished floor level. Adjustable end cap. High impact vinyl acrylic snap-on matt finished. "50mm wide x 10mm thickness x 900mm length ". The corner guard must be 50 mm \* 50 mm, as specified the client in size with aluminum retainer and rigid vinyl, must have 2mm thick aluminum retainer, must have 2 mm thick scratch and stain resistance rigid vinyl cover, should be coated with antifungal and antibacterial chemical. the system shall be designed to withstand impact.

Providing and fixing series high impact surface mount IPS Corner Guard (Inpro) having Vinyl: Snap on cover of .080" (2mm) thickness shall be extruded from chemical and stain resistant polyvinyl chloride with the addition of impact modifiers No plasticizers shall be added (plasticizers may aid in bacterial growth). Surface shall have a pebble texture for scratch resistant. Continuous aluminum retainer of .070" (1.8mm) thickness shall be

fabricated from 6063-T5 aluminum, with a mill finish. Dimensions to be of 2" (51mm) x 2" (51mm), 90 degree. The rigid vinyl profile shall resist an impact of 30.2 ft-lbs/inch as per ASTM D-256-90b and shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The ipc system shall also conform to class A fire rating and ASTM D-543 for chemical and stain resistance. It includes Top caps and bottom caps which shall be made of injection moulded thermoplastics.

#### **7.5.5. WALL HANDRAILS**

Providing and fixing IPC Handrail (MAKE IN INDIA) having rigid vinyl snap-on cover(lead free) of 080" (2mm) thick, Surface shall have a pebblette texture for scratch and stain resistant rigid vinyl cover mounted on a sturdy continuous aluminium retainer of .080" (2mm) thickness that shall be fabricated from 6063-T5 aluminium with a mill finish. 4-5/16" (110mm) height x 1-5/8" (41mm) gripping diameter, extends 3-1/8" (79mm) from wall which has a oval gripping surface. The system shall resist an Impact Strength of 30.2 ft-lbs/inch of thickness as tested in accordance with the procedures specified in ASTM D-256-90b, Impact Resistance of Plastics. The rigid vinyl shall not support fungal or bacterial growth in accordance with ASTM G-21 and G-22. The system shall also conform to class A fire rating and ASTM D-543 for chemical and stain resistance. It includes Moulded end returns with black reveal strip and mounting brackets.

#### **7.5.6. PVC DADDOING**

The System fixing IPC® Rigid PVC Sheet (MAKE IN INDIA) shall be manufactured from chemical and stain resistant un plasticized polyvinyl chloride (uPVC) with the addition of impact modifiers. No plasticizers shall be added (plasticizers may aid in bacterial growth). Dimensions to be 4' x 8' (1.22m x 2.44m). 040" (1mm thick). Surface shall have a velvet texture for scratches and abrasions resistance. Class A fire rating and Impact Strength of 30.4 ft-lbs/ inch of thickness as tested in accordance with the procedures specified in ASTM D-256-90b and shall not support fungal or bacterial growth. Joints will be sealed with silicon Sealant.

#### **List of Approved Makes for Other Medical Services**

<b>SR NO.</b>	<b>DESCRIPTION</b>	<b>Approved Makes</b>
1	<b>Cubical Curtain Track with IV Hanger</b>	INPRO CORP INDIA/ AMBHA/ADISON EQUIPMENT COMPANY

## **7.6. BIO-MEDICAL WASTE TREATMENT FACILITY**

### **7.6.1. BIO-MEDICAL WASTE MANAGEMENT SYSTEM**

Improper handling of general waste may lead to cross-contamination with the hospital infectious waste and contaminate entire waste. If improperly handled and disposed of untreated, the bio-medical waste generated in a hospital may cause serious threat to the personnel handling the waste and also to the society.

The following are the key consideration in planning and designation of the biomedical Waste Management System.

#### **Identification of Bio-Medicals Waste:**

Bio-Medical Waste is generated primarily from the operation Theaters, ICU and Laboratories, Wards and other departments.

#### **Bio-Medical Waste Management System:**

The Bio-Medical Waste Management System process will cover the following aspects:

#### **Bio-Medical Waste Treatment Facility**

A Bio-Medical Waste Treatment Facility shall be provided with the following areas:

- Waste storage area
- Waste sorting area
- Waste Treatment area
- Treated Waste collection and disposal area
- Trolley Park area

The System is elaborated as under:

### **7.6.2. Waste Identification**

Areas Identified from Where Bio Medical Waste Generated Are identified as:

Operation theatres/Labour Rooms

Pathological labs and other



Laboratories

ICU

OPD

Wards

Causality

Diagnostic Areas

Other treatment areas and in the hospital

**7.6.3. Waste segregation and Collection**

Segregation and collection of waster is the first and the most important pre-requisite in the process of waste management in order to minimize quantities of hazardous waste and preventing cross contamination wit non-hazardous waste. Different colored collection bags and containers will be provided for collection of bio-medical waste as follows:

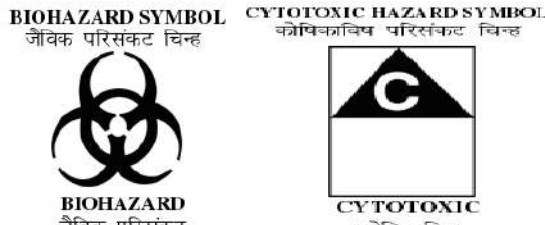
**COLOUR CODING AND TYPE OF CONTAINER FOR DISPOSAL OF BIO-MEDICAL WASTE**

<b>Colour Coding</b>	<b>Type of Container</b>	<b>Waste Category</b>	<b>Treatment/Disposal option</b>
Yellow	Plastic Bag	Human Anatomical wastes, Animal wastes, Microbiology and Biotechnology waste (Infectious wastes from laboratory)	Incineration/Deep Burial
Red	Disinfected container / plastic bag	Microbiology and Biotechnology wastes, Soiled wastes and solid wastes	Autoclave/Microwave/chemical Treatment
Blue /White Translucent	Plastic bag / Puncture proof Container	Waste Sharps and solid wastes	Autoclave/Microwave/chemical Treatment /Destruction and Shredding

Black	Plastic bag	Discarded medicines, Cytotoxic drugs, Incineration ash and chemical waste	Disposal in secured landfills
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#### 7.6.4. Waste Collection Bags

The yellow colored polybags provided for waste collection shall be made on non-chlorinated polythene which can be safely incinerated without having to open the bag. The bags shall be of colors as per recommendation of Ministry of Environment & Forests. Each bag can be easily tied up when it is full without touching the contaminated waste. The bags shall have bio-hazard symbol and inscription of type of waste to be collected into it.



The red, blue/white translucent poly bags used for collection of plastic and other solid waste are safe for autoclaving. The bags are specially designed to withstand high temperatures during autoclaving.

#### 7.6.5. Waste Collection Containers

The Polybags will be placed inside the collection containers which in turn shall be placed at locations where waste is actually generated so that its segregation and collection is possible at the source itself.

The Collection containers are specially designed with following features

- Foot operated lid
- Sturdy construction
- Arrangement for holding non-chlorinated polybags
- Steel construction with epoxy power coating for durability

The collection container(s) shall be with or without caster wheels depending on the location

of its placement.

The waste collection containers shall be of different colors for easy identification of waste that is to go into it.

#### **7.6.6. Waste Transportation**

Easily movable trolleys with large castor wheels shall be provided for collection of waste from different areas of the hospital and transporting the waste to the waste management yard. The trolleys shall have large containers with foot operated covers, mounted on the base framework. The trolleys shall be of sturdy construction and provided with castor wheels to easily move through various areas of the hospital.

Polybags shall be tied and taken out from the waste collection containers, which will be put into the transportation trolleys and then taken to the waste treatment yard for treatment and disposal. Persons handling polybags shall be provided with protective gloves.

#### **7.6.7. Waste Treatment**




Waste collection trolleys shall be taken to the waste treatment building for its treatment / Shredding & Autoclaving/Incineration and thereafter the waste shall be disposed off.




#### **List of Approved Make**



Si.No	DESCRIPTIONS	Approved Make
1	ALL Waste Collection Bins	POLYWEL/SRIKAMACHI TRADERS / RC VENTURES




## 7.7. HOSPITAL & ANNEX BLOCK FURNITURE



### 7.7.1. TECHNICAL SPECIFICATION – FURNITURE’S

S.No.	Item Name	Specification of the Item	Reference Image
1	Matrix 3 Seater Lounge Chair	<p>Supplying and fixing of Matrix Lounge Chair as per the following specifications. DIVANO LITE/TANDEM PUBLIC 3 SEATER/TANDEM SEATING/1735L X 720W X 800H, Seat Perfo - 1.2 mm thk, Seat Bracket - 1.2 mm, Back Perfo - 1.2 mm, Back Bracket- 1.2 mm, Seat Clamp &amp; Back Clamp- 4.0 mm, Solid Center beam- 2.0 mm</p> <p>Handle- 1.2 mm, Handle Bracket- 2.0 mm, Leg- 1.2 mm, Leg Plate- 4.0 mm, Leg Bush-2.0 mm, Leveller Cup - 0.6 mm</p> <p>The above entire unit shall be manufactured as per specifications ,Line Sketches &amp; as per the approval of the The Engineer.The rate including all material, labour, taxes, transportation etc to complete.</p>	
2	Matrix 4 Seater Lounge Chair	<p>Supplying and fixing of Matrix Lounge Chair as per the following specifications. DIVANO LITE/TANDEM PUBLIC 4 SEATER/TANDEM SEATING/2290L X 720W X 800H, Seat Perfo - 1.2 mm thk, Seat Bracket - 1.2 mm, Back Perfo - 1.2 mm, Back Bracket- 1.2 mm, Seat Clamp &amp; Back Clamp- 4.0 mm, Solid Center beam- 2.0 mm, Handle- 1.2 mm, Handle Bracket- 2.0 mm, Leg- 1.2 mm, Leg Plate- 4.0 mm, Leg Bush-2.0 mm, Leveller Cup - 0.6 mm. The above entire unit shall be manufactured as per specifications ,Line Sketches &amp; as per the approval of the The Engineer.The rate including all material, labour, taxes, transportation etc to complete.</p>	
3	Diva 7046R Chair	<p>Supplying and fixing of Chair as per the following specifications.Nexa Chair with foam seating, pushback mechanism, fixed armrest and 50mm twin-wheel Nylon castors mounted on 600 dia Nylon base. Chair back is ergonomically designed , made of Hot pressed Plywood and PU foam of density 50-55 kg/m<sup>3</sup>and upholstered with 100% Polyester Fabric. The above entire unit shall be manufactured as per specifications ,Line Sketches &amp; as per the approval of the The Engineer.The rate including all material, labour, taxes, transportation etc to complete.</p>	



