



CSIR-NATIONAL METALLURGICAL LABORATORY

(Council of Scientific & Industrial Research)

JAMSHEDPUR-831007



CONTRACT DOCUMENTS

FOR THE WORK

Replacement of Existing (2Nos. 86TR Units) Inefficient Creep Central A.C Plant with Energy Efficient Central A.C Plant in CSIR-NML, Jamshedpur.

“Part –I, Technical Bid”

(Document to be submitted in Envelope-1)

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SCOPE OF WORK

- a) Dismantling & removal of existing central AC plant, air-handling units, Cooling towers, all piping, valves, existing foundations, electrical panels, power & control wirings, false ceiling (Ground floor - Creep Lab), Mezzanine floor, First Floor), Light fittings etc.
- b) Buy-Back of Chillers, air-handling units, cooling towers, condenser & chilled water pumps, valves, strainers, chilled water pipe line, condenser water pipe line.
- c) Supply installation testing and commissioning of new items as per schedule of work & as per the system requirement.
- d) The existing duct will be retained however, modifications in the existing duct, supply, installation of new duct as & where deemed necessary has to be carried out by the bidder (Attached Drawings given in tender can be referred).
- e) Existing main power cable end termination with the new main panel (Refer to Electrical SLD drawing). Cable size needs to be checked at site prior to tender for proper termination provision.
- f) The related civil works i.e. preparation of foundation as recommended by OEM for chilling machine (Size needs to be checked by contractor before tendering, including Space for installation), cooling towers, Air handling Units (AHUs), pumps, access/ opening in the walls for the lifting and shifting of machines, repairing of walls including painting or any kind of repair needed to other damages occurring during execution of work shall be carried out by the bidder.
- g) Providing suitable supports to pipe lines as per standard.
- h) New False ceiling work in Ground Floor, Mezzanine Floor, First Floor.
- i) Internal electrification work in all the floors, plant room and AHU rooms as required.
- j) Construction of New room for hot water pumps if required.
- k) Flooring work in chillers plant room.
- l) Operation & Maintenance of new AC Plant with all material & manpower during defect liability period/ guarantee period (One year from the date of acceptance of Work) in three shifts of 8 hours working. Only plant operators & helpers charges shall be payable to the bidder.
- m) Operation & Comprehensive Maintenance of AC Plant with material & manpower for the period of two years from the date of expiry of defect liability period/ guarantee period. If the contractor/ agency is not an OEM, he shall enter into back to back agreement with OEM for chilling unit. The documentary evidence for the same shall be furnished to CSIR-NML, Jamshedpur. A separate **supplementary/rider agreement** will be signed by the tenderer before commencement of operation & annual maintenance work. The payment towards operation & maintenance shall be made monthly after submitting the bill by the tenderer at the end of each month against work done satisfactorily.
- n) Bidder has to provide one operator and one helper in each shift for operation of AC plant.
- o) All necessary documents in respect of Technical particulars of equipment's supplied (Duly filled Data sheets as per format), Basis of Design & Selection criteria, Work completion schedule etc., needs to be submitted along with Technical Bid. Tenderer has to confirm himself the Tender specifications for system completeness, and major deviations if any, needs to be mentioned in a separate sheet of deviation list with Technical Bid. No deviations and any kind of implications will be accepted at a later stage.

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- p) A Detailed Works execution Schedule strictly in line with CSIR-NML requirement stated in Tender document, needs to be submitted separately by the party along with the Technical Bid. Any deviation from CSIR-NML schedule shall not be acceptable.

The brief description of the items has been mentioned in the Schedule of Quantity. Any omission in the description of the items shall not absolve the contractor for his responsibility to complete the work in satisfactory manner. The work shall have to be executed in accordance with the relevant specifications. The firm should quote their rates taking all aspects into consideration. Any discrepancy / omission observed in the tender in order to complete the job in satisfactory manner, the bidder must bring out such items with rates, quantities and specifications in a separate letter along with their tender itself since nothing extra will be payable against any item on this account after award of work. Technical literature of the chilling machine is to be furnished along with the technical bid; Detail drawings, data sheet etc. are to be submitted after award of work.

The work will be carried out on 24 Hr. basis including holidays without interruption and without any extra claim. Contractor has to take prior permission from the concerned authority to carry out any work beyond normal office hours and on holidays.

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CSIR-NATIONAL METALLURGICAL LABORATORY
JAMSHEDPUR-831007
WORKS & SERVICE MAINTENANCE DIVISION
SCHEDULE OF QUANTITY (PART-I)
(Technical Bid)



Name of Work: Replacement of Existing (2Nos.x86TR Units) inefficient Creep Central A.C Plant with energy efficient Central A.C Plant in CSIR-NML, Jamshedpur.

Sub Head -(A) Supply, Installation, Testing & Commissioning of energy efficient Central AC Plant.			
Item. No	Description	Unit	Qty
1)	Water Cooled Screw Chiller		
	Supply, Installation, Testing & Commissioning of 125 TR (Net Capacity) Screw type Chilling unit complete with Screw compressor, Shell and Tube Condenser and Chiller (Flooded Evaporator and Flooded Condenser), Hermetic or Semi Hermetic motor, (R- 134a or equal gas) refrigeration piping, integral microprocessor electrical panel with digital control and controllers, one touch operating parameters display, chiller insulation, 1st charge of R-134a refrigerant, Lube oil, duly factory tested, appropriate packing for shipment in container from factory upto site, finish painting, with all ancillaries, site delivered, erected, commissioned and tested as per specification.	Each	2.00
	Operating Parameters		
	TR output - 125 TR (At Specified Conditions)		
	EWT Chiller - 12°C		
	LWT Chiller - 6.4°C		
	IKW/ TR at Full Load at Stated Conditions: 0.64 to 0.68		
	Refrigerant - R- 134a/ Equal (R-22 not Acceptable)		
	Flow Through Chiller = 2.4 USGPM/ TR		
	Condenser ΔT - 36.60C/32.20C		
	Condenser flow - 4 USGPM/ Ton		
	Fouling Factor Chiller - 0.0005 (British)		
	Fouling Factor Condenser - 0.001 (British)		
	Number of Compressors: 1 or 2		
	Target IKW/TR at 100% Load - 0.64 to 0.67		
2)	Airside Equipment		
	Supply of Air Handling Units (AHU):		

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	Supply, Installation, Testing & Commissioning of Double skin AHU's, 45 mm PUF injected insulation panels (<u>Exterior Panel - 0.8mm Pre-Coated and Interior Panel 0.8mm Plain</u>), Thermal break profile, complete with 10µ washable pleated prefilters, Chilled water cooling coils with copper tubing of 12 mm diameter, Aluminium fins, copper header, SS-304 coil casing, 18 G SS-304 drain tray, DIDW high efficiency backward curved centrifugal fan, low fan rpm (Less than 9 m/s) , low noise level, fire retardent flexible canvas connection, heavy gauge extruded aluminium fan motor base, Efficiency - 1 TEFC squirrel cage motor of 4 pole, belt drive package. <u>All AHU's to be equipped with Limit Switch and Light duly interlocked with AHU motors.</u> Capacity as follows:		
a)	Creep Bay: 13,000 CFM/ 50mm W.G. Static Pressure/ Filter & Coil Area 28 ft² /4-Row Cooling Coil + 2 Row Reheat Coil for RH Control, 5.5 KW Motor.	Set	2.00
b)	Mezzanine Office: 1,600 CFM/ 50mm W.G. Static Pressure/ Filter Area 4 ft²-Coil Area 4 ft² /4-Row Cooling Coil, 1.1 KW Motor	Set	1.00
c)	Director Floor: 3,000 CFM/ 50mm W.G. Static Pressure/ Filter Area 9 ft²--Coil Area 9 ft² /6-Row Cooling Coil, 1.5 KW Motor	Set	1.00
d)	Auditorium: 16,000 CFM/ 60mm W.G. Static Pressure/ Filter & Coil Area 32 ft² /6-Row Cooling Coil, 7.5 KW Motor	Set	1.00
e)	Supply, Installation, Testing & Commissioning of Wall Mounted Axial Fans with Gravity Louver and Bird Screen for capacities as below: 1000 CFM/ 15mm Static Pressure (Power Pack Room)	Set	1.00
3)	Cooling Tower:		
a)	Supply, Installation, Testing & Commissioning of Cooling Tower: - Induced draft cross/counter flow type with FRP Body, PVC Louvers and Eliminators, Polypropylene nozzles, Aluminium Alloy fan blades, FRP fan body, of single cell type (a) Hot water flow = 600 usgpm (b) HW Temp = 36.38C(97.5 F) (c) CW Temp = 32.22 C (90 F) (d) WB Temp = 28.3 C (83 F) (e) Drift Loss = 0.005% (f) Motor = 5.5 KW Making of RCC Support for CT (as per item No.43)	Each	2.00
b)	Fabrication/ Installation of MS Structural Support for Cooling Tower and Grouting to RCC Pedestals, Carrying out Levelling of MS I-Beam/ Channel supports nd finished with 2 Coats of Red Oxide Primer (Berger/ Shalimar make) and Black Enamel paint.	Kg.	2500.00

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4)	Fan Coil Unit		
(A)	Supply, Installation, Testing & Commissioning of Cassette type Fan Coil Unit hung from slab with GI threaded rods and levelled with the False Ceiling. FCU to be of 4-Way type with Powder Coated Architectural finish (on the visible portion under F/C). All FCU'S to be provided with Programmable Thermostat with ability to program 3-speed fan, set Temperature. This thermostat shall be Wall Mounted at 1m level.		
i)	1.5 TR (Director Flr 16 Nos + Mezz Floor 5 Nos)	Each	21.00
ii)	2 TR (Director Flr 11 Nos + Mezz Floor 6 Nos)	Each	17.00
(B)	Supply, Installation, Testing & Commissioning of Concealed type Fan Coil Unit hung from slab with GI threded rods complete with Drain tray insulated with Nitrile foam. All FCU'S to be provided with Programmable Thermostat with ability to program 3-speed fan, set Temperature. This thermostat shall be Wall Mounted at 1m level		
i)	2 TR (40mm Static Pressure Req'd)	Each	2.00
(C)	Supply, Installation, Testing & Commissioning of Combined Valve set (Factory assembled) consisting of Isolation valves (3 Nos), drain cock, bypass, Strainer, and Control Valve with ON-OFF actuator encased in a openable preinsulated kit . All valve sets to be provided with helical flexible steel connector pipes.	Sets	40.00
5)	PUMPS:		
	Supply, Installation, Testing & Commissioning of End Suction Back Pullout Centrifugal Pumps complete with MS Frame Base Mounting Bolts/ Fastenig Bolts of Design Duty as mentioned below. All pumps to be supplied duly mounted on a base frame in coupled and aligned configuration. All motors to be IE-2/ Efficiency 1 rating.		
a)	Primary CHW Pump (PCHWP) 320 GPM/ 50 ft	Set	2.00
b)	Secondary CHW Pumps (SCHWP) 320 GPM/ 55 ft	Set	2.00
	All Secondary pumps to be fitted with VFD, and these shall be part of a pumping solution (VFD's and Programmable Logic Controller in a IP-55 protection panel) with provided as a complete set by pump manufacturer. This price is to include the price of Differential Pressure Transmitter and fixing of same, associated control wiring and all required programming and commissioning of the same under actual operating load. As an alternative, Vertical Inline Pumps may be offered with or without the provision for Sensorless Control of the VFD's.		
c)	Condenser Water Pump (CNDWP) 500 GPM/ 60 ft	Set	2.00
d)	Hot Water Pump 150 GPM / 10m Head (Vertical Inline Pumps)	Set	2.00

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e)	Supply, Installation, Testing & Commissioning of Condensate Removal Pump (CE Marked) for FCUs. All pumps to have pump mounted on integral tank, IP20 rating, Rated for 230V, power cables and suitable for capacity upto 500 L/hr at 5m head. Pump to be provided with MS platform suspended from ceiling by 8mm threaded rods	Each	10.00
6)	<u>Piping: MS C-Class ERW Pipes</u>		
	Supplying, Fixing, Testing & Commissioning of MS "C" class heavy duty pipe (all pipes shall be ISI marked and shall be one of approved makes) along with all necessary clamps, vibration isolators and fittings like elbows, tees, flanges, tapers, (except valves, strainers gauges etc) nuts bolts, gaskets etc, adequately supported wall/slab with suitable rigid supports and painting with two or more coats of synthetic enamel paint of required shade.		
a)	250mm dia. (6mm Thick)	meter	6.00
b)	200mm dia. (Condenser Water Header) 6mm Thick	meter	96.00
c)	150mm dia.	meter	114.00
d)	125mm dia. (Chiller Connections)	meter	30.00
e)	100mm dia. (Creep Bay AHU Connection)	meter	42.00
f)	80mm dia.	meter	60.00
g)	65mm dia.	meter	66.00
h)	50mm dia.	meter	114.00
i)	40mm dia.	meter	150.00
j)	32mm dia.	meter	6.00
k)	25mm dia.	meter	420.00
l)	20mm dia.	meter	24.00
7)	Supply, Installation, Testing & Commissioning of CI/MS Strainers for with SS-Jali of 3 mm Mesh Size, PN-16 rating complete with mathing flanges, nuts, bolts, gaskets etc.-		

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a)	150mm dia. (Pot Strainer with Swinging Arrangement with Wide Pot For Cooling Tower)	each	2.00
b)	125mm dia. (Y-Strainer for Chillers)	each	2.00
c)	100mm dia. (Y-Strainer For Creep Bay AHU)	each	1.00
d)	80mm dia. (Y-Strainer For Auditorium AHU)	each	2.00
e)	50 mm dia. (Y-Strainer For Mezzanine and Director's Floor AHU)	each	1.00
8)	Supply, Installation, Testing & Commissioning of CI Butterfly Valves (PN-10 rating) - with CI body, SS disc disc, SS shaft on Teflon sleeve bearings complete with matching E-Table flanges, GI Nut-Bolts, Gaskets etc as per IS:13095		
a)	150mm dia.	each	16.00
b)	125mm dia.	each	13.00
c)	100mm dia.	each	6.00
d)	80mm dia.	each	11.00
e)	65mm dia.	each	6.00
f)	50mm dia.	each	10.00
9)	Supply/ Installation of Ball valves (Brass) (PN 25 Rating)		
a)	40mm dia.	each	2.00
b)	32mm dia.	each	2.00
c)	25mm dia.	each	10.00
10)	Supply/ Installation of Swing Check Valve (Non Return Valve) with CI body/ Door/ Cover conforming to IS 210 Gr 200, Body-Door ring of leaded tin bronze conforming to IS-318 and SS hinge pin, complete with matching flanges, GI Nut-Bolts, gaskets etc		
a)	6" dia.	each	2.00
b)	5" dia.	each	4.00
c)	3" dia.	each	2.00

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11)	Supply, Installation, Testing & Commissioning of Balancing Valve PN-16 Rated with CI body/ SS-410 stem and Pressure Test cocks complete with flanged ends		
a)	150mm dia.	each	2.00
b)	125mm dia.	each	2.00
c)	100mm dia.	each	1.00
d)	80mm dia.	each	2.00
e)	65mm dia.	each	2.00
f)	50mm dia.	each	2.00
12)	Supply/ Installation of Flow Switches with Paddle installed in MS Socket as suitable for pipe size.	each	4.00
13)	Indicators/ Gauges		
a)	Water pressure gauge, 4" dial, complete with ball valve, syphone etc (0 - 50 psig rating) Make- Fiebig/ Equivalent.	each	26.00
b)	Industrial Thermometer with brass well, mercury in glass type (0 - 50°) complete with fittings. Make- Japsin/Equivalent.	each	18.00
14)	Insulation:		
(A)	Chilled Water Piping Insulation: Supply/ Fixing of Nitrile Foam (Class O) (Preformed Tubes of Class O material where applicable) of 19mm Thickness as follows		
a)	150mm dia. (Plain Sheet with UL/FM Approved Lag Coating 2 Coats on Glass Cloth)	meter	114.00
b)	125mm dia. (Plain Sheet with UL/FM Approved Lag Coating 2 Coats on Glass Cloth)	meter	30.00
c)	100mm dia. (Plain Sheet with UL/FM Approved Lag Coating 2 Coats on Glass Cloth)	meter	42.00
d)	80mm dia. (Aluminium Faced Sheet to be used)	meter	60.00
e)	65mm dia. (Aluminium Faced Sheet to be used)	meter	66.00

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f)	50mm dia. (Preformed Tubes)	meter	114.00
g)	40mm dia. (Preformed Tubes)	meter	150.00
h)	32mm dia. (Preformed Tubes)	meter	6.00
i)	25mm dia. (FCU Connections)	meter	420.00
j)	20mm dia. (Preformed Tubes)	meter	24.00
(B)	Insulation of valves, Strainers, Flow control valves		
	19 mm thick Nitrile Foam insulation material, factory faced with aluminium foil, complete with ancillaries like bituminous paints, PVC cello tape etc.		
a)	200mm dia. Valves / Strainers	each	2.00
b)	150mm dia. Valves / Strainers	each	2.00
c)	125mm dia. Valves / Strainers	each	18.00
d)	100mm dia. Valves / Strainers	each	2.00
e)	80mm dia. Valves / Strainers	each	2.00
f)	65mm dia. Valves / Strainers	each	4.00
g)	25 - 50mm dia. Valves / Strainers	each	20.00
15)	Supply, Installation, Testing & Commissioning of <u>2-Way Flow Control Valve</u> for AHUs with Modulating Actuator and Programmable Temp. Controller & Actuator Motor (24Volts):		
a)	100mm dia. (Auditorium)	each	1.00
b)	80mm dia. (Creep AHU)	each	2.00
c)	50 mm dia. (Mezz and Director Floors) - ON-OFF Type Actuator	each	2.00
16)	Ducting : Limited to small number of Concealed FCU's and AHU Rooms only		
	Supply & Fixing of GSS Ducting made from GI Sheet of approved makes as per IS 655 (Class 1 Zinc Coating thickness) complete with MS Angle Bracing/ MS Angle Flanged Joints for Heavy Gauge Ducts/ GI Nut-Bolts, GI Threaded Rods for Hanging and W-Brackets/ MS Angle where required for supports.		

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a)	24 G	sq.m	100.00
b)	22 G	sq.m	50.00
c)	20 G	sq.m	20.00
17)	Supply & Fixing of Powder coated Extruded Aluminium Grilles		
a)	With Aluminium Collar Damper (Opposed Blade type)	sq.m	15.00
b)	Without Collar Damper	sq.m	3.00
18)	Supply & Fixing of Round Epoxy Painted MS SA Diffuser (Heavy Gauge) as per existing diffusers.		
a)	With Aluminium Butterfly Damper	each	60.00
19)	Supply & Fixing of Powder coated Extruded Aluminium RA Grid Diffusers for Creep Bay		
20)	Duct Insulation		
	Supply/ Fixing of Nitrile foam (Class O) covered with stuck with Pidilite adhesive (AC Duct King), finished joints with sticky aluminium tape. All Flange Joints to be Covered by 200mm strips of Insulation material and tightened by PVC Straps.		
a)	13 mm (UL/FM Certified Lag Coating on Plain Insulation in AHU Room)	sq.m	200.00
b)	13 mm (Factory Faced Aluminium Foil)	sq.m	150.00
21)	Supply/ Fixing GI Volume Control Damper (VCD) , made from 18 G GI Frame , 22 G GI Blades, Nickel Plated Spindels fully enclosed by metal plate. Damper to be fixed by GI Nut-Bolts to Ducts.		
22)	Supply/ Fixing of CBRI Certified Fire Damper (GI 16 G Construction) in SA / RA ducts made of 18G leaves / casing, with UL Stamped Fusible Link		
	Electrical Work :		
23)	Main Electrical Panel & AHU Panels :		
	Supply, Installation, Testing & Commissioning of Front operated totally enclosed Electrical floor standing Panel, IP 54 rating, made of 2 mm thick CRCA sheet metal; powder coated finish. Suitable for 415 volts, 3Ø, 4 wire AC system Fault level 50 KA for 1 second at 415 volts. Refer tender specifications for other details.		No. 1.00
	Main Incomer of 600A and 600A Busbar		
	200 A MCCB for 2 Nos x 125 TR Chillers (Y-Δ starters integral with chiller) - 2 Nos		
	20 A MCCB for 2 Nos PCHWP with DOL Sterters - 2 Nos		

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	30 A MCCB for 2 Nos SCHWP with VFD (Space to be left for VFD's - Supply as separate item) - 2 Nos		
	40 A MCCB for 2 Nos CNDWP with Y-Δ starters - 2 Nos		
	10 A with HWP with DOL Starter - 2 Nos		
	20 A MCCB for 2 Nos Cooling Towers (One Working, one standby) with DOL starters		
	2Nos 5.5 KW DOL Starter for Creep Bay AHU's		
	1.1 KW DOL Starter for Mezzanine AHU		
	2.2 KW DOL Starter for Director Floor AHU		
	7.5 KW Y-Δ Starter for Auditorium AHU		
	Space to supply 1st Floor DB		
	Space to supply Mezz.Floor DB		
	Spare feeder		
24)	AHU Panels/ Sub-Electrical Panels		
	Front operated totally enclosed Electrical Panel (Floor or Wall Mounted), IP 54 rating, made of 2 mm thick CRCA sheet metal; powder coated finish. Suitable for 415 volts, 3Ø, 4 wire AC system Fault level 50 KA for 1 second at 415 volts. Refer tender specifications for other details.		
a)	4 Nos. 20 A TPN MCBs for 2 Nos. AHUs (5.5 Kw), for Creep Bay 2 Nos. AHUs- 13000 Cfm & 2Nos for Cooling Towers (with Ammeter switch)	No.	1.00
b)	10 Amps (1No.)TPN MCB for AHU (1.1 Kw) for Mezzanine Floor 1 No. AHU- 1600 Cfm (with Ammeter switch)	No.	1.00
c)	10 MCB for AHU (2.2 Kw), for Director Floor 1 No. AHU- 3000 Cfm (with Ammeter switch)	No.	1.00
d)	30 Amps(1No.) TPN MCCB incomer, for AHU for Auditorium 1 No. AHU- 16000 Cfm (with Ammeter switch)	No.	1.00
25)	Electrical Wiring :		
	Supply/ Laying/ Termination of XLPE insulated aluminium armoured cable, 1100V grade, complete with end terminations. Refer specifications in tender.		
	<u>Kw Rating</u> <u>Equipment</u> <u>Cable Rating</u>		
a)	87 Chiller (2 Nos)	4C x 185 mm ²	meter 30.00
b)	5.5 PCHWP (2 Nos)	3C x 6 mm ²	meter 30.00
c)	7.5 SCHWP (2 Nos)	3C x 10 mm ²	meter 25.00
d)	14.5 CDWP (2 Nos)	3C x 16 mm ² (Twin)	meter 25.00

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e)	5.5	CT (2 Nos)	3C x 6 mm ²	meter	90.00
f)	1.1	HWP (2 Nos)	3C x 4 mm ²	meter	25.00
g)	5.5	AHU (2 Nos.)	3C x 6 mm ²	meter	60.00
h)	1.1	AHU (1 No.)	3C x 6 mm ²	meter	30.00
i)	2.2	AHU (1 No.)	3C x 10 mm ²	meter	40.00
j)	7.5	AHU (1 No.)	3C x 10 mm ²	meter	45.00
26)	Supply, Installation, Testing & Commissioning of Control Wiring - Multicore Copper Armored: as required for HVAC system.				
a)	2C x 1.5mm ² (Control Valves etc)			meter	60.00
b)	3C x 2.5mm ² (Limit Switches - Control Interlocking of AHU)			meter	150.00
27)	GI Earthing as per IE rules/ IS codes: -				
a)	Supply & laying 8 SWG GI (Twin) Earthing wire for electrical gadgets with soldering etc. as required.			meter	1800.00
28)	Cable Racks/Trays: Supply and Installation of perforated type GI Cable Trays of the following sizes fabricated out of minimum 2mm thick with 50 mm flange to be installed horizontally or vertically. The cable tray shall be complete including cost of all cable tray couplers, 90 deg Turn pieces as per drawing / site condition and rate shall include all support hardware including cost of GI anchor fastners, screws, nuts, bolts, threaded rods, MS Bar & angle iron etc for hanging arrangement complete as required.				
a)	450 mm Wide			meter	50.00
b)	300 mm Wide			meter	90.00
c)	200 mm Wide			meter	60.00
d)	150 mm Wide			meter	120.00
e)	100 mm Wide			meter	45.00
29)	Supply/ Fixing of PPR pipe (for Condensate Drain) with all joints, supports and fittings including unions, tees elbows etc. All piping to be joined using heat-joint method.				
a)	20mm Ø			meter	144.00
b)	25mm Ø			meter	204.00

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Sub Head -(B) CIVIL WORKS: -			
30)	Demolishing cement concrete manually/ by mechanical means including disposal of material within 50 metres lead as per direction of Engineer - in charge.		
	Nominal concrete 1:3:6 or richer mix (i/c equivalent design mix)	Cum	11.50
31)	Demolishing R.C.C. work manually/ by mechanical means including stacking of steel bars and disposal of unserviceable material within 50 metres lead as per direction of Engineer - in- charge.	Cum	20.80
32)	Demolishing brick work manually/ by mechanical means including stacking of serviceable material and disposal of unserviceable material within 50 metres lead as per direction of Engineer-in-charge.		
	In cement mortar	Cum	5.00
33)	Dismantling old plaster or skirting raking out joints and cleaning the surface for plaster including disposal of rubbish to the dumping ground within 50 metres lead.	Sq.m	90.00
34)	Dismantling tile work in floors and roofs laid in cement mortar including stacking material within 50 metres lead.		
	For thickness of tiles above 25 mm and up to 40 m	Sq.m	215.00
35)	Dismantling steel work in single sections including dismembering and stacking within 50 metres lead in:		
	Channels, angles, tees and flats	Kg	6800.00
36)	Dismantling aluminium/ Gypsum partitions, doors, windows, fixed glazing and false ceiling including disposal of unserviceable surplus material and stacking of serviceable material with in 50 meters lead as directed by Engineer-in-charge.	Sq.m	1400.00
37)	Supplying and filling in plinth with sand under floors, including watering, ramming, consolidating and dressing complete.	Cum	12.00
38)	Earth work in excavation by mechanical means (Hydraulic excavator) / manual means in foundation trenches or drains (not exceeding 1.5 m in width or 10 sqm on plan), including dressing of sides and ramming of bottoms, lift upto 1.5 m, including getting out the excavated soil and disposal of surplus excavated soil as directed, within a lead of 50 m.		
	All kinds of soil.	Cum	10.00
39)	Filling available excavated earth (excluding rock) in trenches, plinth, sides of foundations etc.in layers not exceeding 20cm in depth, consolidating each deposited layer by ramming and watering, lead up to 50 m and lift upto 1.5 m.	Cum	4.00

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40)	Supplying chemical emulsion in sealed containers including delivery as specified.		
	Chlorpyriphos/ Lindane emulsifiable concentrate of 20%	Litre	20.00
41)	Diluting and injecting chemical emulsion for POST-CONSTRUCTIONAL antitermite treatment (excluding the cost of chemical emulsion) :		
	Along external wall where the apron is not provided using chemical emulsion @ 7.5 litres / sqm of the vertical surface of the substructure to a depth of 300 mm including excavation channel along the wall & rodding etc. complete:		
(a)	With Chlorpyriphos/ Lindane E.C. 20% with 1% concentration	meter	120.00
(b)	Treatment of soil under existing floors using chemical emulsion @ one litre per hole, 300 mm apart including drilling 12 mm diameter holes and plugging with cement mortar 1:2 (1 cement : 2 Coarse sand) to match the existing floor:		
	With Chlorpyriphos/Lindane E.C. 20% with 1% concentration	Sqm	20.00
(c)	Treatment at points of contact of wood work by chemical emulsion Chlorpyriphos/ Lindane (in oil or kerosene based solution) @ 0.5 litres per hole by drilling 6 mm dia holes at downward angle of 45 degree at 150 mm centre to centre and sealing the same.	Metre	20.00
42)	Providing and laying in position cement concrete of specified grade excluding the cost of centering and shuttering - All work up to plinth level :		
a)	1:2:4 (1 cement : 2 coarse sand (zone-III) : 4 graded stone aggregate 20 mm nominal size).	Cum	2.00
b)	1:3:6 (1 Cement : 3 coarse sand (zone-III) : 6 graded stone aggregate 20 mm nominal size).	Cum	2.00
c)	1:4:8 (1 Cement : 4 coarse sand (zone-III) : 8 graded stone aggregate 40 mm nominal size)	Cum	3.00
43)	Providing and laying in position specified grade of reinforced cement concrete, excluding the cost of centering, shuttering, finishing and reinforcement - All work up to plinth level :		
	1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size).	Cum	2.00
44)	Reinforced cement concrete work in walls (any thickness), including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts and struts etc. above plinth level up to floor five level, excluding cost of centering, shuttering, finishing and reinforcement :		
	1:1.5:3 (1 cement : 1.5 coarse sand(zone-III) : 3 graded stone aggregate 20 mm nominal size).	Cum	21.00

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45)	Steel reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding all complete upto plinth level		
	Thermo-Mechanically Treated bars of grade Fe-500D or more.	Kg.	2760.00
46)	Centering and shuttering including strutting, propping etc. and removal of form for all heights.		
a)	Foundations, footings, bases of columns, etc. for mass concrete	Sq.m	60.00
b)	Suspended floors, roofs, landings, balconies and access platform	Sq.m	40.00
c)	Weather shade, Chajjas, corbels etc., including edges	Sq.m	60.00
47)	Brick work with common burnt clay F.P.S. (non modular) bricks of class designation 7.5 in superstructure above plinth level up to floor V level in all shapes and sizes in :		
	Cement mortar 1:6 (1 cement : 6 coarse sand)	cum	4.00
48)	Half brick masonry with common burnt clay F.P.S. (non modular) bricks of class designation 7.5 in superstructure above plinth level up to floor V level.		
	Cement mortar 1:4 (1 cement : 4 coarse sand)	Sq.m	30.00
49)	Extra for providing and placing in position 2 Nos 6mm dia. M.S. bars at every third course of half brick masonry.	Sq.m	30.00
50)	Structural steel work riveted, bolted or welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer all complete.	kg	6800.00
51)	Cement concrete flooring 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate) finished with a floating coat of neat cement, including cement slurry, but excluding the cost of nosing of steps etc. complete.		
	40 mm thick with 20 mm nominal size stone aggregate	Sq.m	30.00
52)	Providing and fixing aluminium work for doors, windows, ventilators and partitions 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. Aluminium sections shall be smooth, rust free, straight, mitred and jointed mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, C.P. brass / stainless steel screws, all complete as per architectural drawings and the directions of Engineer-in-charge. (Glazing, paneling and dash fasteners to be paid for separately):		

