

The Agricultural Produce Market Committee UNJHA



CCTV GENERAL SPECIFICATION & PUBLIC ADDRESS SYSTEM

NAME OF WORK:

**Construction of New Sub Market yard at Brahmanwada
R.S. NO-613 of A.P.M.C. Unjha. Under the scheme of AMI
sub scheme of ISAM**

Chairman
APMC
Unjha

CLOSED CIRCUIT MONITORING SYSTEM

TECHNICAL SPECIFICATIONS

GENERAL SYSTEM REQUIREMENTS:

The scope of work shall include supply, installation, testing and commissioning of all indoor and outdoor IP cameras, NVRs and control panels with all inter connection as required. The scope includes supply and laying of video coaxial / Cat 6 computer cables, power and control wiring.

GENERAL SYSTEM DESCRIPTION:

The CCTV is required to supply the operator with the following information and facilities:

Display of images on monitors through commands given by the operators' keyboard.

Automatic camera selection, positioning and display to pre-set positions

Remote camera, monitor and recording selection

Display of single and/or quadruplicated images on any selectable monitor.

Recording driven by Network Video Recorders

TECHNICAL BRIEF:

Network Video Recorder –

❧ The Network recorder shall be a 16/32-channel Analog input disk Network recorder. The Network recorder shall have the capability to carry 2 drive bays, and thus it shall have the capability to carry up to 4TB with the optional hard disk drives.

❧ The Network recorder shall have the capability to record 25fps per channel @ CIF resolutions and should be capable to record @Half D1 and D1 Resolutions.

❧ The Network recorder should support the latest compression technology H.264 algorithm.

❧ The Network video recorder should be capable of pentaplex functions.

❧ The Network recorder shall have field recording. The Network recorder shall have 4 different recording modes – 1. Normal recording, 2. Alarm recording, 3. Pre-alarm recording and Instant.

❧ The Network recorder shall have the ability to provide backup of the recorded images through USB, eSATA & network and should have min 1xeSATA.

❧ The Network recorder shall have built-in coaxial and RS-485/422 telemetry allowing control of PTZ cameras .

❧ The Network recorder shall have the following play back functions FF, GO to First, Go to Last and frame Advance.

❧ The Network recorder shall have 4 audio inputs and 1 audio output and should have two way audio supports.

❧ The Network recorder shall have a built-in LAN terminal. The Network recorder shall have the capability to connect to any PC over a LAN, and it shall have the capability to monitor and setup the Network recorder through network. Also, video and audio recordings shall be downloaded to a networked PC.

❧ The Network video recorder should have separated recording/network Dual Streaming feature for transferring the data online with less bandwidth consumption and Frame rate can be adjustable.

❧ The recording device should have remote management software CMS.

❧ The Network recorder shall offer the following search modes:

Date/Time search

Calendar

Event

❧ The Network recorder shall operate on AC Free 100 to 240 V, 50 / 60Hz with the operating temperature of 0degree to 40 degree C

❧ The Network recorder shall be CE, FCC, and UL-ETL.

Video Input	16ch Composite (BNC)
Video Output	Main Output (Simultaneous) : VGA, Composite,
	Spot Output : Composite (up to 16channels division)
Operating System	Embedded Linux
Compression	H.264 Hardware Codec
Multiplex Function	Pentaplex (Live, Recording, Playback, Network,Backup)
Recording FPS	D1, Half D1, CIF
Frame Rate	480fps (NTSC),400fps (PAL) at CIF Resolution
Recording Mode	Continuous, Alarm, Motion, Instant
Playback Mode	Calendar, Date/Time, Event (Motion, Alarm), Bookmark
Display Mode	1, 4, 9, 16, 1+5, 1+7, 1+12
Audio	4 lines Input / 1 line Output
Two-way Communication	Two-way audio support
Sensor Input / Alarm Out	8 Line (NC/NO Selectable) / 4 Line(NC/NO Selectable)
Storage	1 SATA / e-SATA HDD
Backup	USB Memory Network, Internal ODD,External USB ODD
Export	USB Storage, Network,Internal/External ODD
Network	10/100/1000 base Ethernet, DDNS,
	TCP/IP, ADSL/VDSL, DHCP
Data retention	Support (Auto Delete setting on Setup)
NTP	Support
Health Check	Support
Watchdog	Support
Operation Control	Front Key, Mouse and Remote Controller
Firmware Update	USB Memory, Network

Dome camera Indoor -

24 The colour camera shall incorporate 1.3 & 2 mega pixel CMOS image 3.6mm Lens(2.8mm/6mm optional). The colour video camera shall produce H.264 & MJPEG dual-stream encoding. produce max 15fps@1.3M(1280x960)&25/30fps@720P(1280x720 a picture. The CCTV camera shall have the ability to switch from colour mode to black & white mode automatically in Low light conditions. The video camera shall have a minimum light requirement of 0.05 Lux @ F2.0.The video camera shall have a video signal to noise ratio of more than 48dB.

The video output level shall be 1.0 Vp-p (75 ohms composite) with a BNC type connection.

The video camera shall have advanced intelligence to eliminate light hunting and picture distortions caused by colour/black and white switching. The video camera should be Day & Night Camera.

The video camera shall have options for back light compensation in the form of Network WDR / AGC / BLC / HSBLCL.

The video camera shall have 3D-Network Noise Reduction.

The camera shall have internal sync system capabilities.

The Camera Electronic shutter min speed should be 1/50~1/100,000.

Power requirements for the video camera shall be 12V DC and shall consume approx. 1.15 W.

The camera should have a multi Language OSD including English.

The video camera shall be CE, FCC, and UL-ETL Listed.

Imaging Sensor	6.0mm (1/3 Type) Super Had CCD II	
ISP	Network Signal Processor	
Lens Type	3.6mm Fixed Lens (LD120N/P-C1) / Option: 2.5mm Fixed Lens (LD120N/P-A1)	
Sync. System	Internal / Line Lock (Option)	
Scanning Frequency (H/V)		
Horizontal Resolution		
S/N Ratio	48dB	
Minimum Illumination (F1.2, 30IRE)	0.05 Lux @ F2.0	
Video Output Signal	1Vp-p Composite (75Ω)	
Day & Night	Network (Auto / Day / Night)	
Backlight Compensation	Network WDR / AGC / BLC / HSBLC	
Exposure	ELC	
Auto Gain Control	Auto	
Electronic Shutter Speed		
White Balance	ATW (1700-11000K)	
Multi OSD Language	2 Languages	
Power Source	DC 12V	
Power Consumption	1.15 W	
Operating Temperature / Humidity	-10°C ~ 50°C / 0% ~ 80%RH (Non-Condensing)	
Storage Temperature / Humidity	-20°C ~ 60°C / 0% ~ 85%RH (Non-Condensing)	
Certifications	FCC, CE, UL	
Dimension (Ø x H)	Ø 88 x 67.5 mm	
Weight	0.17 g	

TECHNICAL SPECIFICATIONS (PUBLIC ADDRESS SYSTEM)

PUBLIC ADDRESS SYSTEM

GENERAL SYSTEM REQUIREMENTS:

The voice alarm system shall be the integrated solution for BGM and EVAC. The voice alarm system shall be designed for public address and emergency evacuation. All the essential EVAC functionality – such as system supervision, spare amplifier switching, loudspeaker line surveillance, Network message management and a fireman's panel interface – shall be combined.

The system shall provide for emergency call (EMG), business call and BGM audio, up to 60 zones, 8 call stations and two remote control panels.

The voice alarm system shall be a one channel/two channel system. It shall be compatible with BGM sources and 100 V booster amplifiers. It shall be capable of connecting to EVAC compliant loudspeakers and accessories for an integrated public address and voice alarm solution.

The system shall be fully IEC 60849 compliant.

It shall have full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager for at least 200 pre-recorded messages and chimes.

It shall be possible to merge messages to allow even more flexible use of pre-recorded announcements and evacuation messages. It shall be possible for each message to have any length within the total available capacity.

The memory shall have a capacity of 16 MB. It shall be possible to upload from a PC via USB into the memory, after which the unit shall operate without PC connection.

The standard WAV-format shall be used for the messages and sample rates of 8kHz up to 24kHz with 16-bit word length (linear PCM) shall be supported.

Volume override relay contacts shall be provided for each zone separately for overriding local loudspeaker volume controls. All current override schemes shall be supported (3-wire and 4-wire override schemes i.e. standard 24V and failsafe). Upon a call or an activated trigger input these contacts shall be activated for the appropriate zones, together with an additional voltage free contact (Call Active) for control purposes.

A 24Vdc output shall be available to supply power to external relays, so no external power supply shall be required for that purpose. A LED VU-meter shall allow for monitoring of the master output.

The maximum allowed total cable length between the controller and the last router in the chain shall be 1000 meters. The maximum allowed total cable length between the controller and the last call station in the chain shall be 1000 meters.

The maximum allowed total cable length between the controller and the RC panel shall be 1000 meters.

The controller and each connected router shall have 12 trigger inputs to start business and emergency messages. Each shall be configurable for a message consisting of a sequence of up to 8 wave files.

It shall be possible for wave files to be used in different combinations with other messages, optimizing flexibility and used storage space.

The messages shall be merge able to allow even more flexible use of pre-recorded announcements and evacuation messages. The system will be configured for 24 zones, expandable to up to 60 zones using additional six zone routers. Up to 8 call stations shall be connectable. Interconnections shall be made using standard RJ45 connectors and CAT5 cable.

It shall be possible to connect 1000 watts booster amplifier per router. The audio output shall use standard analog audio 100 V line switching for full compatibility with public address equipment and EVAC-compliant loudspeakers. The system shall be configured using DIP switches for basic functionality and a PC for more advanced functions. It shall be possible to specify 16 priority levels.

A built-in 240 W booster amplifier shall provide the power for the emergency call channel and BGM. It shall be possible to add additional booster amplifiers as spare, to provide two-channel operation or if the total power requirement exceeds 240 W (maximum 1000 W per 6 zones).

The maximum/rated output power of the internal booster shall be 360 W / 240 W. max mains inrush current shall be 8A @ 230 Vac / 16A @ 115 Vac

All control equipments should operate on Mains voltage which will be either 230Vac or 115Vac, $\pm 15\%$, 50 / 60Hz (selectable)

The power supply voltage range shall be 18 – 24V with a current consumption of less than 50 mA.

Power consumption of the Central Control Unit shall not exceed 600 Watts, and that of the Matrix shall not exceed 50Watts.

In case of Power failure Battery backup facility should be available and the battery voltage shall be 24Vdc, $+20\%$ / -10% .

The nominal sensitivity shall be 85 dB SPL (gain preset 0dB).

The nominal output level shall be 700 mV.

The maximum allowable sound pressure level shall be 110 dB SPL.

The microphone shall have a limiter. The distortion shall be less than 0.6% at maximum input.

The equivalent input noise level shall be no more than 30 dB SPL. The frequency range shall be 100Hz – 16kHz.

The speech filter shall be a 315 Hz, high-pass, 6 dB/oct filter. The output impedance shall be 200 Ohms. The stem length with microphone shall be 390 mm.

All low level connections and volume override shall be on MC1,5/XX-ST-3,5 type connector blocks.

All high level connections except mains shall be on MSTB 2,5 /XX-ST.

The input contact shall have supervision based on a series and parallel resistor.

All control equipments shall be rack mountable with removable rack mounts. The matrix shall be not higher than 2U. The controller shall be not higher than 3U. The rack mounting kit shall be included.

The operating temperature range shall be -10°C to $+55^{\circ}\text{C}$. The storage temperature range shall be -40°C to $+70^{\circ}\text{C}$.

The system shall comply to the following standards:

EVAC compliance	acc. to IEC 60849
EMC emission	acc. to EN 55103-1
EMC immunity	acc. to EN 55103-2
Safety	acc. to EN 60065

CENTRAL CONTROL UNIT SPECIFICATION

As the basis of the voice alarm system, the Central control unit shall have all the essential functionality for compliance with IEC 60849 standard, including full system supervision, loudspeaker line impedance supervision, a supervised emergency microphone on the front panel and a supervised message manager

- ✓ Frequency response shall be 60 Hz – 18 kHz (+1/-3 dB, @ -10 dB ref. rated output. The distortion shall not exceed 1% at the rated output, 1 kHz.
- ✓ Control unit shall have tone controls to allow for adjustment of the BGM sound.
- ✓ It shall have separate bass and treble controls.
- ✓ The controller shall have two BGM source inputs and a mic/line input with configurable priority, speech filter, phantom power and selectable VOX activation.
- ✓ It shall be possible to select 16 priority levels for microphone, call stations and trigger inputs for optimum system flexibility. It shall have two connectors to connect call stations. It shall have 12 input triggers with 6 supervised trigger inputs.
- ✓ Furthermore it shall have one record output on cinch connectors.
- ✓ The trigger outputs shall be on floating relays with a rating of 250V @ 7A.
- ✓ The controller shall have an emergency active relay, a fault relay and two general purpose relays, for control purposes. The fault relay shall be failsafe.
- ✓ The output section shall have six transformer-isolated 100 V constant voltage outputs for driving 100 V-loudspeakers in six separate zones.
- ✓ All zones shall be individually selectable from the front panel and the BGM output level in each zone shall be individually settable in 6 steps.
- ✓ The BGM output shall be connected to the 70V line, thus it shall be possible to connect a total load of 480 Watts in a two channel system combined with a 480 Watt booster.
- ✓ The output of the booster shall be also available as a separate output on 100V and 70 V. A separate 100 V Call Only output shall be provided for addressing an area where BGM is not required but where evacuation announcements are. Six configurable volume override output contacts shall be available for overriding local volume controls during priority calls. A LED VU-meter shall monitor the output.

MATRIX SPECIFICATION:

- ✓ The Matrix shall be an expansion unit adding 6 zones as well as 12 input- and 8 output contacts to the voice alarm system.
- ✓ It shall be able to use the booster built in the central control unit.
- ✓ It shall provide outputs and inputs for one or two boosters in a multi amplifier for one- or two-channel system.
- ✓ It shall provide dual channel operation for calls and BGM simultaneously to a maximum of six different zones, using two booster amplifiers.
- ✓ Also single channel operation shall be possible with only one booster.
- ✓ The matrix shall have a set of relays for zone-switching the power amplifier output(s) to different loudspeaker groups.
- ✓ Each of the zones shall be switched between the call channel (upon call-station selection or all-call microphone or emergency activation), the BGM channel (upon front panel selection), or off.
- ✓ The zone power handling capacity of the matrix shall be 1000 Watts.
- ✓ The router shall also have 12 input triggers. 6 triggers shall be supervised for EMG purposes.

PAGING STATION SPECIFICATION:

- ✓ The 6-zone paging station shall be a stylish high quality call station with a stable metal base, a flexible microphone stem and a unidirectional condenser microphone.
- ✓ It shall be intended for making calls to selected zones.
- ✓ The special design shall allow for neatly flush mounting in desk tops.
- ✓ Using dip switches on the bottom of the call station, the call station ID shall be selectable. The call station shall have selectable gain, speech filter and limiter for improved intelligibility.