S.No.	Item Name	Specification of the Item	Reference Image
4	Enterprise Table with Pedestal (1200W x600 Dx728 H mm)	Supplying and fixing of Table as per the following specifications. Main Table 1200Lx6000Dx750H, Pedestal - 400W x 450D x 675H, TABLETOP & GABLE END to be made of 25 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. MODESTY PANEL @725H to be made of 18 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. Pedestal - TOP: 18mm Thick Prelaminated Partical Board with 2MM PVC edge band on all edges. CARCASS (Body/ Shutter / Back) : 18MM thick Prelaminated Partical Board with PVC edge band on all exposed edges. HARDWARE : Hettich Hinges, Lock. The above entire unit shall be manufactured as per specifications, Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	
5	Premium L42 2 Seater Sofa	Supplying and fixing of Matrix Lounge Chair as per the following specifications. The seat shall be made of Mild Steel. The back shall be made of SS tubular frame. Size shall be in 78.5 cm. (B) x 210.0 cm. (L) x 63.8 cm (H) & SEAT HEIGHT size shall be in 42.0 cm (SH). The above entire unit shall be manufactured as per specifications ,Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	
6	Mayfair Table with ERU and Pedestal (1200W x750 Dx750 H mm)	Supplying and fixing of Table as per the following specifications. Main Table 1200Lx750Dx750H, Side Combo Storage 1050Lx450Dx750H, TABLETOP & GABLE END to be made of 25 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. MODESTY PANEL @725H to be made of 18 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. STORAGE - TOP: 25mm Thick Prelaminated Partical Board with 2MM PVC edge band on all edges. CARCASS (Body/ Shutter / Back) : 18MM thick Prelaminated Partical Board with PVC edge band on all exposed edges. SHELF : made of 18MM thick Prelaminated Partical Board with PVC edge band on al edges SHUTTERS : Lockable Swing shutters with Flush Handle / Finger Groove handle. HARDWARE : Hettich Hinges, Lock The above entire unit shall be manufactured as per specifications, Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	



S.No.	Item Name	Specification of the Item	Reference Image
7	Thrill Full Back Chair	<p>Supplying and fixing of Chairs as per the following specifications. MID BACK SIZE shall be in 60.0 cm. (L) x 60.0 cm (B) x 100.0 cm. (H) &amp; SEAT HEIGHT shall be in 50.0 cm (SH) {Adjustable}. The seat and back shall be made up of 1.2 cm. thick hot-pressed plywood, upholstered with fabric and moulded Polyurethane foam, together with moulded seat and back covers. The back foam is designed with contoured lumbar support for extra comfort. The Polyurethane foam is moulded with density of 45 +/- 2 kg/m and Hardness of 20 +/- 2 on Hampden machine at 25% compression. The armrest top should be made of moulded polyurethane (Polyurethane) and mounted on to a drop lift height adjustable type Mild Steel tubular armrest support chrome plated. The armrest height should be adjustable up to 6.5cm in 5 steps &amp; also should have swivel adjustment on both sides. The Knee tilt synchro mechanism should be designed with the following features - 360° revolving type, Tilt tension adjustment, 4-position locking with anti-shock feature, Seat back tilting ratio of 1 :2 (11 ° Seat Tilt /22° back tilt).The backrest consists of a sliding up down mechanism, which should be adjusted in the range of 7.5 cm and should be locked in 4 positions for correct position of lumber support.The pneumatic height adjustment has an adjustment stroke of 9.0 cm.The twin wheel castors shall be injection moulded in black Nylon. The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
8		<p><b>Supply and Fixing of Chair For Visitors</b>  Dimensions: 60.90 Lx 64.20 D x 98.20 H x 44.80 seat Ht. in CM  Frame Tubular Stain less Steel  High Density Polyurethane Foam combined with Premium Leatherette.  Sturdy PU Soft Arms.  Seat and back rest with comfort cushion  Legs with Nylon heavy duty bushes  Certificates: ISO 9001, BIS/ CE  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	



S.No.	Item Name	Specification of the Item	Reference Image
9	CH 18C Chair w/ Desklet	<p>Supplying and fixing of Writing Pad Chair as per the following specifications. The seat shall be made of moulded Polyurethane foam and 12mm thick Recycled composite board upholstered with replaceable fabric cover. The back shall be made of MS tubular frame insitu moulded with Polyurethane foam and upholstered with fabric/Leatherite cover. Chair size shall be in 55.0 cm. (B) x 60.0 cm (L) x 90.0 cm. (H) &amp; SEAT HEIGHT shall be in 42.0 cm (SH) (Fixed). The Polyurethane foam is moulded with density = <math>45 \pm 2</math> kg/m<sup>3</sup> and Hardness for back foam is 16 (+0/-2) &amp; that for seat foam is 20 (+/-2) at 25% compression. Armrest has a two piece construction and is mounted on to the tubular frame structure. It is injection moulded in talc filled PP. The powder coated tubular frame structure shall be made of 48 mm x 18.5 mm x 2.5 mm thk M.S. ERW oblong tube. The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
10	Pisa 2 Seater Sofa	<p>Supplying and fixing of Waiting Saba 2 Seater as per the following specifications. Three seater Sofa Set size shall be in seat height 860 mm, Seat width 600mm, Length of seater 1300mm and seat height 400 mm. Base Frame shall be made of Dymetrol stretchable fabric (100 S), M.S. pipe Legs made of Rubber wood, P.U. Foam (Hardness 20, Density 45 kg/cubic m) &amp; 18 mm thick partical board. armrest shall be made of Lining cloth cover placed on moulded P.U. Foam. (Hardness 20, Density 45 kg/cubic m) M.S. pipe, Recron fibre ( 200 grade-chemical bonded). Backrest shall be made up of Lining cloth cover placed on moulded P.U. Foam. (Hardness 14, Density 45 kg/cubic m) M.S. pipe - Recron fibre ( 200 grade chemical bonded). Seat shall be made up of cloth cover placed on moulded P.U. Foam. (Hardness 20, Density 45 kg/cubic m) Recron fibre (200 grade-chemical bonded). The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
11	Pisa Center Table	<p>Supplying and fixing of Centre Table as per the following specifications. PISA TABLE 1200Lx600Dx420HT, Top: Table Top with rectilinear form with rounded boundaries and chamfered edges give it crisp and formal visual appearance.</p>	




S.No.	Item Name	Specification of the Item	Reference Image
		12mm thick black tinted or toughened Glass top is scratch resistant. Understructure: 12mm MS rod or SS (202 GRADE) rod. Understructure provides structural stability with a lighter look to the entire product. The above entire unit shall be manufactured as per specifications ,Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	
12	Pisa Side Table	Supplying and fixing of Centre Table as per the following specifications. 600Lx600Dx420HT, Top: Table Top with rectilinear form with rounded boundaries and chamfered edges give it crisp and formal visual appearance. 12mm thick black tinted or toughened Glass top is scratch resistant. Understructure: 12mm MS rod or SS (202 GRADE) rod. Understructure provides structural stability with a lighter look to the entire product. The above entire unit shall be manufactured as per specifications ,Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	
13	Cignus Executive Table with ERU and Pedestal (1650x1950x750mm)	Supplying and fixing of Table as per the following specifications. TABLETOP & GABLE END made of 25 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. MODESTY PANEL @725H made of 18 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. PRELAM 3 DRAWER (2B+1F) PEDESTAL UNIT 400Wx450Dx670H (With Castor) - madeup of 18mm thick Prelaminated Particle Board with PVC Edge band and the telescopic slides for mobility of drawers and filers. The drawer is made up of 0.7 mm thick CRCA steel. with Centre Locking Mechanism considered. Side Finger Groove Handle is considered. STORAGE - TOP: 25mm Thick Prelaminated Partical Board with 2MM PVC edge band on all edges. CARCASS (Body/ Shutter / Back) : 18MM thick Prelaminated Partical Board with PVC edge band on all exposed edges. SHELF : made of 18MM thick Prelaminated Partical Board with PVC edge band on al edges SHUTTERS : Lockable Swing shutters with Finger Groove handle. HARDWARE : Hettich Hinges, Lock The above entire unit shall be manufactured as per specifications, Line Sketches & as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.	