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a)	For fixed portion		
	Anodised aluminium (anodised transparent or dyed to required shade according to IS: 1868, Minimum anodic coating of grade AC 15)	kg	15.00
b)	For shutters of doors, windows & ventilators including providing and fixing hinges/ pivots and making provision for fixing of fittings wherever required including the cost of EPDM rubber / neoprene gasket required (Fittings shall be paid for separately)		
	Anodised aluminium (anodised transparent or dyed to required shade according to IS: 1868, Minimum anodic coating of grade AC 15)	kg	2.00
53)	Providing and fixing 12 mm thick prelaminated particle board flat pressed three layer or graded wood particle board conforming to IS: 12823 Grade I Type II, in panelling fixed in aluminium doors, windows shutters and partition frames with C.P. brass / stainless steel screws etc. complete as per architectural drawings and directions of Engineer-in-charge.		
	Pre-laminated particle board with decorative lamination on one side and balancing lamination on other side	Sq.m	8.00
54)	Providing and fixing glazing in aluminium door, window, ventilator shutters and partitions etc. with EPDM rubber / neoprene gasket etc. complete as per the architectural drawings and the directions of Engineer-in-charge. (Cost of aluminium snap beading shall be paid in basic item)		
	With float glass panes of 5.50 mm thickness	Sq.m	8.00
55)	Providing and fixing 6 mm dia. G.I. level adjusting hangers (upto 1200mm length), fixed to roof slabs by means of ceiling cleats made out of G.I. flat 40x3mm size 60 mm long and stainless steel expandable dash fastener of 12.5 mm dia and 50 mm long, complete as per direction of Engineer-in-charge.	each	600.00
56)	Providing and fixing powder coated aluminium work (minimum thickness of powder coating 50 micron) consisting of tee/ angle sections, of approved make conforming to IS : 733 in frames of false ceiling including aluminium angle cleats with necessary C.P. brass/ stainless steel sunk screws, aluminium perimeter angles fixed to wall with stainless steel rawl plugs @ 450 mm centre to centre and fixing the frame work to G.I. level adjusting hangers 6 mm dia. with necessary cadmium plated machine screws all complete as per approved architectural drawings and direction of the Engineer-incharge (level adjusting hangers, ceiling cleats and expansion hold fasteners to be paid for separately).	kg	1650.00
57)	Providing and fixing 100mm brass locks (best make of approved quality) for aluminium doors including necessary cutting and making good etc. complete.	each	1.00

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58)	Providing and fixing double action hydraulic floor spring of approved brand and manufacture conforming to IS : 6315, having brand logo embossed on the body / plate with double spring mechanism and door weight upto 125 kg, for doors, including cost of cutting floors, embedding in floors as required and making good the same matching to the existing floor finishing and cover plates with brass pivot and single piece M.S. sheet outer box with slide plate etc. complete as per the direction of Engineer-in-charge.		
	With stainless steel cover plate minimum 1.25 mm thickness	each	1.00
59)	Kota stone slab flooring over 20 mm (average) thick base laid over and jointed with grey cement slurry mixed with pigment to match the shade of the slab, including rubbing and polishing complete with base of cement mortar 1 : 4 (1 cement : 4 coarse sand) :		
	25 mm thick	Sq.m	105.00
60)	Providing and laying Vitrified tiles in different sizes (thickness to be specified by manufacturer), with water absorption less than 0.08 % and conforming to I.S. 15622, of approved make, in all colours & shade, in skirting, riser of steps, over 12 mm thick bed of cement mortar 1:3 (1 cement: 3 coarse sand), jointing with grey cement slurry @3.3kg/sqm including grouting the joint with white cement & matching pigments etc. complete.		
	Size of Tile 600x600 mm	Sq.m	88.00
61)	12 mm cement plaster of mix :		
	1:4 (1 cement: 4 coarse sand)	Sq.m	50.00
62)	15 mm cement plaster on rough side of single or half brick wall of mix:		
	1:4 (1 cement: 4 coarse sand)	Sq.m	50.00
63)	6 mm cement plaster of mix:		
	1:3 (1 cement : 3 fine sand)	Sq.m	30.00
64)	Neat cement punning.	Sq.m	30.00
65)	Providing and applying plaster of paris putty of 2 mm thickness over plastered surface to prepare the surface even and smooth complete.	Sq.m	200.00
66)	Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade :		
	One or more coats on old work	Sq.m	230.00
67)	Painting with synthetic enamel paint of approved brand and manufacture to give an even shade :		
	Two or more coats on new work.	Sq.m	100.00

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68)	Renewing glass panes, with putty and nails wherever necessary including racking out the old putty: Float glass panes of thickness 4 mm	Sq.m	8.00
69)	Renewal of old putty of glass panes (length)	metre	30.00
70)	White washing with lime to give an even shade : Old work (two or more coats)	Sq.m	150.00
71)	Distempering with oil bound washable distemper of approved brand and manufacture to give an even shade : Old work (one or more coats)	Sq.m	150.00
72)	Providing and fixing bright finished brass 100 mm mortice latch and lock with 6 levers and a pair of lever handles of approved quality with necessary screws etc. complete.	each	1.00
73)	Providing and fixing bright finished brass hanging type floor door stopper with necessary screws, etc. complete.	each	2.00
74)	Providing and fixing aluminium extruded section body tubular type universal hydraulic door closer (Hafele make) embossed on the body, door weight upto 36 kg to 80 kg and door width from 701 mm to 1000 mm), with double speed adjustment with necessary accessories and screws etc. complete.	each	5.00
75)	Extra for providing and mixing water proofing material in cement concrete work in doses by weight of cement as per manufacturer's specification.	kg per 50 kg cement	10.00
76)	Finishing with Epoxy paint (two or more coats) at all locations prepared and applied as per manufacturer's specifications including appropriate priming coat, preparation of surface, etc. complete On concrete work	Sq.m	50.00
77)	Providing and fixing precoated galvanised iron profile sheets (size, shape and pitch of corrugation as approved by Engineer-in-charge) 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 Engineer-in-charge. 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.	Sq.m	10.00

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78)	False Ceiling Works in Mezzanine and Director Floor		
a)	Providing, Erecting and fixing in position of 84C lineal G.I./CRCA GI Strip False Ceiling with all necessary fittings and fixtures - 84c- off white consisting of panel made of enamelled coil coated 0.6 mm thick CRCA alloy; 84mm wide and 12.5mm deep with a recessed flange of 23.9mm of approved colour; panel carriers made of enamelled 0.6mm thk steel black sat in; 32mm widex 39mm deep with cut outs to hold panels in a module of 100mm with edge cover at the edges; and cut-outs for light fittings and ventilation grills suspended from ceiling as per direction of the manufacturer including supplying & fixing all fittings and fixtures as necessary as per site requirement with all materials, tools & tackles, plant and labour in complete as per EIC. The complete false ceiling system should be rigid enough to take minor load during maintenance without any deformation. No cost deduction will be made for the area covered by light fittings/A C grills.	Sq.m	300.00
b)	Supply & Fixing of 9.00 mm thick square edge PVC Laminated Gypsum Tiles (Armstrong, India Gypsum make) of size 595 X 595mm, made of Gypsum plaster board, manufactured from natural gypsum and laminated with white 0.16 mm thick fire retardant PVC film on the face side and 12 micron metalized polyester on the back side with all edges seals with face side PVC film which goes around and wraps the edges and is bounded to the edges and the back side metalized polyester film so as to make the tile a completely sealed unit.	Sq.m	1050.00
79)	Scaffolding with bamboo for specified jobs as per direction Engineer -In Charge .	Sq.m	750.00
80)	Disposal Item.		
	Price for taking out of old damaged unusable wood members/ scraps as doors, windows, ventilaors, false ceiling boards, etc.	Kg.	2000.00
Sub Head -(C) INTERNAL ELECTRIFICATION WORK			
Item . No	Description	Unit	Qty
81)	Supplying and fixing of following sizes of medium class PVC conduit along with accessories in surface/recess including cutting the wall and making good the same in case of recessed conduit as required:		
	1) 20 mm.	meter	100.00
	2) 25 mm.	meter	100.00
82)	Supply and drawing following sizes of FRLS PVC insulated copper conductor single core cable in the existing surface/ recessed steel/ heavy gauge PVC conduit/ casing capping etc as required:		
	1) 3 x 1.5 sq. mm	meter	50.00
	2) 3 x 2.5 sq. mm	meter	200.00
	3) 3 x 4 sq. mm	meter	200.00

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	4) 3 x 4 sq. mm	meter	200.00
83)	Installation, testing and commissioning of pre-wired, fluorescent fitting / compact fluorescent fitting of all types, complete with all accessories and tube/lamp etc. directly on ceiling/ wall, including connections with 1.5 sq. mm FRLS PVC insulated, copper conductor, single core cable and earthing etc. as required.	each	344.00
84)	Supplying and fixing 5 A to 32 A rating, 240/415 V, 10 kA, "C" curve, miniature circuit breaker suitable for inductive load of following poles in the existing MCB DB complete with connections, testing and commissioning etc. as required.		
	i) Single pole	each	55.00
	ii) Single pole and neutral	each	55.00
85)	Supplying and fixing of 40 amps rating, four pole, 415 volts, isolator in the existing MCB DB complete with connections, testing and commissioning etc. as required.	each	6.00
86)	Supply and fixing single pole blanking plate in the existing MCB D.B. complete etc. as required.	each	20.00
87)	Providing and fixing following rating and breaking capacity and pole MCCB with thermomagnetic release and terminal spreaders in existing cubicle panel board including drilling holes in cubicle panel, making connections, etc, as required.		
	a) 100A, 16KA, TP MCCB	each	2.00
	b) 125A, 16KA, TP MCCB	each	2.00
88)	Laying and fixing of one number PVC insulated and PVC sheathed/XLPE power cable of 1.1 K V grade of following sizes on wall surface as required: Upto 35 sq.mm (clamped with 1mm thick saddle)	meter	150.00
89)	Supplying and making end termination with brass compression gland & heavy duty lugs for the following size of PVC insulated and PVC sheathed/XLPE aluminium conductor cable of 1.1 KV grades as required: 3&1/2 x 35mm square	each	4.00
90)	Lettering with black Japan paint of approved brand and manufacture as required.	Per letter /cm	1000.00
91)	Providing and fixing 25mmx5mm G.I strip on surface or in recess for connections etc. as required.	meter	30.00

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92)	Supplying and fixing of 4 way (4+12), Double door, prewired TP&N MCB distribution board of steel sheet for 415 volts on surface/ recess complete with loose wire box, terminal connectors for all incoming and outgoing circuits, duly prewired with suitable size FRLS PVC insulated copper conductor up to terminal blocks, tinned copper bus bar, neutral link, earth bar, din bar, detachable gland plate, interconnections, powder painted including earthing etc. as required.(But without MCB/ RCCB/ Isolator).	each	6.00
93)	Supplying and fixing of 4 way Double door, prewired vertical type TP&N Loadline MCB distribution board of steel sheet for 415 volts on surface / recess complete with loose wire box of sheet steel,dust protected, duly powder painted, inclusive of 200 amps tinned copper bus bar, common neutral link, earth bar, din bar for mounting MCB's, trminal connectors for all incoming and outgoing circuits,duly prewired with adequate size of FRLS PVC insulated copper conductor upto the terminal connector/neutral,earthing etc. as required (but without MCB's/ MCCB) . (Note : Vertical type MCB TPDB is normally used where 3 phase outlets are required).	each	2.00
94)	Supply of 1.1KV grade, PVC insulated and PVC sheathed heavy duty/XLPE aluminium conductor cables conforming to IS:1554 (Part-1) of following sizes etc as required.		
	a)3&1/2 x 35mm square	Mtr.	150.00
95)	Supply, testing of following LED tube light fixture, 230 volt, 50Hz including accessories etc as required:		
	a) 4ft, 20 Watts LED Tube Light	Nos.	210.00
	b) 2ft, 12 Watts LED Tube Light	Nos.	20.00
	c) 600mmx600mm, 36 Watts LED light fitting for recessed mounting	Nos.	70.00
	d) LED Spot light (Halogen type), 30 Watt	Nos.	20.00
	e) LED down lighter, 16 Watt, Dia:158mm+/-2mm	Nos.	24.00
96)	Dismantling of existing tube light fixtures / point wiring and handing over the material to electrical section as required.	Nos.	354.00
97)	Dismantling of sub main wiring from the surface, restoring the surface & handing over the materials as required.	Mtr.	100.00
98)	Dismantling of existing old switches, D.B.' s. after disconnecting cables / wires, restoring of walls and handing over the material to electrical section as required.	Nos.	20.00
99)	Dismantling of various sizes of cable from the surfaces, restoring the surfaces & handing over the materials as required.	Mtr.	200.00

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100)	Providing and fixing of 3mm phenolic laminated sheet/Perspex sheet on existing metal board/box etc as required.	Sq.Cm	10000.00
101)	Supply & mounting of SPN sheet steel enclosure fitted with din rail for fixing of existing MCB's etc as required.	Nos.	55.00
102)	Supply and fixing of 63 amps., triple pole rating 240/415 V 'C' series miniature circuit breaker in the existing MCB DB complete with connections, testing and commissioning etc. as required.	Nos.	6.00
Sub Head -(D) BUY-BACK			
Item .No	Description	Unit	Qty
103)	CHILLER		
	Existing Old 86TR (voltas reciprocating chiller -5H80 compressor) water cooled chiller under AMC at present, in working condition- on <u>AS IS WHERE IS</u> basis.	each	2.00
104)	AIR HANDLING UNITS		
	Dismantling of following AHUs, carting away of the same and giving credit to NML towards the value of these goods. All AHU's Single Skin AHU's over 40 years old. All Cooling coils of AHU's have been replaced in the last ten (10) years.		
a)	Air Handling Unit -For Creep Bay- 15 KW Motor	each	1.00
b)	Air Handling Unit -For Mezzanine- 3.7 KW	each	1.00
c)	Air Handling Unit -For First floor- 5.5 KW	each	1.00
d)	Air Handling Unit -For Auditorium- 7.5 KW	each	1.00
105)	CONDENSER PUMPS		
	Monoblock Centrifugal Pumps Complete With TEFC Squirrel cage 4 pole motor, flexible coupling , MS base frame for pumps & motor , Base bolts etc (Nameplates not fixed).(In working condition at present)		
a)	7.5 HP Condenser Water Pump with motor & Base	each	4.00
106)	CHILLER PUMPS		
	Monoblock Centrifugal Pumps Complete With TEFC Squirrel cage 4 pole motor, flexible coupling , MS base frame for pumps & motor , Base bolts etc (Nameplates not fixed).(In working condition at present)		
a)	7.5 HP CHW water Pump with motor & Base	each	4.00

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107)	COOLING TOWER		
	Dismantle Old 2Nos. X 100TR Cooling Tower with all supports etc in its entirety, and carting away the components. Giving credit to NML for buyback of useable components like Motor, Fan , steel channels etc. Cooling tower is on roof.	each	2.00
108)	Condenser Water Piping (Weights are indicative. Actual weight to be taken before disposal)		
	All pipe supports and wooden saddles for pipe supports shall remain as it is - as these are in good condition. The MS Condenser Pipes, Drain pipes Chiller plant, cooling tower make up water line, CT drain etc shall be removed after cutting in small practical pieces and then carted away. # Before dismantling joint measurement shall be made between HVAC Vendor & NML & the measurements signed off.		
(A)	Water Piping		
a)	150 mm dia MS heavy class black pipe	Kg	383.40
b)	125 mm dia MS heavy class black pipe	Kg	751.80
c)	100 mm dia. MS heavy class black pipe	Kg	174.00
d)	80 mm dia. MS heavy class black pipe	Kg	118.80
e)	50 mm dia. MS heavy class black pipe	Kg	74.28
(B)	Butterfly Valve (PN-10) Cast Iron (with flanges)		
a)	150 mm dia. with lever only - 2 Nos	Kg	42
b)	100 mm dia. with lever only- 14 Nos	Kg	224
c)	80 mm dia with lever only- 4 Nos	Kg	48
d)	50 mm dia. with lever only- 2 Nos	Kg	12
(C)	Pot Strainer (PN-10)		
	100 mm dia - 6 Nos.	Kg	300
Sub Head -(E) OPERATION AND ANNUAL MAINTENANCE CHARGES			
	AMC		
Item . No	Description	Unit	Qty
109)	Water Cooled Screw Chiller		

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	Comprehensive Annual Maintenance Contract (AMC) for Water Cooled Screw Chillers as per Sub Head -A of BOQ (Priced Bill of Quantity) to include all periodic maintenance, adjustment and <u>complete replacement of defective item</u> with New (as available at that time). Cost to include all materials, accessories and labour required to perform said maintenance (by OEM of Chiller) and for replacement of any defective parts.	each	2
110)	Airside Equipment		
	Air Handling Units (AHU):		
	AMC of Double SKIN AHU's as supplied per Part-A to include periodic Coil cleaning of AHU's with Pressure pumps and detergent/ changing of V-Belts/ aligning of motor-fan pulleys as required.	Job	1
	Creep Bay:(2Nos AHU's): 13,000 CFM/ 50mm W.G. Static Pressure/ Filter & Coil Area 28 ft² /4-Row Cooling Coil + 2 Row Reheat Coil for RH Control, 5.5 KW Motor		
	Mezzanine Office: 1,600 CFM/ 50mm W.G. Static Pressure/ Filter Area 16 ft²-Coil Area 4 ft² /4-Row Cooling Coil/ Bypass Damper on Remaining Area, 1.1 KW Motor		
	Director Floor: 3,000 CFM/ 50mm W.G. Static Pressure/ Filter Area 9 ft²--Coil Area 9 ft² /6-Row Cooling Coil, 1.5 KW Motor		
	Auditorium: 16,000 CFM/ 60mm W.G. Static Pressure/ Filter & Coil Area 32 ft² /6-Row Cooling Coil, 7.5 KW Motor		
	Wall Mounted Axial Fans with Gravity Louver and Bird Screen for capacities as below		
	1000 CFM/ 15mm Static Pressure (Power Pack Room)		
111)	Cooling Tower: -		
	Comprehensive AMC of Cooling Tower as supplied in Part-A. This is to include periodic cleaning of fills, maintenance of any gear drives, changing of any belts, replacement of any broken fan blades or adjusting pitch angles of the same to maintain the desired performance of the cooling tower	each	2
	(a) Hot water flow = 500 usgpm		
	(b) Motor = 5.5 KW		
112)	Fan Coil Unit:-		
(A)	AMC of Cassette type Fan Coil Unit hung from slab with GI threaded rods and levelled with the False Ceiling. FCU to be of 4-Way type with Powder Coated Architectural finish (on the visible portion under F/C). All FCU'S provided with Programmable Thermostat with ability to program 3-speed fan, set Temperature. This thermostat is Wall Mounted at 1m level.		
a)	1.5 TR (Director Flr 16 Nos + Mezz Floor 5 Nos)	each	21
b)	2 TR (Director Flr 11 Nos + Mezz Floor 6 Nos)	each	17

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(B)	Concealed type Fan Coil Unit hung from slab with GI threaded rods complete with Drain tray insulated with Nitrile foam. All FCU'S provided with Programmable Thermostat with ability to program 3-speed fan, set Temperature. This thermostat are Wall Mounted at 1m level.		
a)	2 TR (40mm Static Pressure Req'd)	each	2
113)	PUMPS:		
	AMC of End Suction Back Pullout Centrifugal Pumps to include changing of mechanical seals in case of early defect/ leakage, rectification of misalignment, annual cleaning of pump casing		
a)	Primary CHW Pump (PCHWP) 320 GPM/ 50 ft	Set	2
b)	Secondary CHW Pumps (SCHWP) 320 GPM/ 55 ft	Set	2
	Comprehensive AMC Price of All Secondary pumps (fitted with VFD and PLC), as part of a pumping solution is to cover the entire pumpset and the Controls (including the Differential Pressure Transmitter). Price to include replacement of Key components (VFD, motor, PLC etc) if repair and troubleshooting operations are unable to restore pump to operating status, or if the pump is unable to supply variable flow to suit system. All work on the PLC/ VFD to be done by OEM authorized personnel ONLY.		
c)	Condenser Water Pump (CNDWP) 500 GPM/ 60 ft	Set	2
d)	Vertical Inline Hot Water (HW) Pumps	Set	2
114)	AMC of 2-Way Flow Control Valve for AHUs with Modulating Actuator and Programmable Temp. Controller & Actuator Motor (24Volts): To cover against all manufacturing defects in Valve body, and repair/ replacement (if deemed not repairable) of Actuator/ Controller if not found working properly.		
a)	100mm dia. (Auditorium)	each	1
b)	80mm dia. (Creep AHU)	each	2
c)	50 mm dia. (Mezz and Director Floors) - ON-OFF Type Actuator	each	2
	Operation of AC plant		
115)	Operation of Plant with three (3) Operators and three (3) helpers for three years (i.e. during defect liability period + 2years AMC period) in three shift (Each Shift to have one Operator and one helper) N.B: There shall be no operation of AC plant during winter season/shut down period of 3 Months.		
a)	Operator (semi-skilled)	Man day	2745.00
b)	Helper (unskilled)	Man day	2745.00

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LIST OF APPROVED MAKES

Following specified makes of equipment or goods will be used in the Air-Conditioning and ventilation system. The engineer will decide the preferred make of equipment out of the given options. Where no make is specified, goods will be either ISI marked or manufactured to IS specifications.

S.No.	Description of equipment / Goods	Approved Makes.
PART – A (Chiller)		
1.	Screw Chiller (With a IKW per TR of 0.68 at full load at specified operating parameters)	Carrier / Voltas/ Bluestar /Daikin/ Kirloskar /Hitachi
PART – B (Water Side)		
2.	Primary Water pumps/ Condenser Water Pumps (Fixed Speed)	Kirloskar/ CG/ Beacon/ Mather and Platt/ KSB
3	Secondary Chilled Water Pumps (Variable Speed with VFD)	Bell and Gossett/ Armstrong/ Grundfos
4	Electric Motor	ABB /C.G /Seimens / Kirloskar/ BBL/ Marathon
5	Pipes (MS)	Jindal(Hissar) / TATA /SAIL/ Surya
6	Butterfly Valves	Audco / L&T/ IVC/ Fouress
7	Check Valves /NRV	IVC/ Audco/ L&T
8	Pot & Y type strainers	Sant / Emerald/ ATAM/ UTM-VTM
9	Balancing Valves	Advance/ Audco/ L&T/ IVC
10	Globe Valves	Kirloskar / Leader/ IVC
11	Gate Valves	Kirloskar / Leader / Audco
12	Ball Valves. (Cast Steel)	Audco/ L&T/ IVC
13	Cooling Tower	Paharpur / Mihir / Advance/ Delta
PART – C (Insulation)		
14	Pipe Insulation Nitrile foam	Armaflex-Armacell / K-Flex
15	Pipe Insulation EPS	Beardsell/ BASF/ SHI/ Unique
16	Duct Insulation Nitrile foam	Armaflex-Armacell / K-Flex
17	Adhesive for Nitrile Rubber	Pidilite/ Armagluce/ Armaflex/K-Flex
18	Lag Coating	Pidilite/ Paramount
19	Duct Acoustic lining (RBFQ)	UP-TWIGA / Owens Corning

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S.No.	Description of equipment / Goods	Approved Makes.
PART –D (AHUs / FANs)		
20	Smoke Exhaust Fans	Alstom/ Howden/ Caryaire/ Airflow
21	Inline Ventilation / Exhaust Fans	Airflow / Howden / Sarla/ Ostberg
22	Floor Mounted AHU's (CHW)	FLAKT-WOODS / Systemair / FEDDERS LLOYD. / Edgetech / Zeco / Ethos
23	AHU Fans	Nicotra/ Krueger/ Airflow/ Greenheck
24	Motors	ABB / Crompton / Siemens/ Kirloskar/ Marathon/ BBL
25	AHU Filters / Fresh Air Filters / FCU Filters	Thermadyne / Spectrum/Pyramid
26	Propeller Type Fans/Axial Fans	Alstom / Crompton/ Howden/ Systemair
27	Fan Coil Unit (Cassette Type)	Midea/ Edgetech/ Trane/ Daikin/ GEA
28	Fan Coil Units (Concealed)	Edgetech/ Zeco/ Midea/
PART –E (Air Distribution)		
29	Galvanized Plain Sheets	SAIL (Bokaro) / Jindal/ Tata/
30	Aluminium Sheets (Plain).	Indian Aluminium.
31	Aluminium Grills, Diffusers.	Airmaster/ Airflow (Mapro)/ Caryaire/ Ruskin- Titus
32	Fire Dampers.	Green heck/ Ruskin-Titus/Caryaire
33	Volume Control Dampers	Greenheck/ Ruskin-Titus/ Airmaster/ Caryaire
34	Fresh Air /Exhaust Air louvers.	Airflow (Mapro) / Caryaire/ Greenheck/ Ruskin- Titus
PART-F (Controls/ Instruments)		
35	Variable Frequency Drive (VFD)	Fuji/ Danfoss/ Belimo/ Siemens/ ABB/ Hitachi/ Yaskawa/ Allen-Bradley
36	Flow Failure switch.	Danfoss / Siemens / Dwyer
37	Differential Pressure Switch.	Danfoss / Siemens / Honeywell/ Owentrop
38	2-way / 3-way/ON-OFF Valve.	Honeywell / Siemens/ JCI / Danfoss
39	Temperature Controller (ForAHUs).	Honeywell / Siemens/ JCI/ Schneider/ Belimo
40	Sensors.	Waree / H.Guru / Japsin.
41	Water Pressure Gauges	Waree / H.Guru / Japsin.
42	Industrial Thermometer Thermowell	Waree /H.Guru /Japsin
43	Dial Thermometers	Waree /H.Guru /Japsin
44	Digital Thermometers with sensor or capillary (To sense CHW temperature)	Warree / Siemens / Honeywell/ Sauter/Wika
45	Magnehelic Gauge	Dwyer

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S.No.	Description of equipment / Goods	Approved Makes.
PART –G (Electricals)		
46	Electrical Panels	RITTAL/ KEPL / Tricolite / Schneider/ SPS (Faridabad)/ International Switchgear
47	Switchgear, Control gear, Starters, Relays	Siemens / L & T / Schneider / ABB / Danfoss
48	MCCB.	L & T / Siemens / Schneider/ C&S
49	MCB.	L & T – Hager/ Le Grand /MDS/Schneider
50	Cables.(As per IS)	CCI / Havells./ Finolex/ Polycab
51	HRC Fuses	L & T / Siemens/ Schneider
52	Indicating Lamps	Schneider/L & T/ Siemens
53	Push Buttons	Automatic Electric, Rishab.
54	Voltmeters, Ammeters	Kappa, AE.
55	Current Transformers	Siemens / Honeywell / Sauter Race /ABB
56	MCB Distribution board / SS Enclosure/ Load line DB	ABB / MDS / L&T / Havell's/Schnider / Siemens
57	FRLS PVC insulated copper conductor single core cable	Havell's / Polycab / HPL / Mescab / Standard / KEI
58	LED Light fittings	Philips / Osram / Wipro
59	1.1KV grade, PVC insulated and PVC sheathed heavy duty/XLPE aluminium conductor cables	Havell's/Polycab/HPL/ Mescab/Laser/KEI

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SPECIAL TERMS AND CONDITIONS

1. The Work shall be executed generally as per CPWD General specification for HVAC works 2004, CPWD General specification for Electrical works Part-I, II & IV as amended upto date, relevant IE Rules; relevant IS and as per direction of Engineer- in charge. These special terms and conditions are to be read in conjunction with General Condition of Contract and in case of variations; special terms & conditions; specifications given in shall apply.
2. The rates for all items of work, unless clearly specified by us otherwise, shall include the cost of all labour, materials, and other inputs involved in the execution of the items.
3. The work shall be carried out in such manner so as not to interfere or affect or disturb other works, being executed by other agencies, if any. He shall arrange his work with that of the other in an acceptable and coordinated manner and shall perform it, in proper sequence to the complete satisfaction of the Engineer-in-Charge. Any damage done by the contractor to any existing work/infrastructure shall be made good by him at his own cost. Otherwise the same shall be got done at his risk and cost.
4. The contractor shall be responsible to arrange at his own cost all necessary tools and plants required for execution of this work. Tools, plant and machinery required shall be brought to the site to maintain the progress as per schedule of work and also as and when required by the Engineer-in-Charge and same shall not be removed without the consent of the Engineer-in-Charge.
5. The contractor or his authorized representative should always be available at the site of work to take instructions from Engineer in charge, and ensure proper execution of work.
6. No payment will be made to the contractor for damage caused by rains, or other natural calamity or other unforeseen reasons during the execution of the works and no such claim on this account will be entertained by CSIR-NML.
7. Contractor shall give the progress report of work done to Engineer-in-charge on daily basis because the time is the essence of the contract and the work should be completed within stipulated time of completion period.
8. The work shall be executed and measured as per metric dimensions given in the Schedule of Quantities, drawings etc. (FPS units wherever indicated are for guidance only).
9. A detailed program in the form of precedence network diagram/ bar chart is to be submitted to the Engineer-in-Charge within 10 days of commencement of work.
10. The approval by the Engineer-in-Charge of detailed programs or the furnishing of such particulars shall not relieve the contractor of any of his duties or responsibility under the contract. This is without prejudice to the right of the Engineer-in-Charge to take action against contractor as per terms and condition of the agreement.
11. In order to adhere to the program, the work may have to be carried out in more than one shift and no claim on this account shall be entertained. Contractor will give advance notice in writing to Engineer-in-Charge for doing any work in odd hour.
12. All supplied equipment should be Brand New& genuine and necessary documents should be shown in support as and when asked by Engineer In-Charge.

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13. AMC services needs to be provided as per Tender document and deduction of twice the prevailing labour rate shall be deducted from running bill in case of not providing the man power as mentioned in tender document. However, for non-compliance in lieu of AMC services, deduction will be made as per GCC.
 14. Based on the assessment of system designs, requirements and Site visits, Major changes if any required in the Tender BOQ needs to be strictly informed in the deviation list (With supporting documents) which needs to be submitted along with Technical Bid. Proper justification henceforth needs to be provided as and when asked by CSIR-NML for evaluation.

15. **Power Supply and Water Supply**

Power Supply

- (i) Unless otherwise specified, 3 phase, 415 volts, 50Hz power shall be provided by the department free of charge to the contractor at one point for installation at site suitable for 10KW load. Termination switchgear, however, shall be provided by the contractor. Further extension, if required, shall be done by the contractor.
- (ii) The contractor shall not use the power supply for any other purpose than that for which it is intended for. No major fabrication work (except Structure of Cooling Towers) shall be done at site. Power shall be used only of welding/cutting works. The power supply shall be disconnected incase of such default and the contractor shall then have to arrange the required power supply at his cost.

Water Supply

Water supply shall be made available to the contractor by the Department free of charge at one point.

16. **INITIAL INSPECTION AT SITE**

A. Chillers

- i) Salient features like type of chiller, capacity, material of tube, type of refrigerant, capacity control arrangement etc. whichever is applicable as per the contract requirement shall be verified.
- ii) Manufacturer internal test certificate shall be furnished and same shall be checked as per contract requirement.

B. Ducting

- i) The sheet used for ducting shall be checked for physical test at site. The physical test should include the sheet thickness and bend test as per relevant IS specifications.
- ii) Zinc coating of GSS sheet as mentioned in the tender documents may be got tested from a laboratory to verify that same meets the contract requirements.

C. Pumps

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- i) Salient features such as model and make shall be checked as per contract requirements.
 - ii) The manufacturers test certificates with Sr. No., head, discharge will be furnished and verified against contract requirements.