- ✓ On each call station it shall be possible to select 6 zones with the possibility to connect a paging station keypad to increase the number of zones or zone groups that can be selected.
- ✓ It shall have LED indications for zone selection, fault and emergency state.
- ✓ The call station extension shall provide seven additional zone and zone group keys
- ✓ On each paging station shall be possible to select 6 zones with the possibility to connect up to 8 call station keypads to increase the number of zones or zone groups that can be selected. Selected zones are indicated with LEDs on the call station, three additional LEDs give visible feedback on the active state of the microphone and the system. Green indicates microphone active, amber indicates that the system has detected a fault (IEC 80649) and red indicates that the system shall be in the emergency state.

LOUD SPEAKER CEILING MOUNT:

- ✓ Recess mount speaker with metal grill, designed in accordance with IEC268-5 Power handling capacity standards. CE conformity. Safety according to EN60065. Ball-proof according to DIN 18032-3. Complete with metal fire dome, with following specifications:
- ✓ Maximum power : 9 watts
- ✓ RMS: 6 watts. Tappings at 6/3/1.5w
- ✓ SPL: 99dB
- ✓ At 6w/1watt (1kHz at 1 mtr)
- ✓ Rated impedance: 1667 ohm
- ✓ 2 pole push-in terminal block

SURFACE MOUNT SPEAKER:

- ✓ Suitable for speech and music reproduction. Metal enclosure designed to mount on surface or for recess mount. Conforming to CE and safety according to EN60065 and Evacuation compliance to BS5839-8 complete with back box with following specifications:
- ✓ Maximum power: 9 watts
- ✓ RMS: 6 watts with tapping at 6/3/1.5/0.75 watts.
- ✓ SPL: 102dB at 6 watts /1w (1kHz, 1mtr)
- ✓ Frequency: 150 Hz to 20kHz.
- ✓ Impedance: 1667 ohm with 3 pole screw connector.

AMPLIFIER:

- ✓ 19 inch rack mounting 2U high metal housing with dual priority switching.
- ✓ Inputs for 100 volts slave operation.
- ✓ Level controls for input 1 and 2.
- ✓ 240 watts RMS
- ✓ Frequency range: 50Hz to 20kHz
- ✓ Distortion: <1% at rated output power, 1kHz
- ✓ Inputs and outputs available at 100volts.
- ✓ Direct output : 100 volts / 70 volts and 8 ohm.
- ✓ Operation: 230 volts AC and 24VDC

BGM SOURCE:

- ✓ Back ground music source consisting of DVD/CD/MP3 player with USB input and a separate FM player.
- ✓ Simultaneous operation of player and FM set

2 CORE CABLE

- ✓ 2 core 1 Sq mm Multi Stranded Overall PVC Cable of any Standard Make
- ✓ This will be laid in the Pre-laid Conduits

15. FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION:

A. The work shall consist of furnishing, installation, testing & commissioning of a complete high quality advanced technology early detection Intelligent Analogue Soft Addressable fire alarm system as shown on the drawings and specified herein.

1.02 REFERENCES FOR INSTALLATION:

German Standards VDE (Verband Deutscher Electrotechniker)
DIN VDE14675 and VDE 0833 Fire Alarm Systems

NFPA- National Fire Protection Association
NFPA 72

British Standard Institute / European Standards
All Applicable codes and standards including BS EN 54

1.03 SUBMITTALS:

A. Product data for fire alarm system components including dimensioned plans, sections, and elevations showing minimum clearances, installed features and devices, and list of materials and data.

B. Shop drawings.

C. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs. Description shall cover this specific project.

D. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with any one of the referenced standards, completely with specifications and Vds approval or equal.

1.04 TRANSPORTATION, HANDLING AND STORAGE:

A. All the components of fire alarm system shall be provided in manufacturer's original new and unopened packing bearing manufacturer's name and label.

B. Store materials, not in actual use, in covered and well ventilated area and protect them from dirt, dust, moisture, direct sunlight and extreme temperatures.

C. For further requirements follow manufacturer's written instructions regarding storage and handling.

1.05 WARRANTY

A. Submit written guarantee signed by the contractor, manufacturer and installer of fire alarm system for the period of 1 year from the date of substantial completion. The guarantee shall cover the repair and replacement of material with manufacturing defects and workmanship as directed by the engineer.

1.06 QUALITY ASSURANCE:

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of fire alarm systems and components, whose products have been in satisfactory use in similar services for not less than 3 years period, and be subject to approval of engineer.

B. Installer Qualifications: An experienced specialist sub-contractor who is authorized by the system manufacturer,

and subject to approval of the engineer.

C. All the components and installations shall comply with the requirements of DIN VDE 14675 & VDE 0833 for design & installation.

D. Provide system and components specified in this section that are listed and approved by Vds, UL & confirm to equivalent DIN/EN standards.

E. Single source responsibility: All components and accessories shall be product of single manufacturer.

PART 2 – PRODUCTS

2.01 SYSTEM DESCRIPTION:

A. The fire detection and alarm system shall comprise of Automatic Soft Addressable Modular design main fire alarm control panels, Dual optical smoke & heat MULTI Sensors , Blue LED Optical Smoke & Heat MULTI Sensors, Optical Smoke / Heat/ CO Gas MULTI sensors, Loop powered Dual Optical Smoke/Heat sensor with integral Sounder / Flasher / Speech units, manual call points, electronic wall mounted Alarm sounder/flasher/speech combined devices, Transponder interface units, each with its own short circuit built-in isolators. All loop cabling and any other components and accessories deemed necessary for a safe, reliable and satisfactory system shall conform to the relevant and applicable requirements and recommendations of DIN EN 54. The system shall be fully programmed to accommodate fire alarm zones. The system shall be configured to allow on site modifications with the minimum of disruption using the PC based software to facilitate future changes or alterations to existing buildings/network on site.

B. The fire alarm and detection system shall provide the following facilities as a minimum:

The system shall be intelligent in operation with advanced decentralised intelligence technology. Each detector shall have its own processor with algorithms built in the device to take a fire or fault decision. System with centralised intelligence by providing signal levels to the control panel are not acceptable.

The system will be capable of providing fire, fault disablement and supervisory monitoring facilities as required by DIN EN 54 Pt 2. All devices on a loop shall have built in SHORT CIRCUIT LINE ISOLATORS for wiring fault isolation to protect the system. "Group Circuit Monitors" which isolate/protect sections of a loop circuit, i.e. a group of field devices are not acceptable. In event of manufacturer not providing in built isolators, style 7 wiring as per NFPA shall be strictly complied with.

All system components and devices shall be connected to two-wire loop circuits (as shown in the typical schematics) with each component having its own individual built-in isolator, should have sensors with integrated sounder in a same unit and no extra cabling should require to power up the sounder. Removal or disconnection of any component from the loop shall not affect the functioning and performance of other components and the system. Please note that the group isolators, which are used to isolate a section of a loop in case of fault, are not acceptable.

System shall be of automatically addressable type i.e. all the devices on the loops of the FACP shall be allocated addresses automatically from the PC / panel at the time of system power. The loop devices shall also be able to commission by using PC interface without the need of FACP.

And also given an address during commissioning, the value of which shall be stored in non-volatile memory, within the electronics module of the outstation. This value shall be read during loop allocation and provided it is valid shall be used to setup the outstations primary address.

Automatic Addressing shall cover the benefits of Soft Addressing and also overcome the limitations of Hard Addressing. This means that If the devices are inserted or removed all the existing devices shall keep the same address and programmed activations and use labels remain unchanged. The panel with PC shall allocate the address to ensure that it is impossible for two devices to have the same address. Fire Detection and Alarm Systems, which rely only on Coding , Programmer or hard addressing techniques are not acceptable.

Facilities shall be provided to constantly monitor and check the following circuits and fault conditions:

- The power supply to the loop /s;
- For open-circuit, short-circuit, earth fault and any other fault condition in the loop wiring;
- For communication failure and errors in all cards and loops
- For faults in keyboard and printer circuits
- All devices, etc. shall be installed on the same loop.

All devices shall be assigned a maximum of 25 character or 2 lines of max. 30 characters each with a ¼ VGA Display. In case of fire, fault or warning, the label of device sensing threshold shall appear on visual display unit of the panel.

Any event i.e. Fire, fault or warning shall be recorded with time, date and place of occurrence in the memory of FACP. These events can either be displayed on normal or ¼ VGA Display of the FACP or printed, as required. Provision shall be done at the fire alarm control panels to silence the loop powered alarm sounders but the visual indication shall remain until the system is reset. The detectors shall have auto learn sensitivity adjustments. The main fire alarm control panels shall be located as shown on the schematics and the floor drawings.

2.02 GENERAL

A. All major component of fire alarm system shall be product of a single manufacturer and shall conform to the requirement of EN54, Vds approved and be designed acc. to DIN VDE14675 and VDE 0833 Fire Alarm Systems CODE OF PRACTICE FOR SYSTEM DESIGN, INSTALLATION AND SERVICING.

B. The power supply breakers for FDA system shall be marked “ DO NOT DISCONNECT. FIRE ALARM SUPPLY”

2.03 ANALOGUE ADDRESSABLE FIRE ALARM CONTROL PANEL (FACP)

B. In the event of a fire being reported from the smoke/heat Detectors, activation of manual call points or sprinkler operation the sequence of alarm operation shall be as follows: If a fire condition is reported from a smoke detector then the evacuation will be done initially by the local integral sounder. Then after a certain delay (to be agreed at the time of commissioning) the evacuation message shall be announced on that fire zone only. If after 3 minutes the alarm has not been acknowledged, the evacuation message shall also be announced on the other adjacent zones. All other zones shall be given the Alert message. The evacuation of the building shall be staged in phases to allow orderly movement of people.

C. If a Manual Break Glass Unit is activated or a sprinkler flow switch is operated, then the evacuation shall be transmitted immediately to the affected fire zone plus the adjacent zones.

D. Activation of the fire alarm system shall directly initiate some or all of the following to be agreed as a part of the overall engineering policy.

- ✓ Signal to all elevator machine rooms indicating fire status (to control lifts)
- ✓ Release doors normally locked by magnetic devices.
- ✓ Release doors normally held open by magnetic devices
- ✓ Shutdown mechanical equipment ventilation plant
- ✓ Shutdown general exhaust fans
- ✓ Start up smoke extract fans
- ✓ Start up exhaust make up fans
- ✓ Start up stair vestibule pressurization fans
- ✓ Automatically operate fire dampers
- ✓ Initiate alert signals to panels in the adjacent office tower.
- ✓ Sprinkler valves, flow switches and other monitored valves shall be directly supervised by the fire alarm systems.

These shall include but not limited to the following:

- ✓ Building automation system via Graphic Supervisor or Hard wired integration if chosen.
- ✓ Emergency lighting system
- ✓ Security system.

2.04 SYSTEM COMPONENTS AND DEVICES

FIRE ALARM CONTROL PANEL:

A. The panel shall be modular Multifunctional computer controlled using **32 bit processor**. De-centralised control and monitoring functions to be realised on the loop and spur.. The panel shall be complete with, but not limited to, the following elements:

- 1) Visual display unit capable of displaying 8 lines 40 characters backlit display / ¼ VGA display as optional.
- 2) Built-in optional 40 character internal protocol thermal printer or external.
- 3) Built-in full numeric keyboard with function keys.
- 4) 64 Single Zone Indicator expandable upto 192 SZI
- 5) USB Port
- 6) SMART Card media slot.
- 7) Key switch to prevent unauthorised operation of keypad.
- 8) Integral sealed lead acid battery and charger, with 24 hour back up in the event of supply mains failure.
- 9) Essential controls – Delay, panel reset, Audible alarm off, Disconnect master box, additional messages, verify/cancel fault buzzer. Fire, Pre-Alarm, Trouble, Disconnection lamps. Each lamp shall also have appropriate indication (Releasing Systems activated, Master box, Delay , Verify, CPU failure, Inoperation normal condition & failure of powersupply / battery) Simple menu driven function keys with password protection shall allow users to an extensive range of software based features such as:

- Overview
- Service
- Time functions
- Informations
- Last 10000 system events
- Current fault and warning logs.
- Interrogation of sensor cleanliness
- On/Off, Enable/ disable sensors, zones, sounders, interface unit channels.
- Status of detectors
- Alarm counters
- Printer on, off, line feed and test facilities.

10) All control buttons and keyboard shall be enclosed behind a lockable cover, Up to 127 device capacity per 3.5km loop and a TTY/ RS 485 communication option.

11) In addition to the above, all other necessary controls, elements and accessories shall be included to provide a complete and efficient panel conforming to the requirements of DIN EN 54.

12) LOOP PARAMETERS:

Individual loop circuits will be capable of accommodating the following.

- / Up to a maximum of 127 addressable devices on 3.5 kms loop length
- / Up to 32 loop powered IQ8 Alarm addressable Sounders.
- / Up to 32 loop powered IQ8 Alarm electronic Strobes.
- / Up to 32 loop powered combined electronic sounders and strobes
- / Up to 80 sensors with integral alarm sounder
- / The detection loop shall have the ability to support both sensors and sounders connected on the same 2 core loop circuit.
- / Up to 127 loop powered input modules.
- / Should have the ability to spur off the detection loop without using 'T' breaker devices, without any degradation.

2.05 SYSTEM EVENT PRINTER

A. The system printer shall be 40 character thermal printer optional in-built on the main control panel, and shall log all events, change of status, alarm and fault messages along with time of the day and date. An external 80 column dot matrix printer along with system PC can also be considered.

The printer shall provide the following:

- Hard copy of every event occurring
- Status read out of every addressable point
- Devices tested on a walk test
- Contaminated detectors needing replacement
- Single point scan printout of analogue values
- Hard copy of historic log.

2.06 FIELD DETECTION DEVICES

GENERAL: ANALOGUE DETECTORS & BASES

All analogue detectors and bases shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible.

All analogue detectors shall have real intelligence itself. This means even without control panel the detector can make decision, adapt to different environmental condition and diagnose itself. They shall have decentralised intelligence, automatic function self test, CPU failure mode, alarm and operating data memory and integrated short circuit line isolators. The detector bases for interfacing between the loop wiring and the detector head shall be manufactured by means of injection moulded ABS plastic coloured white and shall not contain any electronics for addressing. The base fixings should be suitable for any industry standard BESA or conduit boxes. All bases shall include the option to provide a programmable relay output for interfacing, providing a dry contact for third party.

All bases shall be provided with a plastic removable dust cover for protection during site construction as well as an IP rated sealing gasket to prevent dirt and moisture from entering through from the fixing surface.

Each base shall include a lock and removal of locked detectors shall be achievable only through the use of the appropriate removal tools as specified by the manufacturer of the detectors. Detectors removal tools are to be handed over on completion of the contract as part of the spare parts to the client.

Removal of a detector from its associated base shall not affect the continuity of the detection loop.

The Fire alarm manufacturer shall have the complete range of following analogue ADDRESSABLE detectors with decentralised intelligence as standard so as to meet the specific applications of the site.