S.No.	Item Name	Specification of the Item	Reference Image
14	Marvel High Back Chair	<p>Supplying and fixing of Chairs as per the following specifications. MID BACK SIZE shall be in 60.0 cm. (L) x 60.0 cm (B) x 100.0 cm. (H) &amp; SEAT HEIGHT shall be in 50.0 cm (SH) {Adjustable}. The seat and back shall be made up of 1.2 cm. thick hot-pressed plywood, upholstered with fabric and moulded Polyurethane foam, together with moulded seat and back covers. The back foam is designed with contoured lumbar support for extra comfort. The Polyurethane foam is moulded with density of 45 +/- 2 kg/m and Hardness of 20 +/- 2 on Hampden machine at 25% compression. The armrest top should be made of moulded polyurethane (Polyurethane) and mounted on to a drop lift height adjustable type Mild Steel tubular armrest support chrome plated. The armrest height should be adjustable up to 6.5cm in 5 steps &amp; also should have swivel adjustment on both sides. The Knee tilt synchro mechanism should be designed with the following features - 360° revolving type, Tilt tension adjustment, 4-position locking with anti-shock feature, Seat back tilting ratio of 1 :2 (11 ° Seat Tilt /22° back tilt).The backrest consists of a sliding up down mechanism, which should be adjusted in the range of 7.5 cm and should be locked in 4 positions for correct position of lumber support. The pneumatic height adjustment has an adjustment stroke of 9.0 cm. The twin wheel castors shall be injection moulded in black Nylon. The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
15		<p><b>Supply and Fixing of Chair For Visitors</b>  Dimensions: 60.90 Lx 64.20 D x 98.20 H x 44.80 seat Ht. in CM  Frame Tubular Stain less Steel  High Density Polyurethane Foam combined with Premium Leatherette.  Sturdy PU Soft Arms.  Seat and back rest with comfort cushion  Legs with Nylon heavy duty bushes  Certificates: ISO 9001, BIS/ CE  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	

S.No.	Item Name	Specification of the Item	Reference Image
16	Mingle Unitized Meeting Table(3600W X 1500D X 740H)	<p>Supplying and fixing of Meeting Table 15seater as per the following specifications. TABLETOP &amp; GABLE END made of 25 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. MODESTY made of 18mm thick Prelaminated particle board with machine pressed PVC edge band on all sides. WIRE MANAGEMENT The Vertical (snake) &amp; Horizontal(Switch mounting box) wire carriers are placed below worktop, made up of CRCA with Powder Coating &amp; Fixed to the understructure with specially designed brackets. Provision of placing switch plates in the cable tray which is easily accessible through a Access Flap (450L) . The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
17	Oxbo Visitor Chair	<p>Supply and Fixing of Chair For Visitors  Dimensions: 60.90 Lx 64.20 D x 98.20 H x 44.80 seat Ht. in CM  Frame Tubular Stain less Steel  High Density Polyurethane Foam combined with Premium Leatherette.  Sturdy PU Soft Arms.  Seat and back rest with comfort cushion  Legs with Nylon heavy duty bushes  Certificates: ISO 9001, BIS/ CE  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
		<b>BILL OF QUANTITY (MEDICINE STORE)</b>	

S.No.	Item Name	Specification of the Item	Reference Image
1		<p><b>Supply and Fixing of L Angular Rack</b>Size: 2130 (H) X 1080 (W) X 380 (D) mm Rack with 5 Compartments of 6 nos. of shelves. Distance between each shelf will be 410 mm. These 6 shelves should be hanging arrangement (adjustable). Racks shall be manufactured from Slotted M.S angle 14 SWG. Shelves shall be manufactured from 18 SWG thick sheet. The rack shall be assembled with G I bolt, nuts and washers. Slotted angle and M.S sheet shall be made of cold rolled with anti-rust treated and shall be finished with powder coating (color: Prince Gray). H/D Rubber bushes shall be provided to the bottom of legs of slotted angle racks. The quality of M.S sheet which is used for racks shall be free from any defects, Undulations, and old paints and surface corrosion, etc. Certificates: ISO 9001, BIS/CEThe above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
2		<p><b>Supply and Fixing of ALMIRAH SS</b></p> <p>1 Internal Size of Almirah: 1850 (H) X 900 (W) X 450 (D) mm</p> <p>2 Leg Size of Almirah: 150 (H) X 120 (W) X 450 (D) mm</p> <p>3 Rack with 5 Compartments.</p> <p>4 Distance between each shelf will be 360 mm.</p> <p>5 These 4 shelves should be hanging arrangement (adjustable).</p> <p>6 One shelf should have internal door and lock</p> <p>7 Standard lock and 2 sets of keys.</p> <p>8 The thickness of the Almirah sheet shall be 18 SWG.</p> <p>9 The body of the Almirah shall be manufactured from cold rolled MS sheet (C. R. Sheet) with Antirust treatment and shall be finished with powder coating</p> <p>The quality of used M.S sheet for making Almirah shall be free from any pitting and corrosion etc.</p> <p>10 H/D Rubber bushes shall be provided to the bottom of legs of Almirah.</p> <p>Certificates : ISO 9001 and BIS/Notified CE</p> <p>The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	

S.No.	Item Name	Specification of the Item	Reference Image
3		<p><b>Supply and Fixing of Almiraah with glass door</b> Steel almiraah with Toughened Glass Size: Height 1980mm, Width 915mm, Depth 480mm Mmanufactured from CRCA sheet conforming to IS 513-1994 grade D material. The CRCA sheet of uniform thickness and of 22 gauge for the body, 20 gauge for doors duly cut and bend with the help of CNC machines. The almiraah shall be equipped with four fixed shelves, manufactured from 22 gauge CRCA sheet, thereby making five compartments in the Almiraah. The steel shelf shall be capable of carrying a uniformly distributed load of 70kgms. Certification: Manufacturer should have ISO: 9001, BIS/ CE The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
4		<p><b>Supply and Fixing of Table for clerk</b>  <b>WORKTOP</b> - Made of 25 mm thick Prelaminated particle board with machine pressed PVC edge band on all sides.  <b>UNDERSTRUCTURE</b>- C LEG constructed of Vertical of 50X50X1.6 mm &amp; Horizontal of 40mm X 40mm X 1.6mm thick MS Pipe with caps &amp; levellers .  Cross member is made of 40mm X 40mm X 1.6mm MS pipes. .  powder coated finish of 50 to 60 Microns DFT.  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
5		<p><b>Supply and Fixing of Table for Computer</b>  Contemporary &amp; Modern Style Computer Desk  Set-up for Study &amp; Home Office with Storage Space  W x H x D: 1003.3 mm x 749.3 mm x 508 mm (3 ft 3 in x 2 ft 5 in x 1 ft 8 in)  With CPU Compartment  Built-in Keyboard Tray  Certificates: BIS/CE, ISO 9001  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	

S.No.	Item Name	Specification of the Item	Reference Image
6		<p><b>Supply and Fixing of Revolving Chair</b> Material: Fire retardant breathable mesh inbuilt into the backrest and Polyester fabric integrated into the seat. (BM Mesh &amp; 5060 fabric seat).Base: 700 mm diameter Nylon base with 50 mm castors for stability and easy movement.Arms: Fixed Polypropylene inbuilt arms.Centre tilt: Adjust your work posture by using the tilt to recline on the chair for meetings / phone calls and more. Use the tilt lock for upright posture like keyboarding.Pneumatic height: Change the height of the chair relative to the floor by 100 mm.Certificates: ISO 9001, Notified CE/BISThe above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
7		<p><b>Supply and Fixing of Chair For Visitors</b>  Dimensions: 60.90 Lx 64.20 D x 98.20 H x 44.80 seat Ht. in CM  Frame Tubular Stain less Steel  High Density Polyurethane Foam combined with Premium Leatherette.  Sturdy PU Soft Arms.  Seat and back rest with comfort cushion  Legs with Nylon heavy duty bushes  Certificates: ISO 9001, BIS/ CE  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	
8		<p><b>Supply and Fixing of Attender stool</b>  Approx. size:- 300mm square 18G double bent top of MS  Height 510mm. Framework of MS press bent 25mm x 25mm x 3mm angles and 'C' channe riveted to angles made from 18G.  MS CRCA sheet superimposed press bent argon arc welded top made from 0.6mm thick 304 grade S.S. sheet riveted with MS Drive on MS. Top.  Legs fitted with PVC angle shoe  Certificates : Manufacturer should have ISO:900, notified CE/BIS  The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes,</p>	

S.No.	Item Name	Specification of the Item	Reference Image
		transportation etc to complete.	
		<b>BILL OF QUANTITY (NURSE STATION)</b>	
1		<p>Supply and fixing of Nurse station table as per the drawing &amp; detail. The whole structure is formed of 19mm thick ply finished with approved laminate. Table top is formed out of 19mm thick ply finished with laminate cladding on both sides. The Table to have twin level table top at 750mm &amp; 1050mm level of approved laminte finish as per approval of the architect. The depth of table top at 750mm level is 500mm deep and table top at 1050mm level is 600mm deep. below 750mm to be provided with openable storages Counter top to be formed out of 19mm thick ply finished with approved laminate The table to have a 1 Nos of fully extendable drawer pedestal unit at every 2m intervals on ball bearing drawer guides and finished with laminate of approved colour and shade as per details. Drawer to be complete with hardware installed as directed to consist of the following: 1 no multi purpose lock as specified,100mm SS handle, keyboard tray, Space for CPU unit etc complete as per details and Architect's approval.All internal surfaces to be finished with 0.8mm thick balancing laminate of approved shade. Cost to include Borer/Antitermite treatment for wood/plywood Hardware: All hardware shall be as per the approved model/make mentioned in finishing schedule.The above entire unit shall be manufactured as per specifications, Line Sketches &amp; as per the approval of the The Engineer. The rate including all material, labour, taxes, transportation etc to complete.</p>	

### 8. ENGINEERING PERSONNEL OF CONTRACTOR

The contractor should ensure to deploy all the following Engineering personnel permanently for the work:

Sl. No.	Position	Nos.	Education Qualification	Minimum Number of Years	
				Similar Positions	Total Work Experience
1	Project Manager - Civil	1	Master's in Civil / Construction management / Structural Engg. Bachelor's in Civil Engg.	15 years	30 years
2	Construction Manager- Civil (1 Nos. at each Location)	3	Master's in Civil / Construction management / Structural Engg. Bachelor's in Civil Engg.	12 years	20 years
3	Construction Manager – E&M (1 Nos. at each Location)	3	Bachelor's in Electrical/ Mechanical Engg.	12 years	20 years
4	Material Engineer cum QC Engineer (1 Nos. at each Location)	3	Bachelor's in Civil Engg.	10 years	15 years
5	Planning Engineer (1 Nos. at each Location)	3	Master's in Civil / Construction management Bachelor's in Civil Engg. Hands on experience in Primavera software	8 years	12 years
6	Environmental, Health & Safety (1 Nos. at each Location)	3	Master's / Bachelor's in Environmental Engineering	8 years	12 years

The above requirement are minimum and the Engineer reserves the right the instruct for additional man-power deployment as per the work requirement.