D. Cooling Towers

- i) Salient features such as make, model, dimensions, materials used, constructional details, numbers and size of nozzles, headers, size of tank, etc. should verify against the requirements. Inspection of cooling tower in knocked down condition would be carried out at the site.
- ii) Manufacturers test certificate certifying the capacity of cooling tower and static balancing of fan should be furnished.

E. Switch Gear, Control Gear, and Measuring Instruments

These should be of specified make. For air circuit breaker manufacturers test certificate shall be furnished by contractor and the same shall be verified as per contract requirements.

E. Electric Motors

Electric motors should be of specified make, manufacturer test certificate for electric motor shall be furnished.

F. Pipes and valves

- i) It should be checked that the same is as per makes specified in contract.
- ii) Dimensions including weight shall be checked for pipes against the requirements of contract.

G. Insulation and acoustic lining

- i) Physical verification for thickness and make should be made as per contract before application of insulation.
- ii) Manufactures test certificate for density should be furnished.

Note: Accuracy of testing instruments shall be as mentioned in the final specification procedure.

17. FINAL INSPECTION

After completion of the entire installation as per specification in all respects, the contractor shall demonstrate trouble free running of the equipments and installations for a period of minimum 120 hours of running as specified under “**RUNNING IN PERIOD & DATE OF ACCEPTANCE**”. Final Inspection & testing shall be done in presence of Engineer-in-charge/ his representative /any designated agency as decided by CSIR-NML at the site.

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It is to be noted that, Payments may be released at the discretion of CSIR-NML, only if the inspection results are in line with the designed parameters asked in the Tender document and until to the correctness of the requisite parameters.

18. RUNNING IN PERIOD & DATE OF ACCEPTANCE

After the installation work has been completed by the contractor, he will conduct required tests and make adjustments as may be necessary to satisfy him. There after he will offer to the department a running-in period of 7 days subject to a minimum aggregate of 120 hrs. at his cost. The plant will be operated and a log of all parameters will be maintained during this period. The contractor will be free to carry out necessary adjustments etc. during this period. The plant will be said to have successfully completed the running -in-period. After this the plant will be made available for beneficial use. After the plant has operated without any trouble for the above specified running in period, it shall be taken over by the department subject to guarantee clause mentioned below. This date of taking over of plant after trouble free operation during the running in period shall be the date of acceptance.

- i) Any loss of refrigerant or oil during the running in period shall be made good by the contractor free of charge.
- ii) Capacity test of the equipment/units shall be carried out as and when conditions become stabilized as per details given under Appendix 'G' of CPWD General specification for HVAC works, 2004.
- iii) As per clause.1.15 of CPWD, HVAC manual, Seasonal testing for Summer and Monsoon shall be carried out as & when outside conditions become suitable as instructed by Engineer In-Charge.

PROFORMA FOR TEST RESULTS & NOTES **ON TEST INSTRUMENTS AND CAPACIRTY COMPUTATIONS**

Sl. No.	Item	Test Results	
1	Ambient conditions	D.B. Temp W.B. Temp % RH	- °C - °C
2	Compressors	R.P.M. Suction pressure Discharge pressure Oil pressure	 -kg/sq.cm -kg/sq.cm -kg/sq.cm
3	Compressors Motors	R.P.M. Voltage Current At 100% load At partial load 80% 60% 50% 30%	 Volts Amps Amps Amps Amps Amps

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Sl. No.	Item	Test Results	
4	Water chillers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	LPM - °C - °C -kg/sq.cm -kg/sq.cm
5	Condensers	Water flow rate Water temperature Entering Leaving Water pressure Entering Leaving	LPM - °C - °C - kg/sq.cm - kg/sq.cm
6	Pumps	R.P.M. Motor current Discharge pressure Suction pressure	 Amps Kg/sq.cm Kg/sq.cm
7	Cooling towers	Water temperature Entering Leaving Wet bulb approach Fan motor current Fan motor voltage Fan motor R.P.M.	 - °C - °C - °C - Amps - volts
8	Air Handling unit	Total air quantity across coil Coil face area Air temperature Entering (D. B.) Entering (W. B.) Leaving (D. B.) Leaving (W. B.) Water pressure Entering Leaving Water temperature Entering Leaving Water flow rate	 Cu.m / min Sq.m °C °C °C °C Kg/sq.m Kg/sq.m °C °C LPM
9	Fresh air intakes	Face area Air quantity	 - Sq.m - Cu.m/min
10	Room condition at the working plane (No. Of readings shall be taken and averaged out)	Temperature D.B.	 - °C - °C

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Sl. No.	Item	Test Results	
		W.B.	
11	Controls	Function of each control shall be tested and report furnished.	

NOTES

A. Test Instruments

1. All Instruments for testing shall be provided by the air-conditioning contractor.
2. Thermostat used for measurement of temperature of water/ Refrigerant shall have graduation of 0.1 deg C and shall be got calibrated from N.P.L or any recognised test house before hand.
3. Thermometers used in the psychrometers shall have graduations of 0.2 deg C and shall be calibrated as at (2) above.
4. Pressure gauges shall also be got calibrated beforehand from a recognised test house.
5. Orifice type of flow metres shall be used for measuring flow rate through the condensers and chillers.

19. GUARANTEE/ DEFECT LIABILITY PERIOD(DLP)

- i. All equipments shall be guaranteed for a period of 12 months from the date of acceptance and taking over of the installation by the Department against unsatisfactory performance and/or breakdown due to defective design, material, manufacturer, workmanship or installation. The equipment or component or any part thereof so found defective during the guarantee period shall be repaired or replaced free of cost to the satisfaction of the competent authority. In case it is felt by the department that undue delay is being caused by the contractor in doing this, the same will be got done by the department at the risk & cost of the contractor. The decision of competent authority in this regard shall be final.
- ii. Any leakage of refrigerant and/or oil due to defective design, manufacture, workmanship or installation during the guarantee period shall be made good by the contractor free of charge during defect liability period.

20. Completion Documents

- a) Chilling Plant installation drawings (As-Built drawings) giving complete details of all the equipments, including their foundations.
- b) Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits.
- c) Manufacturer's technical catalogues of all equipments and accessories.

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- d) Operation and maintenance manual of all major equipments, detailing all adjustments, operation and maintenance procedure.
 - e) Safety Manual & Guidelines.
 - f) OEM (Original Equipment Manufacturer) representative should be present at site for initial testing and needs to explain the complete operating procedures keeping in lieu of system Safety precautions.

21. OPERATION & COMPREHENSIVE ANNUAL MAINTENANCE

- a) The contractor shall undertake Operation & Comprehensive Annual Maintenance Contract of screw chilling machine for a period of two years from the date of expiry of defect liability period of one year. If the contractor is not an OEM he shall enter into back to back agreement with OEM supplier for chilling unit. The documentary evidence for the same shall be furnished to CSIR-NML. A separate rider agreement will be signed by the tenderer before commencement of AMC. One operator & One helper has to be provided by the contractor for operation of the air conditioning plant in three shifts of **8 hours** working. The payment towards comprehensive AMC shall be made monthly after submitting the bill by the tenderer/bidder at the end of each month against work done satisfactorily.
- b) The Operation of Air Conditioning Plant has to be carried out by the contractor during defect liability period. The contractor has to depute one operator & one helper in three shifts of 8 hours of working. Only plant operator & helper charges shall be payable to the bidder during defect liability period.

22. PAYMENT TERMS

Payment as per General Condition of Contract Sl.No.24 (Secured Advance).

Note: When the major seasonal test cannot be carried out on commissioning of the installation due to any reason not attributable to the contractor, the installation will be handed over to the CSIR-NML for beneficial use after completion of successful running in test of 7 days subject to a minimum aggregate of 120 hrs as per Para **Running in Period & Date of acceptance**. The payment will be released to the contractor on his finishing a bank guarantee in the satisfied format from a scheduled bank for an equivalent amount of **10% of tender amount**. The bank guarantee shall be valid for a period of six months. However, it will be extended till the successful completion of the major seasonal test. This bank guarantee shall be independent of the one furnished for performance guarantee.

Moreover, it should be noted that, Payments may be released at the discretion of CSIR-NML, only if the inspection results are in line with the designed parameters asked in the Tender document and until to the correctness of the requisite parameters.

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23. The technical manual, service manual, maintenance chart for Chilling Machine and all accessories as recommended by the manufacturer shall be provided along-with the supply of the Chilling Machine.

24. **COLOUR SCHEME THE EQUIPMENTS AND COMPONENTS / PAINTING**

The Contractor shall paint all exposed metal parts/insulated pipelines, supports, base of pumps etc with two coats of primer paint and two coats of synthetic enamel paint of approved colour.

- a) Color scheme for equipment like chilling unit, pumps, AHUs, cooling tower etc shall be as per manufactures standard color scheme.
- b) The scheme of color code painting of pipe work services for air conditioning installation shall be as per national building code and is indicated below:

Description	Ground Colour	Lettering Colour	First Colour Band
Condenser water piping	Sea Green	Black	French Blue
Chilled Water Piping	Sea Green	Black	Black
Drain pipe	Black	White	
Vents	White	Black	
Valves and pipe line fittings	White with black handles	Black	
Belt Guard	Black & yellow diagonal strips		
Machine Bases, inertia bases and plinth	Charcoal Grey		

- c) Color bands shall be 150mm wide, superimposed on ground color to distinguish type and condition of fluids. The spacing of band shall not exceed 4.0m.
- d) In addition to the color bands specified above all pipe work shall be legibly marked with black or white letters to indicate the type of service and the direction of flow identified as follows:

- High temperature hot water : HTHW
- Medium temperature hot water : MTHW
- Low temperature hot water : LTHW
- Chilled water : CHW

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Condenser water	:	CDW
Condensate	:	C
Make up Water	:	MUPW

25. MOST IMPORTANT

- I. The bidders participating in the tendering, should have their office/service centre in Jamshedpur/ Ranchi/ Kolkata/ nearby (200 Km) areas necessarily. If the bidder does not have functioning Office/ Service centers as above their tender will be rejected summarily.
- II. Bidders are advised to visit site to familiarize themselves with site conditions, old chilling machine, the existing system of Air conditioning before submission of tender documents. All clarifications, explanation's if any required by CSIR-NML needs to be taken before submitting the tender.
- III. Before submitting the Bid, Tenderer should ensure that the site provided for these installation works is suitable for the Installation of equipment's as mentioned in BOQ. Deviations if any, needs to be mentioned.
- IV. Unserviceable Machine will be allowed to take out from CSIR-NML premises only after supply and inspection of new Screw Type water chilling machine at CSIR-NML, Jamshedpur.
- V. Ample Manpower needs to be arranged at site as per requirement for attaining the work completion schedule.

Note: All the bidders are instructed to strictly follow the Technical Specification and adhere to the Project deliverable and Timelines schedule.

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Project Deliverables , Timelines and Conditions.

1) **FIXING OF MILESTONES**: Following Milestones shall be adhered to:

All Shop Drawings:

All Electrical and mechanical drawings shall be submitted within two weeks of LOI. This is at the heart of the timely completion. Drawings shall be submitted in following order.

Creep Bay Area (Ground Floor)	- GA Drawings
Mezzanine Floor	- GA Drawings
Director Floor (First Floor)	- GA Drawings
Auditorium Floor	- GA Drawings
Chiller Plant	- GA Drawings
CHW Piping	- GA Drawings
CDW Piping & CT	- GA Drawings

Electrical Panels SLDs, Controls drawings, Control wiring drawings, GAD drawings, AHU drawings of Manufacturer, Chiller data sheets & drawings, Condenser Water, Piping layout, Chilled Water Piping layout, Hot water Piping Layout, Single line P-I diagram for system, Cable & Earthing schedule and corresponding drawings needs to be provided.

Being a National Laboratory, Tenderer should note the importance of the area in which HVAC system is being installed. By looking into the criticality, Site will be handed over to tenderer only after the installation materials like chillers & other installation equipment etc., will reach the site. It is only after this time that contractor will start dismantling the existing system and will proceed ahead for necessary installations.

Estimated time for Delivery of Chillers & other installation equipment to site should be within 2 months on issuing LOI. However, Deviation if any needs to be mentioned clearly in Deviation list in technical Bid which is up to discretion of CSIR-NML to accept.

Works Completion Schedule

Delivery of Chillers & other installation equipment - LOI +60 days.

Creep Bay Area (Ground Floor)	- Arrival of Chillers + 30 days
Mezzanine Floor	- Arrival of Chillers + 45 days
Director Floor (First Floor)	- Arrival of Chillers + 60 days
Auditorium Floor	- Arrival of Chillers + 75 days

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Piping All	- Arrival of Chillers + 75 days
Chiller (Installation)	- Arrival of Chillers + 90 days
All Electrical Works	- Arrival of Chillers + 90 days
Commissioning Testing	- Arrival of Chillers + 110 days
Run Test Ends	- Arrival of Chillers + 120 days.

* "Arrival of Chillers" as mentioned above is defined as "Date of Chiller & other Installation equipment delivery to site".

** Tenderer need to mention works completion schedule which is to be submitted along with Technical Bid.

***Tenderer should note that Time for "Completion of Works" should be considered as 6 months from date of Issuing LOI. Air-conditioning/HVAC system installation (Complete in all respects as per tender document) and System Hand-over (In line with tender) to CSIR-NML should be done strictly within 6 months of issuing LOI to tenderer.

2) Deliverables: As-Built Drawings/ Manuals etc.

Three (3) 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 AC plant room. In addition, one set will be given on compact disc.

- a. Plant installation drawings giving complete details of all the equipments, including their foundations.
- b. AHU Room Installation drawings.
- c. Plumbing layout drawings are including insulation giving sizes and lengths of all the pipes and the sizes and locations of all types of valves, and including Section/ Elevation drawings for the entire piping including the pipe connections to the various equipments and insulation details wherever required.
- d. Existing Duct and New Duct layout drawings (Floor Basis) with their sizes and locations, and sizes and locations of all dampers, grill & diffusers.
- e. Line diagram and layout of all electrical control panels giving switchgear ratings and their disposition, cable feeder sizes and their layout.
- f. Control wiring drawings with all control components and sequence of operations to explain the operation of control circuits.
- g. Post Commissioning O & M Manual (3 Sets + 1 Electronic Set)

Three sets of bound operation and maintenance manual containing Basis of Design, Final Priced BOQ, Details of equipment suppliers with mail ID / phone numbers, List of all

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motors, respective manufacturer O/M manuals, All as built drawings, Running in testing results, Troubleshooting guide, List of spare parts.

- h. The successful tenderer should furnish well in advance three copies of detailed instructions and manuals of manufactures for all items of equipment regarding installation, adjustments operation and maintenance including preventive maintenance & trouble shooting together with all the relevant data sheets, spare parts catalogue and workshop procedure for repairs, assembly and adjustment etc. all in triplicate.

3) Extent Of Work

- a. The work shall comprise of entire labor including supervision and all materials necessary to make a complete installation and such tests and adjustments and commissioning as may be required by CSIR-NML. The term complete installation shall not only mean major items of the plant and equipments covered by specifications but all incident sundry components necessary for complete execution and satisfactory performance with all layout charts whether or not those have been mentioned in details in the tender document in connection with this contract.
- b. Minor buildings works necessary for installation of equipment, foundation, making of opening in floors and restoring to their original condition, finish and necessary grouting etc. as required.
- c. Operation & maintenance (Routine, preventive & breakdown) for three (3) years from date of completion and handing over. One year guarantee period plus two (2) years operation and Comprehensive Annual Maintenance Contract.
- d. The work is turnkey project. Any major changes required for system completeness apart from BOQ items, needs to be brought into notice in form of deviations in Technical Bid**
- e. Being a prestigious Asia's biggest creep testing laboratory, CSIR-NML is intending for smooth operation of the Creep lab during the process of Installation works. Hence, Dismantling and further installation works needs to be done as per work completion time lines.
- f. Duration/Milestone time for completion of work should be considered as 6 months from the date of issuing LOI to the Contractor. However, it should be strictly noted that Handing of site will be given to contractor only after arrival of Chiller, Requisite installation equipment/materials at NML site as certified by NML Engineer in-charge.
- g. Beyond any case, Air-conditioning/HVAC system installation (Complete in all respects as per tender document) and System Hand-over (In line with tender) to NML should be done within 6 months of issuing LOI to tenderer.
- h. In the event of delay in "Handover" of the new HVAC system with in the above time, amount of cost incurred for providing a temporary facility of 60TR AC system beyond the tender works completion period for creep laboratory should be borne by Tenderer in addition to the "Compensation for Delay" clause.

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- i. Dismantling works of Existing Air conditioning system should be strictly done after NML Engineer In-charge clearance. Necessary clearance will be given by NML Engineer In-charge only after submission of Proper Chiller equipment Invoices, Test Certificates given by OEM and other necessary supporting documents as a proof of Chiller operating parameters as per NIT requirement.

4) Testing Requirements And Procedures

- a. Balancing of all air and water systems and all tests as called for in the specification shall be carried out by the HVAC contractor in accordance with the specifications and relevant local codes if any. Performance tests of individual equipment and control shall be carried out as per manufactures recommendation. All tests and balancing shall be carried out in the presence of Engineer-in-Charge or his authorised representative.
The instruments shall be capable of storing data and then down loading in to a PC the HVAC contractor shall provide a minimum but not limited to the following instruments:

- Velo meter to measure air volume and air velocity.
- Pitot tube
- Electronic rotary vane anemometer.
- The contractor shall be responsible to provide necessary sockets and connections for fixing of the testing instruments, probes etc.

In case of Chillers the water temperature and pressure readouts can be taken from chiller microprocessor panel. Flow thru vessels shall be calculated based on pressure – flow Curves of the respective vessels.

- b. Air Systems

Systems are to be balanced by first adjusting the total flow at the fan, then by adjusting main dampers and branch dampers. Only final minor adjustments are to be made with register and diffusers dampers. Balancing of the air system shall be accomplished without causing objectionable air noise. Baffles and orifice plates required for proper air balanced shall be furnished and installed by the contractor. Basically the following tests and adjustments are required.

- Test all fan systems to provide proper cfm / cmh.
- Adjust fresh air, return air and exhaust dampers to provide proper air quantities in all models of control.
- Test and record fresh air, return air and mixed air temperature at all air handling units. Test and record data at all coils after air and hydronic systems are balanced. Measures wet and dry bulb temperature on cooling coils.
- Make pitot tube transverse at all main supply and return ducts to set proper air quantities. Adjust all zone and branch dampers to proper cfm/cmh.
- Test and record static pressure drop across all filters and major coils.

- c. Water System

Systems are to be balanced by opening all valves, closing all by-pass and setting all mixing valves to full coil flow. Water systems shall be cleared of air. Verify that the

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system has been properly cleaned, flushed and treated before testing. Basically, the following tests and adjustments are required.

- Test all adjusts all pumps to deliver the proper gpm. Record rpm, motor amperage, discharge and suction pressure. Pumps shall without objectionable noise or cavitations. Plot actual and system performance points on manufacturers pump curves.
 - Check the operation of all automatic valves.
 - Test and adjust correct water through chiller, major items of equipment and main water circuits. The balancing valves, provided on the equipment shall be used for adjustment.
 - Check capacity output of chillers and set water flow rate for proper data.
 - Check and adjust each coil to provide proper gpm. Record water and air temperature charge and water pressure drop.
 - Set pressure drops coil by-pass to match coil full-flow pressure drop.
- d. Unit capacity in Tons Refrigeration shall be computed from the temperature readings, pressure readings and water/ brine flow measurements. Flow measurements shall bepreferably through flow meters. Pumps shall be tested for the discharge head, flow and BHP. Where it is not possible to measure the flow, at least the discharge head and BHP, (on the input side) shall be field-tested.
Alternately take differential pressure readings across Condenser & Chiller using the same accurate water pressure gauge (0-50 psig) with a least count of 1 psi. Check flow rate by seeing the flow rate Vs pressure drop curves of the respective condenser/ chiller.

e. Balancing Tolerance

Systems shall be balanced within the following tolerance:

Duct leakage Rates (at operating pressures)

Low pressure Ducts (0 to 0.5 kPa) 5% of full flow

Air flow rates

Under 70 L/S	10% of flow
Over/ at 70 L/S	5% of flow

Water flow rates

Chilled water	2% of flow
Other	5% of flow

f. Procedure

- Review all pertinent plans, specifications, shop drawings and other documentation to become fully familiar with the systems and their specified and intended performance.

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- Furnish equipment and instruct sheet metal trade on proper use for conducting duct leakage tests. Conduct first test as a way of instructing the above trades in the presence of the Departments representative.
- Test performance and continuously record on a 24 hours, temperature and humidity levels where control equipment is provided for that purpose in certain critical areas.
- Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report shall be furnished by a qualified and authorised person.

g. Reports

Provide 3 copies of the complete balancing and testing reports to the department. Report shall be neatly typed and bound suitable for a permanent record. Report forms shall contain complete test data and equipment data as specified and safety measures provided as all equipments shall incorporate suitable safety provisions to ensure safety of the operating personnel at all times. The initial and final inspection reports shall bring out explicitly the safety provisions incorporated in each equipment.

h. Final Documentation

The contractor shall have the system operating in complete balance with water and air quantities as shown on drawings. Set stops on all balancing valves and lock all damper quadrants in proper position. Secure all automatic damper and valve linkages in proper positions to provide correct operating ranges. Proper damper position shall be marked on ducts with permanent indication. Notify the department of any areas marginal or unacceptable system performance.

Upon commissioning and final handover the installation, the HVAC contractor shall submit (within 4 weeks) to the Engineer-in-Charge/ department 6 (six) portfolios of the following indexed and bound together in hard cover ring binder (300X450mm) in addition to the other drawing:

- Comprehensive operation and maintenance manual.
- Test certificates, consolidated control diagram and technical literature on oil all controls.
- Equipments warranties from manufacturers.
- Commissioning and testing reports.
- Ratings chart for all equipments.
- Log books as per equipment manufacturer's standard format.
- List of recommended spares and consumables.
- Any special tools required for the operation or the maintenance of the plant shall be supplied free with the plant.

At the close of the work and before and before issue of final certificate of completion by the Engineer-in-Charge, the contractor shall furnish a written guarantee indemnifying the departments against defective materials and workmanship for the defects liability periods. The contractor shall hold himself fully responsible for installation, for reinstallation or replace free of cost to the department.

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- Any defective material or equipment supplied by the contractor.
- Any material or equipment supplied by the department, which is proved to be damaged or destroyed as a result of defective workmanship by the contractor.

5) COMPLIANCE WITH REGULATIONS AND INDIAN STANDARDS, INDEMNITY & INSURANCE

All works shall be carried out in accordance with relevant regulation, both statutory and those specified by the Indian standards as detailed below:

a. Conformity With Statutory Acts, Rules, Standards And Codes

All components shall conform to relevant Indian Standard Specifications, wherever existing, amended to date. A list of such standards is appended in the tender.

All electrical works shall be carried out in accordance with the provisions of Indian Electricity Act, 2003 and Indian Electricity Rules, 1956 amended to date. They shall also conform to CPWD General Specifications for Electrical works, Part-I: Internal, 1994 and Part-II: External, 1994 and Part-IV (Sub-station) 1983, amended to date.

b. Safety codes And labour Regulations

- All the safety procedures outlined in the codes listed in the tender shall be complied with.
- In respect of all labour employed directly or indirectly on the work for the performance of the air conditioning contractors part of work, the contractor at his own expense, will arrange for the safety provisions as per the statutory, B.I.S recommendations, factory act, workman's completion act, CPWD code and instructions issued from time to time. Failure to provide such safety requirements would make the tenderer liable for penalty for **Rs. 200/-** for each violation. In addition the Engineer-in-charge shall be at liberty to make arrangements and provide facilities as aforesaid and recover the cost from the contractor.
- The contractor shall provide necessary barriers, warning signals and other safety measures while laying pipelines, ducts cables etc. or wherever necessary so as to avoid accident. He shall also indemnify CSIR-NML against claims for compensation arising out of negligence in this respect. Contractor shall be liable, in accordance with the Indian Law and regulations for any accident occurring due to any cause. The department neither shall nor be responsible for any accident occurred or damage incurred or claims arising there from during the execution of work. The contractor shall also provide all insurance including third party insurance as may be necessary to cover the risk. No extra payment would be made to the contractor due to the above provisions thereof.

c. Works To Be Arranged By The Department

- Unless otherwise specified in the tender documents, the following works shall be arranged by the department.
- Space for accommodating all the equipments and components in the works.

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- Make up water line supply for condenser water. Necessary interfacing with water line to be done by contractor only.
- Power supply, water supply and Drain points as per **Para: “ Power supply, water Supply and drainage”**

d. Works To Be Done By The Contractor:

Unless otherwise mentioned in the tender documents, the following works shall be done by the contractor and therefore, their cost shall be deemed to be included in their tendered cost-whether specifically indicated in the schedule of work or not: -

- Foundations for equipments including foundation bolts and vibration isolation spring/pads.
- Support columns and beams for cooling towers. Cooling tower RCC basin if specified.
- Suspenders, brackets and floor / wall supports for suspending / supporting ducts and pipes,
- Suspenders and / or cable trays and Cable termination accessories for laying the cables.
- Excavation and refilling of trenches in soil wherever the pipes are to be laid directly in ground, including necessary base treatment and supports.
- Sealing of all floor slab/ wall opening provided by CSIR-NML (For exterior walls & RCC slabs) or contractor for all others for pipes and cables, from fire safety point of view, after lying of the same.
- Painting of all exposed metal surface of equipments, pipe lines, valves etc. and components with appropriate colour as per para **“COLOUR SCHEME THE EQUIPMENTS AND COMPONENTS/PAINTING”**.
- Making opening in the walls/ floors/ slabs or modification in the existing openings wherever provided for carrying pipeline, ducts cables etc.
- Providing metallic frames for fixing grills / diffusers / Fire dampers.
- Under deck insulation of top floor slab. Rates to be given.
- Making good all damages caused to the structure during installation and restoring the same to their original finish.
- If not stated otherwise, all other miscellaneous works to be done in link with HVAC system installation

6) **INSURANCE AND STORAGE**

All consignments are to be duly insured up to the destination from warehouse to warehouse at the cost of the contractor. The insurance covers shall be valid till the equipment is handed over installed, tested and commissioned upto the satisfaction of Engineer In-charge of CSIR-NML.

7) **MACHINERY FOR ERECTION**

All tools and tackles required for unloading / handling of equipments and materials at site, their assembly, erection, testing and commissioning shall be the responsibility of the

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contractor. For hoisting Cooling Tower components and Structural members to the roof, proper capacity certified cranes shall be used. All safety precautions shall be taken and work done under contractors senior engineer's supervision.

8) **COMPLETENESS OF THE TENDER, SUBMISSION OF PROGRAMME, APPROVAL OF DRAWINGS AND COMMENCEMENT OF WORK.**

a) **COMPLETENESS OF THE TENDER**

All sundry equipments, fittings, assemblies, accessories, hardware items, foundation bolts, supports, termination lugs for electrical connections, cables glands, junction boxes and all other items which are useful and necessary for proper assembly and efficient working of the various equipments and components of the work shall be deemed to have been included in the tender, irrespective of the fact whether such items are specifically mentioned in the tender or not. This also includes finish painting.

b) **SUBMISSION OF PROGRAMME**

Within Ten days from the date of receipt of the letter of acceptance, the successful tenderer shall submit his programme for submission of drawings, supply of equipment, installation, testing, commissioning and handing over the installation to the Engineer-in-Charge. This program me shall be framed keeping in view the building progress. Items like ducting, piping etc. that directly affect the building progress shall be given priority.

c) **SUBMISSION OF DRAWINGS**

The contractor shall submit the drawings to the engineer-in-Charge as per para "All shop drawing" for approval before start of work. Also refer milestones to be achieved.

d) **COMMENCEMENT OF WORK**

The contractor shall commence the work immediately after issuing the LOI.

9) **DISPATCH OF MATERIALS TO SITE AND THEIR SAFE CUSTODY**

The contractor shall dispatch materials to site in consultation with the Engineer-in-Charge. Suitable lockable storage accommodation shall be made available free of charge temporarily. Watch & ward however, shall be responsibility of contractor. Safe custody of all machinery and equipment supplied by the contractor shall be the responsibility of the contractor till final taking over by the CSIR-NML, Jamshedpur. Materials shall be manufactured / procured only after approval of materials submittal by Contractors is approved.

10) **CO-ORDINATION WITH OTHER AGENCIES**

The contractor shall co-ordinate with all other agencies involved in the work so that the work of other agencies is not hampered due to delay in his work. Ducting, piping, cabling or any other work, which directly affect the progress of building work, shall be given priority.

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TECHNICAL SPECIFICATIONS

T-1: SPECIFICATION FOR CHILLERS

SCREW TYPE WATER COOLED CHILLING UNITS-2Nos

OPERATING PARAMETERS

1) Output of each chilling unit	-----	125 TR (at Stated Conditions)
2) EWT Chiller	-----	12.0 ° C
3) LWT Chiller	-----	6.4 ° C
4) Chiller flow	-----	307.5 usgpm
5) EWT Condenser	-----	32.20° C
6) LWT Condenser	-----	36.38° C
7) Peak wet bulb temp.	-----	28.3 ° C
8) Condenser flow	-----	492 usgpm
9) Condenser fouling factor	-----	0.001 (British)
10) Chiller fouling factor	-----	0.0005 (British)
11) IKW / TR. required at full load	-----	0.67 (For Single Compressor)
12) Condenser pressure drop	-----	27.2 ft. (maxm)
13) Chiller pressure drop	-----	28.4 ft. (maxm)
14) Working Pressure Water Side	-----	10 kg / m ²
15) Refrigerant specified	-----	R-134a
16) Voltage specified	-----	415 V ± 10 %, 50 Hz, 3 Ø, AC.
17) Control voltage	-----	110 V/230 V ± 10 %, 50 Hz
18) AHRI 550 / Eurovent tolerances in capacity and IKW/TR shall be applicable.		
19) Type of Chiller	-----	Flooded
20) No of Compressor	-----	One
21) Computer selection	-----	shall be given with the bid.

Special Note:

Full load capacity test shall be performed at site with vendor's calibrated instruments, in summer or monsoon. Vendor to demonstrate achievement of TR capacity, Input KW/TR at full load, IKW at full load, EWT and LWT chiller, flow rates and running Amps. In case space load is less than full load, then the actual capacity to be recorded.

SCREW TYPE COMPRESSOR

- a) The Screw compressor shall have a rotary twin screw, and may be of Semi sealed / totally (Hermetic) sealed type. It shall be using Refrigerant R-134a.
- b) The twin rotary screw shall be manufactured from forged steel. The profile of screws shall permit safe operation up to a speed of 3000 RPM for 50 HZ operations. The compressor shall

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unload from fully loaded to the minimum capacity by means of hydraulically actuated slide valve positioned over the screw rotor.