- a) Heat Detectors (fixed & ROR temperature)
- b) Optical Smoke Detector
- c) Optical Smoke & Heat Detector
- d) Dual angle Optical/Heat Detector
- e) Blue Light Optical / Heat Smoke Detector
- f) Optical Smoke, Heat & CO gas Detector
- g) Optical Smoke detector with integral Sounder
- h) Dual angle Optical/Heat detector with integral Flasher
- i) Dual angle Optical/Heat detector with integral Sounder
- j) Dual angle Optical/Heat detector with integral Speech Sounder
- k) Dual angle Optical/Heat detector with integral Flasher and integral speech sounder
- l) Duct mounted sensor
- m) Radio Frequency wireless analogue detectors
- n) Manual Call Points

All of the above shall be compatible with the aforementioned base providing inter-changeability between detector heads, without the requirement for switch settings. All detectors shall also have an integral short circuit isolator, which in the event of a single cable fault will isolate the “culprit” piece of cable and retain all devices on the loop operationally.

Each detector shall possess two integral LED giving a red flashing indication for fire and green for normal operation. For remote locations, each detector shall be capable of connection to a remote LED unit by means of 2 core wire connection.

Detectors shall be white in colour and manufactured from ABS plastic. All electronics and associated sensing elements will be housed within this unit, these components being hermitically sealed to prevent their operation from being impaired by dust, dirt and humidity.

The sensitivity of all detectors shall be adjustable from a software. It shall be possible to programme detector sensor sensitivity directly on the loop using interface with a laptop PC and appropriate programming software from manufacturer.

For MULTI SENSOR detectors, disablement of each sensor element shall be possible individually or for whole loop. Also this disablement feature shall be possible to have manually or time / event controlled.

All detectors shall be provided with a plastic removable dust cover for protection during site construction.

A semi-flush recessing kit for analogue detectors shall be available for each detector type incorporating the standard detector base.

2.07 (a) HEAT DETECTORS

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 and shall be VdS approved. This shall be a dedicated heat only detector to provide fixed temperature heat as well as rate of rise sensing. It should be fully compliant with EN54 part 5 to provide grades of A1.

2.07 (b) OPTICAL SMOKE DETECTOR:

Install as shown in the drawings. Analogue Addressable Optical Smoke Detectors. These shall be of Automatic addressable Optical type with inbuilt isolator in a single head. The optical element shall detect visible smoke from slow smoldering fires. Smoke sensing design shall comply with EN 54 part 7 and shall be VdS approved. It shall have microprocessors, short-circuit isolators and all electronic components and circuitry suitable for an Analogue addressable system. The detectors shall also have 360 degree viewing LED fire indicator. Detectors mounted in the false ceilings shall be provided with semi flush mounting kits.

2.07 (c) OPTICAL SMOKE /HEAT DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. These detectors shall have combined two individual sensing elements to provide excellent cover for both types of fires (slow smoldering & fast free burning fires). These detectors shall be of Automatic addressable Combined Optical/Heat type with inbuilt isolator in a single head.

Optical sensing shall be carried out by means of an Infra-red LED transmitting a pulse of light across an obtuse angled chamber & heat sensing shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (d) DUAL ANGLE OPTICAL/HEAT DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7 and shall be VdS approved. This device shall combine two individual sensing elements to provide excellent cover for both “types” of fires. (Slow smouldering and fast free burning).

OPTICAL SENSING: Shall be carried out by 2 infra-red LED transmitters across 2 separate

Optical detection angles. This sensor shall process both the forward and backward scattered Light caused by entering the detection chamber of device, allowing the detector to Differentiate between real smoke and non-smoke particles e.g. Steam & Dust.

HEAT SENSING: Shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (e) Blue-light OPTICAL SMOKE / HEAT DETECTOR

Install as shown in the drawings. These shall comply with the requirements of EN 54: Part 5 & 7. The optical measurement chamber shall be provided with latest developed blue LED sensor technology , enabling the detection of open fire, smouldering fires and fires with high heat generation (Invisible smoke sensing). These detectors shall be capable of identifying the TF1 & TF6 test fires described in EN 54-9 specifications. These detectors shall be intelligent with time related signal analysis, signal correlation of sensor data & decentralised HEAT SENSING: Shall be carried out by a thermistor, sampling the surrounding environmental temperature.

2.07 (f) OPTICAL SMOKE DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings (Hotel guest rooms / suits).These shall comply with the requirements of EN 54: Part 3 & 7.

The sensor element of the optical detector sounder shall be as per the specification for the optical smoke detector, however the device shall incorporate an internal electronic sounder.

The internal electronic sounder shall be an integral part of the detection device comprising of a piezo sounder output device providing the low and high frequency output.

The combined detector sounder shall provide a sound pressure level of 92dBA at 1 metre. The audible volume levels shall be individually selectable for each device and there should also be a configurable soft start feature that ramps up the volume gradually rather than switching on at full level.

It shall be possible to connect a maximum of 80 combined detector sounders to a detection loop.

A minimum of 19 Different tone types are stored in the detector sounders. Upto 4 different tone types shall be combined in a signal set and activated in case of alarm. Individual detector sounder volume levels shall be adjustable at the main control panel or via the use of the remote programmer unit coupled with a laptop PC and appropriate programming software from the manufacturer.

Activation of the sounder shall be independent of the detection of a fire condition by the sensing element. All sounder outputs shall be synchronised with all other loop powered detector sounder devices and other loop powered audible visual units on the panel.

Each sounder shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

2.07 (g) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH FLASHER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 5 & 7.

The sensor element of the dual angle optical/heat detector flasher shall be as per the specification for the dual angle optical/heat detector.

The integral flasher element shall utilize a high power red LED for strobe effect. LED pulsing shall be synchronised with all other loop powered audible visual units located on the fire alarm and detection panel. The flasher LED shall be fault monitored for working operation.

It shall be possible to connect a maximum of 48 combined dual angle optical/heat detector flasher to a detection loop.

Activation of the flashers shall be independent of the detection of a fire condition by the sensing element.

Each flasher shall have its own microcomputer to handle loop communications, which along with all other associated electronic components will be hermetically sealed to provide protection from hostile operating environments.

2.07 (h) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SOUNDER

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector sounder shall be as per the specification for the dual angle optical/heat detector.

The sounder element of the dual angle optical/heat detector shall be as per the specification for the optical smoke detector with integral sounder.

It shall be possible to connect a maximum of 80 combined dual angle optical/heat detector sounder to a detection loop.

2.07 (i) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL SPEECH SOUNDER.

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with speech shall be as per the specification for the dual angle optical/heat detector.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech. Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) shall be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronized with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

2.07 (j) DUAL ANGLE OPTICAL/HEAT DETECTOR WITH INTEGRAL FLASHER AND SPEECH SOUNDER.

Install as shown in the drawings .These shall comply with the requirements of EN 54: Part 3,5 & 7.

The sensor element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angle optical/heat sensor.

The sounder element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angle optical/heat sensor sounder.

The integral strobe element of the dual angle optical/heat detector with Flasher and Speech sounder shall be as per the specification for the dual angle optical/heat sensor strobe.

The speech function shall be provided by stored messages on a non-volatile flash memory component. Output from the flash memory processor shall be up to 25 seconds of speech.

Additionally there shall be the capability to provide complex tones, such as bell and DIN tones. Each device shall include 5 standard messages in 5 languages within the flash memory component. At least 4 signal parts (consisting of tones and speech) can be set into one signal-set. At least 2 signal sets can be programmed for 2 different events, e.g. evacuation and alert.

As standard, the microprocessor shall contain the following messages:

Evacuation: Alarm Message 1 (Voice) "This is a fire alarm. Please leave the building immediately by nearest available exit"

Evacuation: (Voice) "Attention please"

Evacuation Alarm Message 2: (Voice) "This is an emergency. Please leave the building immediately by the nearest available exit"

Alert Message "An incident has been reported in the building. Please await further instructions"

Clear Message: (Voice) "The emergency is now cancelled. We apologise for any inconvenience"

Test Message "This is a test message, no action is required"

All the voice messages shall be synchronised across the detection loops by means of a regular synchronisation signal generated by the fire alarm control panel.

In addition to the voice messages above, an 8 Inch solenoid bell recording shall be provided as a standard complex tone.

All speech outputs shall be synchronised with all other loop powered sensor speech devices and other loop powered audible visual units on the panel.

It shall be possible to connect a maximum of 32 combined dual angle optical/heat detector strobes with sounder speech to a detection loop.

2.07 (k) DUCT MOUNTED SENSORS

Venturi principle air duct detector kit shall be used. The kit with IP 54 protection ABS plastic with filters shall be mounted outside airducts. The venturi tube dips into the airduct. The airspeed in the duct shall not exceed 1 m/s to max 20 m/s. This device shall employ the aforementioned Optical/Heat detector to provide environmental information. Probes are fitted to pick up smoke in ventilation ducts. This unit is particularly suitable for sensing smoke particles in ducting which is likely to be in large quantity and flowing fairly quickly.

2.07 (l) MANUAL CALL POINTS

Install as shown in the drawings. The manual initiation devices shall be electrically compatible with all of the aforementioned detector types and shall be complete with all-electronic components and circuitry for an automatic safe addressable device. The manual call point shall have an inbuilt short circuit isolator and an inbuilt microprocessor to ensure a response time of less than 1 second.

The MCP unit shall also handle all communication to the control panel. All electronic devices contained within the MCP shall be hermetically sealed so as to prevent damage from hostile environment conditions: e.g dust with minimum rating of IP43.

The MCP operating voltage shall be 8-42 volts DC, RED similar to RAL 3020. If the MCP are

located in public areas a transparent cover shall be provided as a protection to prevent inadvertent activation. MCP shall be available in two designs Large & small for aesthetic purposes to architects.

The MCP shall have an input facility to connect conventional devices. It should have an option of using either frangible glass allowing for complete removal upon operation or plastic pane resettable function. There shall be no text but SYMBOLS on the MCP (burning house / press to break).

The device can be tested functionally without the need to either remove the front cover and/or breaking the glass, with a special test key (supplied as standard). The key shall insert the underside of the MCP ensuring easy access of the key at all times.

These devices will comply fully with EN 54 part 1.

2.07 (j) Linear Heat Detector Module & sensor cable

Line heat detector module enable early detection of fires & over heating. This should be specifically designed in narrow rooms, cable alleys & rough ambient condition. This should consist of evaluation unit & sensor cable. The sensor cable shall be connected into evaluation unit.

Maximum sensor cable length connected to evaluation unit shall be 300 mtrs . Unit shall monitor the resistance of sensor cable. The operating voltage of the unit shall be 9-30V. The evaluation unit need to be connected with main fire Panel. It should be Vds approved as per EN 54-5A1.

2.08 FIELD ALARM DEVICES

Electronic sounders, combined sounder/strobe and standalone strobes shall be loop powered for direct connection to the 2 core detection loop shall be electrically compatible with all initiation devices. These wall mounted units shall be available in red or white and suitable for both indoor and outdoor applications with an ingress protection rating of IP31 and IP65 respectively.

All electronic sounders, sounder/strobe and strobe only versions shall have alarm signals synchronised across all the detection loops of the fire alarm control panel.

All alarm devices shall have a short circuit isolation device provided as an integral component of the device.

All sounders shall have a 'soft start' feature controlled by the fire alarm panel, whereby a low initial volume can be set and then increased at a defined rate upto a maximum volume setting.

All alarm devices shall be provided by the same manufacturer of the control system. No other make of detectors will be permissible The Fire alarm manufacturer shall have the complete range of following alarm devices with built in short circuit line isolators so as to meet the specific applications of the site.

2.08 (a) ADDRESSABLE SOUNDER / FLASHER

A combined electronic sounder and flasher shall be capable of providing a minimum sound level of 97dBA \pm 2dBA @ 1 metre.

The sounder shall be capable of providing 4 different sound signals which are selected/configured from 19 tone types store in the device.

The unit shall have its own microprocessor to handle loop communications and monitoring of the internal flasher element for faults in both the quiescent and alarm conditions. The microprocessor shall also monitor the sound producing element during an alarm condition to ensure that faulty devices can be automatically identified during the weekly test procedure.

All associated electronic components shall be hermetically sealed to provide protection from hostile operating environments.

The frequency of the electronic flasher light output shall be 1Hz

The unit shall be manufactured from ABS plastic with a polycarbonate lens. Body and lens colour shall be Red body / red lens.

These devices shall allow for direct connection to the detection loop. It shall be possible to connect upto 32 combined electronic sounder/flasher to each detection loop of the fire alarm control panel.

2.09 FIELD INTERFACE TRANSPONDERS

These devices shall be directly connected to the loop, four variants shall be available as standard, these being:

- (i) 4 In / 2 Out interface unit
- (ii) 1 In interface unit
- (iii) 32 LED output interface unit
- (iv) 12 Relay output Interface unit.

These units shall be self-contained wall mountable units, similar in finish to the main control panel.

(i) 4 In / 2 Out interface unit

Interface units shall be capable of accepting 4 input signals, 2 output signals. Dependent upon the specific application, input signals may be interpreted by the system as any of the following:

- Fire signal input
- Fault signal input
- Supervisory signal input
- Event signal input

The exact nature of which shall be selected by means of the commissioning software. These units will accept and or supply clean contact signals either normally open or normally closed (configurable) OR switched voltage inputs from conventional detectors or MCP's.

The output contacts shall be rated at 30V / 1 amp. DC output of the unit shall be provided with single pole change over contacts for control of plant, door release units or power output to drive conventional bells, sounders etc. Both the outputs on the interface shall be individually programmable. External power supply 12V / 24 VDC shall be provided to this unit

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications. Product shall be approved by VdS.

(iv) 12-Relay output interface units

These interface units contain 12 clean relays which are individually programmable with the commissioning software. All relays can be configured as NO or NC.

As with other outstations previously mentioned, interface units will contain local processing in order to handle all signaling and loop communications.

2.10 NETWORKING OF CONTROL PANELS

It shall be possible to network connect up to 31 controls as a secure network connection. All messages from a panel should be transmitted in both direction on the ring structure. Any wire-break or short-circuit on the ring shall not effect data transmission. The network shall be configurable so that single panels, groups of panels or all panels on the network operate the same site configured cause and effect fire plan.

The network shall also be configured to allow master control from any one of the control panels on the network. To cover longer distance repeaters or fibre optical cable and converters can be used between two panels.

The network shall be able to accommodate intruder alarm panels.

There shall be extensive diagnostic functions on the panel to be used to localize faults caused by interference or wiring, Networking shall be capable of carrying out using a data cable e. g IBM type 1 or CAT5. The distance between each panel shall be standard 1000 meters and capable of extending up to 3000 meters using booster repeaters.

2.11 NETWORKED LCD OPERATING PANELS / REPEATER PANELS

The Repeat Panel shall be sited at the Rear Entrance, guard house or location where it is manned 24 hrs.. It shall provide system repeat facilities to repeat all of the liquid crystal display messages as well as the common indications. Repeat panel shall be interfaced for network fire alarm control panels, designed for standardised display and operation as per DIN EN 54 part 2 and DIN VDE 0833 part 2. Installation and connection to FACP shall be via the short circuit and open circuit resistant essernet. System network. RS 485 interface or TTY interface for connecting remote printers, and fire brigade shall be available. The repeaters shall have minimum three common relays freely programmable, monitored, potential free upto 24 VDC.