### 9. MINIMUM REQUIREMENT OF CONSTRUCTION EQUIPMENT

The contractor should ensure to mobilize the following construction equipments to the site immediately after the commencement of the work:

No.	Equipment Type and Required Performance Characteristics	Minimum Requirement per location (Number of Units)	Minimum Requirement for the work (Number of Units)
1	Centralized concrete batch mix plant of capacity 30 cum per hour (fully automatic with computer control) within the site.	1	3
2	Excavator cum loader (JCB 3D model or equivalent).	3	9
3	Builders hoist	2	6
4	Pile Rig Machine	2	6
5	Compressor machine minimum 20 CFM with rock Breaker.	5	15
6	DG set of minimum capacities of 62.5 KVA.	5	15
7	Mini batching plant Portable (6 cum/hr)	2	6
8	Boom Placer	1	3
9	Transit mixers.	As per requirement	As per requirement
10	Welding machine 400 Ampere 20	20	60
11	Water tanker (Minimum capacity of 5000 litres)	8	24
12	Power driven earth rammer (Soil compactor)	4	12
13	Reinforcement cutting machine.	10	30
14	Total Station Machine	3	9
15	Reinforcement bending machine.	10	30
16	Dumper/Tipper	10	30
17	Automatic Ring making machine (Reinforcement)	3	9



No.	Equipment Type and Required Performance Characteristics	Minimum Requirement per location (Number of Units)	Minimum Requirement for the work (Number of Units)
18	Plate Vibrator	10	30
19	Screed leveller.	10	30
20	Needle Vibrators	10	30
21	Concrete pump	4	12
22	Centrifugal mono block water pump minimum capacity 2 HP	20	60
23	Road roller 8 to 10 tons	3	9
24	Vibratory roller	4	12
25	Drilling machine	5	15
26	Double steel scaffolding and staging materials	8000 Sqm	24000 Sqm
27	Shuttering Material including Beam, Column Slabs etc.	8000 Sqm	24000 Sqm
28	Air compressor	6	18
29	Floor grinding/polishing machines	6	18
30	Granite cutting machine	6	18
31	Ceramic tile cutting machine	20	60
32	Granite polishing machine	4	12
33	Granite hand polishing machine	10	30
34	Mobile tower crane	2	6
35	Sprinklers	2	6

The above said equipments and quantities are minimum requirement and the Engineer reserves the right to instruct for mobilization of additional equipments as per the work requirement.

## **10. LIST OF DRAWINGS TO BE PROVIDED BY THE CONTRACTOR**

During the execution of the contract, the Engineer shall issue all the approved Good for Construction (GFC) drawings to the contractor for the execution. However, contractor has responsibility of obtaining the shop drawings as shown in the Annexure-A enclosed to this Technical Specification. These shop drawings has to be submitted to the Engineer prior to execution of the work for his approval.

## **11. ENVIRONMENTAL MANAGEMENT**

### **11.1. SPECIAL CONDITIONS FOR ENVIRONMENT PROTECTION**

Construction Stage-

All vehicles, equipment and machinery to be procured for construction shall conform to the relevant Bureau of India Standard (BIS) norms

The contractor shall follow all the requirements of Environmental Management Plan (EMP) & Environmental Monitoring Plan (EMoP), Which specifically includes all environmental impacts and their mitigation measures related to construction and demolition activities of Building, prior to commencement of any works under the Contract. & In EMP should also briefly include the Integrated Waste Management Plan.

The Contractor shall undertake monitoring of various environmental aspects through an agency approved by NABL/MoEF&CC / CPCB / SPCB.

The Contractor shall comply at all times with all relevant national and state legislation regarding environmental and social protection, pollution prevention and control, waste management and other relevant environmental and social matters

The Contractor shall follow all the recommendation and guidelines mentioned in the Environmental Clearance (EC) & Consent to establish/Consent to operate(CTE/CTO) taken by the employer for commencement of this project from competent authorities.

The Contractor shall ensure appointment of competent Environmental Officer(s), who shall work in coordination with Employer, PMC and his staff, for effective environment management and implementation of EMP & EMoP.

If a batching plant is needed to produce concrete, SPCB clearances for its establishment and operation must be obtained in accordance with regulations.

Emission from the vehicles must conform to environmental norms & must have valid PUC certificate

Dust produced from the vehicular movement and other site activities is to be mitigated by sprinkling of water.

Construction Wastes Disposal

The pre-identified dump locations will be a part of solid waste management plan to be prepared by the Contractor in consultation with the Engineer.

Contractor shall identify the location of disposal site and get it approved from the competent authority i.e the Engineer prior to commencement of the excavation/demolition work.

Contractor shall ensure that any spoils of material will not be disposed off in any municipality solid waste collection bins.

Procurement of Construction Materials

All vehicles delivering construction materials to the site shall be covered to avoid spillage of materials and maintain cleanliness of the roads.

Wheel Tyers of all vehicles used by of the contractor, or any of his sub-contractor or materials supplies shall be cleaned and washed clear of all dust/mud before leaving the project premises. This shall be done by routing the vehicles through tyre washing tracks.

Contractor shall arrange for regular water sprinkling at least twice a day (i.e. morning and evening) for dust suppression of the construction sites and unpaved roads used by his construction vehicles.

#### Water Pollution

The Contractor shall take all precautionary measures to prevent the wastewater during construction to accumulate anywhere.

The wastewater arising from the project is to be disposed off in the manner that is acceptable to the Engineer.

#### Air and Noise Pollution

Contractor shall use dust screens and sprinkle water around the construction site to arrest spreading of dust in the air and surrounding areas.

Contractor shall ensure that all vehicles, equipment and machinery used for construction are regularly maintained and confirm that emission levels comply with environmental emission standards/norms.

All vehicles and equipment used in construction will be fitted with exhaust silencers.

Servicing of all construction vehicles and machinery will be done regularly and during routine servicing operations, the effectiveness of exhaust silencers will be checked and if found defective will be replaced.

The Contractor shall be provided the noise shields around the construction site. The noise shields can be any physical barriers, which provide adequate attenuation of noise levels.

At the surface of the construction site, the Contractor shall use only equipment that operating under full load meets the noise limits specified in Table: Noise Emission Limits for Construction Equipment Measured at 50 feet From Construction Equipment:

Equipment Category	Lmax Level dB(A)
Backhoe	80
Bar Bender	80
Chain Saw	85
Compactor	80
Compressor	80
Concrete Mixer	85
Concrete Pump	82

Crane	85
Dozer	85
Front End Loader	80
Generator	82
Gradall	85
Grader	85
Paver	85
Pneumatic Tools	85
Roller	85
Tractor	84

The construction activities shall be limited to the Ambient Noise Standards measured at the nearest affected sensitive receptor  
The Ambient Noise Standards are as given in Table:

Category of Area	Limits in dB (A)	
	Day Time #	Night Time #
Industrial	75	70
Commercial	65	55
Residential	55	45
*Silence	50	40

# Day time mean from 6.00 a.m. to 10.00 p.m. and Night Time shall mean from 10.00 p.m. to 6.00 a.m.

\*Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority.

While installing any DG set (manufactured after January 2005), the maximum permissible sound pressure shall be 75dB(A) at 1m from the enclosure surface. Only Acoustic type DG should be use at project site.

#### Vibration Level

The Project location is close to residential / commercial structures, the Contactor shall prepare a monitoring scheme prior to construction at such locations. This scheme for monitoring vibration level at such residential / commercial sites shall be submitted to the PMC for his approval. This scheme shall include:

- (i) Monitoring requirements for vibrations at regular intervals throughout the construction period.
- (ii) Pre-construction structural integrity inspections of sensitive structures in project activity.
- (iii) Information dissemination about the construction method, probable effects, quality control measures and precautions to be used.
- (iv) The vibration level limits at the Site adjacent to the alignment shall conform to the permitted values of Peak Particle Velocity (PPV) as given in Directorate General Mining and Safety (DGMS) (Tech) S&T Circular Vo.7 of 1997.

#### Personal Safety, Hygiene Measures for Labour

Contractor will provide the following items for safety of workers employed by contractor and associate agencies:

Protective footwear and gloves to all workers employed for the work on mixing, cement, lime mortars, concrete etc. and openings in water pipeline/sewer line.

Welder's protective eye-shields to workers who are engaged in welding works.

Safety helmet and Safety harness/ belt.

Provide adequate sanitation/safety facilities for construction workers to ensure the health and safety of the workers during construction, with effective provisions for the basic facilities such as sanitation, drinking water and safety equipment's or machinery.

All the workers should be wearing helmet and shoes all the time on site.

Masks and gloves should be worn whenever and wherever required.

Adequate drinking water facility should be provided at site, adequate number of decentralized latrines and urinals to be provided for construction workers.

If allowed and full time workers are residing on site, then they should be provided with clean and adequate temporary hutment.

First aid facility should also be provided.

Overhead lifting of heavy materials should be avoided. Barrow wheel and hand-lift boxes should be used to transport materials onsite.

Tobacco and cigarette smoking should be prohibited onsite.

All dangerous parts of machinery are well guarded and all precautions for working on machinery are taken.

Maintain hoists and lifts, lifting machines, chains, ropes and other lifting tackles in good condition. Provide safety net of adequate strength to arrest falling material down below.

Use of durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.

Ensure that walking surfaces or boards at height are of sound construction and are provided with safety rails and belts. Provide protective equipment's such as helmets.

Provide measure to prevent fire. Fire extinguisher and buckets of sand to be provided in fire-prone area and elsewhere.

Provide sufficient and suitable light for working during night.

Ensure that measures to protect workers from materials of construction, transportation,

storage and other dangers and health hazards are taken

Ensure that the construction firm/division/company have sound safety policies.

Comply with the safety procedure, norms and guidelines (as applicable) as outlined in NBC 2016.

Adopt additional best practices and prescribed norms as in NBC 2016

Contractor is required to get existing top soil tested for fertility. If test finds it fertile, then top soil preservation is required. For preservation, top layer of soil (150mm- 300mm from the top) must be stripped off the site areas where construction activity will be carried out and kept separately for preservation. The preserved top soil must NOT be mixed with subsoil (soil excavated below 150mm – 300mm depth). The top soil should be preserved from erosion by wind/rain water by planting plants or grass on it. The preserved top soil stack height should not be more than 400mm – 600mm. The area used for preserved top soil should be barricaded from all the sides & nothing should be dumped on it during the construction process. There should be regular water sprinkling on the preserved top soil for its compaction & to maintain its fertility by adding organic manure as per the direction of horticulturist. Top-soil fertility test must be carried out before preservation and post construction to ensure and maintain its fertility. The soil fertility should be enhanced by organic means only if required. Preserved top soil must be spread back to landscaped areas after the construction activity is completed as per the direction of site in charge. Top soil fertility test must be done from an ICAR or NABL accredited laboratory for the following parameters- P.H., Mineral Content, Organic Matter (%), Nitrogen (kg/Hec), Phosphorus (kg/Hec), Potassium (kg/Hec), Free Lime content (%), Iron (ppm), Manganese (ppm), Bauxite (ppm), Copper (ppm), Texture (%), Bulk Density (Mg m<sup>3</sup>), Particle Density (Mg m<sup>3</sup>), Maximum Water Holding Capacity (%), Exchangeable Sodium (Mg/100g)

Identify roads on-site that would be used for vehicular traffic. Update vehicular roads (if these are unpaved) by increasing the surface strength by improving particle size, shape and mineral type that make up the surface base. Add surface gravel to reduce source of dust emission. Limit amount of fine particles (smaller than 0.075mm) to 10 -20%. Limit vehicular speed on site 10km/h. Nothing extra will be payable for this.