- c) The compressor housing shall be of high-grade cast iron, machined with precision, to provide a very close tolerance between the rotor (s) and the housing.
- d) The rotor(s) shall be mounted on antifriction bearing designed to reduce friction and power input. There shall be multiple cylindrical bearing to handle the radial and axial loads.
- e) There shall be built in reservoir to ensure full supply of lubricants to all bearings and a check valve to prevent backspin during shut down.
- f) There shall be oil pump or other means of differential pressure inside the compressor for forced lubrication of all parts during startup, running and during shutdown. An oil sump header shall be provided in the casing.
- g) The **open type compressor** shall also have a suitable shaft seal, to prevent leakage of Refrigerant.
- h) The unit shall be complete with automatic capacity control mechanism, to permit modulation between 20% to 100% of capacity range.

i) Interlocking

The compressor motor shall be interlocked with the following: -

- i.) Paddle type Flow Switch (socket mounted on pipe) switch in the chilled water line (s) in case of chilled water system, and airflow switch in the evaporator fan discharge in the case of direct expansion system.
- ii.) Paddle type Flow Switch (socket mounted on pipe) in case of water-cooled condenser.
- iii.) Anti-freeze thermostat in case of chiller.
- iv.) Condenser Water Pump in case of water-cooled condenser.
- v.) Chilled Water Pump in case of chilled water system.

The interlocks shall be provided with indicating lamps or flags in the control panel in the refrigeration plant room.

- j) The driving motor shall be suitable Hermetic /Semi Hermetic type as required, protected against damage by means of built in protection devices.
- k) Compressor Motor-
 - i) Shall be Hermetic or Semi Hermetic with maximum 3000 RPM.
 - ii) Suitable for continuous duty.

Water Cooled Condenser

• Rating

The condenser capacity shall match the maximum compressor capacity specified in the tender

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specifications. The condenser shall be selected for 4.2 degree C temperature rise of water through the condenser unless otherwise specified in the tender specifications. The condenser shall be designed for a fouling factor of 0.001 (British Units) unless otherwise specified in the tender specifications. Unless otherwise specified, the condenser shall be designed for an entering water temperature of 32.2 degree C.

- **Material and Construction**

- The Condenser shall be horizontal, shell and tube type, designed, constructed and tested for the refrigerant specified in the tender specifications.
- The shell of the condenser shall be made of thickness not less than 8mm with electric fusion welded seams. The shell capacity shall be such as to hold 1.25 times the refrigerant charge in the machine of which the condenser is a part under pumped down conditions.
- The end plates of condenser shall be made of MS of thickness not less than 25 mm.
- The Condenser shall be designed for a working pressure on the refrigerant side suitable for the refrigerant offered, and on the water side for 10 kg. /Sq.cm. Gauge
- The tubes shall be of seamless hard drawn copper and finned, unless otherwise specified. The minimum wall thickness shall be 1.0 mm with root thickness of 0.63 mm below the fins
- Intermediate tube supports of steel shall be provided at not more than 1250 mm intervals to prevent sagging and vibration of tubes. The condensers shall have, openable at both ends water boxes designed for multi pass flow.
- The tubes may be provided with special tabulating arrangement to improve heat transfer where such an arrangement is a standard design of the manufacturer.
- The Condensers shall be provided with removable heads on either side made of cast iron or steel with neatly machined surface for effective jointing with the shell for easy accessibility for cleaning/replacement of the tubes. Suitable baffles shall be incorporated to achieve the required number of passes. It should be possible to descale the tubes without disconnecting the water line connections, wherever marine water boxes have been specified in the tender documents.
- The condenser shall be provided with baffle arrangement for preventing direct impingement of hot gas over the tubes and to enable even distribution of the gas over the tubes bundles.
- The condenser shall include necessary provision for sub cooling of the refrigerant where the refrigerating machine is selected with such sub-cooling requirement. The arrangement shall be such that the cold water entering the condenser first cools the liquid refrigerant in the sub-cooler.
- The condenser shall be sand blasted from both inside and outside.

- **Connections and Accessories**

The condenser shall be provided with the following connections and accessories and conforming to section "Refrigerant Piping" where applicable: -

- Hot gas inlet and liquid outlet connections. The liquid line connection shall be provided with isolating valves.
- Water inlet and outlet connections with Victaulic coupling.

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- Pressure relief device.
- Drain connection with valve for water side.
- Differential flow switch / pressure switch/ flow switch/ flow sensor in the water lines(s).

Pressure Testing

The condenser shall be tested at the works to 1.5 times the maximum working pressure for the refrigerant specified in the tender specifications or 15 kg/Sq.cm. (Pneumatic), for refrigerant R-134a., whichever is higher.

The water side of the condenser shall also be tested to a Hydraulic pressure of 10 kg/sq cm. in the works

Pressure test certificate shall be produced in respect of each condenser.

CHILLER

Shell and Tube Type Water Chillers

- **Ratings**

In water-chilling machine, the chiller shall match the compressor capacity specified in the tender specifications. The chiller shall be selected for **5.5°C (10°F)** temperature drop of water through the Chiller.

The fouling factor shall be 0.0005 (British units).

- **Material and Construction**

- i) The water Chiller shall be horizontal, shell and tube type, designed, constructed and tested for the refrigerant specified in the tender specifications. **Chiller shall be FLOODED type.**
- ii) The Chiller shall be designed for a working pressure on the refrigerant side suitable for the refrigerant offered, and on the water side for 10 kg /sq .cm. gauge.
- iii) The end plates of chiller shall be made of MS of thickness not less than 25mm.
- iv) The shell of chiller shall be made of MS of thickness not less than 8mm with electric Fusion welded seams.
- v) The tubes shall be of seamless, hard drawn copper with a minimum tube wall thickness of 0.71mm for plain tubes & minimum 0.63mm at the root of fins.
- vi) The tubes shall be plain or per manufacturer's design.
- vii) The tube shall be rolled into grooves in the tube sheets and flared at ends.
- viii) Intermediate tube supports of steel or polypropylene shall be provided at spacing not less than 500 mm to prevent sagging / vibration of tubes.
- ix) The chiller shall be provided with adequate number of properly spaced baffles so that the water passes through the tube bundle many times.
- x) The chiller shall be smooth finished with one coat of zinc chromate primer before the insulation is applied.
- xi) The chiller shall be sand blasted from both inside (before insertion of tubes) & outside.

Connections and Accessories: Same as that of Condenser except hot-gas bypass:

- **Pressure Testing**

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- The chiller shall be tested in the works to 1.5 times the maximum working pressure for the refrigerant specified in the tender specifications, or 21 kg./sq.cm. (Pneumatic), whichever is higher.
- The water side of the chiller shall also be tested to a Hydraulic pressure of 10 kg./sq.cm. at the works.
- Pressure test certificates shall be produced in respect of each chiller.

- **Insulation**

The insulation shall be done as per chiller manufacturer’s recommendation using class “0” Nitrile foam.

- **Refrigerant Piping**

Design Aspects of Refrigerant Plumbing

- 1) **Refrigerant piping shall be designed and installed so as to:**

- a) Ensure circulation of adequate refrigerant at all loads.
- b) Ensure oil return to crank case of compressor positively and continuously.
- c) Keep pressure losses within limits, especially in suction lines.
- d) Prevent oil/liquid refrigerant from entering the compressor when the compressor is working as well as when it has stopped.
- e) Prevent trapping of oil in suction lines, which may return to the compressor in the form of slug.

- 2) **Hot gas lines:**

- a) Oil shall be entrained and carried by hot gas under all load conditions likely to be encountered in normal operation.

- 3) **Liquid lines:**

- a) Liquid lines shall be designed to ensure that flashing of liquid refrigerant does not occur by minimizing the pressure drop suitably, by avoiding long vertical risers, and appropriate sub cooling.
- b) Each liquid line shall be provided with a permanently installed refrigerant drier of throw away or rechargeable type. The drier shall be installed in a valve line.
- c) Flow indicator (moisture indicating type) shall be installed on all liquid lines.

- 4) **Suction Lines:**

- a) Oil shall be entrained and carried by the suction gas under all conditions of load likely to be encountered in normal operation.
- b) Piping shall be designed for a suitable velocity of refrigerant (similar to hot gas line) to ensure that oil will not separate from the gas and drain to the compressor in slugs.
- c) Refrigerant line shall be sized to limit pressure drop between evaporator and condensing unit to less than 0.2 kg./sq.cm. (3 psi)

5) Isolating valve shall be provided to enable isolation of each compressor in case of multiple

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compressor units (as built in valves), strainer, drier and other components as may be required for proper operation and maintenance.

- 6) Electronics Expansion valve shall be provided in refrigerant circuit.

Material-

- 1) Any tubing used for controls shall be with copper tubes, with tube thickness conforming to L type to ASTM standards. The tubes shall be bright-annealed copper up to and including 15 mm size. The tube shall be suitable for duty involved.
- 2) Fittings like bends, tees, sockets etc. shall be of wrought copper or forged or brass and shall be suitable for the duty involved. Flare type compression fittings of forged brass shall be allowed up to 15mm piping size. Tubes up to and including 15 mm size may be bent to form 90 degree bends with inside radius not less than 3 tube diameters. For bigger sizes, bend fittings as mentioned above must be used.
- 3) Refrigerant plumbing for centrifugal/ screw type chilling machine shall be mild steel or wrought iron / copper to manufacturer's standards.
- 4) Valves shall be of the packed, back-seating type for both copper and MS refrigerant plumbing work, and these shall be of forged or cast brass construction.

Pressure Testing:

- 1) After completion of the piping installation, the entire chilling unit shall be pressure tested with dry Nitrogen or any other inert gas at the following pressures for the particular refrigerant to be used:

Refrigerant	Test pressure (Kg /Sqcm (Gauge))	
	High-pressure side	Low-pressure side
R-134a	20	8

This test shall be carried out as follows:

- a) The system shall be charged with Nitrogen or inert gas to 1.0 Kg./sq.cm. gauge and all joints shall be checked for leakage with a mixture of four part water, one part liquid soap and a small amount of Glycerin. Leaks shall be marked, pressure released and repairs done. Brazed joints, which leak, shall be opened and redone. These shall not be repaired by addition of brazing alloy to the joints.
- b) The system shall now be charged with Nitrogen or the inert gas to the pressure specified in the above table and the process of locating leaks and repairs shall be repeated.
- 2) Final pressure test:
After all the leaks have been repaired, the system shall be retested with the test pressure maintained for a period of not less than 8 hours. No measurable drop in pressure should

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be detected after the pressure readings are adjusted for temperature changes. Pressure gauges, controls and compressors may be valved off during pressure testing.

Note: Pressure testing may be done as per ASME/ ASHRAE standards.

MICROPROCESSOR CONTROLLER

1. Each Chilling unit shall be complete with a microprocessor based interactive control console in a locked enclosure factory mounted (directly on the unit), prewired with all operating and safety controls and tested.
2. It will provide start, stop, safety, interlock, capacity control and indications for operations for operation of the chiller units through a alphanumeric/graphical display.
3. Controls shall provide to view and change digital programmable essential set points, cause of shutdown and type of restart required.
 - a) Leaving chilled water temperature,
 - b) Percent current limit
 - c) Remote reset temperature range.
4. All safety and cycling shutdowns shall be enunciated through the alphanumeric/graphical display and consist of day, time, cause of shutdown and type of restart required.
5. Cycling shutdown shall include low leaving chilled water temperature, chiller/condenser water flow interruption, power fault, internal time clock and anti-recycle.
6. Safety shutdowns shall include low oil pressure, high compressor discharge temperature, low evaporator pressure, motor controller fault and sensor malfunction.
7. The default display screen shall indicate the following minimum information
 - i. Date and time
 - ii. Return and leaving chilled water temperatures
 - iii. Differential oil pressure
 - iv. Percent motor rated current
 - v. Evaporator & condenser refrigerant saturation temperatures
 - vi. Chiller operating hours (hour run) and
 - vii. Number of compressor starts
 - viii. Oil sump temperature (not required for reciprocating compressor)
 - ix. Status message
8. Security access shall be provided to prevent unauthorized change of set points, to allow local or remote control of the chiller and to allow manual operation of the prerotation vanes and oil pump.
9. The chiller shall be provided with ports compatible with any building management system offered, to output all system operating information, shutdown/cycling message and a record of last four cycling or safety shutdowns to remote printer (option). The control centre shall be programmable to provide data logs to the printer at a set time interval.
10. Control centre shall be able to interface with an automatic controls system to provide remote chiller start/stop; reset of chilled water temperature, reset of current limit, and status messages indicating chiller is ready to start, chiller is operating, chiller is shut down on a safety requiring reset and chiller is shut down on a recycling safety.

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11. The microprocessor control system shall include the interlocking of compressor motor with chilled and condenser water flows, guide vane position of compressor in case of centrifugal units and lubricating oil pump pressure.
 12. On initiation of start, the microprocessor control system shall check all pre-start safeties to verify that all restart safeties are within limits. (if one is not, an indication of the fault will be displayed and the start

INSTALLATION

The complete chilling unit shall be installed over a RCC foundation and shall be adequately isolated against transmission of vibrations of the building structure. Special attention shall be paid to the alignment of the driving and driven shaft in case of open type coupled compressors. Final alignment shall be checked at site in presence of Consultants/ Engineer-in-charge using a dial indicator. Necessary foundation bolts, nuts, leveling screws etc wherever required for mounting the unit shall be provided by the contractor.

PAINTING

The equipment shall be supplied as per manufacturer's standard painting.

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T-2: AIR HANDLING UNIT (AHU)

- a) Maximum face velocity across cooling coil : 152 m/ min (500 fpm) or as indicated
- b) Maximum outlet air velocity : 9.0 m/ sec
- c) Maximum face velocity across filters :
Ordinary filters : 152 MPM (500 FPM)

NOTE: - FOR MORE DETAILS OF AHU PLEASE SEE THE BASIS OF DESIGN AND AIR HANDLING UNIT

1. SCOPE

This chapter covers the detailed requirements of factory built double skin air handling unit (AHU) and single skin fan coil unit (FCU) for central Air-conditioning system.

2. FACTORY BUILT AIRHANDLING UNIT

2.1 Type

The Air handling unit shall be double skin construction, draw through type in sectionalized construction consisting of blower sectional humidification section (Where Specified), filter section and insulated drain pan. Unless otherwise specified, the unit shall be horizontal type.

2.2 Rating (Airflow and Static Pressure as per BOQ)

- 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 152 m /min (500fpm).
- 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. 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 9 m/sec.
- v) Noise level at a distance of 2 M from AHU shall not exceed 75 dBA.

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2.3 Material and Construction

2.3.1 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 50 mm thick, made of 0.8 mm pre-plastised and pre-painted with PVC guard, GSS sheet on outside and 0.8 mm pre-plasticized and pre-painted with PVC guard, GSS sheet on outside and 0.8 mm galvanized sheet inside with polyurethane foam insulation of density not less than 38 kg/m³ 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 gasket shall be inserted within groove in extruded aluminium profile of the framework.
- iii) Framework 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 and 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 (shall) for maintenance to various sections. The entire housing shall be mounted on galvanized steel channel frame work made out of G.I sheet of thickness not less than 2 mm. For higher capacity AHUs hot dip galvanized steel channel framework made of minimum 3 mm thick G.S sheet shall be used.

2.3.2 Drain Pan

Drain pan shall be made out of minimum 1.25 mm stainless steel sheet externally insulated with 10 mm thick closed cell Polyethylene foam insulation with necessary dual slope to facilitate fast removal of condensate. Necessary supports will be provided to slide the coil in the drain pan.

2.3.3 Cooling / Heating Coil (Shall be AHRI Certified)

- 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 requirements, viz. re-circulated air applications, or 100% fresh air applications and the bypass factor required shall be specified in the tender specifications. The coil shall be 4 Row or 6 Row deep for normal re-circulated air application and 8 Row deep for all outdoor air application, unless otherwise specified in the

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tender specifications. In case of 8 Rows deep coils, it shall be made of 2 X 4 rows deep coil with spacing of 200 mm 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/shall in the tubes.
- v) The fins shall be of Aluminum. 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.
- 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 coil shall be designed for a maximum working pressure of 10 kg/cm².
- vii) Shut off and regulating valves at the inlet and outlet of water shall be provided.

2.3.4 Supply Air Fan and Drive (Shall be AMCA / Eurovent Certified)

- i) The supply air fan shall be AMCA certified centrifugal type with forward/backward curved blades double inlet double width type. For static pressure up to 65 mm forward curved blades shall be used and for higher sizes backward curved blades shall be used.
- ii) The fan housing of galvanized sheet steel and the impellers shall be fabricated from heavy gauge steel sheet as per approved manufacturer's standard. The side plates 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 anti vibration spring mount 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-55 protection & sealed for quiet running. The motor shall be suitable for operation on 415 ± 10% V, 3 phase, 50 Hz, A.C Supply. The motor shall conform to IS: 325. "Three

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phase induction motors” having class F insulation. All motors shall be of efficiency -01 as per BEE.

- vi) The fan motor starter shall be as per starter IS specifications.

2.3.5 Air Filters

The air used in 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.

2.3.5.1 Types of filters

Pre- filters:

Cleanable metallic viscous type filter made out of aluminium wire mesh or of dry cleanable synthetic type minimum 50 mm thick, shall be provided on the suction side of AHU as standard equipment with the unit. These filters shall have the efficiency of 90% down to 10micron 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, druid & then given a bath of viscous oil. Face velocity across these filters shall not exceed 155 m/mint.

2.3.5.2 General construction of filters

Each AHU shall be provided with factory assembled filter section containing prefilters made of cleanable metal viscous filters made of corrugated aluminium wire mesh, or dry cleanable synthesis filters. These shall be minimum 50 mm thick with a frame work of aluminium.

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.


In order to indicate the condition of these filters while in operation, a manometer shall be provide to indicate the pressure drop across the fine filters and absolute filters.

Special filters, if any specified in the tender specifications shall be provided in addition to the above filters. In that event, latter shall function as pre-filters.

2.4 Instruments and Valves

The following instruments shall be provided at the specified locations in the AHUs for the chilled water/ Hot water system.

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- i) Pressure gauges at the inlet and outlet of the coil with tubing and gauge cock.
 - ii) Stem type thermometers at the inlet and outlet of coil with tubing and 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 2way diverting/ modulating valve along with proportionate thermostat/ or as specified.

2.6 Controls

These shall be as per details given under “Controls “T-9

2.7 Insulation

The insulation of casing shall be as per detail given under “Insulation Work” T-8 & that of drainpan shall be as per 2.3.2.

2.8 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.

2.9 Important (SP Probes)

All AHUs and indoor units shall be provided with probes with caps to enable measure static pressure. These should be provided in:

- a) After All filters
- b) In Fan compartment / fan Section.
- c) At Fan discharge.

Static pressure readings with respect to atmosphere shall be taken with an open to atmosphere “Inclined Tube Water Manometer” with 1.0 mm least count.

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T-3: FAN COIL UNITS

OPERATING PARAMETERS

S. No	TR	CFM	Rows Deep	Speed Control	Fins/cm
1	1.0	400	3	3	5
2	1.5	600	3	3	5
3	2.0	800	3	3	5
4	2.5	1000	3	3	5
5	3.0	1200	3	3	5

NOTES: -FOR MORE DETAILS PLEASE SEE BASIS OF DESIGN AND THE BOQ

1. General

The fan coil units shall be 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 specified.

1.2 Casing

The casing shall be fabricated out of minimum 1.25 mm thick G.S.S. sheet.

1.3 Cooling Coil

The coil shall be seamless copper tube with Aluminium fins. The fins shall be uniformly bonded to the tubes by mechanical expansion of the tubes. The coil circuit should be sized for adequate water velocity but not exceeding 1.8 m/shall. The air velocity across the coil shall not exceed 155 m / mint.

1.4 Fan

This shall consist of two light weight Aluminium impellers of forward curved types, 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.

High Static Fan Coil units shall deliver at least 7mm w.g. External Static Pressure (ESP) and have a Total Static Pressure of 40mm w.g.

1.5 Drain Pan

Drain pan shall be made out of minimum 1.00 mm stainless steel sheet covering the whole of the coil section and extended on one side for accommodating coil connection valves etc. and complete with a 25 mm drain connection. The drain pan shall be insulated with 10 mm thick

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closed cell polyethylene foam insulation and jacketed from outside with single piece molded FRP tray.

All Cassette type units shall have an in-built Condensate pump which can pump condensate to a vertical head of 700mm w.g.

1.6 Air Filter

The filter shall be cleanable type 15 mm 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.

1.7 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.

1.8 Automatic Controls

Each unit shall have a room type thermostat and a solenoid **ON-OFF type 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 the inlet line shall be of gunmetal ball type with internal water strainers, having BSP female pipe thread inlet and flare type male pipe thread outlet connection. The valves on the return line shall be as above, but without the water strainer.

1.9 Water connections

The water line shall be finally connected to the coil of the fan coil unit, by at least 300 mm long, type 'L' seamless solid drawn copper tubing, with flare fittings and connections.

1.10 Insulation

The drain pan shall be insulated as per specification in the AHUs drain pan Insulation. The entire valve assembly shall be covered in a pre-insulated moulded cover which can be removed for replacing any valve.

1.11 Painting

All equipment shall be supplied as per manufacturer' shall standard finish painting.

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T-4: CIRCULATING WATER PUMPS

PUMP SPECIFICATIONS

Pumps required for chilled water shall be of capacities with the schedule of equipment. Pumps shall be of; vertical split case, end suction type centrifugal pump.

The pump shall be of following construction and material as per IS: 1620

Sl.No	Description	End Suction Split Case - CHW & CDWP/HWP
1	Duty	Chilled water /Cooling Water / Hot Water
2	Casing	Cast iron construction.
3	Impeller	Bronze
4	Shaft	High Tensile steel
5	Bearing	Heavy Duty Ball bearing (Permanent Lubricated, Sealed)
6	Base Plate	Welded steel or Cast Iron. HDG if welded steel.
7	Flanges	Standard Companion Flanges at inlet and outlet.
8	Seal	Mechanical seal for all pumps (Factory Supplied).
9	Maximum speed	1450 RPM
10	Motor	TEFC, direct driven Efficiency1(IE2)
11	Starter	Star delta/ VFD for Secondary Pumps
12	Coupling	Flexible Tyre type coupling /Lovejoy Type (Rigid Type Acceptable for Vertical Inline Pumps).
13	Wearing ring	Bronze
14	Shaft sleeve	SS416
15	Type	End suction centrifugal Back Pullout (High Efficiency)
16	Pump Base	C.I or MS fabricated Hot Dip Galvanized.
17	Pump Efficiency	Minimum 80%

SCOPE

This chapter covers the general requirements of water circulating pumps of central air conditioning, heating. 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. All pumps shall be Base Mounted End-Suction type with tyre type coupling, pre-aligned on a Base Frame. For Secondary pumps, **Vertical Inline pumps** may be considered.

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RATING

The pumps shall be suitable for continuous operating in the system. The head and discharge required 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. **A minimum 15% buffer shall be maintained between Input Power and Motor rating.**

MATERIAL AND CONSTRUCTION

- i) The centrifugal pumps shall conform to IS 1620. The motor starter shall be in accordance with Para "MOTOR STARTER in T-10 Electrical work". The motor shall be screen protected drip proof (SPDP) fan cooled type.
- ii) The pump casing shall be of heavy section close-grained cast iron. The casing shall be provided by 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 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 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 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.

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INSULATION

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 discussed in Insulation Work T-8.

INSTALLATION

- 1) 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.
- 2) More than 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 25mm. neoprene on any other equivalent vibration isolation fittings. Where spring mountings are used for vibration isolation, these shall be complete with leveling screws and lock nuts 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 Engineer-in-Charge.

PAINTING

The pumps shall be supplied with the manufacturer standard finish painting.

SECONDARY CHILLED WATER PUMP (WITH VFD DRIVE)

The secondary chilled water to AHUs is of variable flow commensurate with load. All secondary pumps shall be supplied duly mounted as a coupled set on a base frame. Each pump shall be powered through a VFD. Since both pumps feed into a common header, these pumps are controlled by a common Programmable Logic Controller (PLC) which can regulate the operation of the pumps through the VFD's. The programming protocol (BACNET, LONWORKS, MODBUS) shall be the same as that used by the Water-Cooled screw chillers. The control signal shall be from a Differential Pressure Transmitter sensor mounted in the CHW header, at a location approved by the manufacturer. The entire assembly (Pump-Motor-VFD-PLC-Panel enclosure) shall be supplied by pump manufacturer directly as a Single unit, and the manufacturer shall take guarantee for achieving the specified duty point. The VFD/ PLC enclosure shall be of IP-55 rating.

Secondary chilled water pump shall be horizontal end suction type or Vertical In-line with Integral VFD and PLC.

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T-5: SPECIFICATION FOR COOLING TOWER

Sl.No.	Description	Parameter
1	Type	Counter Flow/Cross flow
2	Hot water Flow (each cell)	600 USGPM
3	Hot water Temp in	97.5 F
4	Cold water out	90 F
5	Design wet bulb	83 F
6	Air flow type	Induced draft
7	Type of Gear reducer & Make	As per manufacturer standard, if applicable.
8	Basin & Vertical members	Virgin FRP (rigidly Braced) / Pultruded FRP
9	Fills	Virgin PVC
10	Hardware / Nuts & Bolts	SS – 304
11	Stack	FRP
12	Drive shaft	Stainless Steel
13	Flow Type	Counter flow/Cross flow
14	Shape of cooling tower	Rectangular
15	Type of motor enclosure	TEFC/ IP-55
16	Motor	Weather Proof, IP-55 Protection capable of delivering high starting torque.
17	Hot water Basin	Should have removable covers for access to target nozzles.

1.SCOPE

This chapter covers the general requirements of cooling towers for packaged units, central air-conditioning plant and cold rooms.

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2. TYPE

The cooling tower shall be mechanical draft type. Fan on mechanical draft towers may be on the inlet airside or exit airside. In case of former it is called forced draft type and in case of later it is called induced draft type. On the basis of direction of airflow and water flow, Mechanical draft cooling tower can be counter flow or cross flow type as per the manufacturer design.

This may be of any of the following construction as may be specified in the tender specifications.

a) In fiberglass reinforced plastic (FRP) construction with PVC fill and FRP basin.

3. DESIGN

Rating:

The cooling tower shall be rated for the heat rejection capacity specified in the tender specification.

Range:

The cooling tower shall be designed to cool the requisite quantity of water through 4.2 degree C or specified in the tender specifications, against the prevailing wet bulb temperature.

Wet Bulb approach:

The cooling tower shall be selected for a wet bulb approach of not more than 3.9 degree centigrade.

Outlet Temperature:

The cold-water temperature from the cooling tower shall match the entering temperature for which the condenser selection is made.

Flow Rate

The water flow rate through the cooling tower shall match that through the condenser.

Multi cell design.

The induced draft-cooling tower shall be a one or more cell.

4.0 MATERIAL AND CONSTRUCTION

Fiber glass Reinforced Plastic (FRP) cooling tower

- i) The structural framework of the cooling tower including all members shall be designed for the load encountered during the normal operation of the cooling tower and its maintenance. The structure shall be rugged and rigid to prevent distortion and shall include tie arrangements as may be necessary.

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- ii) The cooling tower shall be induced draft type, with FRP casing in Square/ Rectangular/octagonal / circular shape, and with FRP Basin to match the shape of the casing.
 - iii) The air intake shall be from opening all along the circumference of the casing near its base in case of circular shape. Air intake shall be along the sides in case of square or Octagonal /Rectangular cooling tower. These opening shall be covered with hot dip galvanized expanded metal mesh screens.
 - iv) The basin shall have a holding capacity adequate for operation for at least 30 minutes without addition of make up water to the basin. The construction such as to eliminate the danger of drawing air into the pump when operating with minimum water in the basin.
 - v) The basin fitting shall include the following.
 - a) Bottom/Side outlet
 - b) Drain connection with valve
 - c) Ball type automatic make up connection with valve.
 - d) Overflow connection.
 - e) Bleed off with valve, from inlet header to overflow pipe.
 - vi) The supporting frame work for the tower casing and water basin shall be made of hot dip galvanized steel and it shall be further protected with epoxy painting.
 - vii) The filling shall be of PVC. Thickness of PVC fills shall not be less than **0.2 mm**. These shall be of such construction as to provide low air resistance, large wetted surface for a high heat transfer efficiency, and easy replace ability.
 - viii) The water distribution may be either self rotating or fixed type sprinklers or through balancing, sub balancing and spreader troughs (unpressurised system) “open gravity type with polypropylene nozzle”, ensuring uniform water loading and distribution of water over the fill. All pipe and fittings shall be of PVC. The sprinklers shall operate from the residual velocity head at the headers. Due care shall be taken with regard to corrosive effects and maintainability in the design of the water distribution system.
 - ix) Drift eliminators of PVC shall be provided for maximum removal of entrained water droplets. The spacers and the tie rods shall be plastic material.
 - x) The fan shall be multi blade axial flow type, made of aluminium alloy or FRP. The fan assembly shall be statically and dynamically balanced.
 - xi) The fan drive shall be from a three-phase induction motor, either direct or through a spiral gear work/ direct drive arrangement as applicable. The entire drive arrangement shall be designed for a minimum noise and it shall be rigidly supported to the tower structure.
 - xii) The motor starter shall be in accordance with Para motor starter.

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- xiii) To ensure safety of the personnel at the time of working on cooling tower a steel structure shall be provided in such a manner and location as necessary to give safe and complete access to all the parts of the cooling tower requiring inspection or adjustments. The structure shall be bolted to the tower at the top and grouted in masonry at the bottom end.

5.0 INSTALLATION

The cooling tower shall be installed on M.S girders fixed in masonry foundation with cement concrete footing. Second class brick work and cement mortar having one part cement & six parts sand shall be used for masonry work. 12 mm sand cement plaster shall be provided over the brickwork.

These may be located at a well-ventilated place either at ground level and contiguous to the plant or on the terrace of the building in consultation with the architect. In case the cooling towers are located on the terrace of the building the structural loading of the terrace shall be considered. For this respective columns are to be raised by the tow feet at the terrace. Cooling tower shall be installed in such a way that there load is transferred directly to the columns for which necessary Mild steel –I sections shall be provided by the air-conditioning contractor. The cooling shall be rested on Mild Steel-I sections & not on terrace slab. Sufficient free space shall be left all around for efficient operation of the cooling tower.

Cooling tower shall be not be less than 75 cm above the ground floor level unless otherwise stated in the tender specifications. 6mm neoprene pads shall be placed between the tower and the girder for vibration isolation whereas directed by the Engineer-in charge. Guy- wires of suitable sized shall be used to secure firmly to its base wherever necessary.

6.0 PAINTING

The cooling tower shall be supplied with the manufacturer's standard finish painting.

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T-6: DUCTING

1.1 SCOPE

This chapter covers the general requirements for sheet metal ductwork for air distribution with associated items such as air outlets, fresh air intake and fire dampers.

1.2 MATERIAL

1.2.1 Ducts

- i) All ducts shall be fabricated either from Galvanized Sheet Steel (GSS) conforming to IS: 277 or aluminium sheets conforming to be: 737. The steel sheets shall be hot dip galvanized with coating of minimum 120 grams per square meter (GSM) of Zinc.
- 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 side of the ductwork.

Minimum sheet thickness	
Longest side (mm)	For GSS
750 mm and below	0.63
751 mm to 1500 mm	0.80
1501 mm to 2250	1.00
2251mm & above	1.25

- iii) All sheet metal connections, partitions and plenums required for flow of air through the filters, fan etc. Shall be at least 1.25 mm thick galvanized sheet steel, incase of G.I. sheet ducting or 1.8 mm thick aluminum sheet, incase of aluminum sheet ducting and shall be stiffened with 25 mm x25 mm x 3 mm angle iron braces.
- iv) Circular ducts, where provided shall be of thickness as specified in IS: 655 as amended up to date.