2.12 BATTERIES :

Batteries shall be provided and shall be the dry sealed lead-acid type. The batteries shall have ample capacity. With primary power disconnected, to operate the fire alarm system for a period of 24 hours with an optional 72 hours battery backup. Following this period of operation via batteries. The batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 30 minutes.

2.13 WIRING

All cables associated with Fire Alarm installation shall be of fire resistant 2 core 1.5 sq. mm twisted pair . Cables shall comply with BS 6207 Part 1. The cable is to BS 6207: Part 1 having, Typically no more than 2 cores each core having 1.5 sq. mm cross sectional area, A red cover sheath (preferred for alarm applications), Having continuous metal sheath encapsulation, Fire resistant tested to BS6387 categories CWZ.

3.0 PART 3 - EXECUTION

3.01 INSTALLATIONS

The entire fire alarm system shall be installed in accordance with DIN / BS EN54/NFPA Standards and manufacturer's approved shop drawings, written instructions and recommendations.

3.02 TESTING

Fire alarm system shall be tested in accordance to Local Civil Defense regulations and put into operation by the manufacturer or his authorized representative in the presence of engineer. Fault and alarm conditions shall be simulated and all data and alarm indicators checked with full events recorded on system printer according to the testing procedure.

LIST OF APPROVED MAKE FOR LT PANEL

LT PANEL		
S.NO.	MATERIAL	APPROVED MAKES
1	CURRENT TRANSFORMER	AE/KAPPA / C &S/ RECO /NEWTEK CAST RESIN
2	PROTECTIVE RELAYS	ALSTOM/ L&T/ ABB
3	MCCB	ABB (ISOMAX) / SCHNEIDER (NSX/NX SERIES ONLY)/L & T - D SINE/SIEMENS - 3VL
4	STARTERS/CONTACTORS AC3 DUTY ONLY	ABB/SIEMENS/SCHNIDER
		(ASPER ONE RATING HIGH TO TYPE-2 COORDINATION)
5	PROTECTION RELAYS	ENGLISH ELECTRIC/ AVK-SEGC/EASUN REYROLLE, L&T/ ABB
6	METERS& EMS SOFTWARE	ELMEASURE/ CONZERV /RISHABH/L&T
	(FREQ. METER, DUAL SOURCE, KWH, MFM)	(FULL FEATURED EMS SOFTWARE)
7	AMMETER & VOLTMETER DIGITAL TYPE ONLY	KAYCEE/SALZER/ L&T /BCH/ELMEASURE/RISHABH/CONZE RV
	SELECTOR SWITCHES	
8	CONNECTORS	ELMEX /WAGO/CONNECTWELL
9	PUSH BUTTONS/IND LAMPS	TEKNIC/ SIEMENS /MIMIC/L&T/BCH
10	CHANGE OVER SWITCHES	HPL SOCOMEC /HH-ELCON (CSH SERIES)
11	APFCR/RTPFC RELAY	DUKATI/ENERCON (20MA SENSITIVITY)/ EPCOS
12	PANEL MANUFACTURER	CPRI APPROVED , TAC APPROVED , (PRIOR APPROVAL IS REQUIRED FROM CONSULTANT)
13	ELCB/RCCB/RCBO	MDS(LEGRAND) /MERLIN GERIN (MULTI-9) / L&T (HAGER)/ ABB
14	MCB (10 KA FAULT LEVEL)	MDS(LEGRAND) /MERLIN GERIN (MULTI-9) / L&T (HAGER)/ ABB
15	INDICATING LAMP,PUSH BUTTONS	SIEMENS /MIMIC/TECNIK
16	UPS & INVERTER	PCI/TATA LIEBERT/ EMERSON
17	SYNCHRONIZATION MODULE AND ALL SYNC RELATED HARDWARE	WOODWARD/ DEIF
18	STARTER RELAYS	ABB /SCHNEIDER /L & T /SIEMENS
19	BUSBAR	HINDALCO OR EQUIVALENT

Note :

Makes Marked in Red Color is preferred by Consultant.

All the materials to be ISI marked.

The materials shall be only of the approved makes as specified in this.

The contractor shall submit samples of all the makes as specified in this list and the consultant /

Employer shall have the power to select any of them.

Consultant / employer decision in this regard shall be binding on the contractor.

In case any material is not available for any one or all of these approved makes the consultant

Employer shall select and approve alternative make(s).

Supplier has to supply copy of original challan / bills on demand to owner. The consultant's decision regarding the use of material mentioned below or mentioned in schedule of quantities or equivalent will be final and binding on the supplier.

SIGNATURE OF TENDERER

LIST OF APPROVED MAKE ELECTRICAL WORKS

S.NO.	MATERIAL	APPROVED MAKES
1	PVC INSULATED COPPER CONDUCTOR PVC INSULATED & SHEATHED FLEXIBLE COPPER CONDUCTOR FR ISI MARKED	POLYCAB/HAVELL'S/FINOLEX/RR CABLE
2	PVC INSULATED TELEPHONE /CAT 6/ TV CABLE ISI MARKED FR	POLYCAB/HAVELL'S/FINOLEX/RR CABLE/LEGRAND
3	PVC CONDUIT PIPE ISI MARKED & ACCESSORIES	POLYCAB/AKG/PRECISION/BEC (FR GRADE)/KING
4	MODULAR TYPE FLUSH TYPE SWITCH ,SOCKET CEILING ROSE,LAMP HOLDER,CALL BELL	LEGRAND/ANCHOR/ROMA/L&T
5	MCB,ISOLATOR,RCCB,RCBO,MCB-DB	LEGRAND/L&T/HAVELL'S/C&S
6	XLPE INSULATED CABLE,AIR BUNCH CABLE	POLYCAB/HAVELL'S/FINOLEX/RR CABLE
7	LED FITTING & LUMINARIES	PHILIPS/BAJAJ/WIPRO/SYSKA
8	GI PIPE ISI MARK	TATA/SWASTIK/JINDAL/SURYA
9	ELECTRIC CEILING FANS(FIVE STAR RATING)	BAJAJ/ORIENT/CROMPTON/USHA
10	WALL MOUNTING FAN, CABIN FAN, EXHAUST FAN	BAJAJ/ORIENT/CROMPTON/USHA
11	EARTHING	ASHLOK
12	FIRE EXTINGUISHERS	FIREX/VIJAY/CEASE FIRE
13	BATTERY CHARGER	CHHABIELECTRICALS/LOGICSTAT/NELCO/EXCIDE
14	UPS & INVERTER	PCI/TATA LIEBERT/EMERSON/
16	TV SPLITTER	ISI MARK- STANDARD MAKE
17	BUILDING LIGHTNING ARRESTOR	ABB/ INDELEC/SCHNEIDER
18	RG-11 & RG-6 CABLE	FINOLEX/POLYCAB
19	INDUSTRIAL SOCKET	SCHNEIDER/ LEGRAND
20	IP66 INDUSTRIAL SOCKET	SCHNEIDER/ LEGRAND
21	ENERGY SAVER	SCHNEIDER- COOL LITE, JINDAL
22	POP-UP BOXES	LEGRAND/SCHNEIDER
23	SWITCH BOARD BACK BOX	LEGRAND/SCHNEIDER
24	FAN HOOK BOX	LEGRAND/ STANDARD MAKE
25	SANDWITCH BUSDUCT/RASING MAIN	LEGRAND/ SCHNEIDER
26	RACEWAY	MK/LEGRAND/LOCALLY FABRICATED WITH 16 GAUGE GI SHEET

27	OCCUPENCY SENSOR	PHILLIPS/SCHENIDER/LEGRAND
28	CABLE GLAND	COMET,CALTER(NATIONAL),COSMOS,JAINSON ASCON,SIGMA
29	CABLE LUG	COMET,CALTER(NATIONAL),COSMOS,JAINSON ASCON,
30	SFU, ACE,CHANGE OVER SWITCH (ON-LOAD), MCCB, SFU REWIREABLE),CHANGE OVER SWITCH(OFF LOAD), ATS BUSBAR.	LEGRAND, L&T, CROMPTON, C&S,HAVELL'S,
31	FAN /LUMINARIES CAPACITOR	ASIAN, UNI-STAR,BAJAJ,EPCOS,USHA
31	POWER CAPACITOR	L&T,NEPTUNE,C&S.
32	AMMETER, VOLT, METER, VOLTMETER, SELECTOR SWITCH ICTs,	AE, NEPTUNE,L&T, ELEMEASURE
33	CABLE JOINTING KIT	RAYCHEM, MAHINDRA, BIRLA, M-SEAL DENSON
34	SUBMERSIBLE/ OPENWELL /CENTRIFUGAL MOTOR PUMP SET	KIRLOSKAR, CROMPTON, V-GUARD, TEXMO ,CRI, KSB,
35	STARTER	KIRLOSKAR, CROMPTON, V-GUARD, TEXMO ,CRI, L&T

Note :

Makes Marked in Red Color is preferred by Consultant.

All the materials to be ISI marked.

The materials shall be only of the approved makes as specified in this.

The contractor shall submit samples of all the makes as specified in this list and the consultant /

Employer shall have the power to select any of them.

Consultant / employer decision in this regard shall be binding on the contractor.

In case any material is not available for any one or all of these approved makes the consultant

Employer shall select and approve alternative make(s).

Supplier has to supply copy of original challan / bills on demand to owner. The consultant's decision regarding the use of material mentioned below or mentioned in schedule of quantities or equivalent will be final and binding on the supplier.

Prior approval on product is mandatory where stand make is defined above.

SIGNATURE OF TENDERER

LIST OF APPROVED MAKE OF LOW VOLTAGE
SYSTEM (FIRE SAFETY)

Sr. No.	Item Description	Approved Make
1	Fire alarm system	Siemens-Fire Finder/ Simplex/ EST
2	Response Indicator	Agni/Equivalent
3	Telephone Jack & Phone	A-Square/ ATIES
4	CCTV Camera	Hikvision/CP Plus/ Dahua
5	CCTV-NVR	Hikvision/CP Plus/ Dahua
6	CCTV Server	IBM/ Dell
7	Monitor 24X7 Duty Operation	Samsung/LG/ Lenovo
8	Public address system	BOSCH / Honeywell
9	All Cables	Finolex/Polycab/RR Kable/Belden
10	POE Switch	CISCO/HP
11	Cat - 6 Cables	Molex/ AMP
12	EPABX	Alkatel/ AVAYA
13	UPS & INVERTER	Tata /Emersion/ APC/PCI
14	Battery	Exide/Standard/ Amco
15	Battery Charger	Chhabielelectricals/Logicstat/Nelco/Exide
16	PVC Conduits	Polycab/ Precision/ AKG/KING
17	Heavy Duty Conduit Accessories	Polycab/ Precision/ AKG/KING
18	Switches, Sockets, Telephone & TV Outlet Boxes etc.	Mk (Blenz)/ MDS (Myris)/Schneider
19	All Cables- FRLS	Polycab/Prime cab/Lapp/Finolex
20	Wires - Copper Type	Finolex(FRLS)/Rr Kable(FRLS) / Havells (FRLS)/Polycab(FRLS)
21	Telephone Wire	Delton/Rcable/Finolex
22	Telephone Cable	Finolex/Delton/Nicco
23	Cable Tray	Indiana/Elecon/Storack/Patny
24	Computer Cable And RJ 45 Connector Socket	Molex/ Amp
25	MCB (10 KA Fault Level)	MDS (Legrand)/SCHNEIDER / L&T (Hager)/ ABB
26	GI Trunking	ABB / MK Electric/ or Equivalent
27	BTU Meter	Landis & GRS/Shenitec/Kampstrup/Sinro
28	CO2 Sensors	Honeywell/ Greystone/ Siemens
29	Access Control	HID/Lilin
30	Door Interlocking	Smart I/TS
31.	Magnetic Lock	Algatech/XPR
32	NO touch Sensor	Branded ISI Marked
33	Fiber Optic Cable	Molex/ Amp
34	Hard Disk	Seagate
35	SERVER ROOM GAS SUPPRESSION SYSTEM	SEIMENCE.
36	AUDIO CONFERENCE SYSTEM OF SAME MAKE WHICH IS AVAILABLE	EXISTING MAKE

Note:

1. All the materials to be ISI marked.
2. The materials shall be only of the approved makes as specified in this.
3. The contractor shall submit samples of all the makes as specified in this list and the consultant / Client Suggestion
4. Employer shall have the power to select any of them.
5. Consultant / employer decision in this regard shall be binding on the contractor.
6. In case any material is not available for any one or all of these approved makes the consultant
7. Employer shall select and approve alternative make(s).
8. Supplier has to supply copy of original challan / bills on demand to owner. The consultant's decision regarding the use of material mentioned below or mentioned in schedule of quantities or equivalent will be final and binding on the supplier.

TECHNICAL SPECIFICATIONS OF HVAC

A) AIR HANDLING UNITS:

DOUBLE SKIN AIR HANDLING UNITS (Also Fan Sections)

1.0 SCOPE:

The scope of this section comprises the supply, erection, testing and commissioning of double skin air handling units, conforming to these specifications and in accordance with requirement of drawings and of the Schedule of Quantities.

2.0 TYPE:

The air handling units shall be double skin construction of approved make having filter section with filters coil section with chilled/ hot water coil with insulated condensate drain pan, and centrifugal fan. Units shall be of the arrangement as mentioned in the Drawings and mentioned in Schedule of Quantities.

3.0 CAPACITY:

The air moving capacities and maximum motor horse power shall be as mentioned Drawings and in Schedule of Quantities.

4.0 HOUSING/CASING:

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 knock down conditions depending upon the locations. The Frame work shall be of Extruded Aluminum hollow sections with thermal barrier. The entire frame shall be assembled using mechanical joints to make a sturdy & strong frame work for various sections.

Double skin panels shall be made of 0.63 mm thick plain galvanized preplasticised on outside and 0.63 mm thick plain Galvanised sheet inside with P.U. foam of 38 Kg/m³ density (min) insulation injected in between two turned finished panels of 25 mm /45-48 mm thickness. These panels shall be bolted from inside / outside on to the frame work with soft rubber gasket in between to make the joints air tight.

Frame work for each section shall be bolted/screwed together with soft rubber gasket in between to make the joints air tight. Suitable doors with aluminium die cast hinges and latches shall be provided for access to various panels for maintenance. The entire housing shall be mounted on extruded Aluminium channel frame work.

Drain Pan shall be constructed of 18 G stainless steel SS 304 with slope on all sides, leading to a common drain point so as to facilitate fast removal of condensate. The drain pan shall be of single piece construction with minimum joints. All joints will be properly welded & be leak proof. Necessary supports will be provided to slide the coil in the drain pan. Drain outlet shall be provided on one side of drain pan as required by site conditions.