All material storages should be adequately covered and contained so that they are not exposed to situations where winds on site could lead to dust/particulate emissions.

Spills of dirt or dusty materials shall be cleaned up promptly so the spilled material does not become a source of fugitive dust and also to prevent of seepage of pollutant laden water into the ground aquifers. When cleaning up the spill, ensure that the clean - up process does not generate additional dust. Similarly, spilled concrete slurries or liquid wastes should be contained/cleaned up immediately before they can infiltrate into the soil/ground or runoff in nearby areas.

The contractor shall ensure that water spraying is carried out by wetting the surface by spraying water on:

Any dusty material.

Areas where demolition work is carried out.

Any unpaved main-haul road and.

Areas where excavation or earth moving activities are to be carried out.

The contractor shall ensure the following:

Cover and enclose the site by providing dust screen, sheeting or netting to scaffold along the perimeter of a building.

Covering stockpiles of dusty material with impervious sheeting.

Covering dusty load on vehicles by impervious sheeting before they leave the site.

Transferring, handling/storing dry loose materials like bulk cement and dry pulverized fly ash inside a totally enclosed system.

Clear vegetation only from areas where work will start right away.

Vegetate/mulch areas where vehicles do not ply.

Apply gravel / landscaping rock to the areas where mulching/paving is impractical.

Adopt measures to prevent air pollution in the vicinity of the site due to construction activities. There is no standard reference for this. The best practices should be followed (as adopted from international best practice documents and codes).

The contractor shall provide experienced personnel with suitable training to ensure that these methods are implemented. Prior to the commencement of any work, the method of working, plant equipment and air pollution control system to be used on -site should be made available for the inspection and approval of the Engineer to ensure that these are suitable for the project.

Employ measures to segregate the waste on-site into inert, chemical or hazardous wastes. Recycle the unused chemical/hazardous wastes such as oil, paint, batteries and asbestos. The inert waste is to be disposed off to Municipal Corporation/local bodies dump yard and landfill sites.

To preserve the existing landscape and protect it from degradation during the process of construction. Proper timing for construction activity shall be selected to minimize the disturbance such as soil pollution due to spilling of the construction material and its mixing with rainwater. The construction management plan including soil erosion control management plan shall be prepared accordingly for each month. The application of erosion control measures includes construction of gravel pits and tyre washing bays of approved size and specification for all vehicular site entry/exits, protection of slopes greater than 10%. Sedimentation Collection System and run-off diversion systems shall be in place before the commencement of construction activity. Existing vegetation shall be preserved and protected by not-disturbing or damaging to specified site areas during construction.

The contractor should follow the construction plans proposed by the Engineer / landscape consultant to minimize the site disturbance such as soil pollution due to spilling. Use staging and spill prevention and control plan to restrict the spilling of the contaminating material on site.

Spill prevention and control plans should clearly state measures to stop the source of the spill. Measures to contain the spill and measures to dispose the contaminated material and hazardous wastes. It should also state the designation of personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners and petroleum products.

A soil Erosion and Sedimentation Control Plan (ESCP) should be prepared prior to construction and should be applied effectively.

The contractor shall prepare and submit 'Spill prevention and control plans' before the start of construction, clearly stating measures to stop the source of the spill, to contain the spill, to dispose the contaminated material and hazardous wastes, and stating designation of

personnel trained to prevent and control spills. Hazardous wastes include pesticides, paints, cleaners, and petroleum products.

The contractor shall ensure that no construction leaches (e.g. cement slurry) is allowed to percolate into the ground. Adequate precautions are to be taken to safeguard against this including reduction of wasteful curing processes, collection, basic filtering and reuse. The contractor shall follow requisite measures for collecting drainage water run-off from construction areas and material storage sites and diverting water flow away from such polluted areas. Temporary drainage channels, perimeter dike/swale, etc. shall be constructed to carry the pollutant -laden water directly to the treatment device or facility (municipal sewer line).

All lighting installed by the contractor around the site and at the labour quarters during construction shall be CFL/ LED bulbs of the appropriate illumination levels. This condition is a must, unless specifically prescribed otherwise.

All the building materials and systems used on site must be as per the specifications and approved makes by the Engineer-In-Charge.

All required certificates explaining the properties of the building material/system needs to be obtained from the manufacturer/vendor as required by the green building rating authority. The purchase orders of all the materials made with the manufacturers / authorized vendors should be maintained and shall be provided for the process with due diligence upon request.

All paints, adhesives and sealants should comply with the VOC limits prescribed as follows:

Table 1- VOC limits for paints, adhesives and sealants

Description	VOC Limit (g/l)	Description	VOC Limit (g/l)
PAINTS		ADHESIVE	
Non-flat	150	Wood flooring	100
Flat (Mat)	50	Tile	65
Anti-corrosive /anti-rust	250	Indoor Carpet	50
COATINGS		Structural Glazing	100
Varnish	350	Multipurpose Construction	70
Lacquer	550		
Floor Coatings	100		
Stains	250		

Water saving measures need to be followed on site. If bore well water is used for construction, it must be metered. For waste water use in construction, record must be maintained of all tankers used at site. All sources of water use during construction must be regularly monitored.

The contractor / subcontractor shall prepare and submit a Site Management Plan (SMP)



within 10 days of start, for approval by the Engineer. This SMP shall indicate the locations of go down, stockpiles, barricading, waste storage, offices, vehicular movement routes etc. In short this SMP would comprehensively represent how the site activities shall be managed. Contractor will be penalized @ Rs. 500 per day of delay on non-submission of SMP beyond due date to be recovered from next RA bill.

Any other site management measures suggested by the Engineer shall be followed on site.

The contractor & his team shall put adequate efforts to minimize construction waste generation at site. This shall include collection and segregation of all construction waste at site like broken bricks, tiles, glass, pavers, Steel scrap, Concrete debris, Plastic bags, drums, packaging cardboard, Timber scrap, Cement bags etc.

The contractor must keep record of all the construction waste being recycled or reused at site and also maintain receipts/records of waste sold from site. The contractor must ensure that no waste from the site is sent to landfill sites, either all waste is reused within the site or sent for recycling. Track the waste sent off the site to its final destination. Contractor must keep record as gate passes/ challans for all the waste material sent out for selling.

The contractor shall submit to the Engineer after construction of the buildings, a detailed as built quantification of the following within 10 days of recording of completion. Contractor will be penalized @ Rs. 500 per day of delay on non-submission of SMP beyond due date to be recovered from the Final bill:

Total materials used

Total waste generated,

Total waste reused,

Total water used,

Total electricity consumed, and

Total diesel consumed.

Evidence for the implementation of the all the above required measures shall be provided in the form of photographs and templates as required which is required for the submission to the authorities

The contractor shall provide potable water for all workers. The contractor shall provide the minimum level of sanitation and safety facilities for the workers at site. The contractor shall ensure cleanliness of workplace with regard to the disposal of waste and effluent; provide clean drinking water and latrines and urinals as per applicable standard. Adequate toilet facilities shall be provided for the workman within easy access of their place of work. The total no. to be provided shall not be less than 1 per 30 employees in any one shift. Toilet facilities shall be provided from the start of building operations, connection to a sewer shall be made as soon as practicable. Every toilet shall be so constructed that the occupant is sheltered from view and protected from the weather and falling objects. Toilet facilities shall be maintained in a sanitary condition. A sufficient quantity of disinfectant shall be provided. Natural or artificial illumination shall be provided.

In compliance to the Hon'ble National Green Tribunal (NGT) and Office Memorandum no. DG/SE/CM/CON/Misc./02 dated 16.03.2016 following preventive/corrective measures to be taken at site in order to control Air pollution from construction and demolition activity: –

The contractor shall not store/dump construction material or debris on metaled road.

The contractor shall get prior approval from Engineer for the area where the construction material or debris can be stored beyond the metalled road. This area shall not cause any obstruction to the free flow of traffic/inconvenience to the pedestrians. It should be ensured by the contractor that no accidents occur on account of such permissible storage.

The contractor shall take appropriate protection measures like raising wind breakers of appropriate height on all sides of the plot /area using CGI sheets or plastic and /or other similar material to ensure that no construction material dust fly outside the plot area.

The contractor shall ensure that all the trucks or vehicles of any kind which are used for construction purposes/or are carrying construction material like cement, sand and other allied material are fully covered. The contractor shall take every necessary precautions that the vehicles are properly cleaned and dust free to ensure that enroute their destination , the dust, sand or any other particles are not released in air/contaminate air.

The contractor shall provide mask to every worker working on the construction site and involved in loading, unloading and carriage of construction material and construction debris to prevent inhalation of dust particles.

The contractor shall provide all medical help, investigation and treatment to the workers involved in the construction of building and carry of construction material and debris relatable to dust emission.

The contractor shall ensure that C&D waste is transported to the C&D Waste site only and due record shall be maintained by the contractor.

The contractor shall compulsory use of wet jet in grinding and stone cutting.

The contractor shall comply all the preventive and protective environmental steps as stated in the MoEF guidelines, 2010.

The contractor shall carry out on-Road-Inspection for black smoke generating machinery. The contractor shall use cleaner fuel.

The contractor shall ensure that all DG sets comply emission norms notified by MoEF.