1.2.2 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	Up to 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	Up to 1000 mm	25 mm x 25 mm x 3 mm

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Application	Duct Width	Angle size
-do- Support angles	More than 1000 mm	40 mm x 40 mm x 3 mm
-do-	Up to 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 10mm dia for ducts up to 2250 mm size and 12 mm diameter for larger sizes.
- iv) All nuts, bolts and washer shall be zinc-plated steel. All rivets shall be galvanized or shall be made of magnesium – aluminium alloy. Self-tapping screws shall not be used.

1.3: CONSTRUCTION (After Drawing Approval Only)

1.3.1 Ducts

- i) Ducts shall be factory fabricated and shall be generally as per IS: 655 “Specifications for metal air ducts” unless otherwise deviated in these General Specifications. Few connection pieces, to suit ducts and off take collars can be made at site.
- ii) The interior surface of the ducting shall be smooth
- iii) All the ducts up to 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 centers for ducts up to 600 mm longest side, and 100 mm centers 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 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, 0.6 mm 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.

1.3.2: 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.

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- 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 up to 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 grills shall have only front louvers. The outer framework of the grills shall be made of not less than 1.6 mm thick aluminium sheet. The louvers shall be of aerofoil design of extruded aluminum section with aluminum thickness of 0.8 mm at front and shall be made of 0.8 mm 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 which ducts 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 0.80mm thick extruded aluminum 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 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) Grills and diffusers constructed of extruded aluminium section shall have grille bars set straight, or deflected as required. These shall be assembled by mechanical interlocking of components to prevent distortion. These grills 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 damper or two or more butterfly dampers in conjunction with equalizing grid. Opposed blade dampers shall be used for square and rectangular ceiling / wall outlets intakes.
 - viii) All the products supplied by contractor should supplement in performance by selection curves of products and rating from the manufacturer.

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- ix) Laminar supply air diffuser shall be made of 2 mm thick powder coated aluminium sheet duly insulated with 5 mm 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 diameter including frame work.

1.3.3: **Fresh Air Intake Louvers**

- 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 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 stiffness shall be provided to prevent sagging / vibrating of the louvers, at not more than 750 mm centers where the louvers' length is longer than 750 mm.
- v) A bird screen 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.

1.3.4: **FIRE DAMPERS**

- i) 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.
- ii) Fire damper shall be multi blade louver 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 blade and frame shall be constructed with minimum 1.6 mm thick galvanised sheet & shall be factory fitted in a sleeve made out of 1.6 mm galvanised sheet of minimum 400 mm long. It shall be complete with locking device, motorized actuator & control panel.
- iii) Fire damper shall be supplied with Spring-loaded UL stamped fusible link to close fire damper in the event of rise in duct temperature.
- iv) Fire damper shall be CBRI tested & certified for 90 minutes rating against collapse & flame penetration as per UL 555-1995. (Underwriters Laboratories)

1.4: **ACOUSTIC LINING AND INSUALTION**

This shall be done as per details given in insulation work “T-8 Insulation Work”

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1.5: INSTALLATION OF METALLIC DUCT

1.5.1: Ducting

- i) The fabrication and installation shall be in a workmanlike manner. Ductwork shall be rigid and straight without kinks.
- ii) All exposed ducts within the conditioned space shall have slip joints. Flanged joints shall not be used.
- iii) All joints shall be airtight.
- iv) Repair of ducts: if on visual inspection existing duct (to be reused) are seen to be damaged/corroded, then they shall be replaced with duct of same gauge.
- v) Duct shall be supported independently from the building structure and adequately, to keep the ducts true to shape. The support spacing shall be not more than 2 m. where ducts cannot be suspended from ceiling, wall brackets or other suitable arrangements, as approved by the engineer-in-Charge shall be adopted. Neoprene or other vibration isolation packing of minimum 6 mm thickness shall be provided between the ducts and the angle iron supports /brackets. Vertical duct work shall be suitably supported each floor by steel structural members.
- vi) Where metal duct or sleeves terminate in woodwork, tight joints shall be made by means of closely fittings heavy flanged collars. Where ducts pass through break or masonry openings, wooden frame work shall be provided within the openings and the crossing duct shall be provided with heavy flanged collars on either side of the wooden frame work, so that duct crossing is made leak-proof.
- vii) Duct connections to the air-handling unit shall be made by inserting a double canvas sleeve 100 mm long. The sleeve shall be securely bounded and bolted to the duct and unit casing.
- viii) Dampers shall be provided in branch duct connections for proper volume control and balancing the air quantities in the system, whether indicated in the drawings or not. Suitable links, labors and quadrants shall be provided for proper operations, controlled and setting of the dampers. Every damper shall have an indicating device clearly showing the positions of the dampers at all times.

1.5.2: Air Outlets and Inlets

- i) The locations of the air outlets and intakes shall be shown in the tender drawings and necessary openings and the wooden framework for fixing the grills shall be provided by the air conditioning contractors. The location of these outlets/ inlets is subject to change and the approval of the Engineer-in-Charge shall be obtained before finally fixing the grills/ diffusers in position.
- ii) In installing fresh air intakes, no fixing device shall be visible from the face of the frame. Where louvers are to be fixed in masonry or concrete, fixing shall be with either expanding

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- plugs or raw plugs. Where the louvers are to be fixed in steel or wood, non-ferrous screws or bolts shall be used.
- iii) Supply air outlets and return air intakes shall be anodized / powder coated aluminium to the desired colour to match the surroundings wall/ceiling. The fresh air intakes shall be anodized/ powder coated aluminum as approved by Engineer-in-Charge. The paint colour shall be approved by the Engineer-in-Charge.
 - iv) All damages to the finish of the structure during the installation work shall be made good by the air-conditioning contractor before handing over the installation to the department.

1.6: **BALANCING**

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. 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.

1.7: **MEASUREMENT**

- i) Duct measurements (for insulated ducts) shall be taken before application of insulation.
- ii) Ductwork shall be measured section wise on the basis of external surface area by multiplying the axial length from flanged 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 external of ducts shall include all wastage allowances, flanges, gaskets for joints, vibrations isolators, bracings, hangers and supports, inspection chambers/access panels, splitter dampers with quadrants and levers for position indication, turning vanes, straightening vanes, and all others accessories required to complete duct installation as per the specifications. These accessories shall not be separately measured.
- v) Grills 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 diffuser 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 air flow. Quoted rate 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.

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T-7 : WATER PIPING WORK

SCOPE

This chapter covers the requirements of plumbing work in chilled water, hot water, water in condenser circuit and drains, to be executed as part of heating, ventilating and air conditioning.

PIPING DESIGN

Pipe size shown in tender documents is 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 air-conditioning contractor shall conform to the following.

- i) Water velocities in pipes not exceed **2.5m/sec**.
- ii) Butterfly/ ball valves shall be provide 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. (Except AHUs, FCUs).
 - d. Inlet & outlet of every heat exchange coil, namely for AHU's, convertor etc.
- iii) Non-return valve shall be provided at the delivery of each pump. This shall be of swing check type.
- iv) Balancing valve shall be provided at the outlet side of the chiller, condenser, heating and cooling coils to regulate the maximum flow rate up to value present as desired.
- v) Balancing valve shall be provided, where specified, for AHUs to regulate the maximum flow rate up to a value preset as desired. A mercury monometer 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 up to 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 Engineer-in-Charge before the execution of the plumbing work.

PIPE MATERIALS

Pipes shall be of the following materials.

- a) Mild steel Heavy "C" class (Black steel) tube conforming to IS: 1239 for sizes up to 150 mm.

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- b) 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 up to 350 mm dia. & from minimum 6 mm thick M.S. sheet for pipes of 400 mm dia. & above. Pipes above 400 Dia shall be spiral welded pipes of minimum 7 mm wall thickness.

PIPE JOINTS

Joints in black steel pipes shall be of any of the following types.

- a) Screwed joints and union joints screwed to pipes, up to 25 mm size.
- b) Butt welded joints for pipes sizes above 25 mm. Electric welding shall be used for sizes 100mm and above.
- c) 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.

VALVES

- i) The material of butter fly valves shall be as under:
- | | |
|--------|-------------------------------------|
| Body | - Cast Iron |
| DISC | - Stainless steel. |
| Seat | - Either integral or Nitrile rubber |
| O-ring | - Nitrile Rubber |

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 up to 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 up to 65mm, flanged ends shall be provided for large sizes.

iv) Air valves shall be of gunmetal body.

STRAINERS

- i) Strainers shall be of Y type or Pot Type as specified. Y-Strainers shall be provided on the inlet side of each air-handling unit and pump in chilled water and condenser water circuit. 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 refrigerant plant room, as an alternate to individual Y type strainers with pumps. The strainers shall be designed of the test pressure specified for the gate valves. Filtration area of Y strainer shall be minimum four times the connecting pipe size.

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ii) They shall be provided with equal size isolating gate valve on either side so that the strainers may be cleaned without draining the system.

iii) Pot strainers 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 (mm)
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

iv) Strainers shall have a removable Bronze / stainless steel minimum 1mm thick screen with 3 mm perforations and permanent magnet. Strainers shall be provided with flanges or threaded sockets as required. They shall be designed so to enable blowing out accumulated dirt and facilitate removable and replacement of screen without disconnection of the main pipe.

CHECK VALVES

Valves upto 600 mm dia. shall conform to IS 5312 Part 1 & above to IS: 5312 Part 2. Valves shall be in graded DI with metal to metal (IS 318 Gr. LTB 2) seating; SS AISI 410 stub pins & slant seat design. Valves above ø600 mm must be of multi – door design with doors having minimum two integral lugs for hinging of the door. Valves ø50 and above shall be rated PN 1.0 / PN 1.6 (as per final design & BOQ) and flanges faced and drilled as per IS 1538 Table 4 & 6 / IS 9523 / BS EN 1092-2. Shall be coated internally and externally with epoxy liquid coating (minimum DFT 250 micron) – Shade: BLUE (RAL 5005/ 5015)

Component	Material of construction
Body / Door (&Diaphragm)	Ductile Iron IS 1865 Gr. 400/15 or 500/7
Hinge pin (single door) / Stub pin (multidoor type)	SS AISI 410
Seat & Face rings	Soft seated upto 300 mm. 350 mm and above: Gun metal : IS 318 Gr. LTB 2
Rivets	Soft annealed brass
Fasteners	Carbon steel
Flange Drilling	IS 1538 Table 4 & 6/ BS En 1092 - 2
PN	10 / 16
By – pass arrangement	Optional

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Component	Material of construction
Hydro-test	Seat: 10 / 16 Kg/cm ² ; Body: 15 / 24 Kg/cm ²

COMBINATION AUTOMATIC AIR VALVE - SINGLE CHAMBER TYPE

Air valve for clean, cold potable water up to 50°C

PN 10 / 16

DN 80 - 200

Single-chamber valve - automatic operation with water.

Two-orifice venting system with 3 functions (supply and release of air as well as automatic venting during operation)

Flange connection dimensions to EN 1092 / IS 1538 Table 4 & 6

Body and Cover made of Ductile Iron IS 1865 Gr. 400 / 15

Inner parts made of stainless steel grade 304

Seal made of EPDM

Corrosion protection:

Inside and outside with epoxy coating; thickness >250 µm, colour: RAL 5005 blue

Accessories: Must have a resilient seated gate valves (description as above for Sluice Valves upto 300 mm) of same diameter for isolation purpose, complete with gasket and fasteners (steel galvanized)

BUTTERFLY VALVE (GENERAL PURPOSE)

Upto 200 mm ø

Flangeless wafer butterfly valve meeting the following –

Bi – directional shut off valve

PN 10 / 16

Cast Iron body with fully vulcanized liner seat preventing corrosion between liner and body

Disc in SS CF8

For manual operation: Lever upto 200 ø; above with Worm Gear box

Suitable for easy installation between all kinds of flanges – IS, BS

No need of separate gasket for installation

Motorised operation with Single / Three Phase electrical actuator.

250 and above

The butterfly valves shall generally conform to BS EN 593, with length over flanges as per Double flanged Short (BS EN 593 / BS EN 558 / ISO 5752 Basic Series 13).

Component	Material of construction
Body / Disc	Ductile Iron GGG 40 / IS 1865 Gr. 400/15 or 500/7
Stub Shafts	SS AISI 431
Bearings	Steel backed Teflon (co-efficient of bearing friction not more than 0.1)
Body seat	Integral (Monel 60) Ni – Cu alloy weld deposited, micro finished
Disc seal	EPDM

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Disc seal retaining ring	SS 304 / Ductile iron
Shaft seal	Halprene
Internal Fasteners	SS
Flange Drilling	BS EN 1092 - 2
PN	10 / 16

Mandatory accessories:	
Enclosed worm gear box with additional spur gear boxes, if required	Required: CI/DI with IP 54 protection; Make - MASTERGEAR INDIA / AUMA
Mechanical Position Indicator	Yes
Limit stops	Yes
Operation	Manual operation by handwheel. Motorised operation by means of electrical actuator.

PAINTING & COATING: Inside and outside quoted with powder (upto 600 mm) liquid epoxy (700 mm and above); DFT not less than 250 microns. Shade: RAL Blue

General

1. Hydro – testing:

	PN 1.0	PN 1.6	Criterion
Seat test (Kg/cm ²)	10	16	Drop - tight
Body test (Kg/cm ²)	15	24	No leakage and deformation

2. Torque / Operating effort / Operating time: Manufacturer to furnish data and if required supporting calculation for review / approval.

INSTRUMENTS

- i) Pressure gauge of appropriate range and 150mm Diameter size shall be provided at the following locations.
 - a) Supply and return of all heat exchange equipment.
 - 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 in installed in separate wells.
- iii) Flow meter of orifice type shall be provided for measuring the flow through each condenser and chiller.

EXPANSION TANKS

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- i) Existing Expansion tanks for chilled water shall be used. The tank shall be insulated and be complete with float valve, gauge glass, drain over flow and make up connection, with gate valves and vent piping wherever required.
- ii) The piping shall be enlarged at the connection to the expansion tank to permit entrained air to separate and to be vented through the tank. The expansion tank should be located at the pump suction side at the highest point of the system.
- iii) Valves, strainers and traps must be omitted from the expansion line since these may be accidentally turned off or become plugged.

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 Engineer-in-Charge.
- ii) Air conditioning contractor shall utilize the structural provisions for Air-conditioning 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 expansive 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 taken of the walls of the main pipe shall not be resorted to.
- v) Wherever reduces are to be made in horizontal runs, eccentric reduces shall be used if the piping is to drain freely, in other locations, concentric reduces 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 fitting shall be accurately cut to the required threaded in accordance with IS: 554 and burs removed before lying.
- viii) Piping installation shall be supported on or suspended from structure adequately. The conditioning shall 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 (Meters)
12 and 15	1.25
20 and 25	2.00
32, 40, 50 and 65	2.50

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80, 100 and 125	2.50
150 and above	3.00

Extra support 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 rawl plugs or approved shear fasteners.

- x) Insulated piping shall be supported such a manner as not to put undue pressure on the insulation.
- xi) Anti-vibration pads, springs or liners of resilient non-deteriorating, material shall be provided at each support, so as 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 retaining rings.
- xiii) a) 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 12mm thick rubber pad or any other resilient material as approved by the Engineer-in-Charge.

b) The space in the floor cut outs around the pipe work (after insulation where applicable) shall be closed using cement concrete (1-2-4 mix) or steel sheets, 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.
- c) Riser shall have suitable supports at the lowest point.
- xiv) Where pipes are to be buried under ground, the top of the pipes shall be not less than 75cms. from the ground level. Where this is not practicable permission of the Engineer-in-Charge shall be obtained for burying the pipes at laser 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 side of work by the air conditioning contractors.
- xv) All pipes and their steel supports shall be thoroughly cleaned and given one primer coat of zinc chromate before being installed.
- xvi) After all the water piping has been installed, pressure tested as per standard. 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 installed pipe work, valves etc. the direction of flow of fluid in the pipes shall be indicated with identifying arrows.
- xvii) 3 mm gasket shall be used for flanged joints.
- xviii) 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.

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PRESSURE TESTING

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 the ring the testing shall be rectified to the satisfaction of the engineer-in-Charge.

Piping repaired subsequent to the above pressure test shall be re-tested in the same manner.

System may be tested in sections and such sections shall be securely capped.

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 flows, walls, etc. as required.

Insulation shall be applied to piping only after the completion of the pressure testing to the satisfaction of the Engineer-in-Charge.

Pressure gauge may be capped off during pressure testing of the installation.

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.

BALANCING

After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted, or as directed.

Automatic control valves and 2-way Modulating valves shall be set for full flow condition during balancing procedure. Water circuit shall be adjusted by balancing cocks provided for balancing. This shall be permanently marked after the balancing is completed so that they can be restored to their correct positions, if disturbed.

MEASUREMENT

Measurements of the plumbing shall be on following basis.

Piping shall be measured along the centre line of installed pipes in 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.

The rates for piping shall include all wastage allowances, pipes supports, hangers, nuts and check nuts, vibrations isolators, suspension where specified or required, and any other item required completing the piping installation. None of these items will be separately measured nor paid for.

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 chapter

“Insulation Work”

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T-8: INSUALTION WORK

SCOPE

This chapter covers the requirements of thermal insulation for chilled water/hot water piping, pumps and tanks etc. This does not cover exposed roof insulation and under deck insulation work.

MATERIALS TYPES

The insulation material to be used for various applications shall be any of the following, as required:

For Insulation of water piping, pumps and tanks: Nitrile Foam (Class "O")

Nitrile Foam (Class "O" type) shall be used for Pipe Insulation like inside the A.C. plant room or exposed to outside. The Nitrile foam shall be in Sheet Form of applicable thickness and shall be factory faced with Aluminium where the pipe is installed inside false ceilings.

MATERAIL SPECIFICATIONS

The insulation material shall satisfy the flowing requirements: -

- i) Material shall be foamed Nitrile Rubber.
- ii) Material shall be Class "O" Self Extinguishing type, once coming into contact with fire. The material exposed to fire shall not drip and spread fire to other areas, and shall get charred in place.
- iii) Ozone Depleting Potential is Zero
- iv) Resistant to water transmission and Ingress.

INSULATION THICKNESS

The thickness of insulation shall be as indicated below unless specified otherwise in the tender specifications

Nitrile Foam Insulation Class O type

Application/ Use	Insulation Thickness (mm)
Pipes – 50mm and Below	19mm Thick Preformed tubes – Aluminium Faced
Pipes – 65mm and Above	19mm Thick Plain Sheet- Covered with 7mm Glass Cloth & Coated with 2 coats of Lag Coating (UL/FM Approved)
Ductwork (Exposed)	13mm Thick Plain Sheet – Covered with 7mm Glass Cloth & Coated with 2 coats of Lag Coating (UL/FM Approved)
Ductwork (Above False Ceiling)	13mm Thick sheet factory faced with Aluminium foil
Pumps/ Expansion Tank	19mm Thick Plain Sheet – Covered with 7mm Glass Cloth & Coated with 2 coats of Lag Coating (UL/FM Approved)
Chiller	19mm Thick Plain Sheet – Coated with 2 coats of Lag Coating (UL/FM Approved) and 7mm glass cloth

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APPLICATION OF INSUALTION (Ducts and Pipes)

The surface to be insulated shall be first cleaned and a coat of zinc chromate primer shall be given. The insulation shall be fixed tightly to the surface with Pidilite Adhesive. All joints shall be staggered and sealed.

The insulation shall be finished as under:

- a) Pipes installed inside covered areas above False Ceiling: The insulation over the pipe work shall be finished with Factory-Faced Aluminium foil. All joints shall be finished with 50mm wide Aluminium tape and then with 50mm wide Clear tape. The meeting ends of the sheet shall be tapered such that greater ease of connection is achievable.
- b) Pipes outside the building/ inside AHU rooms/ Chiller Plant Room: The insulation shall be of plain sheet fixed to the pipe. No interstitial gaps shall be present between Nitrile foam and pipe. The meeting ends of the sheet shall be tapered such that greater ease of connection is achievable. The joints shall be finished with Aluminium tape and Clear tape as above. After plain sheet is firmly fixed, one (1) coat of UL approved Lag Coating shall be applied such that the entire insulation surface is covered. After this the 7mm thick glass cloth shall be wound around the pipe tightly, such that the gaps in the cloth are fully covered with the lag coating. Afterwards a second coat is applied over this entire assembly, till no portion of the glass cloth is visible. This second coat is to be allowed to dry, whence it will form a rigid protective layer around the pipe and shall be impervious to sun and moisture.
- c) For All Ducts Inside AHU rooms: The insulation shall be of plain sheet fixed to EACH SIDE OF THE DUCT. The edges shall be suitably tapered to achieve proper sealing.. The joints shall be finished with Aluminium tape and Clear tape as above. After plain sheet is firmly fixed, one (1) coat of UL approved Lag Coating shall be applied such that the entire insulation surface is covered. After this the 7mm thick glass cloth shall be wound around the duct surface tightly, such that the gaps in the cloth are fully covered with the lag coating. Afterwards a second coat is applied over this entire assembly, till no portion of the glass cloth is visible. This second coat is to be allowed to dry, whence it will form a rigid protective layer around the pipe and shall be impervious to sun and moisture.
- d) All Valves and fittings shall be insulated per points "a" or "b" as per their location above false ceiling or in AHU rooms/ outside etc.
- e) Pumps etc shall be insulated by cutting custom sections from sheet to match the profile of the pump casing.

MEASUREMENT OF INSUALTION

Pipe insulation shall be measured in units of length along the centre line of the insulated pipe. The linear measurement shall be taken before the application of the installation. For piping measurements, all valves, orifice plates and strainers shall be considered strictly by linear measurement along the centre line of the, and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

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T-9 CONTROLS

1) Scope

This chapter covers the requirement of equipment safety controls, refrigerant flow controls, system control and variable speed drive (VFD). For chilling units all the controls shall be microprocessor based.

1.2 Equipment safety controls

1.2.1 Compressor:

a) **Compressor shall be provided with the following safety controls: -**

- i) High discharge pressure (HP) safety (cut out) to stop the compressor automatically, in case discharge pressure exceeds a pre-set safe value. This safety shall operate when discharge head pressure exceeds the set point. Only manual resetting shall be provided for this safety.
- ii) Low suction pressure (LP) safety (Cut-out) to stop the compressor automatically, in case suction pressure falls below the pre-set value. This safety shall operate when the suction pressure falls below the set point. Automatic resetting shall be provided for this safety, with adjustable cut-in cut-out pressures. This safety shall be used for pumping down the system for shutting off the refrigerant plant.
- iii) Oil pressure (O.P) safety (Cut-outs) to stop the compressor, in case lubricating oil pressure falls below the set value. A time delay mechanism shall also be provided, so as to permit running of the compressor up to a maximum period of 90 seconds, with the oil pressure differential below the set value and allow it to continue normal operation if the pressure differential builds up to the set value within that time, or otherwise shut down the compressor. Only manual resetting shall be provided for this safety.
- iv) Time delay mechanism on the starting gear to limit short cycling regardless of malfunctioning of controls.
The cut outs (i) to (iv) mentioned above shall operate when the respective controlled variable crosses the set point to trip the compressor. Audiovisual alarm shall be provided to indicate such operations. A manual reset shall be provided for them.
- v) Safeties mentioned above shall operate when respective controlled variable crosses the set point to trip the compressor.
- vi) Audio visual alarm shall also be provided to indicate such operations.

1.2.2 Condenser

The safety control for a condenser shall comprise a safety pressure relief valve on the shell. This shall operate to relieve the pressure at the set point without prior leakage. For small condensers, a fusible plug may be provided to melt a predetermined temperature.

1.2.3 Chiller

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- i) Antifreeze shall be provided with water chiller, set at a few degrees above the freezing point. This shall operate temperature of water in the chiller falls below the set point to trip the compressor motor. The reset provided for the safety shall be manual.
 - ii) Flooded type of chiller in addition, shall be provided with safety pressure relief valve.

1.2.4 Refrigeration Plant

- i) In addition to the safety controls as above for the individual components of a refrigeration plant, the following safety control shall also be provided for the plant.
 - a) Compressor motor over current cutout.
 - b) Condenser water flow switch.
 - c) Chilled water flow switch.
- ii) The above controls, on operation, shall trip the compressor motor and these shall be provided with manual reset arrangement.
- iii) The compressor motor shall also be interlocked electrically with,
 - i) Condenser water pump in case of water-cooled condenser, and condenser fan with air-cooled condensers.
 - ii) Chilled water pump in case of chilled water system and evaporator fan in case of direct expansion system, and
 - iii) Antifreeze thermostat in case of chillers.
- iv) Indicating lamps shall also be provided on the control panel for indicating operation of the safeties and interlocks.

1.2.5 REFRIGERANT FLOW CONTROLS

As per Manufacturer's standard.

1.2.6 SYSTEM CONTROLS

- i) The requirement for maintaining the inside design conditions as specified in the tender specification for the work shall be met by appropriate system controls and control elements. The system shall satisfy the requirements of both full load and partial load conditions. The tenderer in the tender shall indicate details of complete control elements.
- ii) For cooling applications in plant, controls shall be affected by 2 way flow control valve in chilled water coil.
- iii) The size of 2 way diverting/throttling valves shall be selected so as to match the coil wherein the flow is to be regulated. The make and size shall be indicated in the technical particulars in the tender.
- iv) Operation of the modulating motor 2 way flow control valve in the chilled water coil shall be controlled by programmable thermostat. The programmable thermostat should be housed in a separate glass fronted electrical panel located in the AHU room.
- v) One snap acting humidistat shall be provided for Reheat HW coils for each AHU in the Creep Bay AHU Room.

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1.2.7 OPERATIONAL CONTROL AND INTER LOCKS

- i) The operation of refrigeration plant shall be either manual or automatic, as specified. The plant shall be started by an ON/ OFF switch. Additionally, in the case of an automatic plant, an auto/Manual switch shall also be provided.
- ii) The automatic operation shall be offered through the monitoring of return chilled water temperature, or the room conditions, as case may be. Change over from one operating unit to another shall be manual.
- iii) Pump down shut down shall be provided through low pressure (LP) safety irrespective of the status switch position Auto/manual.
- iv) It should be possible to start the compressor motor only after the cooling tower fan motor, chilled water and condenser water pumps are operated.
- v) The compressor shall be able to be started or run; only after all the safeties as per Para 1.2 are satisfied.
- vi) Provision to cut off the power supply of AHU on receipt of a signal from the fire alarm system to be kept.

CONTROLS SCHEME

1.2.8 CONTROLS SCHEME

1. Maintaining DBT in LABS.

IN SUMMER/MONSOON:

Chilled water flows thru 4 Row CHW Coil. There will be a 2 way flow control valve with each AHU. A DB sensor will be installed in the exhaust duct passing thru the AHU room. The sensor transmits the signal to a programmable thermostat mounted within the AHU room. The controller commands the 24 volt actuator motor of the control valve to modulate and open commensurate with the load. On rise of space DB temperature more CHW will flow into the Cooling Coil and vice-versa.

IN WINTER:

The screw chillers and CHW flow is not working.

2. RH Control in Labs (Summer/Monsoon)

The tolerance band for Labs Rh is quite large, namely $55\% \pm 5\%$ Rh. It is proposed "Not to use heaters" for Rh control (either using Electric duct heaters or thru Hot Water Generator) as this is really wasteful.

The Chillers are working at near to full load in summer and specially in Monsoon due to 100 % fresh air operation. Thus warm water at about $(34-36)^{\circ}\text{C}$ is available at condenser outlet. Part of this water shall be pumped by the fixed speed HW pump to the 2 Row heating Coil. This reheating of air after the cooling coil will result in reduction in % Rh of space.

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There will be an RH Sensor in the AHU Room next to the Fire Dampers. This humidistat will give command to the HW pump to start and divert warm condenser water from going to the Cooling Tower and flow through the 2-Row Reheat coil.

3. Chilled Water Flow Control

Variable Frequency Drive (VFDs) for controlling the chilled water flow rate in the secondary circuit shall be provided. Requirement and specifications of VFD system shall be as follows:

The VFD system shall function to supply variable chilled water flow in the secondary circuit of air conditioning system in response to the load variations including that due to variations in ambient conditions to maintain the inside designed temperature conditions. However, under any circumstances the secondary chilled water pump speed shall not fall below the 30 % of the nominal speed or any other suitable minimum speed as per the system requirement. The VFD shall have the provision to switch over to the **manual mode** as and when required and facility for the manual speed variation from VFD itself. The system shall comprise of dedicated Variable Speed Drives (VFDs) designed for HVAC applications to accept two feedback signals (from differential pressure transmitters installed across the **Creep testing AHUs** of the zone to select either maximum of the two or average of the two (as recommended by pump manufacturer) feedback signals using HVAC terminology, to regulate the speed of the secondary chilled water pump motors in response to the load variations. In case, any additional sensor (S) including wiring etc. if required to meet the system requirements the cost of that shall be deemed to be included in the cost of the VFD. The VFD shall have:

- a) RFI (Radio frequency interference) filters for EMC (Electro Magnetic Compatibility) compliance.
- b) Voltage vector control technology to generate advanced sinusoidal output voltage, 100% true RMS value of the fundamental voltage at rated speed and nominal torque, cause no motor de-ration, and keep motor temperature limits within permissible class B limits.
- c) The VFDs shall have D.C. link rectors/harmonic filters integrated to minimise power line harmonics. There shall be reactors in both the positive and negative rails.
- d) An automatic energy optimisation feature shall be provided as standard in the frequency converter. This feature shall reduce output voltage, further to quadratic V/f characteristics, when the motor is lightly loaded and minimise the motor losses.
- e) The VFDs shall be able to provide full rated output continuously, 110% of rated current for 60 seconds and 160% torque for up to 5 seconds (for high inertia and high friction load).
- f) The VFD shall include Automatic Motor Adaptation (AMA) to optimize motor performance, improve start capabilities and compensate for motor cable variances. The AMA shall be carried out and motor stand still with no need for detaching the pump from motor.
- g) Unlimited output power circuit switching must be possible without the need for central circuit interlocking and without causing damage to the VFD.

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- h) Auto-derating of maximum drive current shall be incorporated in VFD to allow continued operation at reduced speed in case of VFD over temperature phase loss or mains imbalance without damaging the VFD.
 - i) Displays in users friendly Alpha Numeric Characters for all operating parameters, programming parameters, fault.
 - j) Built in energy meter.
 - k) In run time counter.
 - l) Local control panel (key pad)

The system shall also comprise a suitable PLC if required, with electric components.

VFD shall be designed, with built-in PID controller, control panel ((keypads & display), IP 20 enclosure for use on standard centrifugal pumps. The VFDs should not cause any de-ration of the connected motors and must ensure that class B temperatures levels of the connected motors are never exceeded. The display should be in alphanumeric characters and programming facility should be in user-friendly HVAC terminology. The VFDs shall be able to accept up to two-feedback signal from differential pressure transmitters simultaneously and to program set points it.