Damper shall be opposed blade double skinned airfoil aluminium to be provided to discharge side section with integral gasket and assembled within a rigid extruded aluminium alloy frame. All linkages and supporting spindles shall be made of aluminium or nylon, supported in Teflon bushes. Spindle shall be provided with a bake lite knob for locking the damper blades in position. Linkages shall be extended wherever specified for motorized operation. Damper frames shall be sectionalized to minimize blade wrapping. Air leakage through dampers when in the closed position shall not exceed 1.5% of the maximum design air volume flow rate at the maximum design air total pressure. Inspection window shall be provided for inspection during running conditions. Inspection door with proper handles shall be provided on the motor side for its easy removal. It should be interlocked to a limit switch which will start the lighting which the cover is open when the cover is open it should be interlocked with motor so as to trip it if cover is opened.

5.0 MOTOR AND DRIVE:

Fan motors shall be 415 +/- 10 volts, 50 cycles three phase AC supply squirrel cage, TEFC motors. Motors shall be specially designed for quiet operation and motor speed shall not exceed 1450 RPM. Fan motors shall be mounted inside the AHU casing on slide rails for easy belt tensioning. Drive to fan shall be provided through belt-drive with a standard belt guard housing the belt and adjustable pulley sheave. Belts shall be of the oil-resistant type.

6.0 FAN:

Fan wheel and housing shall be fabricated from heavy gauge steel. Fan wheels shall be of the double width, double inlet forward / backward curved (as specified in BOQ) multi-blade type enclosed in a housing and mounted on a common shaft. Each AHU shall have single short shaft fan (multiple fans in one AHU will be used only after prior approval of consultant.) Fan housing shall be made of die-formed steel sheets with stream lined inlets and guide vanes to ensure smooth air flow into the fans. Bearings shall be pre-lubricated sealed for life type. Bearings shall be mounted externally for servicing without dismantling of the unit. All rotating parts shall be statically and dynamically balanced. Fan speed shall not exceed 1000 RPM and maximum fan outlet velocity shall be within 550 meters per minute (1800 FPM). The fan shall be mounted on spring woods/cushy foot mounts. It shall be connected to AHUs horizontal by means of flexible double folded cloth/eq. flexible material.

Maximum fan outlet velocity : 9.14 m/sec (1800 fpm)

Maximum fan speed for DIDW forward/backward curved centrifugal fan :

- | | | | |
|----|------------------------------------|---|----------|
| a. | Fan above 450 mm dia | : | 1000 RPM |
| b. | Fan up to and including 450 mm dia | : | 1450 RPM |

Maximum fan motor speed of DIDW fans : 1450 RPM

In case of AHU's with higher static pressure and those having, backward curved fans, higher RPM may be accepted, after approval from consultant.

7.0 COOLING/HEATING COILS:

Chilled water/hot water coils shall have 12.5/15 mm dia tubes min. 27 gauge thick with aluminium fins firmly bonded to copper tubes by mechanical expansion of copper tubes assembled in stainless steel frame cooling coil shall be integrally finned type. Face and surface areas shall be such as to ensure rated capacity from each unit and such that the air velocity across each coil shall not exceed 500 to 550 feet per minute. The coil shall be pitched in the unit casing for proper drainage. Each coil shall be factory tested at 21 Kg./Sqcm. air pressure while submerged in water. Tube shall be mechanically expanded for minimum thermal contact resistance with fins. Fin spacing shall be 11 to 13 fins per inch (4-5 FINS/CM). Coil shall have copper header with M.S. adopter.

Minimum spacing between two sets of coils in series shall be 450 mm. The number of shall be as per BOQ.

Coils in Two banks (one above another) shall have an additional stainless steel flat drain pan between two banks, which will drain to main drain pan below through rigid pipes.

8.0 FILTER:

Each unit shall be provided with a factory / assembled filter section containing washable expanded viscous metal or dry synthetic media type air filters having extruded aluminum frame. The media shall be supported with aluminum mesh on sides. Filter Media is 100% non-woven electronically enhanced synthetic media. The media is supported by an expanded metal continuously laminated on the air leaving side to provide pleat stability while eliminating flutter. Pleat design is a V-Pleat configuration that aids in reducing pressure drop and energy costs and allows total media usage, providing maximum airflow. Frame shall be two-piece

construction, made of a heavy duty 24 point moisture resistant material. Diagonal and horizontal support members shall be bonded to the media on both sides.

9.0 Pre Filter (EU 4)/10 Micron

Pre-Filters shall be washable HDPE type in AL •frame construction and shall be 50 mm thick. Filter shall be rated either as class 1 or class 2 in accordance with /J S UL900. The filters shall be with 90% efficiency down to 10 microns, and the design velocity across the filter shall not exceed **1.8 meters per second**. The pressure drop through the filter shall not exceed 5.0 mm while clean. Filter shall be supported by a wire mesh and frame. All filters should be complying EN779 :201 1, EN 1822 as applicable.

10.0 ISOLATOR:

Vibration isolators shall be provided in all floor mounted air handling units and AHU mounted within the ceiling space shall be hung through vibration isolation suspensions.

11.0 ACCESSORIES:

Each air handling unit shall be provided with Auto air vent at high point in the cooling coil and drain plug in the bottom of the coil. In addition, the following accessories may be required at air handling unit, their detailed specifications are given in individual sections, and quantities separately in Schedule of Quantities.

- a) Fixing of motorized three/two way valves located in chilled water / Hot water lines connecting to the coil. This valve shall be operated by the cooling sensor and shall control the flow of chilled water (to be priced separately).
- b) Insulated butterfly valves/balancing valves, `Y' strainer, Flanges and condensate drain piping, upto sump or floor drain in air handling unit room, as described in section "Piping". (to be priced separately).
- c) Temperature gauges and pressure gauges (with cocks) within gauge ports in chilled water supply and return lines. (to be priced separately).
- d) Weather Proof light in Fan Section.
- e) Limit Switch.
- g) Wire Guard.

12.0 PAINTING:

Shop coats of paint that have become marred during shipment or erection shall be cleaned off with mineral spirits, wire brushed and spot primed over the affected areas, then coated with enamel paint to match the finish over the adjoining shop painted surfaces.

13.0 PERFORMANCE DATA:

Air handling units shall be selected for the lowest noise level of the equipment. Fan performance rating and power consumption data with operating points clearly indicated shall be submitted with the tender or during execution stage and verified at the time of testing and commissioning of the installation.

14.0 TESTING:

Capacity of various air handling unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow

measurements will be taken by accurate flow measuring device and temperature measurements drive and temperature measurements will be taken by accurately calibrated mercury-in glass thermometers. Computed results shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

NOTES:

1. Wherever there is space constraint for installing the AHUs, the AHUs may be provided with two fans (instead of one) connected to single shaft, with a single drive motor.
2. Vertical AHUs shall be provided with motor access doors on the sides, as well as in the front, as a standard.
3. AHUs having mixing box, TFA AHUs and any other AHU not surrounded by return air, will be provided with thermal break profiles.
4. Roof mounted AHUs and those AHUs which are exposed to atmosphere, shall be provided with reinforced, weather proof canopy of thick GSS sheets, having same finish as AHU outer skin.

B) FAN COIL UNIT

The Fan Coil Units will be made out of GI sheet steel with forward curved fan and three row chilled water coil. The entire FCU will be powder coated and will be provided with filter box. The FCU will also be provided with auxiliary drain pan (sand witched insulated). The drain connection will be made from both the drain points of main drain tray and the auxiliary drain pan. The construction drawing of the FCU will be approved by the Consulting Engineer / Employer and the successful tenderer will have to take specific approval as regards to the installation & various connections from the Consulting Engineer. All the FCUs being installed, as exposed units should be provided with decorative, powder coated extruded sectioned aluminum grille with approved colour shade. The grilles for the FCU shall be measured separately and paid. The FCU should be designed in a manner that the drain tray is housed within the body of FCU. The FCU shall be front accessible type and of draw through type construction.

C) DECORATIVE CHILLED WATER HI-WALL SPLIT / CASSETTE UNITS

1.0 TYPE

The 4 way / 1 way cassette type & Hi-all (split) unit shall be of the factory assembled and of integral fan type with chilled water cooling coil and cassette shall be made for ceiling mounted type, Hi-wall shall be made for wall mounted. The decorative grill and the Panel shall be made with ABS and the Inner coil holding body Cabinets shall be fabricated out of 0.8 mm gauge G.S.Sheet. 4 way / 1way cassette and Hi-wall Unit shall be complete with necessary valve station.

2.0 MOUNTING

The concealed 4 Way / 1 way cassette type coil unit shall be securely attached to the slab with threaded rod and shall be set dead level in both directions. Hi-Wall type coil unit shall be wall mounting

3.0 COILS

Coil shall be constructed of aluminium fins mechanically bonded to copper tubes. The minimum fin thickness shall Not be less than 0.0055" and tubes dia shall be not less than 7.00

mm O.D. and the minimum wall thickness of the tube shall not be less than be 0.3 mm. Coil shall be tested at 17 bar while submerged in water. The coil shall be factory assembled and tested for intensity test pressure and the test certificate shall be submitted.

4.0 DRAIN PAN

Drain Pan shall be provided under the cooling coil, supply and return lines. The pan shall be of sufficient size to catch all drippage of condensation from any part of the unit. The drain pan for Cassette unit shall be sold insulating EPS or as per the manufacturer supply as a standard part and shall be insulated with not less than 12 mm thick thermal EPS / polyurethane sheet to effectively prevent condensation from the pan. The drain pan for valve station is also to be shall be of sufficient size to catch all drippage of condensation from any part of the unit. With insulation to effectively prevent condensation from the pan.

5.0 MOTORS AND FAN

Motor shall be of the split capacitor type and shall have sufficient torque to start on low speed. The motor shall suitable for the current characteristics set out. The motor shall be PSC type motor and have built-in thermal over load protection. Fans shall be of Screw Fan with Forward curve mounted on a vertical axis type direct driven by motor. Motor shall be suitable for 220 - 240V/1Ph/50Hz Power supply.

6.0 FAN SPEED CONTROL / ROOM THERMOSTAT ASSEMBLY.

The unit shall be complete with remote fan speed control switch (either high – medium – low - off). The room thermostat / 3 speed switch will be mounted on a single decorative plate on the location approved by the Engineer.

7.0 TEMPERATURE CONTROL

The unit shall have temperature control by way of a 3 way modulating valve operated by a thermostat.

8.0 FILTER SECTION

Pre-filters (70 % efficiency down to 20 microns), 2 ~ 2.5 mm thick.

Fan Coil Units shall be 4 way cassette type with decorative panel, Drain pump, and drain Pan, Fan and wireless remote control.

9.0 NOISE LEVEL

The Noise Level of the Fan Coil Unit must be within acceptable limits. The Contractor shall note that, if in the opinion of Consultant Engineer the noise level is unacceptable, Contractor has to carryout necessary remedies / alterations as are deemed necessary to reduce noise level to acceptable limits. The noise level based on the capacity of the units shall be within 45 dbA ~ 54 dbA at 1 mtr level from the unit.

10.0 MODE OF MEASUREMENT

Representatives from the Contractor and Clients Engineer/Consultants Engineer shall conduct a joint inspection of the Equipments. All the discrepancies observed either incomplete works or defective work shall be clearly indicated in the joint inspection report. The mode of measurements given below is for the purpose of measurement and payment and the scope of works shall be as specified elsewhere in the specification.

D) PIPING & VALVES:

1.0 SCOPE:

The scope of this section comprises the supply and laying of pipes, pipe fittings and valves, testing and balancing of all water and refrigerant piping required for the complete installation as shown on the drawings. All piping inclusive of fittings and valves shall follow the applicable Indian Standards.

2.0 CHILLED WATER PIPING:

- 2.1 All chilled water and condenser water pipes and fittings shall be of , MS class 'C' (heavy class) conforming to BIS 1239 Latest & revision for pipe size upto 150mm dia and for pipe size 200mm dia and above shall be as per BIS 3589 having minimum 6mm thickness. All jointing in the pipe system shall generally be by welding, unless otherwise mentioned, or directed at site. All welding shall be done by qualified welders and shall strictly conform to Indian Standards code of procedure for manual metalarc welding of Mild steel as per BIS 823.
- 2.2 All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. All chilled water piping will rest on treated teakwood blocks neatly machined to the radius of pipes and seated on MS angles/channel and support Rods. All welded piping shall be subjected to the approval at site.
- 2.3 Fittings shall be of malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be weldable type.
- 2.4 Tee-off connections shall be through equal or reducing tees, otherwise ferrules welded to the main pipe shall be used. Drilling and tapping of the walls of the main pipe shall not be resorted to.
- 2.5 Ball valve, Butterfly valves, globe valve, conforming to the following specifications, shall be provided as shown on drawings:

Size	Construction	Ends
15 to 40 mm	Gun metal Body, Steel spindle	Screwed, ends
50 mm and above	Body cast iron spindle and valve seat of Bronze or Gun metal. (in case of butterfly valve)	Flanged

- 2.6 All valves shall be heavy duty conforming to CPN 10 to 16 rating as per mention on BOQ. Valves shall have non rising spindles unless otherwise specified and shall be suitable for minimum 16 Kg. per sq. cm. gauge working pressure.

Butterfly valve shall perform the function of isolating valves also , Butterfly valves shall have cast iron body with black nitrile seat. All Butterfly valves shall be provided with lever locking devices and valves above 250 mm dia shall be gear driven. The Butterfly valve shall as per CPN 16 rating.

All AHU's shall be provided with balancing/ control valves with built in pressure drop measuring facility.

- 2.7 Flanges shall be as per ASA-150. The supply of flanges shall also include supply of bolts and nuts and suitable nitrile rubber & rubber insertion gaskets (minimum 3mm thick).
- 2.8 Non-return (check) valves shall be provided as shown on the drawings, conforming to BIS 778 and IS 5312 (Part I) and in accordance with the following specifications.

Size	Construction	Ends
10 to 40 mm	Gun Metal	Screwed
50 mm and 150	Cast Iron/Gun Metal	Flanged plate

200mm to 450 mm	Body casting iron, plate	Flanged carbon steel with 13% chrome overlay
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The spring and hinge/stop pin shall be SS 304 and bearing fire material. Valves shall suitable for not less than 10 Kg per Sqcm gauge working pressure.

Non-return valves shall be as per approved make. Dual Plate Swing type check valves shall normally be used in all water services. Lift type valves may be used in horizontal runs. Valves shall be suitable for minimum 16 Kg per sq.cm. gauge working pressure.

- 2.9 Strainers shall be of 'Y' type or pot strainers or Suction Guides cum Strainers as shown on the drawings, with cast bodies designed for the test pressure specified for the gate valves. Strainers shall have bronze screen with 3mm perforations. Screen shall be removable and replaceable without disturbing of the main pipes. All strainers shall be provided with equal size isolating gate, butterfly valves with non rising spindle so that the strainer may be cleaned without draining the system. Strainers shall be provided on the inlet side (at suction) of each pump, and where shown on the drawings. Suction guides with SS queen of 135 mesh shall be provided on all pump suction.
- 2.10 All chilled water piping and fitting shall be pressure tested, then insulated as described under the section "Insulation".
- 2.11 After all chilled/condenser water piping has been installed. The piping system shall be thoroughly cleaned strainers shall be cleaned once again after flushing of lines. Pressure testing shall be carried out on all piping. Test pressure shall be maintained for minimum continuous 24 hours without any drop in pressure.. The piping fittings & supports shall be painted with one coat of red oxide primer & two finish coats of 3 mils each of approved color of synthetic enamel paint conforming to IS 2379. The direction o flow of fluid in the pipes shall be visibly marked with identifying arrows.
- 2.12 Auto Air Vent/Drain valve of suitable size shall be provided in the Chilled/Condenser water piping at highest point and at lowest points in the risers respectively. AAV& drain valves shall also be provided at other locations where required.