The contractor shall use vehicles having pollution under control certificate. The emissions can be reduced by a large extent by reducing the speed of a vehicle to 20 kmph. Speed bumps shall be used to ensure speed reduction. In cases where speed reduction cannot effectively reduce fugitive dust, the contractor shall divert traffic to nearby paved areas.

The contractor shall ensure that the construction material is covered by tarpaulin. The contractor shall take all other precaution to ensure that no dust particles are permitted to pollute air quality as a result of such storage.

The paving of the path for plying of vehicles carrying construction material is more permanent solution to dust control and suitable for longer duration projects.

In case of non Availability of the C& D waste Material / Product, the contractor shall make arrangement of substitute materials/Products with out any cost adjustment.

Any Penalty imposed by Civic bodies/ NGT for Non Compliance of their guidelines issued by them from time to time shall be borne by the contractor.

The contractor shall comply with the safety procedures, norms and guidelines (as applicable) as outlined in the Part 7 of National Building code 2016 of India, Bureau of Indian Standards. A copy of all pertinent regulations and notices concerning accidents, injury and first-aid shall be prominently exhibited at the work site. Depending upon the scope & nature of work, a person qualified in first-aid shall be available at work site to render and direct first-aid to

causalities. A telephone may be provided to first-aid assistant with telephone numbers of the hospitals displayed. Complete reports of all accidents and action taken thereon shall be forwarded to the competent authorities.

The contractor shall ensure the following activities for construction workers safety, among other measures:

Guarding all parts of dangerous machinery.

Precautionary signs for working on machinery

Maintaining hoists and lifts, lifting machines, chains, ropes, and other lifting tackles in good condition.

Durable and reusable formwork systems to replace timber formwork and ensure that formwork where used is properly maintained.

Ensuring that walking surfaces or boards at height are of sound construction and are provided with safety rails or belts.

Provide protective equipment; helmets etc.

Provide measures to prevent fires.

Fire extinguishers and buckets of sand to be provided in the fire-prone area and elsewhere.

Provide sufficient and suitable light for working during night time.

Where possible, the contractor shall select materials / vendors, harvested and manufactured regionally, within a 800-km radius of the project site. Contractor shall collect & submit the relevant material certificates for materials with high recycled (both post-industrial and post-consumer) content, including materials like RMC mix with fly-ash, glass with recycled content, calcium silicate boards etc. Contractor shall collect the relevant material certificates for rapidly renewable materials such as bamboo, wool, cotton insulation, agri-fiber, linoleum, wheat board, strawboard and cork etc.

The contractor shall ensure that a flush out of all internal spaces is conducted prior to handover. This shall comprise an opening of all doors and windows for 14 days to vent out any toxic fumes due to paints, varnishes, polishes, etc.

Apart from the above conditions, the Environmental Management Plan to be followed by the contract before and during Construction Phase and during operation phase is enclosed as Annexure-B.

## **11.2. ENVIRONMENTAL MONITORING**

During the construction phase and operation phase of this project the contractor is required to carryout environmental monitoring and reporting as per environmental monitoring plan enclosed at Annexure-C. The filling in the monitoring form shall be done by the contractor on a quarterly basis during construction and same annually after the completion of the project during defect liability period i.e., 24 Months, provided that there is no outstanding environmental issue during operation. The reporting forms are enclosed at Annexure-D the reporting is to be strictly done as per the given formats.

In case the contractor fails to monitor and report the environmental items indicated in the monitoring plan mentioned above the same shall be got done by Environmental Expert and suitable deductions shall be carried from contractors account for above default.

**PENALTY FOR NON-COMPLIANCE WITH ABOVE ENVIRONMENTAL REQUIREMENT :**

**In case of non-compliance/delay in compliance to the above Environmental protection / monitoring requirements, a recovery @ Rs. 5000/- per day will be imposed which will be recovered from the immediate next R/A Bill of the Contractor.**

**CONSTRUCTION WASTE**

The contractor shall prepare and make himself conversant with the Site Waste Management Program Manual and actively contribute to its compilation by estimating the nature and volume of waste generated by the process/installation in question.

Contractor shall ensure that wastage of construction material is minimum . Subject to the suitability, all construction debris shall be used for road preparation, back filling, etc, as per the instructions of the Engineer in Charge, with necessary activities of sorting, crushing, etc. No construction debris shall be taken away from the site, without the prior approval of the Engineer in Charge. If and when construction debris is taken out of the site, after prior permissions from the Engineer in Charge, then the contractor shall ensure the safe disposal of all wastes and will only dispose of any such construction waste in approved dumping sites.

Contractor shall collect all construction waste generated on site. Segregate these wastes based on their utility and examine means of sending such waste to manufacturing units which use them as raw material or other site which require it for specific purpose. All construction debris generated during construction shall be carefully segregated and stored in a demarcated waste yard. Clear, identifiable areas shall be provided for each waste type. Employ measures to segregate the waste on site into inert, chemical, or hazardous wastes. Typical construction debris could be broken bricks, steel bars, broken tiles, spilled concrete and mortar etc.

Water spray, through a simple hose for small projects, to keep dust under control. Fine mists should be used to control fine particulate. However, this should be done with care so as not to waste water. Heavy watering can also create mud, which when tracked onto paved public roadways, must be promptly removed. Also, there must be an adequate supply of clean water nearby to ensure that spray nozzles don't get plugged.

Contractor shall be required to provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics, and metals. He shall coordinate the size and functionality of the recycling areas with the anticipated collections services for glass, plastic, office paper, newspaper, cardboard, and organic wastes to maximize the effectiveness of the dedicated areas. Consider employing cardboard balers, aluminum can crushers, recycling chutes, and collection bins at individual workstations to further enhance the recycling program.

Staging (dividing a construction area into two or more areas to minimize the area of soil that will be exposed at any given time) should be done to separate undisturbed land from land disturbed by construction activity and material storage.

The storage of material shall be as per standard good practices as specified in Part 7, Section 2 in Planning Aspects, NBC 2016 and shall be to the satisfaction of the Engineer in Charge to ensure minimum wastage and to prevent any misuse, damage, inconvenience or accident. There should be a proper planning of the layout for stacking and storage of different materials, components and equipment's with proper access and proper maneuverability of the vehicles carrying the materials. While planning the layout, the requirements of various materials, components and equipment's at different stages of construction shall be

considered.

The contractor shall provide for adequate number of garbage bins around the construction site and the workers facilities and will be responsible for the proper utilization of these bins for any solid waste generated during the construction. The contractor shall ensure that the site and the workers facilities are kept litter free. Separate bins should be provided for plastic, glass, metal, biological land paper waste and labelled in both Hindi and English with suitable symbols.

The Contractor shall remove from site all rubbish and debris generated by the Works and keep Works clean and tidy throughout the Contract Period. All the serviceable and non-serviceable (Malba) material shall be segregated and stored separately. The Malba obtained during construction shall be collected in well-formed heaps at properly selected places, keeping in a view safe condition for workmen in the area. Materials which are likely to cause dust nuisance or undue environmental pollution in any other way, shall be removed from the site at the earliest and till then they shall be suitable covered. Glass & steel should be dumped or buried separately to prevent injury. The work of removal of debris should be carried out during day. In case of poor visibility artificial light may be provided.

**Annexure-B : Environmental Management Plan**

## Environmental Management Plan Before and during Construction Phase

<b>Field</b>	<b>Items</b>	<b>Identified Potential Negative Impact</b>	<b>Mitigation Measures</b>	<b>Implementing Organization</b>	<b>Responsible Organization</b>
Pollution	Air quality	Impact on air quality due to operation of construction machineries and traveling of the construction vehicles is expected. During construction phase, particulate matter will be main pollutant followed by SO <sub>x</sub> , NO <sub>x</sub> and CO from construction machineries and vehicles.	<ul style="list-style-type: none"> <li>- To utilize fuel-economy/ low-emission construction vehicle and machineries.</li> <li>- To sprinkle water around the project site dust is generated especially during dry season.</li> <li>- To maintain construction vehicles and construction machineries adequately.</li> <li>- To install temporal enclosure around the construction site.</li> <li>- To give guidance for drivers about idling stop and avoiding excessive load operation such as quick acceleration and overloading.</li> </ul>	Contractor	PMU & PMC
	Water pollution	Impact on water quality due to leakage of oil from machineries and construction chemical are expected.	<ul style="list-style-type: none"> <li>-To install appropriate drainage system in the construction site before construction activities commence.</li> <li>-To check leakage of oil and chemical products periodically.</li> </ul>	Contractor	PMU & PMC

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
			<p>To install impermeable material around the oil and chemical storage and oil handling area.</p> <p>-To train operators of construction machineries in daily maintenance to prevent oil leakage</p> <p>-To collect waste oil into the designated container separately and hand over to authorized third party for treatment and disposal.</p>		
	Solid Waste	The excavated solid waste as well as construction related waste will be main component of solid waste.	<p>-To handle wastes within the project site and store them with cover until handed over to authorized third party.</p> <p>-Especially for the demolishing the existing facilities built with Asbestos materials, the waste shall be handled in compliance with Construction and Demolition Waste Management Rules, 2016.</p> <p>-To segregate waste and recycle or sell to third party as applicable. The waste must not contain hazardous substances.</p>	Contractor	PMU & PMC

<b>Field</b>	<b>Items</b>	<b>Identified Potential Negative Impact</b>	<b>Mitigation Measures</b>	<b>Implementing Organization</b>	<b>Responsible Organization</b>
	Soil Contamination	It is possible that oil leakage may cause soil contamination during construction phase.	-Same as water pollution	-	-
	Noise and vibration	Various machineries such as concrete mixer, crane, and track generate noise nearly 90 (dB) as well as project related traffics may generate noise in and around project site.	-To install temporal fence. -To strive to introduce low-nose and low-vibration machineries. -To avoid construction at nighttime as much as possible. -To avoid intensive operation of construction machineries that generate noise and vibration.	Contractor	PMU & PMC
	Ground Subsidence	There is potential risk of ground subsidence if it is planned that the construction activities at some target facilities utilize ground water for construction activities.	-To monitor groundwater level and ground subsidence status periodically and adopt other source such as tanker water supply in case significant declines are observed.	Contractor	PMU & PMC
	Offensive Odor	Inadequate management of waste and wastewater can be the source of odor.	Same as "solid waste"	-	-