The system shall have following features incorporated: -

- a) Heat sink over temperature protection.
- b) Under voltage protection.
- c) Over voltage protection.
- d) Protections against input transients, loss of A.C. line phase, short circuit, ground fault, frequency converter over temperature.
- e) Alphanumeric display facilities.
- f) ON indication.
- g) Trip indication.
- h) Selectable display of various parameters like output line voltage, output frequency, speed, power, motor temperature percentage, heat sink temperature, VFD temperature percentage, KWH, hours run, differential pressure.
- i) Raise and lower speed push button in local mode.
- j) Frequency range variation from 0 to 50 Hz.
- k) Remote start and stop facility including indications thereof with necessary hardware and terminal blocks, including toggle switch etc. for over ride of remote start & stop of at the time of maintenance/ repairs.
- l) Safeguard facility against single phasing.

Where buildings management system and air quantity flow quantity flow control / chilled water flow control through VFD are provided for same application, control panel for sequencing of VFD shall not be required.

Note: In this project BMS system is not considered.

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T-10: ELECTRICAL WORK

SCOPE

This chapter covers the requirements for the electrical works associated with heating, air conditioning, ventilation and cold room applications, namely, switch boards, power cabling, control wiring, earthing, p. f. Capacitors and remote control-cum-indicating panels. Electric motors are not covered here, as these are covered as part of the respective equipment specifications.

GENERAL

- i) Unless otherwise specified in the tender specifications, all equipments and materials for electrical works shall be suitable for continuous on 415 V/ 240 V \pm 10% (3 phase / signal phase), 50 Hz. Ac system. Where the use of high voltage equipments is specified in particular works, all the respective equipments shall be suitable for continuous operation on such specified high voltage.
- ii) All electrical works shall be carried out complying with the Indian Electricity rules, 1956 as amended to date.
- iii) All parts of electrical works shall be carried out as per appropriate CPWD General Specifications for electrical works, namely, Part I (internal) 1994, part II (external) 1994 work, and Part IV (Sub-station), 1982 all as amended to date.
- iv) All material and components used shall conform to the relevant IS specifications amended to date.

SWITCH BOARDS

- i) The main switchboard in the A.C. plant room shall be floor mounted free standing cubical type and shall be factory built fabricated by on the reputed switch board manufacturer. It shall be suitable for termination of the incoming cable (s) / bus trunking from top/ bottom. The switch board in air handling unit (AHU) rooms shall be wall mounted, or floor mounted as feasible at site and as approved by the Engineer-in-Charge, but they shall be cubical design, unless otherwise specified and open able from front.
- ii) The capacity of switchgear, starters etc. shall be suitable for the requirements of loads fed/ controlled. Starting currents shall be duly considered in case of motor loads.
- iii) MCCB shall be used for all feeders lower than 630Amps. ACB shall be used for 630 A and above ratings.
- iv) Electrical panel controlling motors shall house starters for motors, unless otherwise specified. Independent single phasing preventers for each such starter shall be provided. The starter and SPP shall be located adjacent to the controlling gear.
- v) One-volt meter with selector switch, a set of indicating lamps and fuses for voltmeter and lamps shall be provided at each switchboard. One ammeter with CTS and selector switch shall be provided with each motor starter. Instruments shall be flush mounted with the panel and have glass index not higher than 1.5. The instruments and accessories shall be provided whether or not specifically indicated in the tender specifications.
- vi) The fabrication of switchboard shall be taken up only after the drawings for the fabrication of the same are approved by the Engineer-in-Charge.
- vii) Switchboards shall be fabricated as specifications indicated in sub-para above.

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- viii) The layout of bus bars and cable alleys shall be designed for convenient connections and inter-connections with the various switchgear. Connections from individual compartments to cable alleys shall be such as not to shut down healthy circuit in the event of maintenance work becomes necessary on a defective circuit.
- ix) Care shall be taken to provide adequate clearance between phase bus bars as well as between phase bus bars, neutral and earth.
- x) Where terminations are done on the bus bars by drilling holes therein, extra cross section shall be provided for the bus bars. Alternately, terminations may be made by clamping.
- xi) Provision shall be made for proper termination of cables at the switchboards such that there is no strain either on the cables, or on the terminators. Cables connected to the upper tiers shall be duly clamped within the switchboard.
- xii) Identifications shall be provided against each switchgear and starter compartment, using plastic engraved labels.
- xiii) Metallic danger board conforming to relevant IS shall be fixed on each electrical switchboard.
- xiv) Switchboard housing only isolators near cooling towers shall be housed in weather proof enclosure. The mounting arrangement shall be as approved by the Engineer-in-Charge to suit the site conditions.

POWER CABLING

- i) Unless otherwise specified, the power cable shall be XLPE insulated, PVC outer sheathed aluminium conductor, armoured cables rated for 1100 V grade. The power cables shall be of 2 cores for single phase, 4 cores for sizes up to and including 25 sq.mm, 3-½ core for sizes higher than 25 sq. mm for 3 phases. Where high voltage equipments are to be fed, the cables shall be rated for continuous operation at the voltage to suit the same.
- ii) Power cables shall be of sizes as indicated in the tender specifications. In all other cases, the sizes shall be as approved by the Engineer-in-Charge, after taking in to consideration the load, the length of cabling and the type of load.
- iii) Cables shall be laid in suitable metallic trays suspended from ceiling, or mounted on walls, or laid directly in ground or clamped on structures, as may be required. Cable ducts shall not be provided in plant rooms. Cable trays shall be fabricated from slotted angle/solid angles to make ladder type cable tray, design with adequate dimensions for proper heat dissipation and also access to the cables. Alternatively, cable trays may be of steel sheet with adequate structural strength and rigidity, with necessary ventilation holes therein. In both the cases, necessary supports and suspenders shall be provided by the air conditioning contractor as required.
- iv) Cable laying work shall be carried out in accordance with Para Power cabling III above. The scope of work for the air-conditioning contractor shall include making trenches in ground in refilling as required, but excludes any masonry trenches for the cable work.

CONTROL WIRING

- i) Control wiring in the plant rooms and AHU rooms shall be done using ISI marked PVC insulated and PVC sheathed, 1.5 sq. mm copper conductor, 250 V grades, cables drawn in ISI marked sheet or PVC conduits. Alternatively, armoured multi-core copper conductor cable may also be used for the purpose. The control cables interconnecting the plant room and the AHU room shall be of multi-core armoured type only, and suitable for laying direct in ground.

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- ii) The number of size of the control cables shall be such as to suit the control system design adopted by the air conditioning contractor.
 - iii) ISI marked steel conduit pipes, wherever used, shall be of gauge not less than 1.6 mm thick for conduits up to 32 mm dia and not less than 2.0 mm thick for higher sizes. All conduits accessories shall be threaded type with substantial wall thickness.
 - iv) Control cables shall be of adequate cross section to restrict the voltage drop.
 - v) In the case of control wires drawn through steel conduits, the wire drawing capacity of conduits as specified under the CPWD general specifications for electrical work (Part I) 1994 shall not be exceeded.
 - vi) Runs of control wires within the switchboard shall be neatly bunched and suitably supported / clamped. Means shall be provided for easy identification of the control wires.
 - vii) Control wiring shall correspond to the circuitry / sequence of operations and interlocks approved by Engineer-in-Charge.

EARTHING (GI Earthing shall be used in this case)

- i) Provision of earth electrodes and the type of earthing shall be as specified in the tender specifications.
- ii) The earth work shall be carried out in conformity with CPWD Specifications for electrical works (Part I), internal 1994.
- iii) Metallic body of all medium voltage equipments and switch boards shall be connected by separate and distinct earth conductors to the earth stations of the installations, loping of such body earth contractors is acceptable from one equipment, or switch board to another.
- iv) G.I. plate earthing shall be provided for PTAC plants and reciprocating central AC plants up to 100 TR capacities. Above 100 TR reciprocation units and centrifugal/ screw chilling units copper plate earthing shall be provided.
- v) The size of earth conductors for body earthing of equipments shall be as under:

Motor/ Equipment Size	Earthing Type and Quantity Required
Motors up to and including 10HP rating	2 Nos. 3 mm dia copper wire/ 2 nos. 4 mm dia GI wire
12.5 HP to 40 HP	2 Nos. 4 mm dia copper wire/ 2 nos. 6mm dia GI wire
50 HP to 75 HP strip	2 Nos. 6mm dia copper wire/ 2 nos. 25x3mm GI
Above 75 HP	2 Nos. 25mmx3mm copper strip/ 2 nos. 25x6mm GI Strip
Switch Boards with Incoming Rating up to	
100A Rating	2 Nos. 3mm dia. copper wire/ 2 nos. 4mm dia GI wire
125 A to 200 A Rating	2 Nos. 6mm dia copper wire/ 2 nos. 25x3mm GI strip
Above 200A Rating	2 Nos. 25mmx3mm copper strip/2 nos. 25x6 mm GI strip.

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- vi) Armouring of cables shall be connected to the body of the equipments/ switchboard at both the ends. Compression type glands shall be used for all such terminations in the case PVC cables.

REMOTE CONTROL CUM INDICATING PANEL

- i) The remote control cum indicating panel shall be provided in the plant room. This panel shall have necessary push buttons for on and off controls and status indication of all electric motors except for small motors as of humidifiers of AHUs and FCUs.
- ii) In view of (i) above, push buttons' need not be provide as part of the starters in the switch boards, except of the AHU blower motors. In the case of the AHU blower motors, push buttons' shall be provided as part of the starters for local on and off operations.
- iii) Back indication to show the status of operation of all the motors (except small motors as in humidifiers of AHUs and FCUs) and also of the electric strip heaters (AHU wise) shall be provided.
- iv) Panel shall be fabricated from 1.6mm thick steel sheet. This shall be of freestanding floor mounting type design. This shall be complete with necessary termination arrangements, multicore cables, tag blocks, control transformer, designation plastic, double earth studs etc. as required.

MOTOR STARTER

- i) The motor starter shall conform to IS 1822 "Motor starters of voltage not exceeding 1000 volts" and shall be air insulated and suitable for 415 volts, $\pm 10\%$, 50 Hz. 3 phase AC supply. Enclosures shall have protection of IP 52 for indoor applications and IP 55 for outdoor applications.
- ii) Starter for the motor shall be direct on line (D.O.L.) for motors up to and including 7.5 HP rating and automatic star-delta close transition type for motors of higher ratings unless otherwise specified in the tender specifications. Starters shall be rated for intermittent duty. Starting current should not exceed two times the full load current.
- iii) The starter chiller shall be mounted on the main electrical control panel/ unit mounted/ self mounted as specified.
- iv) Each starter shall be provided with the following protections.
 - a) Thermal overload on all the three phase with adjustable settings,
 - b) Under voltage protection, and
 - c) Independent single phasing preventer. (Current sensing type)
- v) Adequate number of extra NO/ NC contacts for interlocks, indicating lamp etc. shall be provided on the starter/ contactor.
- vi) The Screw chiller will have its own closed transition star Delta starter.

PAINTING

All panels shall be supplied with the manufacturer standard finish painting or as indicated in the schedule of work.

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T-11: SPECIFICATION FOR 84RC GI Strip Ceiling System

PANEL:

84C linear G.I/CRCA false ceiling with all necessary fittings and fixtures.

Detailed Specification: 84C- off white consisting of panel made of enameled coil coated 0.6mm thick CRCA allot; 84mm wide and 12.5mm deep with a recessed flanged of 23.9mm of approved colour; panel carriers made pf enameled 0.6mm thick sheet blank satin; 32mm wide x 39mm deep with cut outs to hold panels in a module of 100mm with edge cover at the edges; and cut-outs for light fittings and ventilation grill suspended from ceiling as per direction of the manufacturer including supplying & fixing all fittings and fixtures as directed by the engineer; all materials, tools; plant and labour Complete.

T-12: SPECIFICATION FOR ARMSTRONG CEILING SYSTEM

Providing and fixing in true horizontal level 600 mm. X 600 mm. false ceiling system manufactured by M/s. Armstrong World Industries using hot dipped galvanized steel section, exposed surface with pre-coated capping, main tee of size 24 x 32 mm., having 0.27 mm gauge at every 1200 mm. centre to centre maximum and rotary stitched cross tee of size 24 x 27 mm, having 0.27 mm gauge at every 600 mm. c/c. and sub cross tee of size 24 x 27 mm, having 0.25 mm gauge at 1200 mm c/c. and wall angle of size 19 x 19 mm., having 0.35 mm gauge fixed to the periphery of the wall. The above grid is suspended at every 1200mm c/c. in both directions using 2.0 mm. thick pre-straightened GI wire laying FINE FISSURED BUTT Edge ceiling tiles manufactured by M/s. Armstrong World Industries, of size 600mmx600mmx15mm having NRC 0.55, Light reflectance of >84% (WT), thermal conductivity $k = 0.052-0.057$ W/m0K, Humidity Resistance of 99% , having Fire Performance CLASS O / CLASS 1 (BS 476), surface having 3 coats of white paint with Fine Fissured, back of the tile duly sanded and finished with a coat of protective paint over the formed grid complete. Diameter (minimum) GI suspension rods & suspension clips. The maximum surface area per Suspension is approximate 1.5 m². The carrier would be suspended from the roof/truss by 4mm diameter galvanized steel wire rod hangers with height adjustment spring clips made out of galvanized spring steel OR stainless steel.

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T-13: OPERATION & ANNUAL MAINTENANCE

The section covers the maintenance schedule during guarantee period and 2 years subsequent to the guarantee period.

The maintenance provided during the warranty shall be fully comprehensive and shall include but not limited to all equipment, labour part and emergency calls providing and site response within 24 hours for rectification of breakdown. The spares parts, accessories, Refrigerant gas and other consumable etc required for the maintenance work shall be replaced by the vendor under the scope of AMC. The AMC shall cover complete Air Conditioning Plant.

The maintenance shall also include a minimum of 12 monthly preventive maintenance visits by qualified personnel who are thoroughly familiar with the type of equipment and system provided for this project.

List of equipment mentioned below is non-exhaustive. Being a Comprehensive AMC, tenderer should note that all installed systems through this tender should cover under AMC without any extra cost implication to CSIR-NML during the period.

Equipment	Interval of Service	Tasks to be Performed
<u>Chiller</u>	Monthly inspection and Service	<ol style="list-style-type: none"> 1. Check Refrigerant level, leak test with electronic leak detector. If abnormal, trace and rectify as necessary, inform department in writing on the rectification. 2. Inspect level and condition of oil. If abnormal, trace fault and rectify as necessary. Inform department in writing on the rectification. 3. Check the liquid line sight glasses for proper flow. 4. Check all operating pressure and temperature. 5. Inspect and adjust, if required, all operating safety controls. 6. Check capacity control, adjust if necessary. 7. Lubricate vane/linkage/bearings. 8. Visually inspect machine and associated components, and listen for unusual sound or noise for evidence of unusual conditions. 9. Check lock bolts and chiller spring mount. 10. Review daily operating log maintained by operating personnel of vendor. 11. Providing written report to department, outlining services carried out, adjustment made, rectification carried out and if the deficiency is of a major nature, arrange with department for shut-down to rectify equipment.
<u>Chiller</u>	Annual	<ol style="list-style-type: none"> 1. Perform all functions for monthly check. 2. Check all flanges for tightness.

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Equipment	Interval of Service	Tasks to be Performed
	inspection prior to expiry of warranty period.	<ol style="list-style-type: none"> 3. Change oil and oil sump. 4. Replace filter. 5. Check oil temperature control. 6. Check motors terminals. 7. Check connections in starter. <p>Please note that oil filter gasket replacement shall be deemed to be included in the contract.</p> <ol style="list-style-type: none"> 1. Check motor earthling, meggar motor and connection wiring on each leg. 2. Check motor temperature cut-out, tighten motor terminals. 3. Check starter contracts, arc shield and transformer. 4. Check dashpot oil, clean dashpot and replace oil when necessary. 5. Test and calibrate overload setting. 6. Inspect, calibrate and adjust to original specifications all gauges, safety and operating controls including low temperature and high pressure cutout, oil pressure switch, load limit relay and electrical interlocks. 7. For water cooled condenser systems, inspect condenser tubes for fouling. If fouling exceeds original specifications, the contractor shall carry out cleaning of the tubes at his own expense.
<u>Water pumps</u>	Monthly inspection	<ol style="list-style-type: none"> 1. Inspect all water pumps. 2. Check all seals, glands and pipelines for leaks and rectify as necessary. 3. Re-pack and adjust pump glands as necessary. 4. Check all pumps bearings and lubricate with oil or grease as necessary. 5. Check the alignment and condition of all rubber couplings between pumps and drive motors and rectify as necessary. 6. Check all bolts and nuts for tightness and tighten as necessary. Grease all pump bolts, nuts.
<u>Water pumps</u>	Annual inspection prior to expiry of warranty period.	<ol style="list-style-type: none"> 1. Perform all function for monthly checks. 2. Check motor earthling, meggar Motor and connection wiring on each leg. 3. Tighten motor terminals. 4. Check starter contracts. 5. Test and calibrate overload setting.
<u>Expansion Tank</u>	Annual inspection prior to expiry of warranty	<ol style="list-style-type: none"> 1. Inspect expansion tank, Drain, clean and flush out tanks as necessary.

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Equipment	Interval of Service	Tasks to be Performed
	period.	
<u>Air handling units and Fan coil units</u>	Monthly inspection	<ol style="list-style-type: none"> 1. Inspect all air handling and fan coil units. 2. Check all air filters and clean or change filters as necessary. 3. Check all water coils, seals and pipelines for leaks and rectify as necessary. 4. Check and re-calibrate modulating valves and controls. Adjust and rectify as necessary to ensure compliance to the original specifications. 5. Purge air from all water coils. 6. Check all fan bearings and lubricate with grease as necessary. 7. Check the tension of all belt drives and adjust as necessary. 8. Check and clean all the condensate pans, trays and drains. 9. Check measure and re-calibrate all sensors if necessary. 10. Check spring vibration isolators for abnormal vibration. Rectify if necessary 11. Coil to be cleaned by (a) spray of high-pressure clean water (not exceeding 30 psi) (b) with chemical spray, if necessary
<u>Air handling units and Fan coil units</u>	Annual inspection prior to expiry of warranty period.	<ol style="list-style-type: none"> 1. Perform all functions for monthly checks. 2. Tighten motor terminals. 3. Check starter contracts. 4. Test and calibrate overload settings.
<u>Air Distribution system</u>	Monthly and annual inspection prior to expiry of warranty period.	<ol style="list-style-type: none"> 1. Check operation of all modulating and fixed dampers controlling air flow through unit. Lubricate all damper bearings and linkages as necessary. 2. Carry out space temperature checks on air-conditioned areas with thermo hydrograph. Balance air flow as necessary to compliance with requirements of original specifications. These checks include the calibration of sensors, thermostat, etc. 3. Check noise level of discharged air from diffusers.
<u>Ventilation</u>	Monthly and annual inspection prior to expiry of warranty period.	<ol style="list-style-type: none"> 1. Check adjust as necessary the air flow of all fans are in compliance with the original specifications. 2. Check the tension of all belt drives and adjust as necessary. 3. Check and lubricate all fan bearings. 4. Tighten motor terminals. 5. Check starter contacts. 6. Test and calibrate overload settings. 7. A system check shall be carried out for all mechanical

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Equipment	Interval of Service	Tasks to be Performed
		ventilation (MV), Pressurization and Exhaust system to verify the performance of the systems.
<u>Switch Board</u>	Six-monthly and annual inspection prior to the expiry of the warranty period.	<ol style="list-style-type: none"> 1. Clean and adjust all switch gear, contactors, relays and associated electrical equipment at intervals not exceeding six months. 2. Check and prove operation of thermal over load and protection devices. 3. Check and ensure tightness of all equipment fastenings and cable terminations within switchboards. 4. Vacuum clean all switch board cubicles.
<u>Piping System</u>	Six-monthly and annual inspection prior to the expiry of the warranty period	<ol style="list-style-type: none"> 1. Check all piping system for leaks and repair these where they have occurred. 2. Check for damages & deterioration of insulation or sheathings. Rectify as necessary.
	Consumable materials	<p>The vendor shall also supply the following consumable materials as and when required: -</p> <ol style="list-style-type: none"> 1. All oils and greases required for lubrication of compressors, fan bearings, motors bearings, pivots and other moving parts. 2. All refrigerant required for topping up. Refrigerant loss if due to manufacturing defect or due to negligence shall be made good by the contractor. 3. All consumable filter elements / rolls. 4. All chemicals for the correct chemical treatment of the cooling tower and chilled water system. 5. All carbon brushes required to replace worn brushes in electric motors.' 6. All electrical contract points required to replace worn electric contact points in switchgears, motor starter gears, electrical control gears and electric relays. 7. All electric fuses required to replace blown fuses. Just before the expiry of the warranty of the contract, the contractor shall carry out a complete system operability test on all the systems or sub-systems as called for in the contract. <p>The purpose of the test is to verify that the performance of all the systems or sub-systems in the contract is in</p>

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Equipment	Interval of Service	Tasks to be Performed
		accordance to the specifications. All test shall be carried out in the presence of the NML Engineer. The warranty period is deemed to be over if the department or his representative is completely satisfied with the system Performance during the test.

Operation & Comprehensive Maintenance:

The Operation & Comprehensive Maintenance Contract (for 2years) after completion of Defect Liability Period shall cover supply of manpower for operation of AC plant, for Maintenance the contractor shall bear the full responsibility for all kind of maintenance as well as attending to all breakdown and emergency call at short notice whenever called. During this two year period the scope of annual maintenance contract includes repair and replacement of any or all the parts as required. Besides, the replenishment of all consumables shall also to be included in the scope of annual maintenance.

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(DATA SHEET)

Name of work: - Replacement of Existing (2Nos. 86TR Units) Inefficient Creep Central AC Plant with Energy Efficient Central AC Plant in CSIR-NML, Jamshedpur.

Technical Bid

Datasheets to be filled by vendors	Yes / No
1) Screw Chillers -	
2) AHU'S -	
3) FCUs (Cassette Type) -	
4) Cooling towers -	
5) Pumps -	
6) Valves, Strainers -	
7) Piping -	
8) Insulation -	
9) Filters -	
10) Sheet Metal work -	

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TECHNICAL DATA SHEET
(To be filled by Vendor)

1. SCREW TYPE CHILLER: -

Sl. No.	Name of Parameter	As Specified in NIT	(Vendor to fill) As Per Vendor
1	Manufacturer's Name / Origin (Imported)	Carrier/Voltas/Bluestar/ Daikin/Kirloskar/Hitachi	
2	Model	Vendor to Indicate	
	Compressor Type	Screw Type (Hermatic/ Semi-Hermatic)	
3	Actual output TR each machine at following condition	125TR	
4	CHILLER		
a	CHW EWT Chiller	12 °C	
b	CHW LWT Chiller	6.4 °C	
d	Flow thru Chiller (Shell and tube type)	300 USGPM	
e	Chiller fouling factor	0.0005 (FPS)	
f	Pressure drop Chiller	Maximum 15 ft.	
h	Chiller Type	Flooded	
p	No of Passes	Vendor to Select	
5	CONDENSER		
a	Condenser Fouling factor	0.001 (British Units)	
b	Condenser EWT	90 F	
c	Condenser LWT	97.5 F	
d	Condenser Flow (Approx)	480USGPM	
g	Type of Condenser	Water cooled	
h	No of Passes.	2 / 3 pass	
6	Compressor Type	Screw type Semi-Hermetic/ Hermetic	
a	Compressors per Chiller	1/ 2	
b	Circuits per chiller	1 (One) per Comp.	
7	Working Pressure Water Side (Max.)	10 Bar	
8	Working Pressure Refrigerant side (Max)	16 Bar	
9	Refrigerant	134a	
10	Refrigerant 1st charge (kg)	Vendor to write	
11	Refrigerant Material for Pipes	Vendor to write	
12	Refrigerant Pipe wall thickness	Vendor to write	
13	Type of Capacity Control.	Vendor to write	
14	No of Steps of Capacity Control	Stepless	
15	Capacity Control Range	20 % - 100%	
16	Operating Speed (Less than 3000 rpm)	Vendor to indicate	

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Sl. No.	Name of Parameter	As Specified in NIT	(Vendor to fill) As Per Vendor
17	Overall Dimension of Chilling unit Length: ----- Width: ----- Height: -----	Vendor to Indicate. (Should be accommodated in space provided)	
19	Anti vibration spring mounts part of chiller	Yes	
20	Type of Starters	Closed Transition Star Delta	
24	Whether suitable for 24 X 7 working in Hot, dusty and Humid condition.	Vendor to confirm Mandatory	
25	What is the overall machine Power factor at full load?	Vendor to indicate	
26	Gross Shipping weight.	Vendor to indicate	
27	Operating weight.	Vendor to indicate	
28	Target IKW / TR (100% load) at specified parameters.	Not More than 0.68	
29	IKW at part load.	IKW at Fixed EWT Condenser & Chiller	
	100 % Load	Vendor to indicate	
	75 % Load	Vendor to indicate	
	60 % Load	Vendor to indicate	
	50 % Load	Vendor to indicate	
	40 % Load	Vendor to indicate	
30	Vendor to confirm that Manufacturer's Engineer will conduct a capacity load test at the site for both chillers one by one		PI Confirm
31	Vendor shall submit computerized Selection sheet of chiller at specified operating conditions. This should be done along with the bid.	Vendor bid will be considered incomplete without this.	

STATE ANY OTHER ITEM NOT MENTIONED ABOVE: (Use separate page)

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2. DATA SHEET FOR AHUs: -

Use Separate Sheet for Each AHU or Make a Matrix

S.NO.	DESCRIPTION	UNIT	VALUE / DETAILS
A.	General:		
1	AHU Tag No.		
2	Manufacturer's Name		
3	Type of Unit	Floor Mounted Horizontal	
4	Model & Size		
5	Overall dimensions	mm	
6	Width		
7	Depth-length		
8	Height		
9	Type of unit	Draw Thru	
B.	Fan and Fan Motor		
1	Type of fan		
2	Make of fan		
3	Diameter	mm	
4	Type of blades (i.e., whether forward curved or backward curved or aerofoil section).		
5	Air Flow	cfm	
6	Static Pressure	mm wg	
7	Speed	RPM	
8	Motor Capacity	KW	
9	Type of motor		
10	Motor speed	RPM	
11	Fan Outlet velocity	m/s	
C.	Cooling Coil:		
(i)	Chilled Water		
1	Air flow rate	cfm	
2	Face area of cooling coil	Sqm	
3	Face velocity	mps	
4	Number of rows	Nos.	

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S.NO.	DESCRIPTION	UNIT	VALUE / DETAILS
5	Number of fins	4-5Fins per cm	
6	Fin material	Aluminium	
7	Tube material	Copper	
8	Test pressure	Kg/sqcm	
9	Pressure drop across coil (air side)	mm of WC	
10	Pressure drop across coil (water side)	M of WC	
(ii)	Hot Water Coil		
1	Air flow rate	cfm	
2	Face area of cooling coil	Sqm	
3	Face velocity	mps	
4	Number of rows	Nos.	
5	Number of fins	4-5 Fins per cm	
6	Fin material	Aluminium	
7	Tube material	Copper	
8	Test pressure	Kg/sqcm	
9	Pressure drop across coil (air side)	mm of WC	
10	Pressure drop across coil (water side)	M of WC	
D	Panels:		
1	Material and thickness of outer skin	GI	
2	Material and thickness of inner skin	GI	
3	Finish of outer skin	Pre-Coated	
4	Finish of inner skin	Plain	
5	Panel thickness	0.8mm	
6	Density of PUF	40-50 Kg/m ³	
7	Insulation material for panels	PUF	
8	Insulation material thickness for panels	40-50mm	
E	Drain Pan		
1	Material of drain pan	Aluminium	
2	Thickness of material	mm	
3	Material of insulation		
4	Thickness of insulation material		

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S.NO.	DESCRIPTION	UNIT	VALUE / DETAILS
F	Mist Eliminator		
1	Type	Bend Type	
2	Material	PVC	
G	Volume Control Damper		
1	Type	OBD	
2	Material of construction	Aluminium	
3	Suitable for motorized operation	Yes / No	
H	Accessories		
1	Marine light provided	Yes / No	
2	Belt Guard provided	Yes / No	
3	Limit switches provided	Yes / No	
4	Compression gland for cable entry at AHU	Yes / No	
5	Ports for measuring air pressure	Yes / No	
6	View window in each access door	Yes / No	
I	Special Requirements		
1	Thermal break profile	Yes / No	
2	By pass damper in AHUs	Yes / No	
3	2 Nos. fresh air damper (Normal & Fumigation / Defumigation)	Yes / No	
4	2 Nos. exhaust air damper (Normal & Fumigation / Defumigation)	Yes / No	
5	All gaskets food grade type	Yes / No	
6	Noise level at 1.5mt. Distance	Not more than 75dBA	
K	PREFILTER		
1	Manufacturer Name	Thermadyne/ Anfilco/ Spectrum	
2	Rating of Filter	90% down to 10μ	

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S.NO.	DESCRIPTION	UNIT	VALUE / DETAILS
3	Type of Medium		
4	Filter Medium	Synthetic	
5	Material of frame work and its thickness	Vendor to write	
6	Face velocity across filters	500 fpm	
7	Pressure drop across filters	Vendor to write	

3. COOLING TOWER DATA SHEET (FRP TYPE): -

S.No	Description	Specification	VENDOR TO FILL UP
1	Manufacturer	Paharpur/Advance/ MIHIR	
3	Fan or Cells per Tower	Vendor to write	
4	Type	Cross Flow/ Counter Flow	
5	Hot water Flow (each tower)	600usgpm	
6	Hot water Temp In	97.5 F	
7	Cold water out	90 F	
8	Design wet bulb	83 F	
9	Air flow type	Induced draft	
10	Type of Gear reducer & Make	Spiral Bevel (if required)	
11	Basin	Virgin FRP (Rigidly Braced)	
12	Fills	Virgin PVC	
13	Hardware	SS – 304	
14	Stack	FRP	
15	Drive shaft (If required)	SS – 304	
16	Overall Dimensions	Vendor to write	
17	No of fans	Vendor to write	
18	CFM per fan	Vendor to write	
21	Drift Loss	Vendor to write	
22	Total Water Loss	Vendor to write	
23	Approach to the Design Wet Bulb	Vendor to write	
24	Weight With Water	Vendor to write	
26	Motor KW	Vendor to write	

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S.No	Description	Specification	VENDOR TO FILL UP
27	Make of Motor	Vendor to write	

4. DATA SHEET FOR PUMP

S. NO	Description	CDW Pump	PCHW Pump	SCHW Pump (*)	HW PUMP	Vendor to Fill Up	Vendor to Fill Up	Vendor to Fill Up	Vendor to Fill Up
	Manufacturer	Kirloskar/Beacon/KSB/Mather & Platt							
	Type / Model	As per NIT	As per NIT	As per NIT	As per NIT				
	Discharge	500USGPM	320USGPM	320USGPM	150USGPM				
	Head	60 ft	50 ft	55ft	33 ft				
	Motor KW	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Efficiency	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Speed (RPM)	1450	1450	1450	1450				
	Class of Insulation	Class F	Class F	Class F	Class F				
	Current Characteristic	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Overall Dimension	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Weight (Kg)	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Size of Foundations (mm)	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Material								
	Pump Casing	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Impeller	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Type of Material of Seal	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	Type of Water Seal	Mech.	Mech.	Mech.	Mech.				
	Vibration Isolation	Vendor to write	Vendor to write	Vendor to write	Vendor to write				
	NPSH	Vendor to write	Vendor to write	Vendor to write	Vendor to write				

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	Base Frame Provided	Yes/No	Yes/No	Yes/No	Yes/No				
	Self Priming Arrangement	Yes/No	Yes/No	Yes/No	Yes/No				
	Performance Curves	Whether enclosed	Whether enclosed	Whether enclosed	Whether enclosed				

Vendors to indicate if there is a change in above parameters from the specified datasheet In case not mentioned, then it is assumed pump will be as per above data sheet.