3.0 COLD WATER AND DRAIN PIPING:

- 3.1 All pipes to be used for cold water (makeup), drain, and condensate drain shall be approved make and fittings of 6 KG / CM² pressure rating Rigid PVC Pipes.
- 3.2 Condensate from the evaporator unit shall be drained through properly installed drain piping designed to prevent any accumulation of condensate in the drain pan. Drain piping shall be made of 20mm dia /25mm dia / 32mm dia / 40mm dia / 50mm dia rigid PVC pipe of 6 Kg/Sq cm. pressure rating with water tight threaded connections, leading from the room unit to a suitable drain point. Complete drain piping shall be made leak proof and water tight by means of precise installation and the use of leak proof sealant/adhesives. Insulation of drain piping by 6 mm thick Nitrile Rubber 'O' class pipe section. Cold water piping within the building may also be insulated.

4.0 PIPING INSTALLATION:

- 4.1 Tender drawings indicate schematically the size and location of pipes. The contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air

auto vent valves, and all pipe supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

- 4.2 Piping shall be properly supported on, or suspended from, stands, clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.
- 4.3 Pipe supports shall be of steel, adjustable for height and primer coated with rust preventive paint and finish coated black. Where pipe and clamps are of dissimilar materials, a gasket shall be provided in between spacing of pipe supports shall not exceed the following:

Pipe Size	Spacing between supports
Upto 12mm	1.5 meter
15 to 25mm	2.0 meter
30 to 150mm	2.0 meter
Over 150mm	2.5 meter

- 4.4 Vertical risers shall be parallel to walls and column lines and shall be straight and plumb. Risers passing from floor to floor shall be supported at each floor by clamps or collars attached to pipe and with a 15mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.
- 4.5 Pipe sleeves, 50mm larger diameter than pipes, shall be provided wherever pipes pass through walls and slabs, and annular space filled with fiberglass and finished with retainer rings.
- 4.6 Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15cm on both sides of the clamp, saddles or roller.
- 4.7 All pipe work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings, rods and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipe supports, pipe and pressure testing for each area shall be carried out in one stretch.
- 4.8 Cut-outs in the floor slab for installing the various pipes are indicated in the drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where ever the cut- outs shown in the drawings, do not meet with the requirements. Workable alternatives may be suggested in such cases.
- 4.9 The contractor shall make sure that the clamps, brackets, clamps saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes, and include expansion Loop where required.
- 4.10 All pipes shall be accurately cut to the required sizes in accordance with IS 554 and burrs removed before laying. Open ends of the piping shall be closed as the pipe is installed to avoid entrance of foreign matter. Where reducers are to be made in horizontal runs, eccentric reducers shall be used for the piping to drain freely. In other locations, concentric reducers may be used.
- 4.11 Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres wherever shown in approved for construction to facilitate future cleaning of all welded pipes.
- 4.12 Auto Manual air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15 mm pipe size and shall be associated with an equal size gate valve.

- Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.
- 4.13 Pressure gauges as specified under section "Automatic Controls and Instruments", shall be provided at the suction and discharge of chilled water/condenser water pumps supply and return at air handling units, at chillers and at condensers, as shown on the drawings and included in schedule of quantities. Care shall be taken to protect pressure gauges during pressure testing.
- 4.14 Temperature gauge as specified under section "Automatic Controls and Instruments" shall be provided at each Air handling unit's Supply / Return Chilled water line, at chillers, and condensers, as shown on drawings and included in schedule of quantities.

5.0 PASSIVATION OF WATER PIPING

The M. S. pipe line should be passivated by following method-

- Rinse the M. S. pipe line with water 4 times to remove all dust & dirt.
- Circulate mild solution (@5%) of Sulphuric acid or oxalic acid for 24 HRS.
- Rinse the M. S. pipe line with water to remove the acid content. Circulate mild solution (@2%) of Caustic soda for 24 HRS and rinse the line with water.
- Circulate solution of SODIUM HEXA META PHOSPHATE in ratio of 10 Gm. per Liter for 12-14 hours.
- Drain the solution and check the pipe surface. If found O. K. fill the line again and drain again before final charging of fresh soft water.

A required dosing of Anti-Oxidant is required to add periodically.

The sample of water which will be used for the chilled water system shall be analyzed by the successful contractor free of cost. The analysis report shall be submitted to PMC / Owners / Owner's representative with the recommendation as to any changes in water input is required.

6.0 TESTING & BALANCING:

- 6.1 All piping shall be tested to hydrostatic test pressure of at least two and half times the maximum operating pressure, but minimum not less than 10 Kg per sq.cm. gauge for a period of not less than 24 hours. All leaks and defects in joints revealed during the testing shall be rectified contractor shall get such rectification approved at site.
- 6.2 Piping repaired subsequent to the above pressure test, shall be re-tested in the same manner.
- 6.3 System may be tested in sections and such sections shall be securely capped, then retested for entire system.
- 6.4 The contractor shall give sufficient notice to all other agencies at site, of his intention to test a section or sections of piping and all testing shall be witnessed and recorded by Owner's site representative.
- 6.5 The Contractor shall make sure that proper noiseless circulation of fluid is achieved through all coils and other heat exchange equipment in the system concerned. In case of improper circulations, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications. Including the tearing up and re-finishing insulation of floors and walls as required false ceiling.
- 6.6 The contractor shall provide all materials, tools, equipment, instruments, services and labour required to perform the test and to remove water resulting from cleaning and after testing.

- 6.7 After completion of the installation, all water system shall be adjusted and balanced to deliver the water quantities as specified, quoted or as directed, to individual air handling units and fan coil units cooling coil.
- 6.8 Water circuit shall be adjusted by balancing cocks provided for balancing; these shall be permanently marked after balancing is completed so that they can be restored to their correct positions, if disturbed.
- 6.9 Complete certified balancing report shall be submitted for evaluation and approval. Upon approval, four copies of the balancing report shall be submitted with complete drawings and documents.
- 6.10 Painting of condenser water pipes as per approved color.

7.0 Mode of Measurement

The measurement shall be taken along centerline measuring meter including all bends, tee, etc. but excluding valves which shall be paid as unit rate item.

E) AIR DISTRIBUTION SYSTEM:

1.0 GENERAL:

Ducts shall be made of either galvanized steel sheet as specified in the BOQ and confirm to BIS 655, BIS 277, BIS 737 & SMACNA .The ducts shall be factory made as per list of makes. The galvanized steel sheet shall confirm to IS-277. Aluminium sheet shall confirm to IS-737 the duct construction shall be as follows-

2.0 RAW MATERIALS:

Galvanizing shall be Class VII – light coating of zinc, nominal 120gm/sq.m surface area and Lock Forming Quality prime material along with mill test certificates. In addition, if deemed necessary, samples of raw material, selected at random by owner's site representative shall be subject to approval and tested for thickness and zinc coating at contractor's expense.

2.1 For Ducts with External SP upto 250 Pa (50mmWg)

Rectangular	Pressure 500 Pa		
Ducts G. S.	Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	Gauge	Joint Type	Bracing Spacing
1–500 mm	26	C&S Connector	Nil
501-750 mm	26	C&S Connector	Nil
751-900 mm	26	TDF Flange	Nil
901-1200 mm	24	TDF Flange	Nil
1201-1500 mm	22	TDF Flange	JTR or ZEE BAR
1501-1800	22	TDF Flange	JTR or ZEE BAR

- 2.2 Kitchen exhaust ducting shall be with 16 G MS welded construction. Suitable access doors shall be provided at every 3m. Provision shall be made for firefighting agency to install duct mounted sprinklers at every 3m. Generally exhaust ducts shall have slope towards kitchen hood. Spot Welded M.S Stuck-up pins shall be provided facilitating insulation of the Duct.

Sheet metal ducts shall be fabricated out of galvanized steel sheets conforming to BIS 655, BIS 277, BIS 737 & SMACNA. Sheets used shall be produced by Hot dip process and galvanizing shall be Class VIII- Minimum Average Coating as per BIS 277: 1992.

3.0 HANGERS FOR DUCT:

Duct Size (mm)	Spacing (M)	Size of MS angle (mm x mm)	Size of rod dia (mm)
Upto 750	2.5	40 x 3	10
751 to 1500	2.0	40 x 3	12
1501 to 2250	2.0	50 x 3	15
2251 to above	2.0	50 x 3	15

4.0 FABRICATION:

All ducts shall be factory fabricated complete with joints and supports and installed in workman like manner, generally conforming to IS 655. Round exposed ducts shall be die formed for achieving perfect circle configuration.

- a) Ducts so identified on the drawings shall be acoustically lined with thermal insulation as described in the section 'Insulation' and as indicated in schedule of quantities. Duct dimensions shown on drawings are overall sheet metal dimensions inclusive of the acoustic lining, where required and indicated in schedule of quantities.
- b) Ducts shall be straight and smooth on the inside with neatly finished joints. All joints shall be made air tight.
- c) All exposed ducts within conditioned spaces shall have slip joints - no flanged joints. The internal ends of slip joints shall be made in the direction of air flow.

Exposed ducts, where required or as indicated in Schedule of quantities, shall be painted with two coats, of enamel paint of approved colour. Ducts and accessories within ceiling spaces, visible from air conditioned areas shall be provided with two coats of mat black finish paint.

- d) Changes in dimensions and shape of ducts shall be gradual. Curved elbows, unless otherwise indicated, shall have a centre line radius equal to one and a half times the width of the duct. Air turns vanes shall be installed in all bends & elbows, arranged to permit the air to make the turn without appreciable turbulence. Suitable vanes shall be provided in duct collar to have uniform/ proper air distribution.
- e) Ducts shall be fabricated as per details shown on drawings. All ducts shall be rigid and shall be adequately supported and braced where required with standing seams, tees, or angles of sample size to keep the ducts true to shape and to prevent bulking, vibration or breathing.
- f) All sheet metal connections, partitions and plenums required to confine the flow of air to and through 18g GI/16 gauge aluminium, thoroughly stiffened with 25mm x 25mm x 3mm angle iron braces and fitted with all necessary doors as required to give access to all parts of the apparatus. Access Doors shall be not less than 45cm x 45cm in size. VCDs shall be provided to balance air quantity in each branch.

5.0 INSTALLATION:

All ducts shall be installed generally as per the drawings and in strict accordance with approved shop drawings to be prepared by the Contractor.

- i. The Contractor shall provide and neatly erect all sheet metal work as may be required to carry out the intent, of these specifications and drawings. The work shall meet with the approval of Owner's site representative in all its parts and details.
- ii. All necessary allowances and provisions shall be made by the Contractor for beams, pipes, or other obstructions in the building, whether or not the same are shown on the drawings. Where necessary to avoid beams or other structural work, plumbing or other pipes, and/or conduits, the ducts shall be transformed, divided or curved to one side, the required area being maintained, all as per the site requirements.
- iii. If a duct cannot be run as shown on the drawings, the contractor shall install the duct between the required points by any path available, in accordance with other services and as per approval of Owners site representatives, so as to meet desired conditions.
- iv. All duct work shall be independently supported from building structure. All horizontal ducts shall be rigidly and securely supported, in approved manner with trapeze hangers formed

of MS rods and angle iron under ducts at not greater than 2 meter centres. All vertical duct work shall be supported by structural members at each floor. Air conditioning contractor shall supply and install 50mm cube MS boxes with 10mm dia steel rod passing through box, all given two coats of red oxide paint, the MS rod tied with reinforcement bar at point of suspension shall be neatly exposed and opening subsequently filled with plastic compound after duct hangers are installed.

If duct is passing through in such areas where space between ceiling slab to false ceiling is more than 1500 mm then duct should be supported by wall mounted brackets of 40 x 40 x 3 mm angle.

- v. Ducting over furred ceiling shall be supported from the slab above, or from beams, after obtaining approval of Owner's site representative. In no case shall any duct be supported from false ceiling hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other contractors on the building.
- vi. Where metal ducts or sleeves terminate in wood work, tight joints shall be made by means of closely fitted heavy flanged collars. Where ducts pass through brick or masonry opening and wooden frame work shall be provided within the opening and crossing ducts provided with heavy flanged collars on each side of wooden frame work, so that duct crossing is made leak-proof.
- vii. All ducts shall be totally free from vibration under all conditions of operation. Whenever duct work is connected to fans, air handling units or blower coil units that may cause vibrations in the ducts, ducts shall be provided of closely woven, rubber impregnated double layer asbestos/canvas or neoprene coated fibre glass fire resistant flexible connection. The flexible connections located close to the unit, in mutually perpendicular directions. The flexible sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting duct work rigidly held by independent supports on both ends. The flexible connection shall be suitable for pressures at the point of installation.
- i. Air conditioning unit and exhaust fans shall be connected to duct work by inserting at air inlet and air outlet a double canvas sleeve. Each sleeve shall minimum 150 mm securely bolted to duct and the connecting duct work rigidly held in line with unit inlet or outlet.

Mode of Duct Measurement

The periphery of duct piece will be calculated $(A+B) \times 2 \times L = \text{Area}$. Centre length of the piece will be measured. In case of tape the peri. will be worked and on average of both ends and center length of the piece $[(A_1+A_2)/2 + (B_1+B_2)/2] \times 2 \times \text{Length}$.

Where A and B are dimension of the piece.

Bends shall consider the center line length for computing area.

6.0 SPLITTERS AND DAMPERS:

All dampers shall be opposed blade type dampers of robust construction and tight fitting. They shall be made of G.S. sheet minimum 16 g thick and shall have brass bushes. The design, method of handling, and control shall be suitable for the location and service required.

Dampers shall be provided with suitable links, levers and quadrants as required for their proper operation control or setting devices shall be made robust, easily operatable and accessible through suitable access doors in the ducts. Every damper shall have an indicating device clearly showing the damper position at all times. Handles and knobs voided with extended arms to account for insulation thickness.

Dampers shall be placed in ducts and at every branch supply or return air duct connection, whether or not indicated on the drawings, for the proper volume control and balancing of the system.