<b>Field</b>	<b>Items</b>	<b>Identified Potential Negative Impact</b>	<b>Mitigation Measures</b>	<b>Implementing Organization</b>	<b>Responsible Organization</b>
Social Environment	Hydrology	Construction of drainage inside and around the site will modify the hydrology of site.	-To install proper drainage system in the project site.	Contractor	PMU & PMC
	Water usage	Usage of ground water is planned during construction phase that might affect water usage of surrounding community.	Same as ground subsidence	-	-
	Existing social infrastructures and services	Conceivable major impact on existing social infrastructures and services during the construction phase is traffic congestion because of traffic construction related vehicles.	-To plan timing and route for construction related traffic. -To deploy traffic controller -To inform foreseen activities to the public as needed.	Contractor	PMU & PMC
	Landscape	It is expected that the project implementation would impact landscape around the project site in some extent.	-To install temporary enclosure wall during construction works.	Contractor	PMU & PMC

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
	Occupational health and safety	<p>Handling of Asbestos for demolishing existing buildings may cause health issues of workers.</p> <p>In general, various occupational risks are foreseen as the construction works involve various machineries operations, and buildings with multi stories are designed.</p>	<p>-To provide safety and health training to workers when employed and enforce norm of safety demolition and construction, including isolation of the area built with Asbestos using polyethylene sheets or equivalent. To promote use of appropriate personal protective equipment (eye protections, helmet, protective shoes, glove, etc.).</p> <p>-To establish the system for safety and health management at the construction site, and to clarify the responsible person and reporting system.</p> <p>-To apply good practices for similar construction.</p>	Contractor	PMU & PMC
	Community Health and Safety	Some negative impacts on public health, such as spread of infectious diseases due to influx of construction workers are anticipated, since the project includes large-scale construction works.	-To provide training about public health and infectious diseases for construction workers.	Contractor	PMU & PMC

<b>Field</b>	<b>Items</b>	<b>Identified Potential Negative Impact</b>	<b>Mitigation Measures</b>	<b>Implementing Organization</b>	<b>Responsible Organization</b>
Others	Trans boundary impacts including Climate Change	GHGs emission from operation of the construction machines and traveling of the vehicles are expected.	<p>-To adopt fuel-economy/ low-emission construction vehicle and machineries as applicable and economically feasible.</p> <p>-To control idling operation of machineries.</p>	Contractor	PMU & PMC

## Environmental Management Plan during Operation Phase

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
Pollution	Air quality	Impact on air quality due to diesel generator (DG) sets and increased project related transportation is expected.	-To utilize low-pollutant fuel as applicable and financially feasible. -To maintain generator periodically to sustain high performance for long term.  Apply same measures as in construction phase.	Contractor & PIU - PWD	PIU – PWD / PMU
	Water pollution	Treated wastewater to be discharged through rainwater drainage will be main source of pollution from project operation. Another potential impact would be medical effluent, which may contain hazardous elements.	-To monitor quality of treated wastewater and check compliance with standards prescribed by SPCB.  -To install ETP designed for medical institute, and properly operating them following instruction by SPCB. -To inspect the rainwater drainage system and maintain it periodically.	Contractor & PIU - PWD	PIU – PWD / PMU
	Solid Waste	Various medical, non-medical, hazardous, and non-hazardous wastes will be generated.	-To segregate waste by type and hazard level of them in proper container, collect and store them in sealed storage until hand over to authorized third party.	Contractor & PIU	PIU – PWD / PMU

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
			-To develop manual for waste handling to all medical staff and enforce it to practice.		
	Soil Contamination	Negative impact is expected due to varying contaminates from oil and grease, inorganic and organic chemical compounds.	<p>-To develop management rules for chemical products, and to practices the rules with relevant medical workers and educational staff.</p> <p>-To prepare action plans in case of leakage of chemical substance.</p> <p>-To collect solid and liquid wastes with infectious or chemical substances separately, store them in sealed container or storage until handed over to authorized third parties for disposal or treatment.</p> <p>-To inspect the containers and storages regularly and to maintain them in good condition to prevent accidental leakage.</p> <p>-To conduct mitigation measures listed for water pollution and solid waste</p>	Contractor & PIU	PIU – PWD / PMU
	Noise and	Generation of noise because of increased traffic volume	-To install low-noise type system, to inspect them regularly to maintain	Contractor & PIU -	PIU – PWD /

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
	vibration	with ambulance, cars of visitors and project personnel, operation of boiler system and emergency generator are expected.	them in good condition. -To prepare concrete enclosure around the facilities that may generate noise and vibration as needed.	PWD	PMU
	Offensive Odor	Inadequate management of waste, wastewater and sludge from wastewater treatment plant can be the source of odor.	Same as "solid waste"	-	-
Social Environment	Existing social infrastructures and service	It is expected that visitor's transportation would be conceivable impact on existing social infrastructures and services during operation phase.	-To separate the traffic route for visitor and non-visitor (staff and third parties) for smooth traffic management in and around the project site. Take same measures as construction phase if appropriate.	Contractor & PIU - PWD	PIU – PWD / PMU
	Landscap e	It is expected that the project implementation would impact landscape of the project site.	-To maintain green zone in order to buffer the appearance of buildings that can be seen from boundaries of project site	Contractor & PIU - PWD	PIU – PWD / PMU
Health	Occupatio	Various potential	-To formulate the safety manual for	Contractor	PIU –

Field	Items	Identified Potential Negative Impact	Mitigation Measures	Implementing Organization	Responsible Organization
and Safety	nal Health and Safety	occupational risks are foreseen associated with medical treatment utilizing equipment such as physical injuries with blades and needles, infectious accident, exposure to radiation are expected.	hospital operation, update it regularly and to enforce it to all relevant staff. To provide the safety training for all employees, to formulate the health and safety education plan and to implement it.  -To provide annual health check for all employees.  -To monitor occupational risk associated with medical activities such as radiation exposure level, solvent handling and worker's injuries and provide additional health check to prevent irreversible health damage of staff.	& PIU - PWD	PWD / PMU
Others	Trans boundary impacts including Climate Change	Conceivable major activities that emit GHGs during the operation phase are 1) Operation of wastewater treatment system, 2) increase of traffic caused by the project operation, 3) usage of diesel generator and 4) (if adopted) biogas production	-To introduce vehicles and machineries that would generate less GHGs, and to maintain them adequately.	Contractor & PIU - PWD	PIU - PWD / PMU

<b>Field</b>	<b>Items</b>	<b>Identified Potential Negative Impact</b>	<b>Mitigation Measures</b>	<b>Implemen ting Organizat ion</b>	<b>Responsi ble Organiza tion</b>
		with solid waste.			



**Annexure-C : Environmental Monitoring Plan for Category 8(a) and 8(b) facilities**

## Environmental Monitoring Plan (Construction Phase)

Category	Monitoring item	Monitoring site	Frequency
Air Pollution (Ambient air)	PM10, PM2s, SOx, NOx and CO	Near the project site	Monthly
Water Pollution	Water quality (BOD, COD, pH, oil & grease, total coliform, TSS, TN, TP, etc.)	Open well located at southern part of the project site	Monthly
	Maintenance situation of temporary drainage, temporary storm water reservoir, and septic tank	Construction Site	Monthly
Solid waste	Generation and treatment amount of construction and general waste	Construction Site	Monthly
	Status of waste management (if covered or stored properly etc.)	Construction Site	Monthly
Soil Contamination	Oil leakage (daily maintenance record of relevant machineries, record of oil leakage accidents etc.)	Construction Site	Monthly
Noise and Vibration	Noise level, Vibration level	Several points on boundary of the project site	More than monthly, when noise generating activities are conducted
Offensive Odor	Record of unusual smell	In and around construction site	When sensed
Ground subsidence/ Hydrology/ Water Usage	Groundwater level, ground level	Well and several point close to well	Monthly
Existing Social Infrastructures and Services	Number of traffic accident that involved construction related vehicles	Project Site and its surrounding area	Monthly
	Placement of traffic guard in the exit of the	Construction Site	Monthly

Category	Monitoring item	Monitoring site	Frequency
	construction site		
Occupational Health and Safety	Implementation of safety training/ safety driving trainings for the construction workers	Project Site	Monthly
	Workers' accidents	Project Site	Monthly
	Safety situation in the construction site	Project Site	Everyday
Community Health and Safety	Implementation of training of public health and safety for the construction workers	Project Site	Monthly
Common	Complaints from neighbors	Project site and its surrounding	Monthly

## Proposed Environmental Monitoring Plan (Operation Phase)

Category	Monitoring item	Monitoring site	Frequency
Common	Implementation of environmental mitigation plan	Project Site and its surroundings	Monthly
	Complaints from neighbors	Project Site and its surroundings	Monthly
Air Pollution	PM10, PM2s, SOx, NOx and CO	Near the project site	Monthly
(Stack Emissions from DG set)	PM, SOx, NOx, HC and CO	Outlet of stack	Once in a month (half year after construction, while generator is operated)
Water Pollution	Water quality (BOD, COD, pH, oil & grease, total coliform, TSS, TN, TP, etc.)	Open well located at southern part of the project site	Biannually (once in dry and rainy season)
	pH, BOD, TSS, COD, TN, TP, and total Coliform	Outlet of STP	Monthly
		Outlet of ETP	Monthly

Category	Monitoring item	Monitoring site	Frequency
Solid Waste	Amount of generated waste by each category	Project Site (waste storage)	Monthly
	Status of waste storage (if there is no leakage, contamination with other categories, etc.)	Project Site (waste storage)	Monthly
Soil Contamination	Oil leakage (daily maintenance record of relevant facilities, record of oil leakage accidents etc.)	Project Site	Monthly
	Leakage of chemical/hazardous liquids	Project Site	Monthly
Noise and Vibration	Implementation status of periodic check of noise generating facilities and the emergency power supply	Project Site	Monthly (while facilities are operated)
Offensive Odor	Record of unusual smell	In and around construction site	When sensed
Existing Social Infrastructures and Services	Traffic accident, status of traffic congestions	In and around Project Site	Monthly
Occupational Health and Safety	Implementation of safety training/ safety driving trainings for the employees	Project Site	Annual
	Employees' radiation dose	Project Site	Monthly (Safety and Health Committee)
	Occupational accidents	Project Site	Monthly (Safety and Health Committee)
	Implementation status of employees health check	Project Site	Annual
	Safety condition of working environment	Project Site	Everyday

**Annexure-D : Environmental Monitoring Form**

The latest result of the monitoring items shall be submitted to the part of Quarterly Progress Report throughout the construction phase.