All characteristic curves of pumps shall be provided clearly showing the operating point on the curve.

(*) Secondary CHW pumps are with VFD drive. Make Grundfoss/ITT Bell & Gosset/ Armstrong.

Please select pump makes with highest efficiency.

**5. DATA SHEET FOR VALVES / STRAINERS: -
(VENDORS TO FILL)**

SL	PARAMETER	As per NIT	VALVES	STRAINERS
1	Butterfly/ NRV / Balancing / Ball valves			
	# Material of Construction Body	CI		
	# M.O.C. Butterfly gate	SS		
	# M.O.C. Shaft	SS		
	# Suitable for pressure (kg/cm ²)	PN-10 or as noted		
	# Spring load handle provide (up to 150Ø)	YES		
	# Whether SS-416 strainer jail			

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6. DATA SHEET FOR MS PIPES

SL	PARAMETER	VENDORS TO FILL
1	Pipes manufactured to IS 1239	Yes / No
2	Pipes manufactured to IS 3589	Yes / No
3	MS Heavy class pipes used for CHW piping	Yes / No
5	All MS pipes weldable using butt joints	Yes / No
7	Pipe supports to be provided as per ISHRAE guidelines.	Yes / No

7. DATA SHEET FOR INSULATION

SL	PARAMETER	VENDOR TO FILL
	(A) DUCT EXTERIOR THERMAL INSULATION	
1.)	Material of insulation / make/ Class	
2.)	Density	
3.)	Thickness (SA / RA)	
4.)	Thickness of Aluminium facing	
6.)	Density of RBFG / Nitrile Foam	
7.)	UL/ FM Approval	Vendor to give Approval Certificate Copy
	(B) CHW PIPE INSULATION	
1.)	Material / make of insulation/ Class	
2.)	Density	
3.)	Insulation Thickness	
4.)	UL/ FM Approval	Vendor to give Approval Certificate Copy

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8. DATA SHEET FOR FILTERS

			VENDOR TO FILL
S.NO	DESCRIPTION	UNIT	VALUE /DETAILS
A.	Pre – filter (10 Micron) (EU-4)		
1	Make	As per List	
2	Type of Filter	Washable	
3	Material of Frame	GI	
4	Capacity of Filter	CFM	
5	Media of Filter	Nylon	
6	Media of sealing	Epoxy	
7	Efficiency and Particle Size.	Percentage/ Micron	
8	Washable	Yes / No	

9. DATA SHEET FOR DUCTING

			VENDOR TO FILL
S.NO	DESCRIPTION	SPECIFICATIONS	VALUE /DETAILS
A.			
1	Ducting Material	G.I	
2	Manufacturer	Jindal / Tata / SAIL (BOKARO)	
3	Whether ducting is as per IS: 655	Mandatory	
4	Zinc Galvanising	120g/m ²	

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DECLARATIONS

Name of Work: Replacement of Existing (2Nos.86TR Units) Inefficient Creep Central AC Plant with Energy Efficient Central AC Plant in CSIR-NML, Jamshedpur.

1. I/We hereby declare that I/We have read and understood the conditions of contract, scope of work, schedule of quantities etc. and hereby agrees to abide by them. In token thereof I/We also understand that otherwise this Tender is liable to be rejected.
2. I/We understand that our Tender will not be considered, if the rates for the items are not written both in FIGURE and WORDS.
3. I/We hereby confirm that only the relevant entries asked for have been made within the tender documents issued to me /us. I/We also confirm that in the event of any entry in this tender document, other than the relevant entry, shall make this tender invalid.
4. I/We hereby agree to comply with all the provisions of the applicable Labour laws and other enactments and amendments made thereto, from time to time. It shall remain exclusively and solely liable for all obligations under all applicable laws such as the contract labour (regulations & Abolition) Act,1970 the payment of wages Act, 1936, The workmen's compensation Act, 1923, the industrial disputes ACT.1947, the minimum wages act, 1948. The payment of Bonus Act, 1965, the employee's provident funds and miscellaneous provisions Act, 1952 & the Employees state insurance Act, 1948. The Fatal accident Act,& establishment Act, any other rules/by laws that are relevant or may be promulgated in this matter. I/We shall also be responsible to comply with all provisions of any other labour laws as or may be in force and applicable.
5. I/We hereby declare that my/our firm is registered for works contract tax/VAT/ Service Tax etc. as per its applicability with the respective Govt. Authority. I/We shall submit an attested copy of valid registration certificate with Engineer In-charge CSIR-NML, Jamshedpur immediately on award of work.

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LIST OF RELEVANT INDIAN STANDARDS (LATEST TO BE FOLLOWED)

- I.S. 3615 Glossary of Terms Used in refrigeration & Air Conditioning.
- I.S. 325 Three phase Induction Motors.
- I.S. 1822 Motor Starters of Voltage Not Exceeding 1000 volts
- I.S. 3624 Bourden tube Pressure and Vacuum Gauges
- I.S. 2372 Timber for Cooling Towers
- I.S. 7403 Code of practice for selection of standard worm and helical gear boxes
- I.S. 1620 Horizontal centrifugal pumps for clear, cold, fresh water
- I.S. 996 Single phase small A. C. And Universal motors.
- I.S. 1239 Mild steel tubes, tubular and other wrought steel fittings.
- I.S. 3589 Electrically welded steel pipes for water, gas and sewage.
- I.S. 6392 Steel pipe flanges
- I.S. 778 Gun metal gate, globe and check valves for general purpose.
- I.S. 2592 Recommendation for methods of measurement of fluid flow by means of orifice plates and nozzles
- I.S. 277 Galvanised Steel sheet.
- I.S. 737 Wrought aluminium and aluminium alloy sheet and strip for general engineering purpose.
- I.S. 655 Metal air ducts.
- I.S. 732 Code of practice for electrical wiring and fittings for buildings.
- I.S. 2516 A. C. Circuit breakers
- I.S. 900 Code of practice for installation and maintenance of induction motors.
- I.S. 1248 Direct acting electrical indicating instruments
- I.S. 2516 A.C. circuit breakers for voltages not exceeding 1000 volts
- I.S. 4047 Heavy duty air break switches and composite units of air break switches and fuses for voltage not exceeding 1000 volts.
- I.S. 2208 HRC cartridge fuse links up to 650 volts

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I.S. 1554 PVC insulated (heavy duty) electric cables for working voltage up to and including(PART)
1100 volts.

I.S. 8183 Specification for bonded glass wool/ mineral wool

I.S. 4671 Specification for external polystyrene for thermal insulation purposes

I.S. 11561 Code of practice for testing of cooling towers.

I.S. 7896 Data for outside design condition for air conditioning for summer months.

I.S. 8148 Packages air conditioners.

I.S. 2370 Section cold rooms (walk-in-type)

I.S. 5111 Testing of refrigerant compressors

I.S. 10594 Thermostatic Expansion Valve

ISHRAE STANDARDS

LIST OF RELEVANT INDIAN STANDARDS SAFETY CODES

I.S. 660 Safety Code for Mechanical Refrigeration.

I.S. 659 Safety Code for Air Conditioning.

I.S. 3016 Code of Practice for Fire Precautions in welding and cutting operations.

I.S. 818 Code of Practice for safety and health requirements in electrical and gas welding and cutting
Operations

I.S. 5216 Code for Safety procedure and practice in electrical works

I.S. 3696 Safety code for scaffolds and ladders

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Basis of Design

1) Introduction to Existing HVAC System in CSIR-National Metallurgical Laboratory Creep Testing Lab:

- a) The original HVAC system had 2Nos x 86 TR Reciprocating Chillers of 1973 vintage, operating with R-22 refrigerant. These chillers have been maintained well, but over time their capacity has derated due to wear and tear and loss of machined clearances. During peak summers, NML has to run both the chillers to satisfy the cooling load.
- b) There are 2 Nos Cooling towers which are still operating from the original design, but one of these towers recently had a failure of the fan assembly and several blades had to be replaced.
- c) There is not standby in this system.
- d) The temperatures in the conditioned spaces vary widely, with fluctuating temperatures in the Creep Testing lab, and non-uniform air distribution in the offices.
- e) The Air Distribution system is served by old Single skin AHU's of the same vintage as the chiller.

2) Design Data for New System:

Location: Jamshedpur, Jharkhand at 22.5°N Latitude

Ambient: Summer (DB-43.3°C/ WB-25.6°C)/ Monsoon (DB-32.2/ WB-28.3)

Design: As per ISHRAE Handbook 1997

Glass: Single Pane No Shade/ No Storm Windows

Wall Construction: Dark Coloured walls of construction 100 lb/ ft².

Roof Construction: Exposed to Sun of construction 60 lb/ ft².

Correction Factors to Equivalent Temperature Difference: 35°F temperature difference (Indoor-Outdoor) and 20°F daily range.

Load: Peak Load at 4pm Local Sun time, All Motor Load to Airstream

Outside Air Requirement is about 20 cfm/ Person in Offices and 5 cfm per Person in Auditorium/ 7.5 cfm per Person in Lecture Hall

3) System Design:

The following paras to be read in conjunction with the attached set of drawings, for complete understanding.

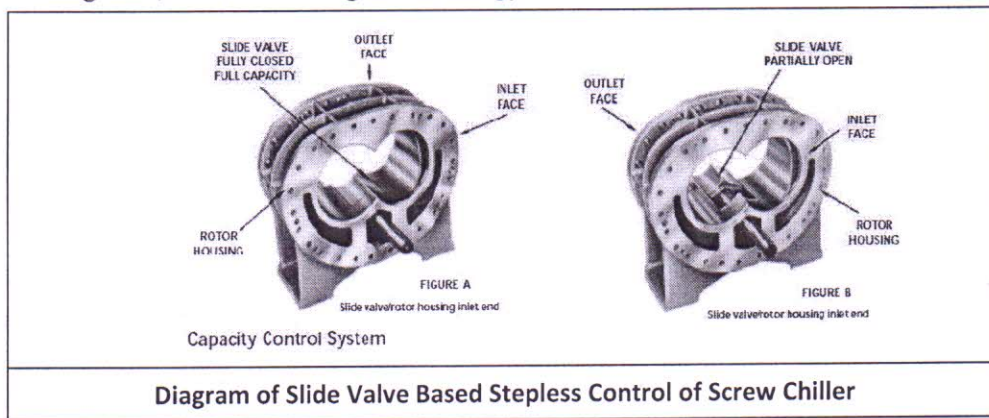
a) Chillers:

Two (2) Nos Screw chillers are to be installed to replace the existing chillers. Each chiller will be served by one (1) compressor with a Flooded Evaporator (water in tubes/refrigerant in shell) and Condenser, both of shell and tube type.

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The chiller will be factory assembled and run-tested and can be directly mounted on foundations. In the capacity range, this configuration is the most efficient. Chillers will be sized at Indian Fouling factors where the worst case scenarios are anticipated.

Capacity Control of Chiller: Screw Chillers have stepless capacity control (From 25-100% of full load), where the compressor is unloaded as per real time sensing of the Chilled Water Return (CHWR) Temperature. A "Slide Valve" mechanism is built into the housing of the compressor itself. When CHWR Temperature starts to get lower (lower ΔT across the chiller meaning lower load on the chiller), the Slide Valve opens and exposes a section of the Rotor Housing and causes Refrigerant gas to return towards the suction port of the compressor. This Return of the refrigerant gas to the compressor suction port consumes negligible energy and the energy savings are realized by the compressor processing lesser amount of refrigerant, thus consuming lesser energy.



b) Plant Capacity:

The AC plant is to be designed with 100% standby. The entire load of the spaces (Creep Testing Lab, Mezzanine Floor, and Director Floor) is to be borne by one (1) chiller operating at full load. The chiller will operate at Part Load during night/evening hours when the Creep Testing Labs are operating, but the office spaces are not. The heat load calculations call for a load of 122 TR at full load, thus a chiller with capacity of at least 125TR should be accepted. The Chiller capacity will be at Constant Entering Condenser Water Temperature (**andnot at AHRI Conditions**).

For Condenser Cooling Water:

Peak Operating Tonnage – 1 x 125 TR = 125 TR
Water Flow - @ 4 USGPM per TR
Therefore, Peak Flow Rate = 4 x 125 = 500 USGPM

For Chilled Water Flow:

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Peak Operating Tonnage – 1 x 125 TR = 125 TR

Water Flow - @ 2.56 USGPM per TR

Therefore, Peak Flow Rate = 2.56x 125 = 320 USGPM (Minimum)

To provide Chilled Water flow as per variable load on the system, a primary-secondary pumping system shall be used. The primary pumps shall be sized to overcome Chiller Pressure drop, and the valves of the pumps and that of the Chilled Water header piping. These pumps are selected to provide constant flow through the chillers. The secondary pumps are controlled through a Variable Frequency Drive (VFD) and control the speed of the Secondary pumps to make sure pumping energy is conserved while adequate pressure is available at the remote AHU.

c) Headers Sizing (Condenser Water and Chilled Water):

CNDW – 500 Usgpm – 200mm Ø Header (Please note, that if required this header can accommodate 1000 GPM at an elevated pressure drop)

CHW – 320 Usgpm – 150mm Ø Header (Please note, that if required this header can accommodate 640 USGPM at an elevated pressure drop)

Reverse Return Piping has been specified for the Chilled Water piping to various floors. CHW and CNDW header piping sizes have not been increased as the occasions when both chillers are to be operated are going to be rare. At these times, the total flow through the system may be slightly less than the combined design flow rates of both Chillers/ Condensers.

d) Cooling Towers:

The cooling towers shall be able to treat a minimum of 500 USGPM and assure a temperature difference from 36.38°C (97.5°F) to 32.22°C (90°F), at a Wet Bulb temperature of 28.3°C (83°F). The tower can be of Counter flow or Cross flow type.

Type of Cooling tower:

The towers shall be with rigid FRP basin with structural steel support grid below. The latter will rest on RCC columns. Water level shall be at least 600mm deep in the cooling tower basin. Outlet of cold water shall be from the bottom of cooling tower. The main headers from cooling tower location to the chiller plant shall be buried and not be visible from the main building. Each CT shall have a GI ladder from ground level to HW basin level./ CT Motor. The hot water basin shall have removable covers.

Strainers:

The cooling tower shall have its own integral strainer. In addition each cooling tower shall have a basket type Pot Strainer (CI/MS construction). Height of Pot strainer shall be minimum 1200 mm. Diameter of SS-Double jali basket shall be minimum 500mm Dia. There are no other strainers in the condenser pumps. Each CHW pump shall have a Y-type strainer with SS-Double jali at suction. Strainers

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in the Condenser water line inside the chiller plant room are not suggested, as these will make a mess in the Chiller plant room on opening.

Cooling Towers Maintenance and Safety:

It is proposed to provide remote stop button with lock, for each cooling tower. These are to be switched off before carrying out maintenance work inside the tower/ cell. These will be installed in weatherproof enclosures near each Cooling Tower.

e) **Air Distribution:**

The existing system has a single AHU supplying conditioned air to the spaces, and all AHU's are Single-skin, AHU's more than 43 years old. The new AHU's are to be as follows.

- **Creep Bay:** Two(2) Nos Constant Speed AHU's are to be installed. Each AHU will have a 4-Row Chilled Water Coil and a 2-Row Reheat coil for removing excessive humidity from the air. Return air shall be through existing opening/ Return Air Path.
- **Mezzanine Floor:** The AHU for this floor will be a Treated Fresh Air AHU which will supply 100% Outside Air to the space, and will not take any return air. This AHU will be sized for 1600 CFM (roughly double the Fresh Air requirement for the combined space) of outside air. The AHU will have a 6-Row Cooling coil for removing maximum moisture in the humid monsoon months. The air quantity is in excess, as the existing ductwork may have leakage and some air may escape into the plenum.
- **Director Floor:** The AHU for this floor will be a Treated Fresh Air AHU which will supply 100% Outside Air to the space, and will not take any return air. This AHU will be sized for 3000 CFM (roughly double the Fresh Air requirement for the combined space) of outside air. The AHU will have a 6-Row Cooling coil for removing maximum moisture in the humid monsoon months. The air quantity is in excess, as the existing ductwork may have leakage and some air may escape into the plenum.
- **Auditorium:** The Auditorium AHU is being replaced with a new double-skin AHU sized for 18,000 CFM. This AHU is sized for occupancy of 470 persons, shall have a 6-Row coil to remove the high latent load.

f) **Temperature Control:**

Creep Testing Lab: The Return Air (RA) from this space comes through the false ceiling above.

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Cooling: Each AHU will have a 2-way modulating control valve on the chilled water line. The valve movement shall be controlled through a thermostat located in the AHU room. Upon achieving temperature set-point (as per Return Air Temperature) a control signal will be sent to the valve actuator to close the valve in small increments. This modulation continues till temperature set-point is achieved. When RA temperature increases above set-point, the valve actuator opens incrementally till set point is reached.

Mezzanine Floor/ Director Floor: Individual offices will have FCU's with individual control to regulate the temperature inside the space. Each FCU shall have ON-OFF type control valves which open/ close per thermostat provided with FCU. Mezzanine Floor/ Director Floor TFA AHU's: The AHU's for these floors are Treated Fresh Air AHU's, and have ON-OFF type Control valves on the Chilled Water line. When Fresh Air temperature is achieved, the valve closes and chilled water flow through AHU is stopped.

- g) **Humidity Control (For Creep AHU Only):** Each AHU has a Humidistat (snap acting type) in the AHU room which when energized sends a signal for the Hot Water Pump (HWP) to start, and stops the HWP when the RH level is achieved. The HWP diverts hot Condenser Water (at ~37°C) after the Condenser discharge of the Screw Chiller and circulates through the 2-Row coil. The air going through the coil is ~ 13°C, and this temperature difference is sufficient to sensibly heat the supply air and bring the excess RH down towards the set-point. After passing through the coil, the warmer water is returned to the Condenser Water heading towards the Cooling Tower. The pumping energy expended in this process is much less than the energy that would be required if direct electric heat (about 30 KW would be required as opposed to about 2 KW pumping energy) were to be used.

h) **Flow Control in System:**

Primary Chilled Water Pumps/ Condenser Water Pumps: These are constant flow pumps and their flow can be regulated by regulating the Butterfly Valves at the pump suction and discharge. The deciding factor shall be the flow through the Chiller/ Condenser and the "Specified Pressure Drop" across the respective sections.

Secondary Chilled Water Pumps: These pumps are variable speed and are controlled by a Variable Frequency Drive (VFD).

- i) Each pump is controlled by an independent VFD, and both are linked to a Programmable Log Controller (PLC) which sends a signal to the VFD and dictates which frequency the motor runs on, and thus the speed of motor and discharge of pump.

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- ii) Control Signal: All the AHU's/ FCU's are equipped with 2-way valves (or ON-OFF in case of FCU's) which regulate the flow to the equipment by adding load to the system. As the load across the building reduces, numerous valves close (partially or completely), and this builds up back pressure in the system (in the risers). A Differential Pressure Transmitter (DPT) sensor detects this rise in pressure and sends a signal to the PLC. The PLC (as programmed by the vendor) regulates the control signal to the VFD, and the VFD reduces the frequency gradually and slows down the pump. This reduction (in VFD frequency) takes place till the DPT sensor's analog output comes in line with the set-point. When DPT senses pressure dropping below set-point, the signal from the PLC speeds up the VFD's incrementally to achieve set-point.
- iii) System Reliability: To assure the system performs as guaranteed, the entire package (Pump/ Motor/ VFD and PLC) is to be provided by the manufacturer as one package, not as separate components.

5) Heat Load Summary:

Area Name	AC Area (Ft ²)	Height (Ft)	Occpncy	FA cfm	Internal Load Kw	Room Condition			By Heat Load (Summer / Monsoon)		Selected Data	
						DB (F)	Rh (%)	ADP (F)	Deh cfm	TR	CFM	TR
Creep Bay + Power Pack Room	7661	18.6	27	2331	95.0	77	55	57	26,796	62	26,796	62.0
Mezzanine Rom	2039	9.3	22	449	10.2	75	55	57	6,835	14.9	6,835	14.9
Director Floor Offices	3363	10.0	34	755	17.6	75	55	56	12,257	26.8	12,257	26.8
Lecture Hall	1259	10.0	87	653	4.0	75	55	56	3,837	12.7	3,837	12.7
Committee Room	536	10.0	21	158	4.0	75	55	56	2,274	5.2	2,274	5.2
												121.6
Auditorium	3443	25.9	470	2491	13.0	77	55	56	15,090	50.4	15,090	50.4

1) AC Plant load can taken with the following factors.

a) Creep Bay and Power Room = 100%

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- 5/12
- b) Mezzanine Offices = 100%
 - c) Director Floor Offices (sans Committee Rooms/ Lecture Hall) = 100%
 - d) Lecture Hall = 50% (Occasional Use)
 - e) Committee Rooms = 25% (Rare Use)
 - f) Auditorium/ Stage = 10% (Very Rare Use)

Chiller Selection: 2 Nos x 125 TR (Net Capacity) Water-Cooled Screw Chillers. **One Working and One Standby.**

- 2) The Chiller Plant shall be sized to cater to the combined Cooling Load of Creep Bay, Mezzanine Floor, Director Floor, Committee Room and Lecture Hall all occupied concurrently.
- 3) The Auditorium Load is not factored into the load total, as this space is used very rarely, and on these occasions regular activity in the Office areas does not take place. Thus when the auditorium is fully occupied, the Central AC system shall have the capacity to serve the Auditorium and the Creep Testing Lab simultaneously.
- 4) The **Existing Ductwork will be Retained** and used for the purposes of supplying Outside Air/ Fresh Air to the interior offices.

NB. The basis of design is for reference only however the bidder should ensure that the design conditions are met.

SIGNATURE OF THE CONTRACTOR WITH DATE AND SEAL

LIST OF THE DRAWINGS

The Tender Drawings enclosed are for guidelines of the bidder. However the bidder shall make his own drawing as per NIT.

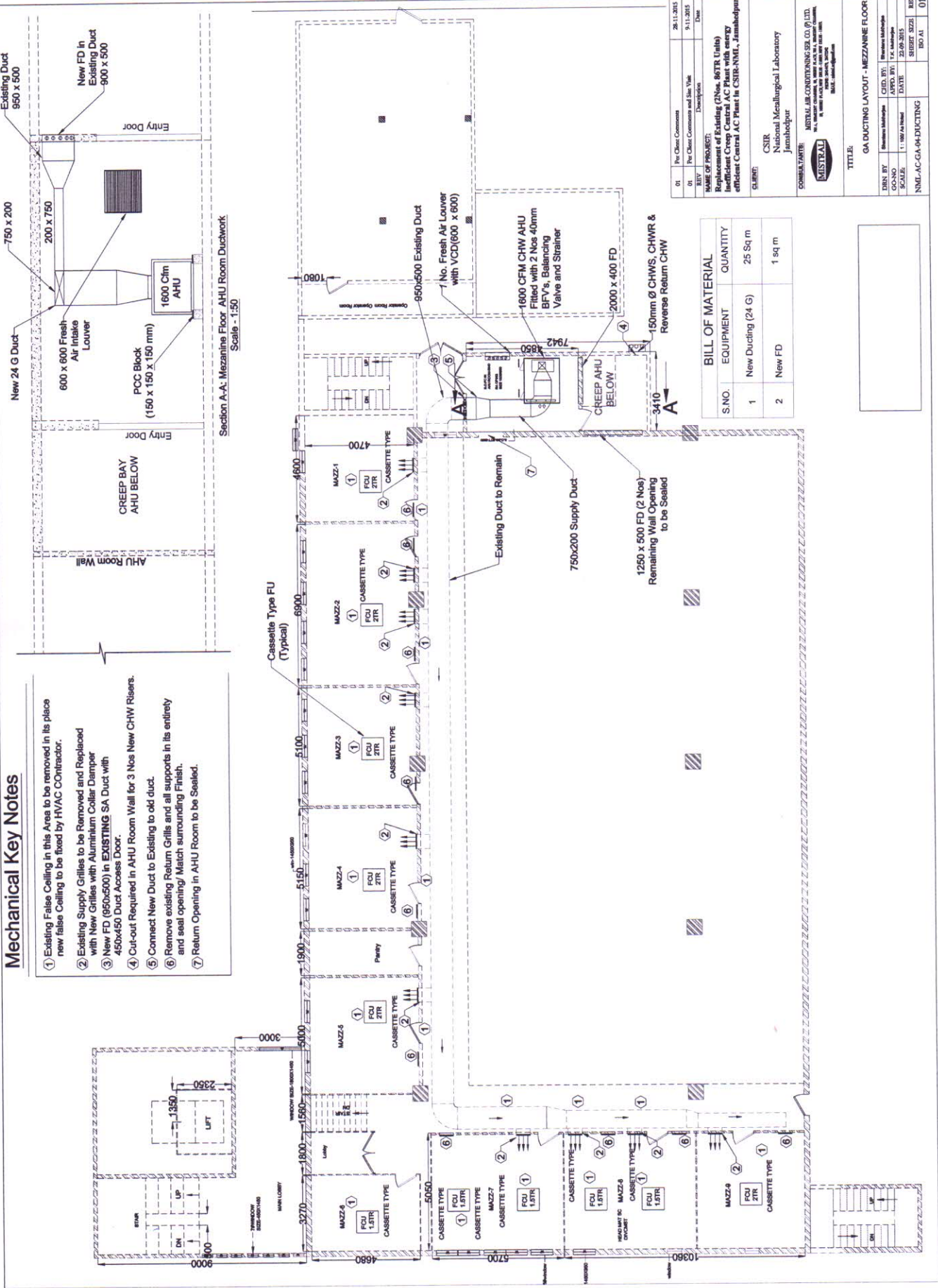
Sl.No.	Floor	Title	Drawing No.
1	Ground Floor	CHW/HW Piping (Schematic SLD)	NML-AC-SLD-01
2	Ground Floor	Chiller Plant Layout	NML-AC-GA-02
3	Ground Floor	GA-Ducting Layout-Creep Bay	NML-AC-GA-03
4	Mezzanine Floor	GA-Ducting Layout-Mezzanine Floor	NML-AC-GA-04-DUCTING
5	Mezzanine Floor	GA Piping Layout-Mezzanine Floor	NML-AC-GA-05-PIPING
6	First Floor	GA Ducting Layout-First Floor	NML-AC-GA-06-DUCT
7	First Floor	GA Piping Layout	NML-AC-PIPE-07-PIPING
8	Second Floor	GA Ducting Layout For Auditorium	NML-AC-GA-08
9	Mezzanine Floor	F.C Layout-Mezzanine Floor	NML-AC-FALSE-09
10	First Floor	F.C Layout-First Floor	NML-AC-FALSE-10
11	-	Electrical SLD	NML-EL-11
12	First Floor	Cooling Tower Layout	NML-AC-CT-12

SIGNATURE OF THE CONTRACTOR WITH DATE AND SEAL

2012

Mechanical Key Notes

- 1 Existing False Ceiling in this Area to be removed in its place new false Ceiling to be fixed by HVAC Contractor.
- 2 Existing Supply Grilles to be Removed and Replaced with New Grilles with Aluminum Collar Damper
- 3 New FD (950x500) in EXISTING SA Duct with 450x450 Duct Access Door.
- 4 Cut-out Required in AHU Room Wall for 3 Nos New CHW Risers.
- 5 Connect New Duct to Existing to old duct.
- 6 Remove existing Return Grills and all supports in its entirety and seal opening/ Match surrounding Finish.
- 7 Return Opening in AHU Room to be Sealed.



Section A-A: Mezzanine Floor. AHU Room Ductwork
Scale - 1:50

01	Per Client Comments	28.11.2015
02	Per Client Comments and Site Visit	04.12.2015
03	Final	04.12.2015

NAME OF PROJECT: Replacement of Existing (2 Nos. 86TR Units) Inefficient Creep Central AC Plant with energy efficient Central AC Plant in CSIR-NML, Jamshedpur

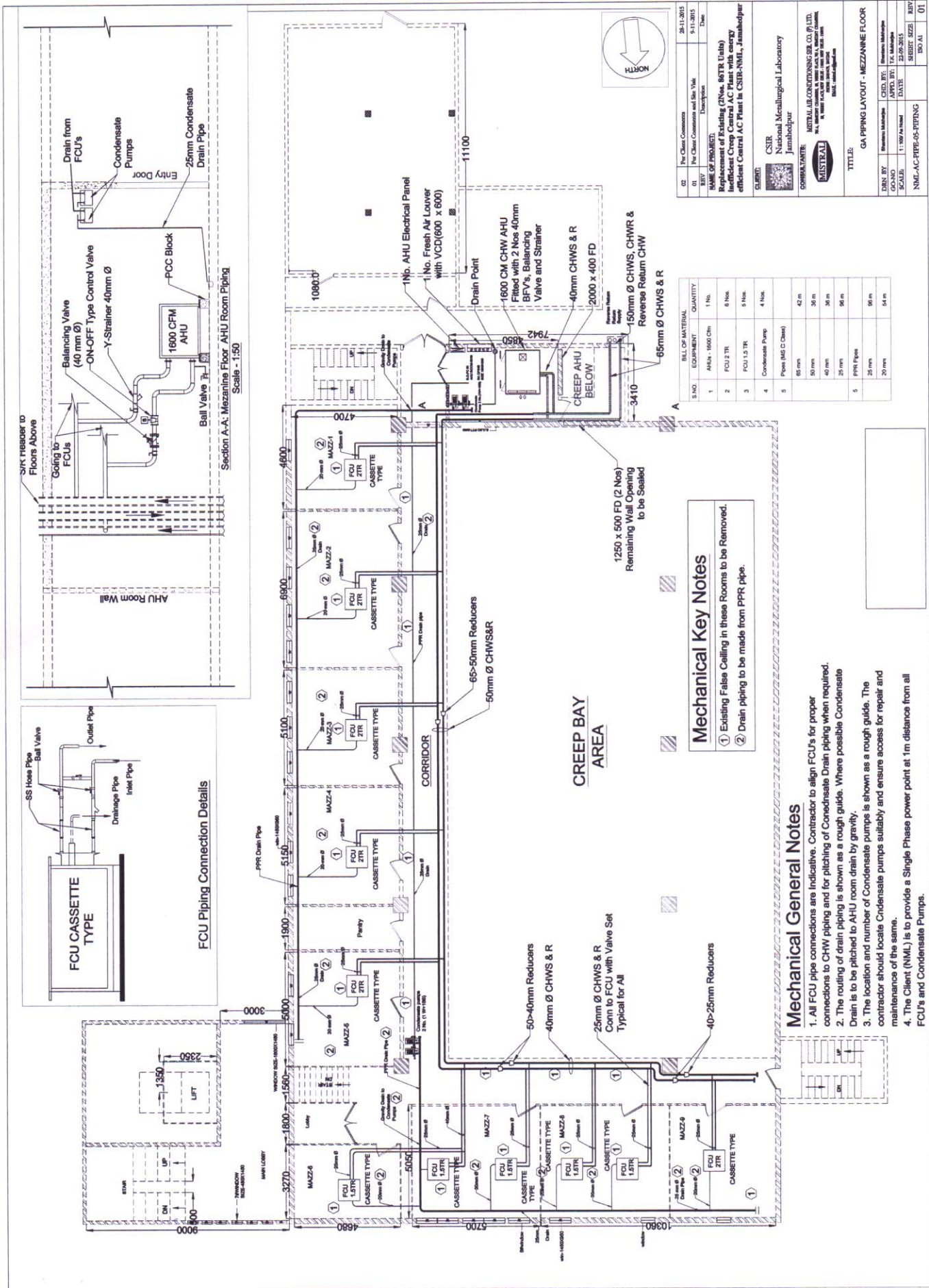
CLIENT: CSIR National Metallurgical Laboratory Jamshedpur

CONSULTANT: METAL AIR-CONDITIONING SYSTEMS (P) LTD. 10, Sector 10, Phase 1, Block No. 1, Jamshedpur, Jharkhand, India. (MUSTANG)

BILL OF MATERIAL		
S.NO.	EQUIPMENT	QUANTITY
1	New Ducting (24 G)	25 Sq m
2	New FD	1 sq m

TITLE: GA DUCTING LAYOUT - MEZZANINE FLOOR	
DRAWN BY: M. S. SINGH	CHECKED BY: M. S. SINGH
DESIGNED BY: T. K. SINGH	APPROVED BY: T. K. SINGH
SCALE: 1:100 As Shown	DATE: 04.12.2015
BY: M. S. SINGH	DATE: 04.12.2015
NO: 01	REV: 01

Scale



03	Per Client Comments	28.11.2015
02	Per Client Comments and Site Visit	9.11.2015
01	Issue	Date

NAME OF PROJECT:
Replacement of Existing (2 Nos. 8RTX Units) Inefficient Creep Central AC Plant with energy efficient Central AC Plant in CSIR-NML, Jamshedpur

CLIENT:
CSIR National Metallurgical Laboratory
Jamshedpur

DESIGNER:
GOMHA SANKER
MUSTRAL

CLIENT'S ADDRESS:
MUSTRAL AIR CONDITIONING SER. CO. LTD.
11, NEW MARKET, JAMSHEDPUR, JHARKHAND, INDIA.
Ph: 91-94321-11111

TITLE:
GA PIPING LAYOUT - MEZZANINE FLOOR

DEN BY	DESIGNED	CHECKED	DATE
SOJEE	11/09/2015	22/09/2015	22/09/2015

SCALE: NML-AC-PIPE-05-PIPING

REVISED SIZE: RBY

NO. OF SHEETS: 01

S.NO	EQUIPMENT	QUANTITY
1	AHU - 1600 CH	1 No.
2	FCU 2 TR	8 Nos.
3	FCU 1.5 TR	8 Nos.
4	Condensate Pump	4 Nos.
5	Pipes (MS C Class)	
	65 mm	42 m
	50 mm	30 m
	40 mm	30 m
	25 mm	96 m
	PPR Pipe	56 m
	20 mm	56 m
	20 mm	54 m

Mechanical Key Notes

- Existing False Ceiling in these Rooms to be Removed.
- Drain piping to be made from PPR pipe.