7.0 MOTORISED COMBINATION SMOKE & FIRE DAMPER:

All supply/return air duct or path at AHU room wall or slab crossing shall be provided motorized combined smoke and fire damper. The fire rating shall be of 90 minutes fire damper blades and outer frame shall be formed of 1.6mm galvanized sheet steel. The damper blade shall be provided spindles in self lubricated bronze bushes, stop seals shall be provided on top and bottom of the damper housing made of 16g galvanized sheet steel. Side seal shall be provided to preventing fine leakages. Fire damper shall be kept open during normal mode with the help of 230 V operated electric actuators spring to providing maximum air passage without creating any noise or actuated either through electric actuator or through UL stamped electro-thermal link. The actuator shall be energized with the help of a signal from smoke detector installed in AHU room / RA duct/damper. The fire damper shall also close due to temp rise in SA. Ducts through the electronic temp sensor factory set at 165 deg F, micro switches with Bakelite base will be provided to stop fan motor & give open & close signal at remote panel in case of closing of motorized damper. In case of power failure the damper shall closed and automatically open (with spring) in case of power is 'ON'.

8.0 SUPPLY AND RETURN AIR GRILLES:

Supply and return air grilles shall be anodized extruded aluminium construction with individually adjustable bars as shown on drawings and indicated in schedule of quantities. Supply air grilles shall be removable key operated volume control dampers. Return air grilles shall be similar to supply air grilles but without dampers. All supply and return air grilles behind wooden grilles shall be single deflection type with one way bars only, the supply air grilles being provided with removable key operated volume control dampers. Aluminium supply and return grilles shall be powder coated and to have color of Client's/ Architects choice or extruded aluminium as per bill of quantities.

9.0 SUPPLY AND RETURN AIR DIFFUSERS:

The Supply & return air diffusers shall be of powered coated (approved shade), center core removable type. Supply diffuser to have extruded aluminium blade Box type under dampers.

i. Round or Rectangular Diffusers:

Supply/return air linear diffuser shall be M.S. or Extruded aluminium construction, square, rectangular, or round diffusers with flush fixed pattern or adjustable flow pattern. Diffusers for different spaces shall be selected in consultation with the Architect/Consultants. Supply air diffusers may be equipped with fixed air-distribution grids, removable key-operated volume control dampers, and ant smudge rings as per requirements of schedule of quantities.

ii. Linear Supply air/ Return Air Grilles:

This shall be extruded aluminium construction with fixed horizontal bars at 15 deg inclination and flange on both side. The thickness of fixed bar louvers shall be at least 5.5mm & angle shall be 20mm/30mm inside. The grilles shall be suitable for concealed fixing volume control damper of extruded. Aluminium construction with black anodized finished shall be provided in SA duct collars.

LINEAR DIFFUSER / SLOT DIFFUSERS:

Liner diffuser shall be extruded aluminium construction multisport type with air pattern controlled provided in each slot. Supply air diffusion shall be provided with volume damper or hit & miss dampers in each slot of the supply air diffuser. Plenum shall be provided for each supply air diffuser.

The Material of Grilles shall be as follows:

- i. All grilles shall be selected in consultation with the Client/ Consultant. Different spaces shall require horizontal or vertical face bars, and different width of margin frames.
- ii. All grilles shall have a soft, continuous rubber gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers shall not be less than 75 percent.
- iii. Grilles shall be adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to 100 deg horizontal arc and upto 30 deg C deflection up or down. Bars shall hold deflection settings under all conditions of velocity and pressure. Extruded aluminium grilles shall have fixed bars.
- iv. Bars longer than 45cm shall be reinforced by set-back vertical members of approved thickness.

The material thickness of grills, diffuser, damper shall be as follows:

	Diffuser	MS	Aluminium
a)	Frame	20 gauge	18 gauge
b)	Louvers	20 gauge	18 gauge

Grills :

a)	Frame	20 gauge	18 gauge
b)	Louvers	26 gauge	24 gauge

V.C. Damper :

a)	Frame	20 gauge	18 gauge
b)	Louver	26 gauge	24 gauge

iv. **Fresh air intake and extract louvers:**

All the louvers shall be rain protection type and shall be fabricated from extruded aluminium section. The louvers shall additionally be provided with heavy duty expanded metal (aluminium –alloy) bird screed.

v. **Testing & Balancing:**

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks. Before painting the interiors of conditioned spaces air distribution system shall be allowed to run continuously for 48 hours for driving away any dust or foreign material lodged within ducts during installation.

Mode of Diffuser & Grill Measurement

For Diffuser: - The neck area shall be considered for purpose of measurement.
Area Less than 1 Sq.mtr. shall be paid as unit rate of 1 Sq.mtr.

For Diffuser: - Flange face area shall be considered for pane of measurement.

F) THERMAL/ACOUSTIC INSULATION:

GENERAL:

Scope of this specification comprises of supplying, installing, testing and commissioning of insulation on duct, pumps, chilled water piping, expansion tank, AHU room and duct lining.

This specification covers the technical requirements and essential particulars for the supply, application and finishing of the composite thermal insulation for cold equipment, piping systems, air-conditioning ducts, etc. The scope of supply of the contractor shall include, but not be limited to, the following items:

- ✓ Insulation material as specified
- ✓ Finishing and cladding/covering, 5 mil fiber glass cloth with one coat of enamel paint.
- ✓ Angles, clamps, on PUF gutties chilled water pipes shall be supported.
- ✓ Any material as may be required for making the installation of insulation material complete and safe from mechanical damages.

The following are some of the codes and standards relevant to this specification:

EN 14304/ DIN EN 8497	For Flexible Elastomeric Foam Insulation material.
IS 14164	Industrial Application and finishing of Thermal Insulation Materials at Temperatures above (-) 80° C and up to (+) 700° C
BS 5970	Thermal Insulation of Pipework and Equipment (in the Temperature Range (-) 100° C to (+) 870° C

MATERIAL

- ✓ Insulation material shall be Closed Cell Microcellular Elastomeric Nitrile Rubber.
- ✓ The Density of Material shall be between 40 to 60 Kg/m³.
- ✓ Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.036 W/m²K at an average temperature of 0°C.
- ✓ The insulation shall have fire performance such that it passes minimum fire rating Class "O" as per BS 476 Part 7 for surface spread of flame and also pass Fire Propagation requirement as per BS476 Part 6 to meet the Class 'O' Fire classification as per 1991 Building Regulations (England & Wales) and the Building Standards (Scotland) Regulations 1990.
- ✓ Water vapour permeability shall not exceed 0.024 Perm inch (2.48 x 10⁻¹⁴ Kg/m.s.Pa) i.e. Moisture Diffusion Resistance Factor or 'μ' value should be minimum 10,000.
- ✓ Material should have FM Global (Factory Mutual) USA approval for fire behavior.
- ✓ Insulation material shall have Ultra-Fresh® anti-microbial protection, which is EPA (Environmental Protection Agency), USA approved(or equivalent), as an integral part of insulation that cannot be washed off or worn off as per ASTM G-21 **(whenever asked)**
- ✓ It shall give enhanced level of protection against harmful Microbes such as bacteria, mold, mildew and fungi
- ✓ Insulation products shall be free from CFC/HCFC, Formaldehyde, Dust & Fibres.

Thickness of the insulation shall be as specified for the individual application.

1.0 DUCT INSULATION (INDOOR)

External thermal insulation shall be provided as follow:

The thickness of Nitrile rubber shall be as shown on drawing or identified in the schedule of quantity.
Following procedure shall be adhered to:

- ✓ Duct surfaces shall be cleaned to remove all grease, oil, dirt, etc. prior to carrying out insulation work.
- ✓ Measurement of surface dimensions shall be taken properly to cut closed cell elastomeric rubbers sheets to size with sufficient allowance in dimension.
- ✓ Material shall be fitted under compression and no stretching of material shall be permitted.
- ✓ A thin film of Synthetic Rubber based adhesive shall be applied on the metal surface and then on the back of the insulating material sheet.
- ✓ When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. Also care should be taken to prevent the trapping of air bubbles between metal sheets and insulating material sheet.
- ✓ All duct flanges should be covered properly with a 150mm wide strip of insulation sheet after gaining uniform height by applying multiples layer of 75mm wide strip of insulation sheet from the both side of flanges.
- ✓ All longitudinal and transverse joints shall be sealed with adhesive tapes of 50mm (wide) x 3mm (thick). (as recommended by Manufacturer).
- ✓ The adhesive shall be strictly as recommended by the manufacturer.
- ✓ The detailed Application specifications are as per the manufacturer's application manual.
- ✓ Adhesive should be as recommended by Manufacturer.

2.0 INSTALLATION OF DUCTS EXPOSED DIRECTLY TO SUNLIGHT:

For installations exposed to sunlight specified thickness of insulation sheet with a factory applied black glass fabric covering of 200gsm $\pm 5\%$ should be installed with application procedure same as Indoor installation and apply two coats of epoxy paint/ Starbond or equivalent after giving 36 hours curing time for the adhesive apply manufacturer's recommended UV/Mechanical Protection. No locally available separate glass fabric shall be allowed for UV protection treatment. Please refer the separate detailed guidelines on UV/Mechanical Protection.

3.0 PIPING INSULATION

All chilled water, refrigerant and condensate drain pipe shall be insulated in the manner specified herein. An air gap of 50 mm shall be present between adjacent insulation surfaces carrying chilled water or refrigerant and also between the insulated surface and the wall to allow natural ventilation without affecting its external surface coefficient of heat transfer. Before applying insulation, all pipes shall be brushed and cleaned. All Pipe surfaces shall be free from dirt, dust, mortar, grease, oil, etc. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Insulating material in tube form shall be sleeved on the pipes.

- On existing piping, slit opened tube of the insulating material (slit with a very sharp manufacturer's recommended knife for straight line longitudinal cuts) shall be placed over the pipe and adhesive shall be applied as suggested by the manufacturer.
- Adhesive must be allowed to tack dry and then press surface firmly together starting from butt ends and working towards centre.
- Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed with of 50mm (wide) x 3mm thick adhesive tape The insulation shall be continuous over the entire run of piping, fittings and valves. Multiple layer of Insulation sheet wherever applicable should be applied to stagger all longitudinal & transversal joints.
- All valves, fittings, joints, strainers, etc. in chilled water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

The detailed application specifications are as mentioned separately.

4.0 PUMP INSULATION

Chilled water pump shall be insulated to the same thickness as the pipe to which they are connected and application shall be same as above. Care shall be taken to apply insulation in a manner as to allow the dismantling of pumps without damaging the insulation.

5.0 SHELL INSULATION

The chiller shells shall be factory insulated in accordance with the manufacturer's standards.

6.0 COLD WATER AND EXPANSION TANK INSULATION

Cold water tank, and chilled water expansion tank shall be insulated as per manufacturer's standard.

7.0 ACOUSTIC INSULATION

MATERIAL:

ACOUSTIC LINING OF AHU ROOM AND LINING OF DUCTS:

For acoustic lining of AHU room/plant room the material shall be resin bonded glass wool of density 32 Kg/m³. All duct up to a distance of 3m from AHU outlet or as shown in the drawing shall be acoustically lined from inside.

7.1 Application:

7.1.1 AHU/DG Plant Room room acoustic insulation:

Clean the inner surface of duct which is to be lined with wire brush to remove the dirt.

Fix insulation material of specified thickness covered over-lapped with R P Tissue paper over it and then covering the material with 28 gauge perforated aluminium sheet fixed with the help of self tapping screws and shall be neatly finished to give true surface finish. The overlap at the corner shall not be less than 10mm.

7.1.2 LINING OF DUCTS:

First 3 meter length of supply air duct shall be & Plenum acoustically insulated with 12.5 mm thick fiberglass of density 48 Kg./Cu.M. and covered with 28 G perforated Aluminium sheets from the inside of the duct.

- a) Apply a thin layer of tar paints.
- b) Fix-up fiberglass slabs
- c) Cover-up with perforated Aluminium sheets with the help of G. I. Screw Washers.

8.0 CHILLED WATER & COPPER PIPES INSULATIONS:

Closed Air Cell Flame proof nitrile rubber as per above specification.

Application:

All chilled water and refrigerant pipe shall be insulated after pressure testes as follows:-

- Brush and clean all piping and fittings to remove all dust, dirt, mortar and oil and then provide 2 coats of zinc chromate primer of ASIAN Paints or approved equal.
- Apply 2 coats of adhesive compound.
- Apply insulation sheets / insulation tubes over the pipe before the adhesive dries up and seal all longitudinal and transverse joints with adhesive compound approved by

manufacturer of insulation wrap 5 mill 500g polythene sheet over the surface with 50 mm overlap in longitudinal and transverse joints. All joints shall be sealed by 75 mm wide PVC adhesive tape.

- Fix 5 TO 7 Mill fiber Glass cloth with suitable approved adhesive overlapping all joints & fitting.
- Finish paint in desired shade.
- Insulation pipes shall be marked with arrows to indicate the direction of flow.

Piping Exposed to Atmosphere:

- The pipes after pressure test shall be cleaned, derusted, phosphate and then coated with epoxy primer or black Japan.
- Apply insulation same as Clause 3.1 (Adhesive where used shall be as approved by insulation manufacturer.)
- Apply UV protection paint (Paint as approved by insulation manufacturer)
- 3 mm thick coat of water proofing compound shalikota shall be applied and wrapped with fibre glass R P Tissue and final coat of 3 mm thick shalikota over the fiberglass R P tissue and allowed to dry.

NOTE: - The insulation shall be cut & applied by installer who is trained and proficient in applying insulation.

UNDERDECK INSULATION-

The exposed roof shall be insulated with 50 mm thick 'TF' quality expanded polystyrene with 85/20 grade hot bitumen and GI screw washer & GI diagonal wires.

Mode of Measurement

Shall be similar to as explain in duct measurement but considering Thickness of insulation. However for piping the measurement shall be including bends, tee, fittings etc. but excluding valves which shall be paid as unit rate item of BOQ.

G) IS CODES

Following IS CODES will be applicable for the project.