Date of record:                    /            /            ( Day /Month/ Year )

Note:\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline result can be left blank.

**Construction Phase****1. Response/ Action to Comments and Instruction from Authorities and the Public**

Comments or Instructions		Response/ Action which was taken by contractor
Authority (Government)		
Public (Residents)		

**2. Pollution****Air quality**

Parameter	Unit	Measured Value	NAAQ Standard Value	Baseline* (mean value during Dry season)	Location (Measured point, Source, Implant Recipients)	Note (Frequency etc.)
Near Project Site	PM10	µg/m3	100			
	PM2.5	µg/m3	60			
	SO2	µg/m3	80			
	NOx	µg/m3	80			
	CO	µg/m3	2			

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## Water Quality

Parameter		Unit	Measured Value	Tolerance limits for discharge of trade effluent into Inland Surface Water	Baseline * (During Dry season)	Location (Measured point, Source, Implant Recipients)	Note (Frequency etc.)
Open well located at southern part of the site	BOD	mg/L		30			
	COD	mg/L		250			
	pH	-		5.5 to 9.0			
	Oil and grease	mg/L		10			
	Total Coliform	MPN / 100 mL		-			
	TDS	mg/L		2100			
	TN	mg/L		100			
	TP	mg/L		-			

## Waste (Generation of Waste)

Item	Unit	Volume	Period		Explanation of status (Example XXXXm3 Surplus soil has carried to the contractor's stock yard)	Note (Frequency, data source etc.)
			From	To		
Generated Construction waste	m3					
Treated Construction waste	m3					
Generated General waste	m3					
Treated General waste	m3					

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## Waste (Status of waste management)

Item	Description / Photo of the disposal site	Observations ( e.g. Distance from the residence, messy/ tidy)	Note (Frequency, data source etc.)
Status of the storage site			
Status of the disposal site			

## Soil Contamination

Item	Description	Observations	Note (Frequency, responsible person etc.)
Maintenance record of relevant machineries	(List of machineries utilizing oil, frequency of maintenance, status of oil handling area)		
Record of oil leakage accidents	( date, time, source of leakage etc)		(measures to prevent accidents)

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Noise & Vibration (Several points on boundary of the project site, number of points can be modified)

Parameter	Unit	Measured Value	SPCB Permissible Limits		Baseline *	Location (Measured points, Source, Implant Recipients )	Note (Frequency etc)
			Residential area	Commercial area			
Noise 1	dB	(Leq)	55 (Daytime)	65 (Daytime)			
Noise 2	dB	(Leq)					
Noise 3	dB	(Leq)					
Noise 4	dB	(Leq)					
Parameter	Unit	Measured Value	Max. Acceptable Limit of ISO 2372 & VDI 2056 Group G				
Vibration 1	mm/s		1.81 to 4.5				
Vibration 2	mm/s						

Vibration 3	mm /s					
Vibration 4	mm /s					

## Offensive Odor (Record of unusual smell)

Item	Description	Observations, cause of odor	Note
Record of unusual smell	(date, time, source of smell etc)		(measures to prevent generation of odor, responsible person)

## Ground subsidence/ Hydrology/ Water Usage

Location	Groundwater level(m)	Observations (variation from last measurement)	Note (necessity of suspending pumping up ground water, operation plan)
Well 1			
Well 2			
	Ground level(m)	Observations (variation from last measurement)	
Point 1			
Point 2			

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2. Pollution

Existing Social Infrastructure and Service

Item	Location	Description	Measures to be taken	Note(Frequency etc)
Number of traffic accident that involved construction related vehicles				
Placement of traffic guard				
Complain from surrounding communities				

Occupational Health & Safety: Safety training

Item	Contents of training	Date of training, number of participants, reaction	Note
Record of training			

Worker's Accidents

Record of accident (date, place, number of involved people)	Causes of accident	Note (Preventive measures etc)

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Record of site situation (related to occupational health) : Daily observations and record

Date	Description of site condition (case of nearly accidents etc)	Points to be improved (if there are any), responsible person

Common: Complaints from Neighbors

Description of Complaints	Date, time, duration of cause of complaints etc)	Note(Contact person etc.)

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Date of record:     /     /     (Day / Month / Year)

Operation Phase

1. Response/ Action to Comments and Instruction from Authorities and the Public

Comments or Instructions		Response/ Action which was taken by project proponent
Authority (Government)		
Public (Residents)		

2. Pollution

Air quality

Parameter	Unit	Measured Value	NAAQ Ambient Standard Value	Baseline* (Dry season, mean value)	Location (Measured point, Source, Implant Recipients)	Note (Frequency etc.)
Near Project Site	PM10	µg/m3	100			
	PM2.5	µg/m3	60			
	SO2	µg/m3	80			
	NOx	µg/m3	80			
	CO	µg/m3	2			

## Water Quality (surface water)

Parameter		Unit	Measured Value	Tolerance limits for discharge of trade effluent into Inland Surface Water	Baseline * (During Dry season)	Location (Measured point, Source, Implant Recipients)	Note (Frequency etc.)
Open well located at	BOD	mg/L		30			
	COD	mg/L		250			
	pH	-		5.5 to 9.0			
	Oil and grease	mg/L		10			
	Total Coliform	MPN / 100 mL		-			
	TDS	mg/L		2100			
	TN	mg/L		100			
	TP	mg/L		-			

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\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline should be left blank.

## Water quality (Effluent from Sewage/Effluent treatment plants)

Parameter		Unit	Measured value	SPCB Standards (Applicable to all mode of disposal for Mega and Metropolitan cities)	Observation/ record of operation	Note
Outlet of Sewage Treatment Plant (STP)	pH	-		5.5 to 9.0		
	BOD	Mg/I		10		
	TSS	Mg/I		20		
	COD	Mg/I		50		
	TN	Mg/I		10		

Parameter	Unit	Measured value	SPCB Standards (Applicable to all mode of disposal for Mega and Metropolitan cities)	Observation/ record of operation	Note
	TP	Mg/I		1.0	
	Fecal Coliform	MPN /100 mL		Desirable-100 Permissible -230	
Outlet of Effluent Treatment Plant (ETP)	pH	-		5.5 to 9.0	
	BOD	Mg/I		10	
	TSS	Mg/I		20	
	COD	Mg/I		50	
	TN	Mg/I		10	
	TP	Mg/I		1.0	
	Fecal Coliform	MPN /100 mL		Desirable-100 Permissible -230	

## Waste (Generation of Waste by category)

Item	Volume	Unit *	Authorized third party to hand over / disposal method (in case of general wastes)	Note (Frequency, data source etc.)
Bio-Medical wastes		m <sup>3</sup>		
Hazardous wastes (chemical)		m <sup>3</sup>		
Radioactive material		m <sup>3</sup>		
Bio degradable wastes		m <sup>3</sup>		
General wastes		m <sup>3</sup>		

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\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline should be left blank.

Waste (Sludge) Sludge from STP

Item	Unit	Volume	Period		Explanation of status (Example XXXX m3 sludge recycled as xxxxxx  XXXX m3 Temporary stocked in the site.)	Note
			From	To		
Generated sludge	m3					
Recycled sludge volume	m3					
Surplus	m3					

Sludge from ETP

Item	Unit	Volume	Period		Explanation of status (Example XXXX m3 sludge recycled as xxxxxx  XXXX m3 Temporary stocked in the site.)	Note
			From	To		
Generated sludge	m3					
Recycled sludge volume	m3					
Surplus	m3					

## Waste (Status of waste management)

Item	Description / Photo of the disposal site	Observations	Additional Note
Status of the waste storage			
Status of segregation			

## Soil Contamination (Record of Oil leakage)

Item	Description	Observations	Note (Responsible person etc.)
Maintenance record of relevant facilities	(name of facility, date, frequency, possible source of leakage etc if there were any)		
Record of oil leakage accidents	( date, time, source of leakage etc if there were any)		(measures to prevent accidents)
Leakage of chemical / hazardous liquids	( date, time, source of leakage etc if there were any)		(measures to prevent accidents)

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\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline should be left blank.



## Noise and Vibration (Status of periodic check of Noise / Vibration generating facilities)

Item	Description (date, frequency, running condition)	Observations	Note (Responsible department/person etc.)
Maintenance record of air conditioning system			
Maintenance record of Diesel Generator sets			
Maintenance record of XXX (possible source of Noise / Vibration)			

## Offensive Odor (Record of unusual smell)

Description (date, time, source of smell etc)	Observations, cause of odor	Note (measures to prevent generation of odor, responsible person)

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\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline should be left blank.

## 3.Social

## Existing Social Infrastructure and Service

Item	Location	Description (time, frequency etc)	Measures to be taken	Note
Number of traffic accident that involved project related vehicles				
Status of Traffic congestions caused by project related vehicles				
Complain from surrounding communities				

## Occupational Health &amp; Safety: Record of safety training

Date / Period	Contents of training	Number of participants, reaction	Note

This form is provisional prepared based on the available information as of Nov. 2021, subject to modification based on instruction by SPCB and other relevant authorities.

\*) baseline values should be filled based on the result of site measurement for EIA study under SPCB or result of national monitoring program if applicable. If these are not available, baseline should be left blank.

Occupational Health & Safety: Record of accident

Date	Place (section / department)	Detailed description including causes of accident	Note (Preventive measures etc)

Occupational Health & Safety: Record Employee's health check

Department / Unit	Contents of health check	Coverage of Health check inside the Department / Unit	Note

Occupational health & Safety: Record of Employee’s Radiation Dose (Limited to workers at relevant departments/Units)

Department/Unit	Name of Employee	Duration of Exposure to radiation	Type of Radiation and exposure	Exposure limit (National/International standards)	Cumulative / lifetime exposure	Note

Common: Complaints from Neighbors

Description of Complaints	Date, time, duration of cause of complaints etc.)	Note (Contact person etc.)

End

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