Mechanical General Notes

- All FCU pipe connections are indicative. Contractor to align FCU's for proper connections to CHW piping and for pitching of Condensate Drain piping when required.
- The routing of drain piping is shown as a rough guide. Where possible Condensate Drain is to be pitched to AHU room drain by gravity.
- The location and number of Condensate pumps is shown as a rough guide. The contractor should locate Condensate pumps suitably and ensure access for repair and maintenance of the same.
- The Client (NML) is to provide a Single Phase power point at 1m distance from all FCU's and Condensate Pumps.

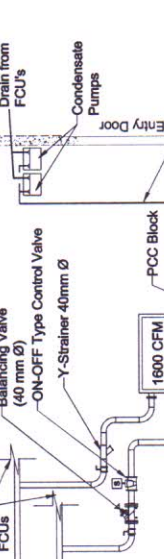
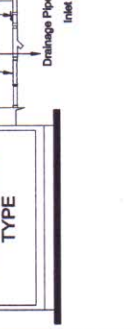
1250 x 500 FD (2 Nos) Remaining Wall Opening to be Sealed

CREEP BAY AREA

FCU Piping Connection Details

Section A-A. Mezzanine Floor AHU Room Piping
Scale - 1:50

FCU CASSETTE TYPE



S/W Inlet to Floors Above Going to FCU's

Drain from FCU's

Condensate Pumps

25mm Condensate Drain Pipe

Entry Door

1600 CFM AHU

Balancing Valve (40mm Ø)

ON-OFF Type Control Valve

Y-Strainer 40mm Ø

PCC Block

Ball Valve

Drain from FCU's

Condensate Pumps

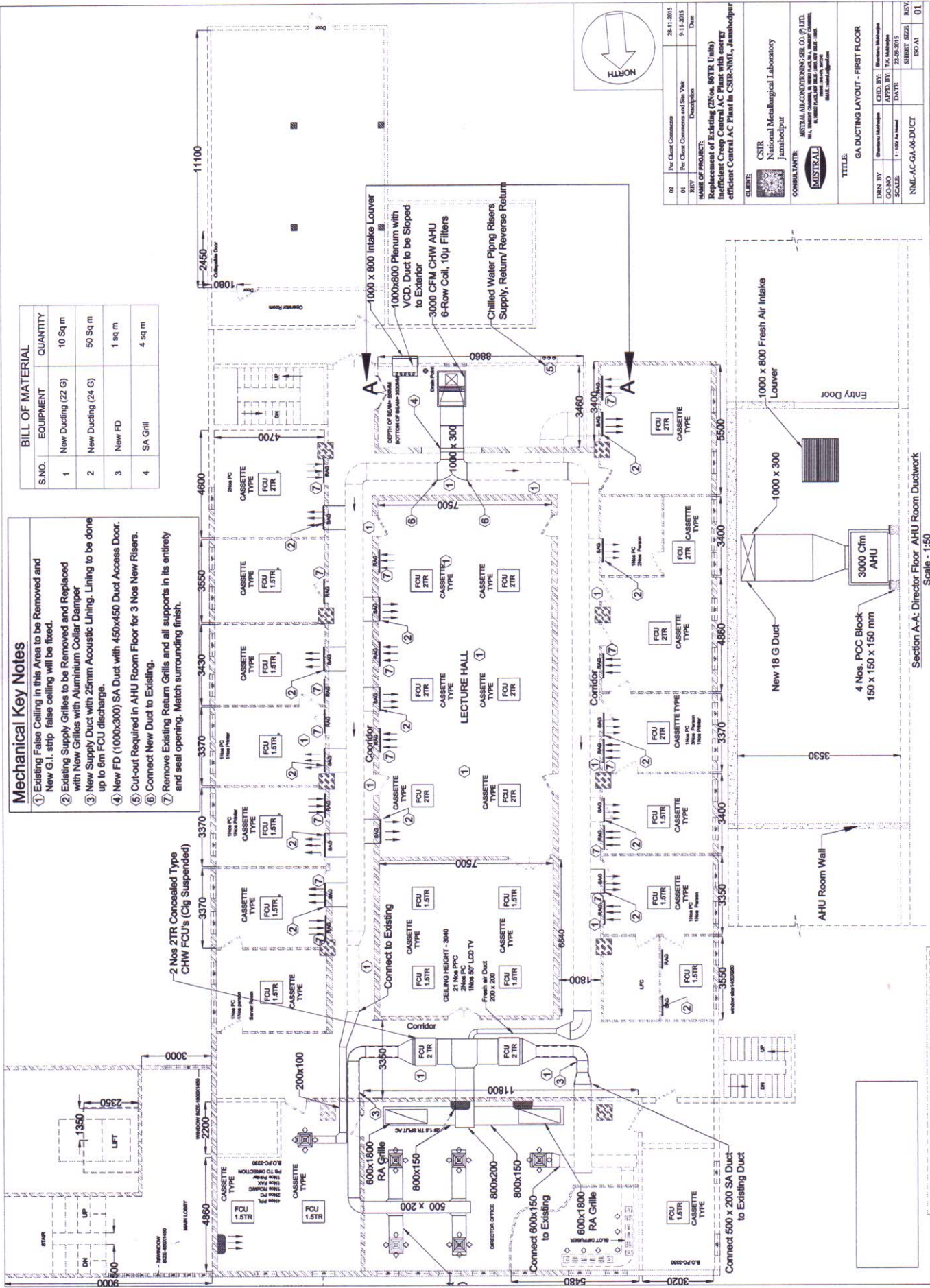
25mm Condensate Drain Pipe

Entry Door

Mechanical Key Notes

- 1 Existing False Ceiling in this Area to be Removed and New G.I. strip false ceiling will be fixed.
- 2 Existing Supply Grilles to be Removed and Replaced with New Grilles with Aluminium Collar Damper
- 3 New Supply Duct with 25mm Acoustic Lining. Lining to be done up to 6m FCU discharge.
- 4 New FD (1000x300) SA Duct with 450x450 Duct Access Door.
- 5 Cut-out Required in AHU Room Floor for 3 Nos New Risers.
- 6 Connect New Duct to Existing.
- 7 Remove Existing Return Grills and all supports in its entirety and seal opening. Match surrounding finish.

S.NO.	EQUIPMENT	QUANTITY
1	New Ducting (22 G)	10 Sq m
2	New Ducting (24 G)	50 Sq m
3	New FD	1 sq m
4	SA Grill	4 sq m



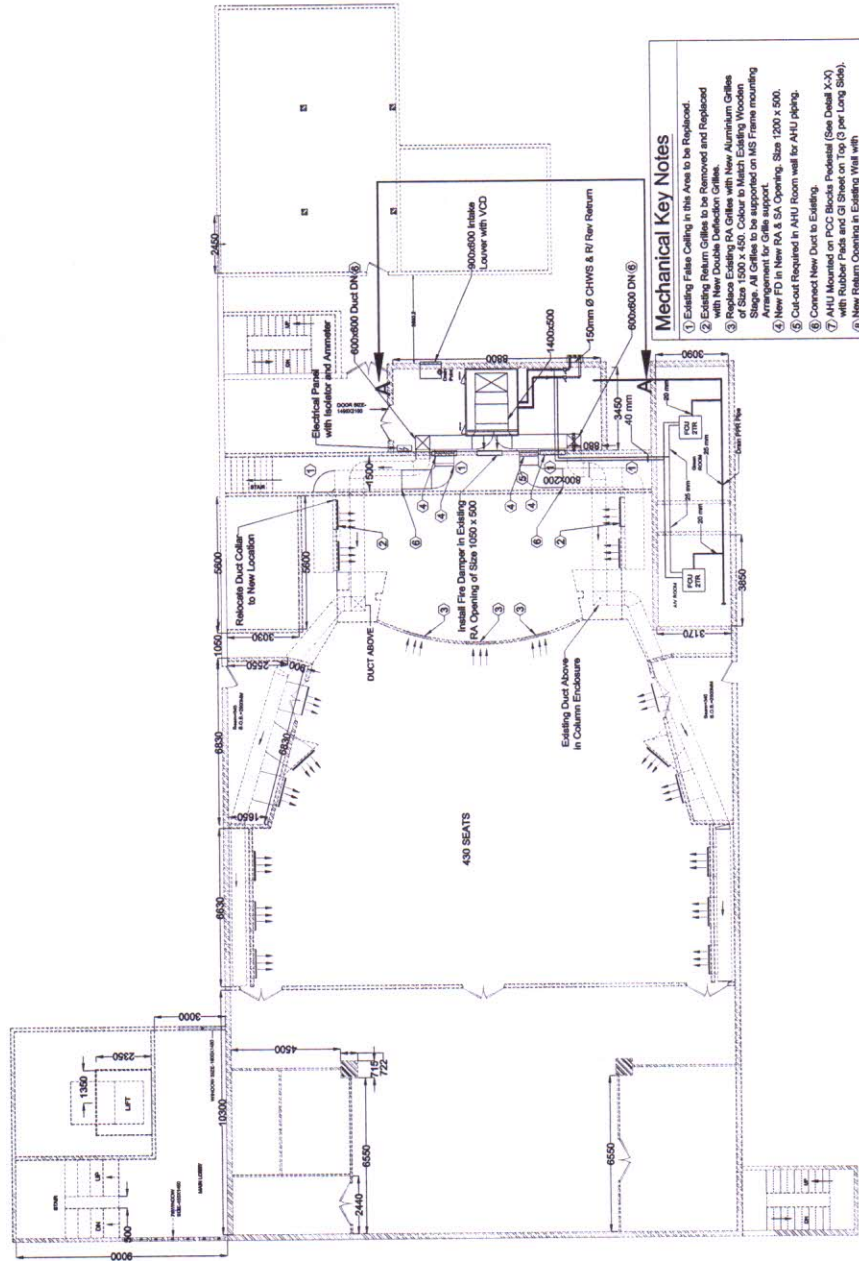
02	Per Client Comments	28-11-2015
01	Per Client Comments and Site Visit	9-11-2015
00	Issue	

NAME OF PROJECT: Replacement of Existing (2Nos. 96TR Units) Inefficient Creep Central AC Plant with energy efficient Central AC Plant in CSIR-NML, Jamshedpur
CLIENT: CSIR National Metallurgical Laboratory Jamshedpur
CONSULTANT: MESTRAL
DESIGNER: MESTRAL AIR CONDITIONING SER. CO. (P) LTD.
DATE: 29-09-2015
SCALE: 1:1000 As Shown
SHEET NO.: NML-AC-GA-06-DUCT
SHEET SIZE: B0/A1
REV: 01

Section A-A: Director Floor: AHU Room Ductwork
Scale - 1:50

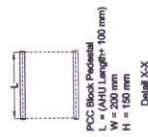
1-2

S. NO.	EQUIPMENT	QUANTITY
1	AHU's - 16000 CFM	1 No.
2	Ducting (22 G)	10 Sq.m
3	Fire Damper	1.5 Sq.m
4	SA Coll	8 Sq.m
5	FCU (2 TR)	2 Nos.
6	Pipes (MS C Class)	6 m
	40 mm	24 m
	25 mm	12m
	20 mm	6 m



Mechanical Key Notes

- Existing False Ceiling in this Area to be Replaced.
- Existing Return Grilles to be Removed and Replaced with New Double Deflection Grilles.
- Replace Existing RA Grilles with New Muschler Grilles with New Double Deflection Grilles.
- Stage AH Grilles to be supported on MS Frame mounting Arrangement for Grilles support.
- New FD in New RA & SA Opening, Size 1200 x 500.
- Cut-out Required in AHU Room wall for AHU piping.
- Connect New Duct to Existing.
- AHU Mounted on PCC Blocks Pedestal (See Detail X-X) with Rubber Pads and GI Shear on Top (3 per Long Side).
- New AHU to be mounted on existing Wall with New 1000x200 Fire Damper.



NO.	REV.	DESCRIPTION	DATE
1		ISSUED FOR PERMIT	14.04.15
2		FOR CONSTRUCTION	14.04.15



REVISION	NO.	DATE	DESCRIPTION
1	1	2015-01-11	ISSUED FOR PERMIT
2	2	2015-01-11	FOR CONSTRUCTION

PROJECT: Replacement of Existing (2 Nos. 80TR Units) Muschler Chilled Water Return Grilles with New Double Deflection Grilles in Auditorium AHU Room in CSIR-NMIL, Jamshedpur

CLIENT: CSIR National Metallurgical Laboratory Jamshedpur

CONSULTANT: MISTRAE NATIONAL RECONDITIONING CO. (P) LTD. 10, Market Crossing, B-Block, Sector-1, Jamshedpur, Jharkhand - 831001, India. TEL: 0659-2600000, 2600001, 2600002 FAX: 0659-2600003, 2600004, 2600005

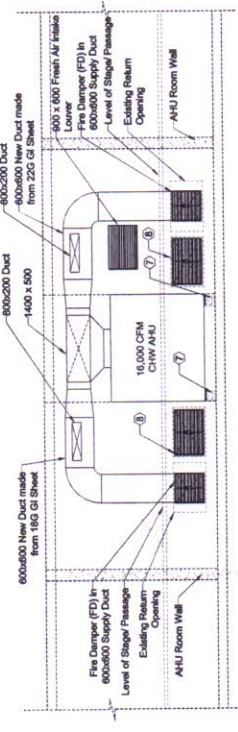
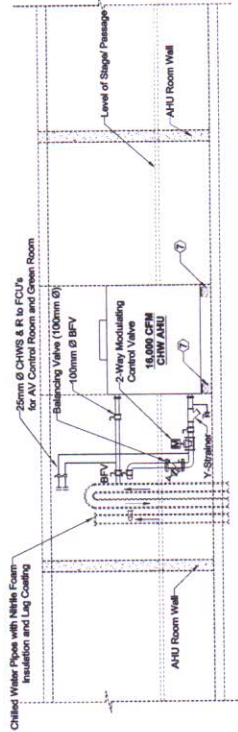
TITLE: GA DUCTING LAYOUT FOR AUDITORIUM LEVEL

DRAWN BY: [Name] CHECKED BY: [Name]

DATE: 22.08.2015

SCALE: 1:100 (As Shown) SUBJECT SIZE: [] REV: []

PROJECT NO: NMI-AC-GA-08 DRAWING NO: []

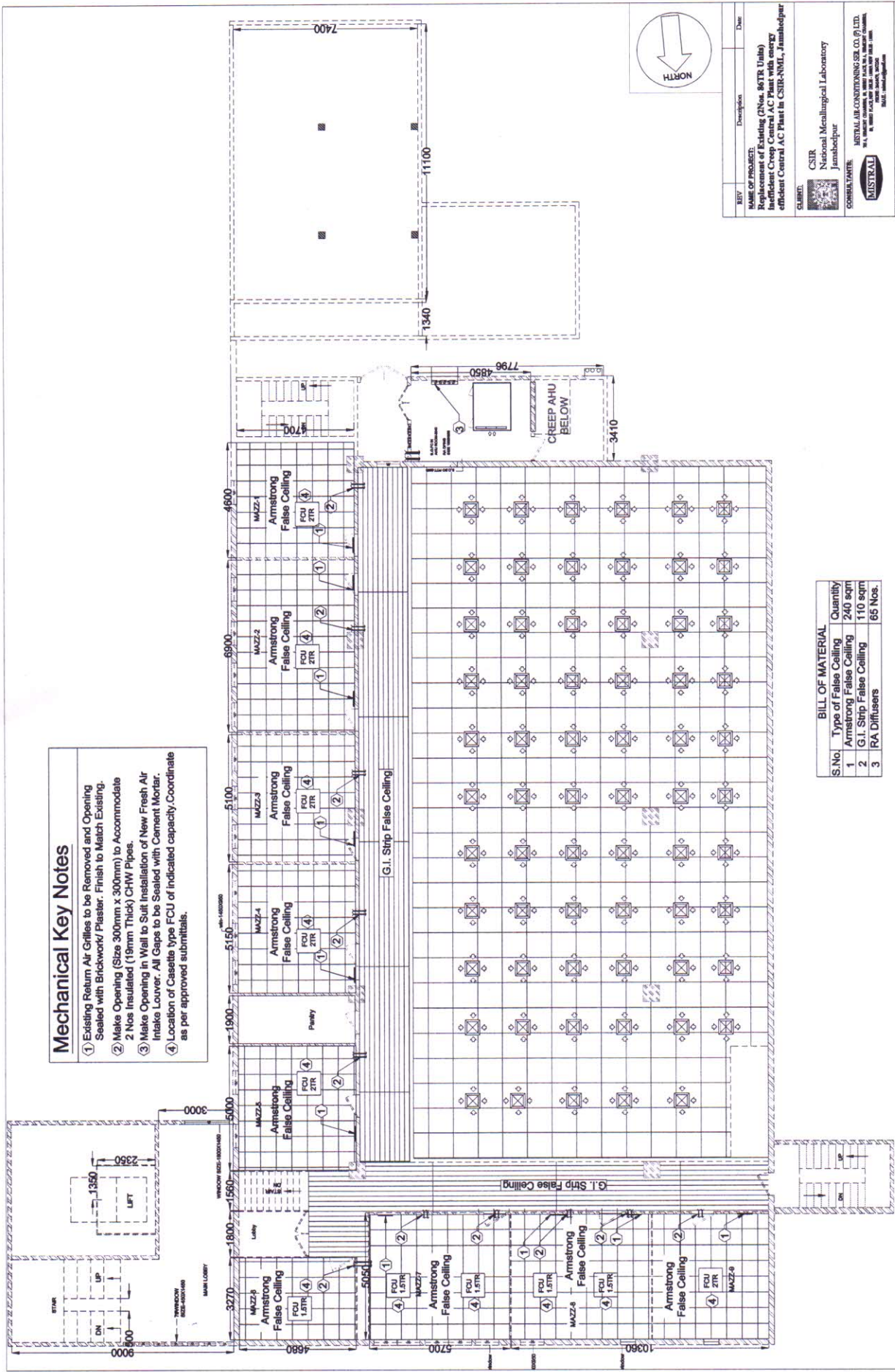


Section A-A: Auditorium AHU Room Piping
Scale - 1:50

Section A-A: Auditorium AHU Room Ductwork
Scale - 1:50

Mechanical Key Notes

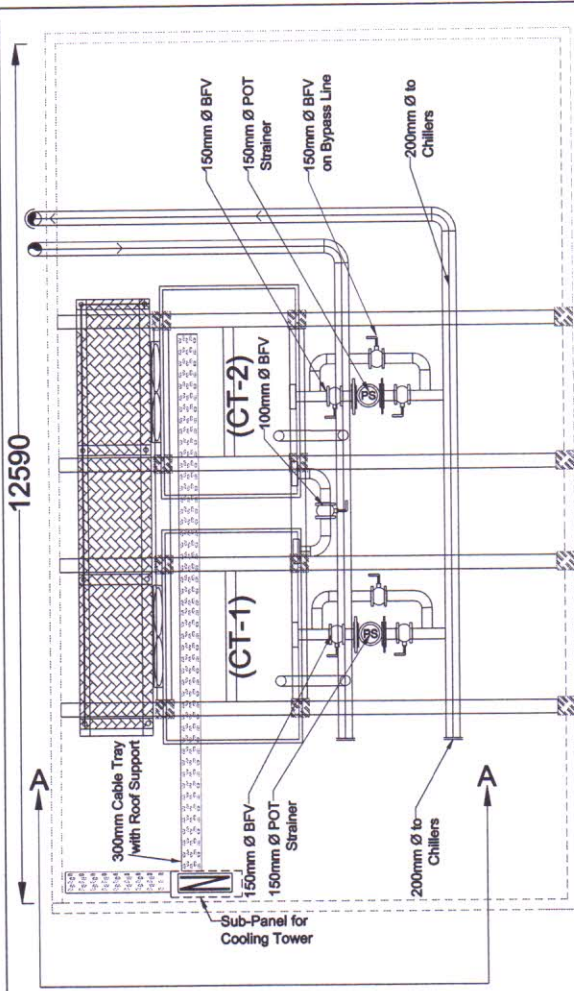
- ① Existing Return Air Grilles to be Removed and Opening Sealed with Brickwork/Plaster. Finish to Match Existing.
- ② Make Opening (Size 300mm x 300mm) to Accommodate 2 Nos Insulated (19mm Thick) CHW Pipes.
- ③ Make Opening in Wall to Suit Installation of New Fresh Air Intake Louver. All Gaps to be Sealed with Cement Mortar.
- ④ Location of Cassette Type FCU of indicated capacity. Coordinate as per approved submittals.



S.No.	Type of Material	Quantity
1	Armstrong False Ceiling	240 sqm
2	G.I. Strip False Ceiling	110 sqm
3	RA Diffusers	65 Nos.

REV	Description	Date
<p>NAME OF PROJECT: Replacement of Existing (2Nos. 80TR Units) with 2 Nos. Creep AHU and 2 Nos. efficient Central AC Plant at CSIR-NMIL, Jambhampur</p> <p>CLIENT: CSIR National Metallurgical Laboratory Jambhampur</p> <p>CONSULTANT: MISTRAL</p> <p>MISTRAL AIR-CONDITIONING SER. CO. PVT. LTD. <small>101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000</small></p>		

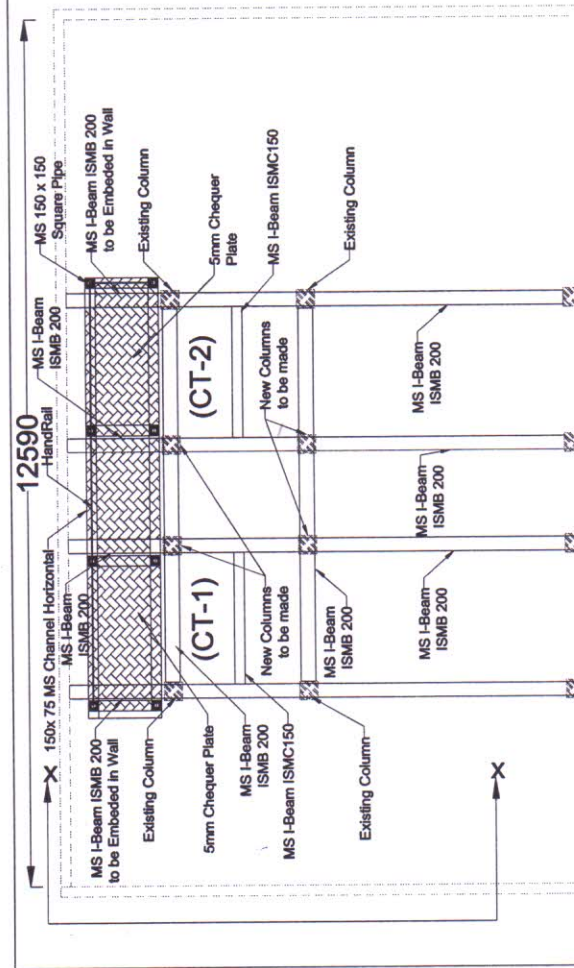
<p>TITLE: F.C. LAYOUT - MEZZANINE FLOOR</p>	
<p>DESIGNER: Ashish Bhatt</p> <p>DATE: 15/08/2024</p> <p>SCALE: 1:100 As Shown</p> <p>PROJECT NO.: NME-AC-FALSE-09</p> <p>REV. NO.: 01</p>	<p>CHKD. BY: [Signature]</p> <p>APPD. BY: [Signature]</p> <p>DATE: 15/08/2024</p> <p>REVISIONS:</p>



Cooling Tower Layout
Scale:- 1:50

Bill of Material - Pipes/Valves

1. MS C-Class Pipe 200mm Ø - 24m
2. MS C-Class Pipe 150mm Ø - 20m
3. MS C-Class Pipe 100mm Ø - 1m
4. Butterfly Valve 150mm Ø - 6 Nos
5. MS Pot Strainer 150mm Ø - 2 Nos



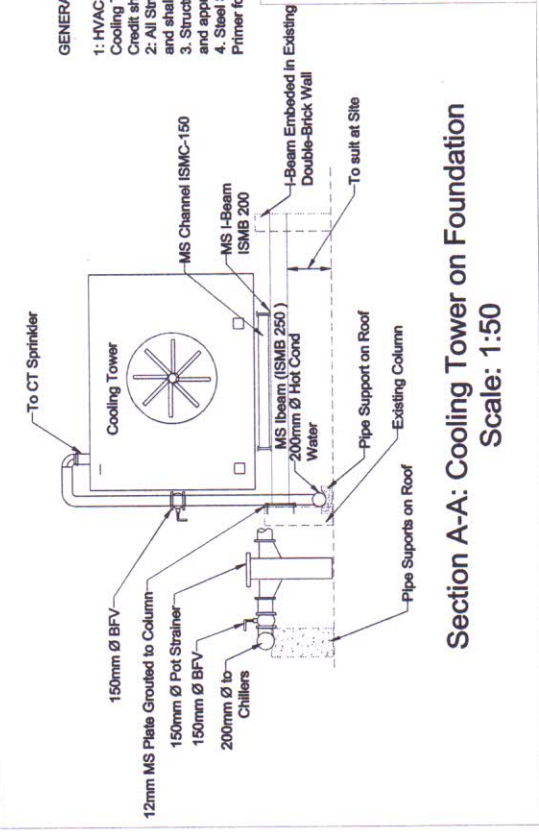
CT Foundation Layout
Scale:- 1:50

Bill of Material - Structural Steel

1. MS I-Beam ISMB 200 - 42 m
2. MS Channel ISMC 150 - 7.5m
3. MS Channel 150 x 75 - 12.58m
4. Ms Square Pipe 150 x 150 - 28 m
- 5.

Details of MS Platform & CT

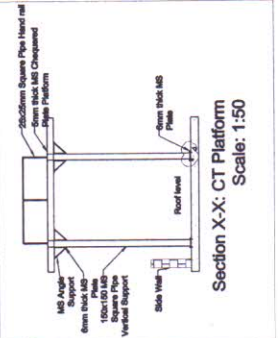
S. NO	Description	Area of Platform	Weight	Total Weight in Kg
01	5mm thick MS Chequered Plate	6.83 sqm	@ 39 kg / sqm	266.37 kg
02	150x150 MS Square Pipe	(3.5m x 8 Nos) = 28 m	@ 26.4 kg / m	739.2 Kg
03	150x75 MS Channel	= 12.58 m	@ 17.7 kg / m	222.67 kg
04	40x40x5 MS Angle	= 3.2 m	@ 3 kg / m	9.6 kg
05	25x25 MS Square Pipe	= 7 m	@ 1.69 kg / m	11.83kg
06	6mm thick MS Flat	= 1 sqm	@ 47 kg / m	47 kg
07	ISMB 200	42 m	@ 25.4 kg/m	1068.8 kg
08	ISMC 150	7.5 m	@ 16.4kg/m	123kg
TOTAL				2486.47 kg
OPERATING WEIGHT OF 2 NO. TOWERS				3786 kg
TOTAL WEIGHT				6284.47 kg



Section A-A: Cooling Tower on Foundation
Scale: 1:50

GENERAL NOTES:

1. HVAC Contractor shall dismantle the Existing Cooling Towers and cart away from NML premises. Credit shall be given to NML for dismantled components.
2. All Structural Elements shall be of TATA/SAIL make and shall be as per IS.
3. Structural drawing shall be made by HVAC vendor and approved by NML.
4. Steel Structure shall be painted with 2 coats of Epoxy Primer followed by 2 coats of Epoxy paint.



Section X-X: CT Platform
Scale: 1:50

REV	DESCRIPTION	DATE

NAME OF PROJECT: Replacement of Existing (2 Nos. 80TR Units) with 2 Nos. 100TR Units. AC Plant with energy efficient Central AC Plant in CSIR-NML, Jamshedpur
 CLIENT: CSIR National Metallurgical Laboratory Jamshedpur
 CONSULTANT: MISTRAL CONSULTANTS (P) LTD. 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.

TITLE: COOLING TOWER LAYOUT

DRN BY	DESIGNED BY	DATE	SCALE

SHEET NO: 1.00
 SHEET SIZE: B0 A1
 NO. A1: 01