- | | | | |
|------|------------------------------------|---|---|
| 1) | IS : 659 - 1964 | : | Safety Code for Air-conditioning. |
| 2) | IS : 660 - 1963 | : | Safety Code for Mechanical Ref. |
| 3) | IS : 325 - 1970 | : | Specifications for 3 Ph. Induction Motor. Also confirm to IS : 1231 for Foot Mounted & IS : 2223 for flange mounted motors. |
| 4) | IS : 2147 - 1962 | : | Degree of protection provided by enclosures for low voltage switch and control gears. |
| 5) | IS : 3012 - 1965 | : | Code of Practice for installation (PART-I) & maintenance of switchgear. |
| 6) | IS : 3016 - 1982 | : | Code of Practice for Fire precautions in welding and cutting operations. |
| 7) | IS : 3615 - 1967 | : | Glossary of terms used in Refrigeration and Air-conditioning. |
| 8) | IS STD.FOR INSULATION WORK- | | |
| 8.1) | IS : 4671 - 1984 | : | Expanded Polystyrene For Thermal insulation purposes |
| 8.2) | IS : 7240 - 1981 | : | Code of Practice for Application and finishing of Thermal Insulation. |
| 9) | IS : 1239 | : | Pipes up to 150 MM Dia. |
| 10) | IS : 3589 | : | Pipes above 200 MM Dia. |
| 11) | IS : 780/ISI | : | Values of PN 1.6 rating Certificate |
| 12) | IS :5312/ISI | : | Check Valves Certificate |
| 13) | IS : 900 | : | Installation of motor |
| 14) | IS :4064 & 4047 | : | Switch fuse unit |
| 15) | IS : 2516 | : | ACB |
| 16) | Relevant ISS | : | MCCB |
| 17) | IS : 3069 | : | Glossary of Items symbols & units relating to thermal materials. |
| 18) | IS : 702 | : | Industrial bitumen. |
| 19) | IS : 655 – 1963 | : | Ducting work. |
| 20) | IS : 277 | : | For Sheet galvanising spec. |
| 21) | IS : 3043 -1963 | : | Earthing. |
| 22) | IS : 3043 | : | Earth Station. |
| 23) | IS : 732 - 1963 | : | Testing of Electrical Installation. |
| 25) | IS : 2825 | : | Unfired pressure vessels. |

H) TECHNICAL DATA:

(TO BE FURNISHED BY CONTRACTOR)

1) AIR HANDLING UNIT:

Manufacturer	:
Model no.	:
Material/Gauge	:
Inner sheet of casing	:
Outer sheet of casing	:
Fan - make	:
Details of Insulation (Material/Thickness)	:
Type of Bearing	:
Dia of Fans (mm.)	:
No. of Fans	:
AHU Size - L mm.	:
- D mm.	:
- H mm.	:
Operating Weight (Kg.)	:
Type of Vibration isolators	:

Fan Section:

Make	:
Type of Fan	:
Air Quantity M ³ /hr. (CFM)	:
Total Static Pressure	:
Fan Speed RPM (normal/critical/maximum)	:
Fan Efficiency	:
No. of Vanes	:
Outlet Velocity mtr/Min	:

Coils:

Make	:
Face Velocity (FPM)	:
Material of tubes/fins	:

Face Area (Sq.ft) :

Dia of tubes (inch) :

Rows deep :

Fins/Inch :

Filters:

Make :

Filter medium :

Material of Frame Work :

Filter face area Sq.ft :

Motors:

Manufacturer :

Motor HP :

Type :

Class of Insulation :

Electrical Characteristics :

Starting Current (Amps) :

Full Load Current (Amps) :

Motor Speed RPM :

Method of Starting :

Starter manufacturer :

2) VENTILATION FANS:

Make	:	
Type of Fan	:	
Type of Drive	:	
Air Quantity M ³ /hr. (CFM)	:	
Total Static Pressure	:	
Fan Speed RPM (normal/critical/maximum)	:	
Fan Efficiency	:	
No. of Vanes	:	
Outlet Velocity mtr/Min	:	
Noise Level DB	:	
Motors:		
Manufacturer	:	
Motor HP	:	
Type	:	
Class of Insulation	:	
Electrical Characteristics	:	
Starting Current (Amps)	:	
Full Load Current (Amps)	:	
Motor Speed RPM	:	
Method of Starting	:	
Starter manufacturer	:	:

3) MS PIPE :

a.	Make	:
b.	Class	:
c.	Wall thickness of pipes	:

4) VALVES :	Manufacture	I.S.I Marked	Pressure Drop
a.	Butterfly Valve	:	
b.	Balancing valve	:	
c.	Non return valve make	:	
d.	Ball valves	:	
e.	Pot strainer	:	
f.	Y strainer	:	
f.	Suction Guides cum Strainers	:	
g.	3/2 Way Mixing Valve	:	

5) GRILLES/DIFFUSERS/DAMPERS:

Make, Materials and Gauge

- | | | |
|------|--------------|---|
| i) | Fire dampers | : |
| ii) | Grilles | : |
| iii) | Louvers | : |
| iv) | Diffusers | : |
| v) | Duct Dampers | : |

6) INSULATIONS:

- | | | |
|----|--------------------------------|---|
| a. | Manufacturer | : |
| b. | Duct Acoustic Lining materials | : |
| c. | Duct insulation material | : |
| d. | Pipe insulation material | : |
| e. | Thermal conductivity | : |
| | Duct insulation | : |
| | Pipe insulation | : |
| f. | Density - Pipe insulation. | : |
| | Density - Duct Insulation. | : |

7) CONTROL

- | | | |
|----|------------------------------|---|
| a) | Return Air Thermostat | : |
| b) | Room Thermostats | : |
| b) | 2 way/3 way valves actuators | : |

I) SPECIFICATIONS FOR PAINTING WORK

- 1) Cleaning the surface
- 2) Apply a primer coat of Red oxide
- 3) Applying two coats of enamel paint of APPROVED colour code after applying cement primer for plastered surface.
- 4) Standard colour code.

a)	Pump sets	:	Battleship Grey
b)	Motor	:	Siemens Grey
c)	Ductable Units	:	As Directed
d)	Pot Strainers (Base)	:	Grey
e)	Liquid Line	:	Orange
f)	Suction Line	:	Green / Blue
g)	B. M. Valve / Copper Line	:	Golden paint
h)	Gauge Panel	:	Siemens Grey
i)	Chilled Water Line		
i.	Inlet Line (Hot)	:	Dark Blue
ii.	Outlet Line (Cold)	:	Light Blue
j)	All supports / Stands	:	Black
k)	Condenser Water Piping	:	
i.	Hot	:	Dark Green
ii.	Cold	:	Light Green
l)	Ducting		
i.	Concealed	:	Black Rust Proof
ii.	Exposed to Grilles		
iii.	Insulated / un-insulated duct	:	Black
iv.	Exposed	:	Fiesta Blue

All painting works shall form part of the cost of equipment, piping etc. No separate payment shall be applicable.

J) TESTING OF AIRCONDITIONING SYSTEM-

- 1.1. Routine and types tests for various items of equipment shall be performed at the contractor's work and the test certificated furnished. Functional test shall be conducted at site.
- 1.2. The performance test to determine whether OR not the full indent of the specification is met shall be conducted by the contractor. After notification to the Employers that the installation has been completed and the system has run continuously for a period of at-least two weeks, the contractor shall conduct under the direction of the Consultants & in the presence of Employer's representatives perform such test as specified to establish the capacity of various equipment supplied and installed by the contractor.
- 1.3. The contractor shall operate test and adjust the air conditioning system units, fans, motors, all air-conditioning appliances including adjustments of regulators dampers etc.
- 1.4. All test equipment, labour, operating personnel required for this test shall be furnished by the contractor to enable the system to be put in continuous running test for a period of 3 days after all other tests and adjustments have been made.

The contractor shall make arrangement of electrical power and water for testing. The performance test shall be conducted during peak summer and peak monsoon.

2.0 PROCEDURE

2.1. Design Conditions

The inlet and outlet conditions of the Units will be recorded for 7 days duration on hourly basis. The outside and inside Dry Bulb and Wet Bulb temperatures shall be recorded by the means of a sling psychrometer with mercury thermometers. The relative humidity shall be computed from the psychrometric chart. The inside Dry Bulb temp. and relative humidity shall fall within the specified limits.

2.2. Capacity of the System

The following aspects shall be checked before conducting the performance tests-

- i. The outside conditions shall be as close to the design values as possible. The tests shall be arranged during the peak summer and monsoon.
- ii. The internal loads of various spaces shall be close to the design values as far as possible.
- iii. The system shall be fully loaded and the temperatures stabilised.
- iv. Hourly readings of air-flow shall be recorded by a calibrated flow meter.
- v. Hourly readings of pressure, temperature, electrical current, voltage, KW, KWH and power factor shall be properly recorded.

The capacity of the plant and various other equipments and accessories shall be ascertained as follows-

2.3 Cooling coil of AHUs and Indoor units

The flow of air over the cooling coil will be measured by recording the velocity of air across each filter placed before the cooling coil. The velocity shall be measured by means of an anemometer

Air quantity across the filters = velocity of air across the filters in FPM x net filter area (in sq. ft.).

The wet bulb temperature of air entering the coil and that leaving the coil shall be measured. The enthalpy of entering and leaving air shall be noted from the psychrometric chart, corresponding to the wet bulb temp. recorded.

SAY,

he - Enthalpy of Entering Air in Btu /lb

H1 - Enthalpy of Leaving Air in Btu / lb.

Ve - Specific Volume of Entering Air (CFT. / lb. of air) V1 -

Specific volume of Leaving Air (CFT. / lb. of air) Average

specific volume = $(ve + v1) / 2 = v$ (CFT/ lb of air) cap. Of

cooling coil = $(CFM \times 60) / v \times (He - H1) / 1200$

$(CFM \times \{He - H1\} \times 4.5 / 12000)$

2.4 System capacity

The capacity of the AHU / Indoor unit will be the capacity of system.

2.5 Air Balancing

After the desired inside conditions are achieved, the quantity of air thru' every outlet shall be measured. Air quantity in CFM = Air velocity at the outlet in FPM x effective area of

the outlet in Ft².

The pressure levels of each area will be measured and recorded with respective adjoining areas. On load actual CFM of each cell will be recorded.

2.6 SUPPLY AIR GRILLES

1]	Area of Grill	–	M ² (FT ²)
2]	Velocity	–	M/Hr. (FPM)
3]	Air Flow Rate	–	M3 (FPM)
4]	Temperature DB	–	°C (°F)
5]	Temperature WB	–	°C (°F)

2.7 FRESH AIR /EXHAUST AIR LOUVERS

1]	Total Area	–	M ² (FT ²)
2]	Effective Area	–	M ² (FT ²)
3]	Velocity of Air	–	M/Hr. (FPM)
4]	Quantity of Air	–	M3/Hr. (CFM)

Approved Make List for HVAC				
S.no.	Item	Make		
1.0	Machines/Equipment :	1	2	3
1.1	Chilled Water Handling Unit with Coil	Edgetech Air Systems Pvt. Ltd.	Zeco Aircon Ltd.	Citizen Industries Limited
1.2	Centrifugal Fans for AHUs	Kruger Ventilation Industries India Private Limited	Nicotra India Private Limited	
1.3	Chilled Water based Four Way /Compact Cassette units & One Way Cassette unit	GD Midea heating & ventilation Equipment co., LTD. (from Bhutoria Refrigeration Pvt. Ltd.)	Blue Star Limited	Bhutoria Refrigeration Pvt. Ltd
1.4	Chilled Water based Hi-wall units	GD Midea heating & ventilation Equipment co., LTD. (from Bhutoria Refrigeration Pvt. Ltd.)	Blue Star Limited	Bhutoria Refrigeration Pvt. Ltd
1.5	Air Cooled Hi-wall (Split) units(1:1) DX system)	Toshiba From Carrier & Airconditioning Refrigeration Ltd	Blue Star Limited	Hitachi India Pvt. Ltd.
2.0	Ventilations Fan :			
2.1	Ceiling Mount Toilet / Pantry Exhaust Fan	Kruger Ventilation Industries India Private Limited	Airovient Fans & Systems Pvt Ltd	
3.0	Pipes:			
3.1	MS upto 150 mm dia	TATA Pipes by Tata Steel of Tata Group	Jindal Pipes Limited	
3.2	MS 200 dia to 350 dia	TATA Pipes by Tata Steel of Tata Group	Jindal Pipes Limited	Mukut Pipes Limited
3.3	Copper Pipes (Hard/Soft)	Mandev Tubes Private Limited	Totaline by Carrier Airconditioning & Refrigeration Ltd	Rajco Metal Industries Pvt.Ltd
4.0	Sheets:			
4.1	G.I. Sheets, Rolls	TATA Steel Ltd.	Jindal Steel Ltd.	National Steel
4.2	Factory Fabricated Duct Work	Zeco Aircon Ltd	Rolastar Pvt Ltd by Ruskin titus India plc	Alfa Duct Private Limited (ETA Engineering Pvt.Ltd)
4.3	Grilles, Diffuser, Collar,Duct Damper, Louvers , Gravity Louvers, Jet Nozzles	Caryaire Equipment India Pvt.Ltd	Cosmos Air Distribution Products (SPECTRUM INDUSTRIES)	Systemair India Pvt. Ltd.

4.4	Fire Damper	Caryaire Equipment India Pvt.Ltd	Cosmos Air Distribution Products (SPECTRUM INDUSTRIES)	Systemair India Pvt. Ltd.
5.0	Valves			
5.1	Butterfly Valve	Advance Valves	KITZ Corporation (India Liaison Office)/Micro Pneumatics Pvt. Ltd.	Audco by L& T Valves
5.2	Balancing Valve Manual	Advance Valves	Danfoss Industries Pvt Ltd	Audco by L& T Valves
5.3	Ball Valve & Ball Valve with Strainer (SS Ball)	Emerald Airtech (india)	Rapid Controls Private Limited	
5.4	Y-Strainer	Emerald Airtech (india)	Sant Industrial Control Pvt. Ltd.	Armstrong international - India
6.0	Electronic Control Valve			
6.1	Two Way Flow Valve WITH Rotary Actuators (Motorised Control Valve) OR 2Way Dynamic Balancing Cum Flow Control Valves with digital thermostat	Belimo Actuators India Pvt. Ltd.	Danfoss Industries Pvt Ltd	Johnson Controls (I) PVT LTD /
、	Motorised Valves For FCU	Belimo Actuators India Pvt. Ltd.		、
6.3	Motorised Butterfly Valve	Advance Valves	Belimo Actuators India Pvt. Ltd.	Honeywell
7.0	Thermostat For FCU	Belimo Actuators India Pvt. Ltd.	Honeywell	Danfoss Industries Pvt Ltd
8.0	Mercury Thermometer, Pressure Gauge with Isolating Valve	H Guru Industries	Fiebig by Mano meter (India)Pvt Ltd.	
9.0	Auto air Vent	Anergy Instruments Pvt. Ltd.	Danfoss Industries Pvt Ltd	Honey Well
10.0	Vibration Isolators	Resistoflex (P) Ltd.	Kanwal Industrial Corporation	
11.0	Flexible Connections	Kanwal Industrial Corporation	Resistoflex (P) Ltd.	
z	Insulation :			
12.1	Glass wool	U.P.Twiga Fiberglass Limited	Owens-Corning (India) Private Limited	Kimmco (Kuwait Insulating Material Manufacturing Co.)

12.2	Closed Cell Nitrile Rubber	Armacell India Private Ltd	K-Flex india Pvt Ltd	Thermaflex in India
12.3	Expanded Polystyrene (TF Quality)	Beardsell Limited	Styrene Packings Pvt. Ltd.	
13.0	Electric Motors (EFF-1 / IE-2)	ABB (India) Limited	Crompton Graves Limited	Siemens Limited
14.0	Rigid PVC Drain Pipe	Astral Poly Technik Limited,	Finolex Industries Limited	Supreme Industries Limited
15.0	Anchor Fastener	Hilti India Pvt. Ltd.	Fischer by BOSCH India Ltd.	
16.0	Anti-vibration mounting	Resistoflex (P) Ltd.	Kanwal Industrial Corporation	
17.0	Paint Primer	Asian Paints Limited	Berger Paints India Limited.	Kansai Nerolac Paints
NOTE :				

All The materials to be ISI marked.

The materials shall be only of the approved makes as specified in this .

The Contractor shall submit samples of all the makes as specified in this list and the Consultant / Owner shall have the power to select any of them.

Consultant/ Owner decision in this regard shall be binding on the Contractor.

In case any material is not available for any one or all of these approved makes the Consultant/ Owner shall select and approve alterve make(s).